Project co-financed by the European Regional Development Fund

UNDER THE AUSPICES OF H.E. THE PRESIDENT OF THE HELLENIC REPUBLIC
MR. PROKOPIOS PAVLOPOULOS

International Conference in Management of Accessible Underwater Cultural and Natural Heritage SItes:

“DIVE IN BLUE GROWTH”

16-18 October 2019
Athens, Acropolis Museum, Auditorium

CONFERENCE PROCEEDINGS

Introduction

The International Conference in Management of Accessible Underwater Cultural and Natural Heritage Sites, *"Dive in Blue Growth"*, was organized by the University of Patras in collaboration with Region of Thessaly, Ephorate of Underwater Antiquities, ATLANTIS Consulting and the active participation of BLUEMED partners, under the auspices of H.E. the President of the Hellenic Republic Mr. Prokopios Pavlopoulos, in Acropolis Museum, in Athens, from 16 to 18 October 2019.

Coastal areas and islands of the Mediterranean are tourism-based economies with key underwater assets that are vulnerable to extreme climatic conditions. They face common challenges: a) lack of coordinated policies, methods and tools to support sustainable economic development, b) ineffective protection of underwater heritage and inability to use it for sustainable tourism development, c) insufficient measures to tackle impacts of extreme climatic conditions.

BLUEMED aims to protect and preserve in a unified manner the underwater natural and cultural heritage of the Mediterranean, to help coastal and island economies prosper through a sustainable blue model for tourism development, and to protect our marine ecosystem. BLUEMED is part of Interreg MED 2014-20 Programme, co-financed by the European Regional Development Fund.

The overall success of the Conference is based on the warm welcome that conference subjects received and the high level of participation, as more than 300 people from 11 countries, from Europe, Asia and the America participated in the conference.

The three productive days of the Conference, in which 55 speakers from all over the world participated, was a great opportunity for underwater archaeologists, public organizations, local governments, universities, marine researchers, NGOs, tourist organizations, diving park/dry dive managers, and underwater industry players to exchange views on problems and solutions for underwater natural and cultural heritage.

Roberto Petriaggi, Istituto Superiore per la Conservazione ed il Restauro (ISCR) consultant for Restoring Underwater Project, Dimitris A. Pados, Charles E. Schmidt Eminent Chair Professor of Engineering and Computer Science in the Florida Atlantic University and Christos Economou, Head of the Unit Sea basin strategies in DG MARE, specialist Maritime Regional Cooperation and Maritime Security participated as Keynote Speakers in the International Conference.

During the conference different perspectives were discussed in the 3 very interesting conference topics:

- Management and protection of accessible Underwater Cultural Heritage sites and diving parks

- Initiatives for sustainable Blue tourism through accessible UCH sites and diving parks
- Technologies for offering dry dive experiences to non-drivers.

Conference participants had the opportunity to live a dry dive experience in BLUEMED pilot sites with the Virtual Reality glasses and equipment that University of Calabria provided.

In the following, you can find the submitted full papers that were presented during the Conference.

For more information about *"Dive in Blue Growth"* Conference visit the official website of BLUEMED (bluemed.interreg-med.eu).

Acknowledgement

We express our sincere gratitude to all who have actively contributed towards the success of this International Conference and particularly the authors for their contributions. We are indebted to all who assisted in the organizing effort.

Conference Chair

Dr. Kalamara Pari
Director of the Ephorate of Underwater Antiquities
Hellenic Ministry of Culture and Sports

Dr. Davidde Barbara
Director of the Underwater Archaeology Operation Unit (NIAS - Nucleo per gli Interventi di Archaeologia Subacquea) at the Istituto Superiore per la Conservazione ed il Restauro -Superior Institute for Conservation and Restoration (ISCR)
Italian Ministry of Cultural Heritage and Activities (MiBAC

Committees

Scientific Program Committee

Dr. Pari Kalamara

Dr. Barbara Davidde

Dr. Yorgos Stephanedes

† Sebastiano Tusa

Dr. Fabio Bruno

Dr. Irena Radic Rossi

Organizing Committee

Aggela Veneti

Angelos Manglis

Dimitra Chondrogianni

Irini Kafousia

Anastasia Mitsopoulou

Michela Ricca

Valentina Puglisi

Salvatore Medaglia

Public Relations Committee

Stjepan Rezo

Consuelo Garcia

Yianna Samuel – Rhoads

Nikola Miskovic

Welcoming Committee

Panagiota Saranti

Anastasia Mitsopoulou

Michela Ricca

Zoi Pataki

In memory of Sebastiano Tusa who tragically passed away in the Ethiopian Airlines plane crash (Sunday March 10th, 2019).

Interreg Mediterranean BLUEMED

Project co-financed by the European Regional Development Fund

2018 EUROPEAN YEAR OF CULTURAL HERITAGE #EuropeForCulture

ΠΑΝΕΠΙΣΤΗΜΙΟ ΠΑΤΡΩΝ UNIVERSITY OF PATRAS

UNDER THE AUSPICES OF H.E. THE PRESIDENT OF THE HELLENIC REPUBLIC MR. PROKOPIOS PAVLOPOULOS

INTERNATIONAL CONFERENCE IN MANAGEMENT OF ACCESSIBLE UNDERWATER CULTURAL AND NATURAL HERITAGE SITES:

"DIVE IN BLUE GROWTH"

ATHENS, GREECE
16-18 October 2019
ACROPOLIS MUSEUM, AUDITORIUM

CONFERENCE AGENDA

DAY 1- 16 October 2019

09.00 -09.30 REGISTRATION OF PARTICIPANTS

09:30 -10.00 OPENING AND WELCOME REMARKS
Yorgos J. Stephanedes, *Professor, Civil Engineering, BLUEMED Scientific Coordinator at University of Patras*
Kostas Agorastos, *Regional Governor of Thessaly*

Lina G. Mendoni, *Minister of Culture and Sports*

Prof. John Chrysoulakis, *Secretary General for Greeks Abroad, Ministry of Foreign Affairs*

Angela Gerekou, *President of Board of the Greek National Tourism Organization (GNTO)*

Luigi Ficacci, *Director of the Istituto Superiore per la Conservazione ed il Restauro, Ministry of Cultural Heritage and Activities (MiBAC)*

10.00 -10.30 KEYNOTE SPEECH

The "Restoring Underwater Project": how everything started
Dr. Roberto Petriaggi, Underwater Archaeologist, Consultant of the Istituto Superiore per la Conservazione ed il Restauro for the Restoring Underwater Project

10.30 -12.00 **Management and protection of accessible Underwater Cultural Heritage (UCH) sites and UCH diving parks**
Session Chair: Yorgos J. Stephanedes

Reflections on the prospects and the institutional framework of the organization of the Accessible Underwater Archaeological Site: starting with BLUEMED
Pari Kalamara

Touristic potential of the Supetar, Cavtat, underwater archaeological zone
Irena Radić Rossi, Katarina Batur

Sustainable management and protection of accessible Underwater Cultural Heritage sites; global practices and bottom-up initiatives
Angelos Manglis, Anastasia Fourkiotou, Dimitra Papadopoulou

Protecting marine biodiversity at accessible Underwater Cultural Heritage (UCH) sites and UCH diving parks
Yianna Samuel, Yiannos Mylonas, Stavros Stylianou, Gregory Konnaris, Pavlos Diplaros, Georgios Fyttis

12.00 -12.30 ***Coffee break***

12.30 -14.00 **Technologies for offering dry dive experiences to non-divers**
Session Chair: Fabio Bruno

Diving into a sea of history. Communicating the Underwater Experience in a Museum: An Analysis of ARQVA's Interactive Media
Antonio Cosseddu

Raising the awareness about underwater archaeological heritage through Edutainment and Virtual/Augmented Reality
Fabio Bruno, Marco Cozza , Maurizio Mangeruga , Dimitrios Skarlatos , Panagiotis Agrafiotis , Barbara Davidde Petriaggi , Roberto Petriaggi , Selma Rizvic , Fotis Liarokapis

Results of the "SOMMERGIAMOCI" project in the MPA Gaiola underwater park
Maurizio Simeone, Paola Masucci, Caterina De Vivo

An innovative platform for virtual underwater experiences targeting the cultural and tourism industries
Paraskevi Nomikou, Konstantinos Karantzalos, Andreas El Saer, George Pehlivanides, Panagiotis Tsoris, Christos Stentoumis, Anna Dura, Giotis Ioannidis, Michalis Sarantinos, Varvara Antoniou, Othonas Vlassopoulos, George Katopodis, Katerina Plessa, Ilias Kalisperakis, Konstantina Bejelou, Konstantinos Monastiridis

Deep-Sea archaeology in the Exclusive Economic Zone (EEZ) of Cyprus
Achilleas Iasonos

14.00 -15.00 ***Light lunch and networking***

15.00 -15.30 KEYNOTE SPEECH

Financing Opportunities for Blue Growth
Christos Economou, Unit Sea basin strategies, DG MARE, Maritime Regional Cooperation and Maritime Security

15.30 -17.00 **Initiatives for sustainable Blue tourism through accessible UCH sites and diving parks**
Session Chair: Barbara Davidde Petriaggi

Technological protection of an underwater archeological site; a newly discovered Roman shipwreck from the 1st century BC, on the island of Pag
Vedran Dorušić, Matko Čvrljak

Theraic Sea: A bottom-up initiative for marine conservation and sustainable living
Maria Salomidi, Sylvaine Giakoumi, Vangelis Paravas, Pierre-Yves Cousteau

Towards the Creation of Accessible Underwater Archaeological and Historical Sites in Fournoi and Leros (Eastern Aegean): an Interreg VA, Hellas - Cyprus 2014 -2020 program under Development
George Koutsouflakis

Project: blue HOMER
Marko Mišić, Toni Mandušić

17.00 -18.30 **Management and protection of accessible UCH sites and diving parks – Case studies**
Session Chair: Angelos Manglis

The studies on the underwater cultural heritage of Istanbul from the Anatolian side to the Princes' islands
Ahmet Bilir, Mustafa Şahin

Accessing Underwater Cultural Heritage on dry feet: some Sicilian case studies
Francesca Oliveri

Preservation, management and protection of Tangible Underwater Cultural Heritage of Anfeh (North Lebanon)
Nadine Panayot Haroun

Community cultural infrastructure: sustainability of the underwtaer cultural heritage of Bocachica, Cartagena
Liliana Patricia Rozo Pinzón

The in situ preservation as a priority option. Experiments in the upper Adriatic Sea
Massimo Capulli

18.30 -20.00 ***Networking hour***

10.00 -18.00 PARALLEL ACTIVITY

Dive in Virtual Reality!
Live a Virtual Diving experience in BLUEMED pilot sites **#VR #drydive**
Supported by 3D Research s.r.l.

DAY 2- 17 October 2019

09.00 -09.30 REGISTRATION OF PARTICIPANTS

09.30 -11.30 **Management and protection of accessible Underwater Cultural Heritage (UCH) sites and UCH diving parks**
Session Chair: Pari Kalamara

How the Greek pilot sites were selected and the creation of the Knowledge Awernsess Centers (KACs) in Greece
Angeliki G. Simosi

EGNAZIA: Enhancement and use of submerged Structures along the coast guided diving and snorkeling tours
Gianpaolo Colucci

Change behavior and raise awareness about the Adriatic's underwater treasures as common goods: the UnderwaterMuse Project
Rita Auriemma, Carlo Beltrame, Ivanka Kamenjarin, Danilo Leone, Ivan Šuta, Maria Turchiano

MUSAS: an innovative project for the enhancement of the Underwater Cultural Heritage
Barbara Davidde Petriaggi, Michele Stefanile, Marco D'Agostino, Sandra Ricci, Carlotta Sacco Perasso

Linking WWI and II Underwater Cultural Heritage to Sustainable Development in the Mediterranean: An Integrated Participatory Strategic Planning Approach
Vasilike Argyropoulos, Anastasia Stratigea

Tourism experience in the Underwater Archaeological heritage site: managing emotional state to increase archaeological diving tourism in the Sunken City of Baiae
Cristina Canoro, Francesco Izzo, Barbara Masiello

11.30 -12.00 KEYNOTE SPEECH

Autonomous underwater localization, communication, and networking
Dr. Dimitris A. Pados, Charles E. Schmidt Eminent Chair Professor of Engineering and Computer Science, Florida Atlantic University

12.00 -12.30 ***Coffee break***

12.30 -14.30	**Initiatives for sustainable Blue tourism through accessible UCH sites and diving parks** ***Session Chair: Angelos Manglis***

Diving and Underwater Cultural Heritage: a reasonable or a forced marriage? The Greek case
Dimitris Kourkoumelis, Alexandros Tourtas

Protection and development of the Lake Bolsena underwater heritage
Antonia Sciancalepore, Edigio Severi, Maria Letizia Arancio, Barbara Barbaro

Cartographic Documentation and Proposed Criteria towards the Protection and Preservation of Wrecks from the Great War in the Greek Seas
Elpida Katopodi, Kimon Papadimitriou

The National Marine Park of Alonnisos Northern Sporades: an area of rich natural and cultural heritage facing human and climatic pressures
Dimitris Poursanidis, Vasiliki Vasilopoulou

A fresh (water) case study: the time travel under water project in Lake Attersee
Cyril Dworsky

A framework for underwater cultural heritage and environmental services evaluation
Lydia Stergiopoulou

S/S Burdigala, former Schnelldampfer Kaiser Friedrich (1897-1916)
Dimitris Galon

14.30 -15.30 ***Light lunch and networking***

15.30 -18.30	**Management and protection of accessible Underwater Cultural Heritage (UCH) sites and UCH diving parks** ***Session Chair: Elpida Hadjidaki, Yianna Samuel***

Performance management in Underwater Cultural Heritage (UCH) site, UCH diving parks and Knowledge Awareness Centers (KACs)
Dimitra Chondrogianni, Yorgos J. Stephanedes, Panagiota-Georgia Saranti, Irini Kafousia

SUB: THE WRECKS in THE GREEK SEAS, 1830-1951. The Underwater Heritage of Navy's Shareholding Fund And Mariners' Retirement Fund
Panagiotis Tripontikas

Management and protection of a little known underwater archaeological site: the case of the "Roman Villa of the Dolia" in Ancient Epidaurus; past experience and future prospects
Barbara Davidde Petriaggi, Panagiota Galiatsatou, Angelos Tsompanidis

L'Anfora ASD, the sustainable tourism and use of submerged archaeological sites in Apulia
Gianpaolo Colucci, Paola Palumbo

Japanese Shipwreck and Diving Tourism in Sangihe Islands Indonesia
Sultan Kurnia Alam Bagagarsyah

The Faro Convention and the sustainable valorization of the underwater heritage. Case studies and projects in the Adriatic and Ionian Sea
Rita Auriemma

Perspectives and obstacles for accessible underwater archaeological sites. The case of Crete
Theotokis Theodoulou

Public Access to Underwater Archaeological Sites. Enjoying and Protecting our Maritime Heritage
Carles Aguilar

"Hippocampus" the Microscopic Mythical Dragon of the Sea
Vasilis Mentogiannis

10.00 -18.00 PARALLEL ACTIVITY

Dive in Virtual Reality!
Live a Virtual Diving experience in BLUEMED pilot sites **#VR #drydive**
Supported by 3D Research s.r.l.

DAY 3- 18 October 2019

09.00 -09.30 REGISTRATION OF PARTICIPANTS

09.30 -11.30 **Technologies for offering dry dive experiences to non-divers**
Session Chair: Fabio Bruno

A low cost equipment and SFM software photogrammetric survey of two shipwrecks in the sea area of Methoni, Southwestern Greece
George Michailidis

Operating contemporary recreational submersibles in Kea's Underwater Historic Park
Ioannis Tzavelakos

Reconstructing a submerged villa maritima: the case of the villa dei Pisoni in Baia
Barbara Davidde Petriaggi, Michele Stefanile, Roberto Petriaggi, Fabio Bruno, Raffaele Peluso, Marco Cozza

Opto-acoustic 3D Reconstruction for Virtual Diving on the Peristera Classical Shipwreck
Fabio Bruno, Antonio Lagudi, Matteo Collina, Salvatore Medaglia, Pari Kalamara, Dimitris Kourkoumelis, Nikola Miskovic, Dula Nad, Nadir Kapetanovic, Mato Markovic

Remotely operated group of vehicles for underwater scientific exploration and intervention
Lorenz E. Baumer, Yanis Bitsakis, Mathias Buttet, Eftstratios Charchalakis, Alessia Mistretta, Alexandros Sotiriou

Monitoring and protection of accessible underwater cultural heritage
Siarita Kouka, Paraskevi Nomikou, Konstantinos Karantzalos, Aikaterini Tagonidou

11.30 -13.30 **Initiatives for sustainable Blue tourism through accessible UCH sites and diving parks**
Session Chair: Yianna Samuel

In situ conservation of cannons in marine environment: cathodic protection, cleaning treatment and coverage with geotextiles
Flavia Puoti, Barbara DaviddePetriaggi, Marco Ciabattoni, Claudio Di Franco

Underwater Archaeological Sites as a touristic and educational resource. The Isla Grosa Project
Carlota Pérez-Reverte Mañas, Felipe Cerezo-Andreo

Western Black Sea underwater cultural tourist routes
Preslav Peev

New institutions for diving tourism: Diving Parks, Archaeological Diving Parks, Modern Shipwrecks & Implementation opportunities and problems in Greece
Thanassis Stathis, Dimitris Markatos, Kostas Koutsis

Creation of a virtual museum and a diving park east of the island of Lemnos on the site of the wreck of the Svyatoslav ship
Sergey Fazlullin, Ivan Gorlov, Yury Tkachenko, Sergey Khokhlov, Michael Bardashov, Rolan Sadekov

Integrated management plan for the preservation and promotion of cultural and natural environment at Pavlopetri (Elafonissos, Greece)
Despina Koutsoumba, Stamatis Zogaris, Ioannis Kapakos, Maria Salomidi, Stergiopoulou Lydia

13.30 -14.00 CONCLUSIONS
Moderator: Dimitra Chondrogianni

Fabio Bruno, Barbara Davidde Petriaggi, Pari Kalamara, Angelos Manglis, Yianna Samuel, Yorgos J. Stephanedes

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Reflections on the perspectives and the institutional framework of the organization of the Accessible Underwater Archaeological Site: starting with BLUEMED

Dr. Pari Kalamara[1]

[1] Director of the Ephorate of Underwater Antiquities, Archaeologist with Grade A', Greek Ministry of Culture

Abstract: BLUEMED has given to our Service the opportunity to identify gaps and needs for the proper operation of the Underwater Archaeological Sites -and I refer here to sites that can be accessible to visitors using SCUBA- and to mature its choices towards this direction. So, this urged the planning to address issues related with monitoring of the sites, the creation of a framework of principles concerning their operation, the identification of the potentialities and weaknesses of such an operational planning, which will shape future impact on a plethora of sectors (protection of cultural heritage, issues of accessibility, socio-economic area development, development of alternative forms of tourism, etc.).

At the same time, it helped to advance the strategic planning for the coastal, already accessible, underwater archaeological sites, although the latter do not fall under the scope of the program.

More specifically, the related options, the procedures developed for their implementation in practice, any changes required in the existing legal framework and the expected results will be described.

Keywords: Accessible Underwater Archaeological Sites, Institutional framework, strategic planning

In 2016 the Ephorate of Underwater Antiquities (EUA) undertook the European project with the acronym BLUEMED as one of the fourteen partners from five countries, Greece, Italy, Spain, Croatia and Cyprus, and lead partner the Region of Thessaly. The project will be completed by January 2020. BLUEMED aimed to protect and exploit the underwater natural wealth and biodiversity of the Mediterranean, and study, for the first time on a global level, the best practices for the protection and promotion of the underwater cultural heritage and particularly regarding the operation of Accessible Underwater Archaeological Sites (AUAS, or "underwater museums") at ancient shipwrecks. For the Ephorate, its participation in the project has been a unique opportunity to focus on a desired issue for many years, the opening of the underwater cultural heritage to the general public and especially to the diving community, to identify and document the challenges and needs associated with the endeavor, to face the difficulties that arise from it, to seek feasible solutions, to make synergies. Today, that we are standing towards the end of the course, I am allowed to say that the overall experience has been particularly positive, thanks to the excellent cooperation developed between the partners, beneficial also for the Ephorate in various ways. More specifically, the project provided to the Ephorate a interdisciplinary framework of continuous exchange of experiences with the other partners, giving a the boost to focus on the issue «organization and operation of the Accessible Underwater Archaeological Sites», to understand the individual issues involved, to know the practices already implemented and to design in detail the actions that should complement the opening of the sites for the public. At the same time, it gave rise to the involvement and activation of a large part of the Ephorate's human resources towards this direction, the awareness of the role of different specialties in this endeavor and the cultivation of a sense of teamwork within the service. The common objective was the preparation for the successful operation of the declared from the Hellenic Ministry of Culture and Sports in 2015 as Accessible Underwater Archaeological Sites in the area of Northern Sporades – West Pagasetic (1), as well as the organization of the Knowledge Awareness Centers related to them. The opening of the Accessible Underwater Archaeological Sites to a wide audience falls into the field of recreational diving.

Of course, according to the Law 3028/2002 "On the Protection of Antiquities and Cultural Heritage in general" (Law 3028/2002, article 15) (2) and for the better protection of underwater cultural goods, diving activity with breathing apparatus is explicitly prohibited «unless a permit has been granted by the Minister of Culture which is issued after the Council's opinion» within the declared, demarcated archaeological sites, but also within the protection zones of declared underwater monuments or sites (3). It should be noted that in 2003 (4) all shipwrecks, both ships and aircraft, which sank before the last fifty years, have been characterized as monuments within a protection zone of 300m. around them and are now protected under the provisions of Law 3028.

The Law 3409/2005 on "Recreational diving and other regulations" (Law 3409/2005, article 11, par. 1) (5) however, provided for the first time in Greece the possibility of establishing "underwater museums", at which the visit is carried out under conditions: «... declared archaeological sites can be characterized as underwater museums, where guided diving is permitted, always accompanied by diving guards of antiquities or archaeologists.». It is the same law that changes the general view of the Hellenic state in dealing with «recreational diving» (6), which altogether until then was prohibited throughout our territorial waters and has since been allowed everywhere off the limits of archaeological sites and protected ecological areas.

To make it clearer, in 2005 the possibility is given to organize diving parks within archaeological sites and at the same time to operate «underwater museums», under the conditions that were mentioned above, two provisions that create the proper conditions for the development of diving tourism in the country.

During the period 2012 - 2015, with the Joint Ministerial Decisions of the Ministers of Culture and Merchant Shipping some areas of already declared archaeological sites are characterized as Accessible Underwater Archaeological Sites, for which there is the intention on behalf of the state to open them for the diving public.

Fig.1: Shipwreck in Sapientza, Methoni. Shipwreck of columns, ©MCS-EUA, photo by Panagiotis Gkionis

Fig.2: Shipwreck in Sapientza, Methoni. Shipwreck of sarcophaghi, ©MCS-EUA, photo by Panagiotis Gkionis

Fig. 3: Amphorae from the area Lavrio – Makronissos (2015), © MCS-EUA, photo by Vassilis Mentogiannis

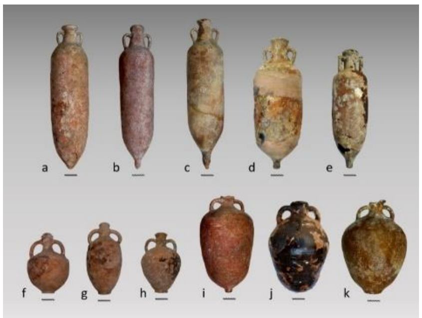

Fig. 4: Amphorae from the area Lavrio – Makronissos (2015), © MCS-EUA, photo by Petros Vezyrtzis

Fig. 5: Shipwreck of Peristera, Alonissos, ©MCS-EUA, photo by Matteo Collina, Univerità della Calabria –DIMEG

They are actually sites of ancient shipwrecks, located in three regions of the country, constituting groups per region that subsequently require a united management, at the areas of Methoni-Pylos Messinia (7), Lavrio-Kea Attica and Cyclades (8) and West Pagasetic – Northern Sporades.(9) Moreover, the total of the accessible cores of the area of West Pagasetic – Northern Sporades has recently been strengthened by the Joint Ministerial Decision of 2019 (10), with four new shipwrecks at the area of Alonissos, rendering the tourist-developmental perspective of the Accessible Underwater Archaeological Sites at the area more dynamic.

Fig. 6: Shipwreck of Peristera, Alonissos, ©MCS-EUA, photo by Matteo Collina, Univerità della Calabria –DIMEG

Fig. 7: Shipwreck of Glaros, West Pagasetic, ©MCS-EUA, photo by Matteo Collina, Univerità della Calabria – DIMEG

Fig. 8: Shipwreck of Kikinthos, West Pagasetic, ©MCS-EUA, photo by Matteo Collina, Univerità della Calabria–DIMEG

Fig. 9: Shipwreck of Telegrafos, West Pagasetic, ©MCS-EUA, photo by Matteo Collina, Univerità della Calabria–DIMEG

However, until today, despite the aforementioned legislative and administrative arrangements, the pressing demands of the diving community and the in principle positive disposition of the involved public authorities on this endeavor, no Accessible Underwater Archaeological Site has been operational nor has opened for the public (11).

The Sites of West Pagasetic – Northern Sporades have been at the centre of our interest in the framework of BLUEMED (12), as pilot sites.

Each of these sites has its own characteristics, which are not simply limited to the different history of each shipwreck *–the shipwreck of Peristera Alonissos goes back to the last quarter of the 5th century B.C. and is linked with one of the largest known until today ships of the period; the rest are shipwrecks of the Late Roman period (at Telegrafos) and the Byzantine period (at Kikinthos and Glaros)–***but also at the level of their preservation and the image that they present today at the seabed** *–for example at Glaros many dispersed traces of more shipwrecks are preserved, at Kikinthos the jars and amphorae are shattered, while at Telegrafos, little authentic archaeological material remains at the seabed)–* **regarding the kind of the archaeological research (excavation or survey) which has been conducted on each site** *–Peristera* **(13)** *and Telegrafos* **(14)** *have been systematically excavated by EUA and the Hellenic Institution of Marine Archaeology (HIMA) under the direction of the archaeologists Elpida Chatzidaki and Elias Spondylis respectively, while an underwater survey has been conducted at the positions of the Pagasetic* **(15)** *also by HIMA and again under the direction of Elias Spondylis–* **at the environmental characteristics of the site etc**. *–Peristera is located within the National Marine Park of Alonissos and Northern Sporades while the vegetation at Glaros is hypertrophic during some periods of the year, thus sometimes it covers the antiquities.*

These particular characteristics of the four sites, which inevitably lead to different choices in terms of both the narration that will be formed for the visitor and the management of the sites, were partly known thanks to the archaeological researches of the Ephorate and the Hellenic Institute of Marine Archaeology which had been realized, and to the related publications, but were fully understood by the personnel the EUA involved in the project (16) during the on-site, underwater missions organized in the framework of the Project (October 2018, March-April 2019, July 2019, October 2019, November 2019 and December 2019). In the context of these missions, the active manpower of the Ephorate, which undertook the responsibility for the implementation of the Project, had the opportunity to get an immediate view of the sites that had to organize as accessible, to protect and promote in various ways, answering to a number of questions.

One first question that was raised was what kind of infrastructure is required; and if they are required. The design up until today, based on the experience of BLUEMED and the preparation of a relevant Application Form of the project for the funding of the project «Organization of the Accessible Underwater Archaeological Sites in Alonnissos - Western Pagasitic» by the current National Strategic Reference Framework – Thessaly Regional Operational Program, submitted by the EUA in October 2018, that was recently approved, has helped to identify the minimum necessary infrastructures.

Apart from the marine area, the infrastructures of an Accessible Underwater Archaeological Site may also concern the dock from which the vessels travelling to and from the Accessible Underwater Archaeological Sites will start and return, i.e. the points of departure and arrival. Besides, BLUEMED plans to deploy the Knowledge Awareness Centres (KACs) to a close location at the point of departure and arrival (17), in order to provide information to diving visitors but also to render the underwater cultural heritage accessible and understandable even to non-divers (18). But in the context of this presentation we will focus on the infrastructures at the marines area where diving will be carried out, infrastructures which concern both the safety of the monument and the functionality and quality of the visit.


Fig. 10: Knowledge Awareness Centre in Alonissos, photo by Angelos Manglis

Its safe operation requires, in principle, the placement of mooring buoys for the approach of vessels at the site, for both visitors and audit authorities, and in particular two mooring buoys per site are favored. The necessary beacons for the marking of the boundaries of the site can also be placed on the mooring buoys.

Concerning the visitors, whose course at the seabed or the «movement path» will have been determined from the beginning, and for the quality of the visit, the marking of the points of archaeological or environmental interest at the seabed is considered necessary with the placement of a limited number of informative signs, that could also serve as compasses for divers –the information will be elementary and possibly confined to the object's identity. For similar purposes –safety and quality of visit– the placement of other elements may be favored, such as a rope to ascend – descend, a rope to mark the route, etc., which will per site become object of a specific study for the conversion of the sites to accessible ones, that is being prepared by the EUA and will be officially approved by the Ministry of Culture and Sports.

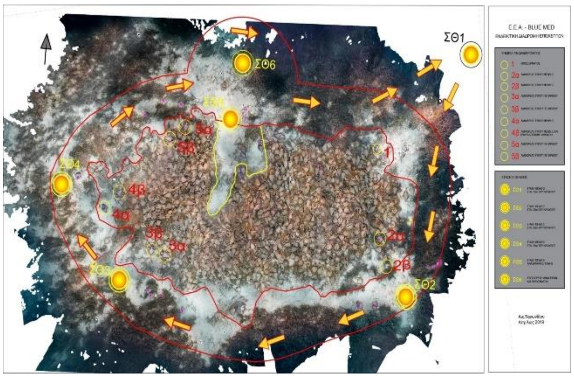

Fig. 11: Peristera shipwreck, ©MCS-EUA, orthophotomosaic by Univerità della Calabria–DIMEG, design of the visiting route by Aikaterini Tagonidou

Fig. 12: Public visiting of Peristera shipwreck, 6 & 7 April 2019, ©MCS-EUA, photo by Yiannis Issaris

Underwater infrastructures are also required for the safety of the monument. A placement of cameras is already being tested for the "Development of a System of an Underwater Visual Surveillance of Accessible Underwater Archaeological Sites – Underwater Museums", which will enable remote monitoring of sites with a view of the seabed, both during visits and when the sites will be closed. The system is intended to be connected to and give an alarm signal to the Centre of Reception and Processing Alarm Signals of the Ministry and local port authorities.

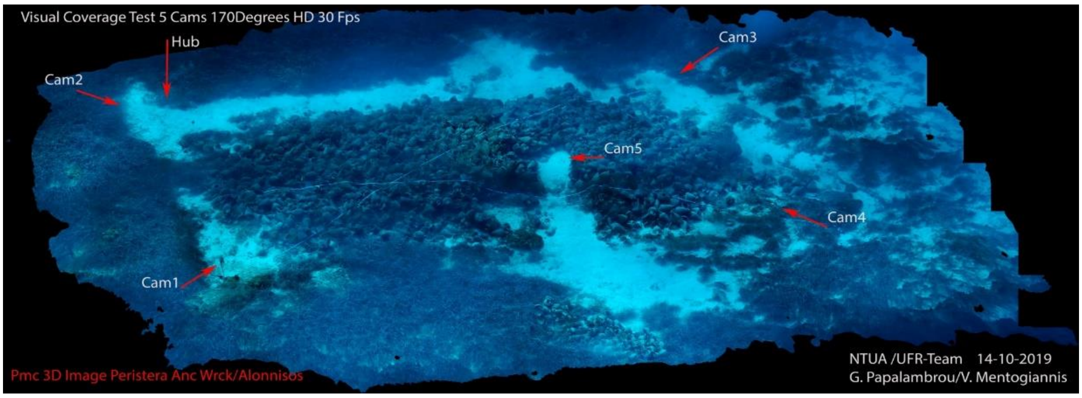

Fig. 13: Peristera shipwreck, ©MCS-EUA, orthophotomosaic with the points of cameras' placement by NTUA/UFR Team, photo by George Papalambrou – Vassilis Mentogiannis

At the seabed of Kikinthos and Peristera monitoring sensors for environmental parameters, temperature and visibility of the marine environment of the monuments, are also placed in the framework of BLUEMED by the Oceanography Centre - University of Cyprus. The data, that will be collected by the EUA, will provide the basis for long-term monitoring of the sites and for the diagnosis of any environmental changes that the opening to the public may bring.

The intention is for the infrastructure facilities to be kept to the minimum and to be placed in such a way that any damage of the monument or any obstacle for the movement of visitors or the navigation to be avoided. The aforementioned infrastructures are greatly affected by the evolution of technology.

Nevertheless, the safety of these sites is also based on their systematic monitoring of both the state of the monuments and their natural environment, which of course requires the establishment of relevant monitoring indicators and the provision of comparative baseline material - the latter must reflect the situation before their opening to the public and was collected in the framework of BLUEMED, during which monitoring indicators were also discussed.

In particular, one of the first actions in the context of the project, in October 2018, was the three-dimensional modelling of the four pilot sites, by our Italian and Croatian partners from the Universities of Calabria and Zagreb respectively, with the aim to operate in two directions. Immediately, for the creation of an interactive digital immersion application, already installed at the Knowledge Awareness Centres at Chora, in Alonissos and in Amaliapolis as well as the other pilot sites in Italy and Croatia, providing access to shipwrecks and to non-divers. In the long term, to provide a reliable basis for monitoring any changes of the site, so that timely intervention for their protection and documented decision-making can be achieved.

Fig. 14: Member of the University of Calabria–DIMEG's team photographs Peristera shipwreck in order to create the 3D photomosaic of the shipwreck, ©MCS-EUA, photo by Matteo Collina, Università della Calabria–DIMEG

In addition, based on the three-dimensional modelling of the Peristera shipwreck, the conservators of the EUA realized a mapping design of the amphorae Peristera shipwreck and marked them in three categories based on their state of preservation, using colour: those that are concreted and therefore immovable, those that are semi-concreted and those that are free, introducing a new methodology that

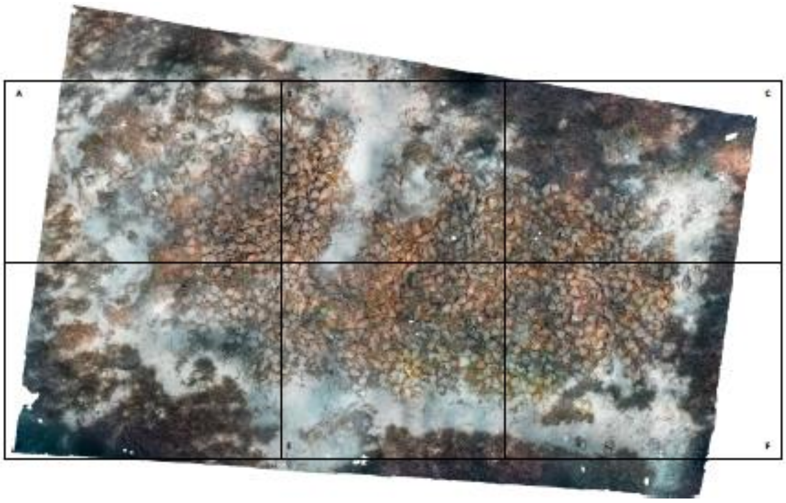

Fig. 15: The separation of the amphorae of Peristera shipwreck into six sections, ©MCS-EUA, orthotophotomosaic by Università della Calabria–DIMEG, drawing by Helen Margaret Bardas, Angelos Tsompanidis

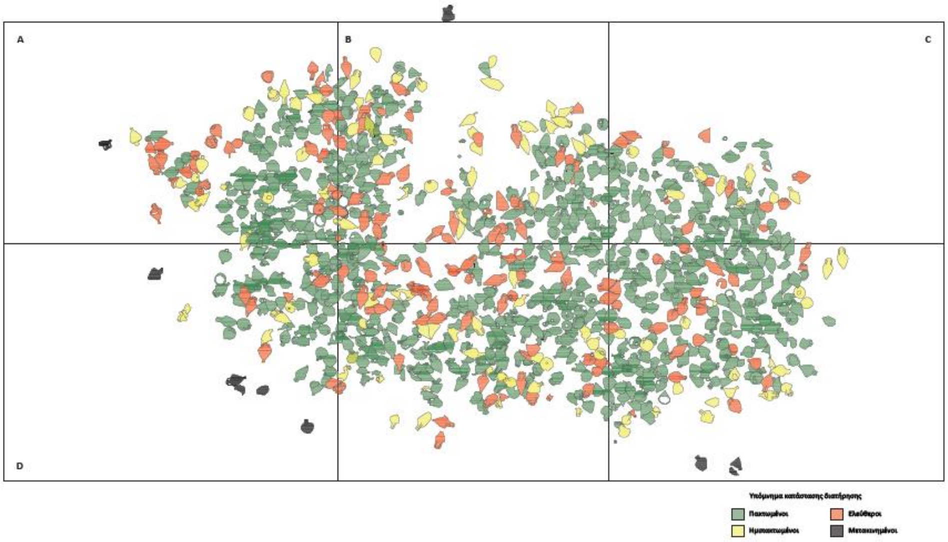

Fig. 16: Mapping design of the amphorae of Peristera shipwreck and their state of preservation, ©MCS- EUA, drawing by Helen Margaret Bardas, Angelos Tsompanidis

will allow the location of the weakest points against natural phenomena or illegal actions but also the creation of a reliable mapping which will further facilitate the monitoring of the site –of course this method is not applicable to all environments and it depends on the intrinsic characteristics of each site.

At the same time, the use of underwater tablets, with 3D photography and geo-referencing capabilities, purchased in the framework of the project, allows the easy direct comparison of the data obtained each time with the original 3D digital background, and will also contribute to the proper supervision of the site.

The Oceanography Centre **-** University of Cyprus, carried out at the beginning of the project, prior to any diving activities, the collection of biological data for the creation of a database to ensure also the possibility of monitoring changes, in the natural environment of monuments,.

Besides the above, the functioning of the Greek Accessible Underwater Archaeological Sites presupposes the decision-making and its reflection on legislative improvements and / or administrative acts that will shape the institutional framework for the operation of the Accessible Underwater Archaeological Sites as far as general principles and specific aspects of the operation of each site are concerned (i.e. duration and opening hours of each site, permitted number of visitors and escorts per visit, method of training and licensing of the involved diving centers and their personnel etc.).

First of all, it is necessary to amend the Law 3409/2005 as to who accompanies the diver-visitors. It is now clear, that this point has been disfunctional and that the Ministry of Culture and Sports shall and can take over the safety of the accessible underwater sites, but the escort and safety of the visitor goes beyond its jurisdictions and capabilities, and can be undertaken by the Diving Centres, under the supervision of the Ephorate of Underwater Antiquities.». The initial concept of the abovementioned Law of «accompanied diving» always remains, of course.

The specific settings, such as opening hours, number of visitors per visit, etc., can be specified by an operation mode for each site or group of sites depending from the same point of departure – arrival.

The basic general operating principles of the Accessible Underwater Archaeological Sites, however, which refer to issues such as the placement of mooring buoys, beacons, underwater safety systems and other elements that may affect navigation require the issuing of a Joint Ministerial Decision. The setting of a visit fee in favor of the Archaeological Resources Fund or of a system of issuing group e-tickets, the way of training and licensing professional divers, who could be engaged in the Accessible Underwater Archaeological Sites, as well as the process of withdrawing their license demand also arrangements.

In any case, for the proper functioning of the Accessible Underwater Archaeological Sites, it is though necessary to have on-site, at each point of departure – arrival, from which more that one site is controlled, a group of diving personnel of the EUA, which will have the responsibility for monitoring, protecting and generally taking care of the underwater sites. The conduct of systematic or emergency underwater surveys at the sites will be at the jurisdiction of this team and the EUA in general, based on an operation mode for each site. Also, cleanliness, maintenance and care for the proper operation of the sites.

In addition, the experience from BLUEMED has made it clear that supporting functions of the endeavor, such as knowledge Awareness Centers or the promotion of the Accessible Underwater Archaeological Sites as tourist destinations, can be undertaken by local authorities through the Municipalities and / or the Region. Summing up, diving centers, local and regional institutions and central government are invited to work together for the exploitation of the challenge posed by the development of cultural diving tourism, an environmentally friendly, sustainable form of tourism with expected positive consequences on local economies.

Even more, we believe that the opening of the sites will contribute to raising awareness and to the better protection of the underwater monuments in the end.

So, in closing, it is worth mentioning that until today the concept of the accessible underwater cultural heritage has been almost exclusively associated with the visit of shipwrecks by divers. There is, however, also a huge cultural stock of coastal underwater antiquities, which is already freely accessible to swimmers or snorkellers and whose conceptual accessibility we must primarily improve as Ministry, for the benefit of their protection. Furthermore, individual monuments linked with modern and recent Greek and European history could also become interesting visiting points.

In any case it must be said that the Accessible Underwater Archaeological Sites of Alonissos and West Pagasetic will become the guide for other corresponding projects in the future (19).

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(2) Law 3028/2002 "On the Protection of Antiquities and Cultural Heritage", article 15, Official Government Gazette 153/A/28-6-2002.

Official Government Gazette 153/A/28-6-2002.

(3) In general, the allowed diving activities with breathing apparatus –except recreational diving– within the archaeological sites were determined in 2004 with the Joint Ministerial Decision ΥΠΠΟ/ΓΔΑΠΚ/ΑΡΧ/Α1/Φ41/11228/1865, "Determination of the conditions of anchoring and fishing and underwater activities with breathing apparatus", Official Government Gazette B-336/11-2-2004 signed by the

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(16) General co-ordinator: Dr Pari Kalamara, archaeologist, Director of the EUA; scientific field co-ordinators: the diver archaeologists Dr Dimitris Kourkoumelis (Head of the EUA's office in Northern Greece) and Dr Theotokis Theodoulou (Head of the EUA's office in Crete); diver archaeologists: Despoina Koutsoumpa, Eugenia Loizou; diver architects: Ekaterini Tagonidou, Elianna Kolyva; diver conservators: Chryssa Fouseki (Head of the EUA's Conservation Department), Angelos Tsompanidis, Irini Malliou, Aggeliki Bei, Helen Margaret Bardas; diver technicians: Spiros Moureas, Themis Troupakis, Kostas Kipriotis; archaeologist – museologist: Elia Vlachou; administrative support: Aris Michail, Sotiria Sideri, Chryssoula Pleura, Anastasia Mitsopoulou, Paraskevi Margariti.

(17) For the points of departure-arrival the concession of a space is required from the port authorities, which will generally control the anchorage points of vessels at the area. Building facilities are required for the KACs where the EUA can also place a control room.

(18) This increases the number of the public that will become more aware and engaged in the long-term with the protection of the underwater cultural heritage, while in the framework of the development of diving tourism in the area, KACs can also serve as poles of interest for the escorts of diving visitors.

(19) From this position I would like to thank particularly the Region of Thessaly, the project's coordinator, and namely the Regional Governor, Mr. Agorastos. Besides special thanks go to the Minister of Culture and Sports, Mrs. Mendoni, who honoured the entire effort with her presence at the International Conference "Dive in Blue Growth" as well as to the political leadership of the Ministry in general for their overtime support on this endeavor.

Touristic potential of the Supetar (Cavtat) underwater archaeological zone

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Two decades ago, information about some well-preserved ancient shipwrecks near the islet of Supetar in front of Cavtat reached the responsible institutions. The first site consisted of a group of large ceramic dolia (containers for storing liquid or solid provisions) from the 1st cent. BC or the 1st cent. AD, while the second contained several hundred cylindrical North African amphorae from the 3rd/4th cent. AD, exposed on the seabed.

The extraordinary state of preservation of both sites impressed the scientists. The finds were left in situ, with physical protection (iron cage) placed over the amphorae. The initial idea of the establishment of the underwater archeological park up to recently had no success. It was refreshed in the framework of the BlueMed Project, resulting in some attractive initiatives toward public presentation.

Protective cage placed over the amphorae does not allow the direct contact with finds, and the penetration into the cage should not be practiced due to the safety reasons. In such case, virtual presentation of the site is a valuable solution to the problem, as the visitors can capture details which are otherwise not available.

The site with the dolia cargo is of special interest due to their large dimensions, leaving every visitor amazed. Historical information about dolia includes curiosities, mythological stories and anecdotes, which can be used for the presentation purposes. The site is easy to reach, and the finds on the seabed offer unique experience during visits. Considering the main features of the site, where the remains of the wooden ship hull were recently discovered, the future turistic promotion could rely on the active participation of divers in the whole process of the archaeological fieldwork research.

***Keywords:** in situ* protection, amphorae, dolia, underwater presentation, citizen science

Sustainable management and protection of Accessible Underwater Cultural Heritage sites; global practices and bottom-up initiatives

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***Abstract*:** This paper aims to present the better practices for the protection and sustainable management of Underwater Cultural Heritage (UCH) worldwide as well as relevant bottom-up initiatives. The development of accessible UCH sites and diving tourism further indicate the sustainable character and the positive effects of such models for local economies, including both economic benefits and social opportunities. It also supports that the responsible physical access to sites through dive trails or virtual visits fosters public awareness and consequently the protection of underwater cultural heritage. Knowledge Awareness Centers and innovative technologies enhance the participation of locals and tourists and promote their engagement in the protection of sites. The Med area is an ideal environment encouraging some pioneering initiatives in this direction.

Keywords: Underwater Cultural Heritage, value, protection, accessibility, local benefits, sustainability, Dry Dive, inclusion

1. VALUE AND PROTECTION OF UNDERWATER CULTURAL HERITAGE

For most people Underwater Cultural Heritage is synonymous to ancient shipwrecks, however, the concept includes also a variety of submerged sites and prehistoric landscapes. According to the UNESCO 2001 Convention on the Protection of the Underwater Cultural Heritage (UNESCO 2001, *Article 1, §1*), "Underwater Cultural Heritage encompasses all traces of human existence of a cultural or historical character that lie under water or have now been recovered for at least 100 years". This cultural wealth is estimated around three million ancient shipwrecks worldwide (UNESCO 2013) and it grows radically when modern wrecks of ships or aircrafts are also included. In Greek seas only, the estimations on the number of wrecks of vessels and aircrafts of the World War II report around one thousand in number (Papadimitriou 2018). In fact, on the centennial of WWI awareness is being raised on their historic and cultural value as memorial sites as well (UNESCO 2014) and the need for their protection. Aside the impressive numbers, what is primarily important is the multidimensional value of UCH for humanity. In particular, when accessible and communicated to the public, UCH can foster peoples' interaction with their historic background and marine environment. Several cases of accessible underwater cultural sites and maritime museums highlight such a benefit from a cultural, educational and sustainable socioeconomic development standpoint (Tikkanen 2011).

Recognizing the value of UCH, we need to assess all possible threats with a view to its safeguarding for the next generations. Apart from the apparent risks due to the marine environment, several human activities such as trawling, anchorage or looting also cause serious damage to the UCH (UNESCO "Threats to Underwater Cultural Heritage"). In order to protect the sites effectively, strict legislation and delimitation has proven ineffective in practice, considering the recent technological developments in marine research even in deep waters. Instead, what calls is for public awareness and active engagement of stakeholders, supported by systematic mapping, research and study of sites, as well as the implementation of integrated actions for the protection and promotion of underwater cultural and natural heritage.

Granted that there is no such thing as a best solution, the different environmental and cultural context of each site should be taken into consideration. Under this understanding, UNESCO has suggested that the preservation of UCH *in situ* should be considered as the first option, while it encourages the responsible non-intrusive access to sites to observe or document in situ, in order to create public awareness, appreciation, and protection of cultural heritage (UNESCO 2001, *Article 2, §10*). Furthermore, it has encouraged the adoption of "practicable measures to raise public awareness regarding the value and significance of underwater cultural heritage and the importance of protecting it" (UNESCO 2001, *Article 10*). In this direction, different models have been developed around the world over the past years.

2. ACCESSIBILITY & MANAGEMENT

There are different approaches of management of UCH with both advantages and challenges in terms of protection and accessibility. A method mostly adopted over the past decades due to difficulty of accessibility or for preservation reasons has been the exhibition of shipwreck finds in land-based maritime museums. There are several examples in Europe and worldwide, where artifacts or whole wrecks have been recovered (UNESCO "Underwater Archaeology Museums"). There is even the model of museums in the form of restored ships that allow visitors to get to know to the structure of different types of ships in various time eras. Among the most known examples of land-based museums are the ARQUA National Museum of Underwater Archaeology in Spain, the Mary Rose Museum in the UK, the Bodrum Museum of Underwater Archaeology in Turkey, and the Roskilde Viking Ship Museum in Denmark[1]. The most popular Vasa Museum in Sweden with one million visitors per year ("About the Vasa Museum" 2019) has become a point of reference in this paradigm. The advantage of on-land museums is that since they are easily accessible they raise broad public awareness on cultural heritage. Equally impressive are the so-called underwater museums in aquarium settings, with most characteristic examples being the Baiheliang Underwater Museum and the Guangdong Maritime Silk Road Museum in China (UNESCO "Underwater Archaeology Museums"). Despite their costly construction - the Baiheliang museum cost 28 million US Dollars -, both models have maintained the original marine and cultural context in a spectacular aquarium setting and provided in situ access to the non-diving visitors.

Easier access to submerged sites due to technological development has led to accessible Underwater Archaeological Sites, a model that best meets the UNESCO Convention 2001 suggestion for preservation in situ and raising of public awareness. Their optimum advantage is that they offer an in situ experience for both divers and non-divers. More specifically, there is the possibility for dive trails for SCUBA divers as well as snorkeling or tours with submersibles for the non-diving visitors in cases of low depth sites, like the ROV trips for tourists in Orkney, UK, Dalarö Sweden or in Vermont USA. There are several names used for this model: underwater parks, underwater archaeological trails, preserves, sanctuaries or underwater museums as well as plentiful examples (UNESCO "In situ

[1] For more information visit the museums websites: www.culturaydeporte.gob.es/mnarqua/en/museo/visitan, https://maryrose.org/, https://www.vasamuseet.se/en, http://www.bodrum-museum.com/, https://www.vikingeskibsmuseet.dk/en/

access"); the Underwater Archaeological Park of Caesarea in Israel, the Croatian Underwater Museums, the Victorian Underwater Shipwreck Discovery Trail in Australia.

In situ accessibility should primarily safeguard the underwater natural and cultural heritage. In this purpose, the use of a protective covering in the Bou Ferrer wreck (UNESCO "Diver access") or of a metal cage in the case of Croatia (Zmaić 2009) is under dispute in terms of cultural and environmental sustainability of the sites. What is usually applied is the establishment of official dive trails to secure the divers safely approaching at the wrecks. There is usually an underwater rope path combined with information labels or waterproof booklets that guide the divers around the site. This is the case for example at the Park Kronprins Gustav Adolf in Helsinki, Finland and the Norman's Bay wreck diver trail in East Sussex, UK, while at the Lossen Trail in Norway there are signs on stone slabs laying on the seafloor in order not to affect the surroundings. It is worth noting that at Park Kronprins Gustav Adolf, the first established in the Baltic Sea, entry is free for individual divers who do not require permission to dive or take photos. In the USA, the Florida Underwater Archaeological Preserves and the Thunder Bay National Marine Sanctuary are also examples of open access sites, where the local community is engaged in the monitoring of the sites (Delgado et al. 2015). At the Underwater Archaeological Park of Baiae in Italy, the local diving clubs are authorized to guide visitors along the marked itinerary. Among the UNESCO best practices of fostering accessibility to UCH are the examples of Andalusia, where site visit is encouraged to include both diving clubs and private individuals, the guided tours under the supervision of underwater archaeologists at the Bou Ferrer, which is the only accessible ancient shipwreck in Spain, as well as the public visits during the conduction of an underwater archaeological excavation to the well-preserved shipwreck of Deltebre I in Catalonia, Spain (UNESCO "Best Practices").

3. PUBLIC AWARENESS & INNOVATION TECHNOLOGY

There is currently a great interest and a broad public appeal on issues concerning the underwater natural and cultural environment. In an effort to stimulate awareness among stakeholders on the sustainable development of the Ocean, the United Nations have declared the upcoming decade (2021-2030) as the Decade of Ocean Science for Sustainable Development ("Ocean Decade"). This is the perfect timing to include the underwater cultural heritage in the broader discussion of the protection and sustainable management of the underwater environment, in terms of its social aspects. The great response of the public towards UCH issues is obvious by the increase in numbers of visitors in underwater museums (e.g. the Vasa Museum) and accessible underwater cultural sites (e.g. the Underwater Archaeological Park of Baia). Moreover, it reflects on the positive reaction to initiatives such as the Big Anchor Project ("Big Anchor Project") or the several citizen science projects. In the context of this dynamic, the engagement of the public in the protection strategies of UCH is not a step very far away.

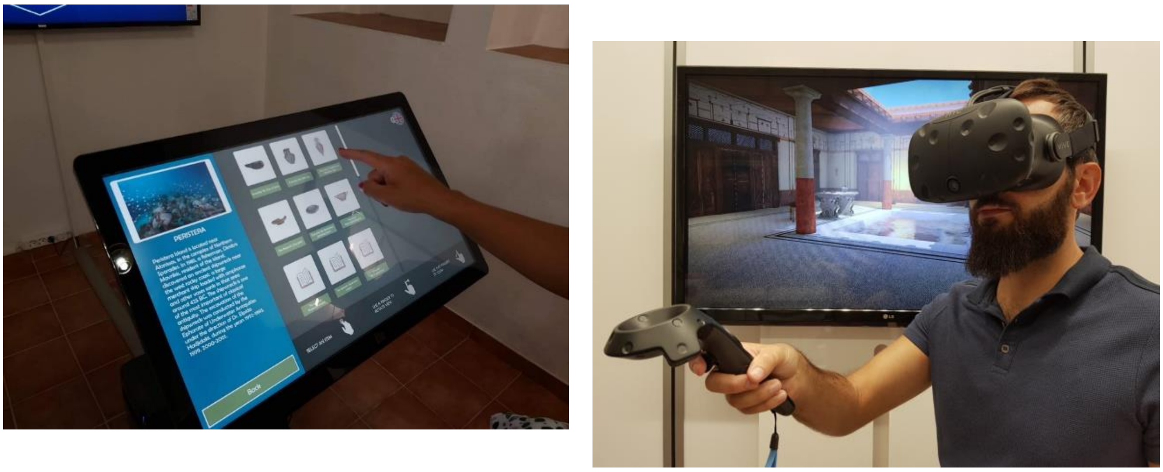

Fig.1 Innovative technologies applied for the promotion of UCH in the BLUEMED project.

Regardless of whether access is open or controlled, public accessibility to UCH is a crucial parameter in terms of protection and sustainability of the sites, given that it enhances broad awareness on the value of UCH (UNESCO 2013). According to the Cultural Heritage Diagram, when people understand the value of their cultural heritage they are more likely to participate actively in safeguarding it and as a result develop an ongoing interest for its protection (Thurley 2005). What calls is for the integration of responsible accessibility practices**,** in order to attract both the diving community and non-divers. For this purpose, innovative technologies are being more and more integrated into promoting UCH to the general public, including wet and dry dive techniques. As a result, 3D reconstructions of submerged cultural remains and the surrounding marine environment can advance the diving experience and offer a virtual reality experience of real time diving from a distance. This is now possible due to recent technological developments that have allowed high-resolution research and mapping even in deep waters (Sakellariou 2011). Such examples are the Blake Ridge Shipwreck off the North Carolina coast or the 2.400 year old shipwreck recently found in the Black Sea, both in more than 2.000 meters depth.

Virtual museums have been the focus of interest lately as an effective way to stimulate interest on UCH (UNESCO "Virtual Museums"). In the North and Baltic Sea, the Nordic Blue Parks project has designed underwater trails combining natural and cultural heritage sites, while the Vrouw Maria Underwater Project created an interactive, real-time virtual reality simulation of a shipwreck (Tikkanen 2011). The Virtual Archaeology Museum launched by BOEM is featuring 3-D models, video footage and mosaic maps of wrecks in the Gulf of Mexico "Virtual Archaeology Museum". The Pearl Harbor Virtual Reality Center provides virtual reality tours of the USS Arizona Memorial in Hawaii and has contributed to the Memorial becoming a destination for 1.7 million international tourists in 2018 ("Pearl Harbor National Memorial Park"). In the UK, Historic England has supported virtual tour visits of several wrecks, such as the Coronation wreck in Plymouth and the HMS Colossus Dive Trail ("Visit a protected wreck site"). This initiative has actually increased the number of visitors to the sites indicating the growing interest on the display of modern wrecks and the contribution of technology in this direction. Virtual dive trails not only facilitate accessibility but also stimulate awareness on the protection of UCH as they serve teaching purposes for schools or universities, thus offer immediate access to disabled visitors in case they cannot dive (Cant 2018), which is an aspect of great social validity. Most importantly, advanced applications contribute to the underwater cultural heritage becoming a part of people's lives so that sites are more effectively protected and maintained.

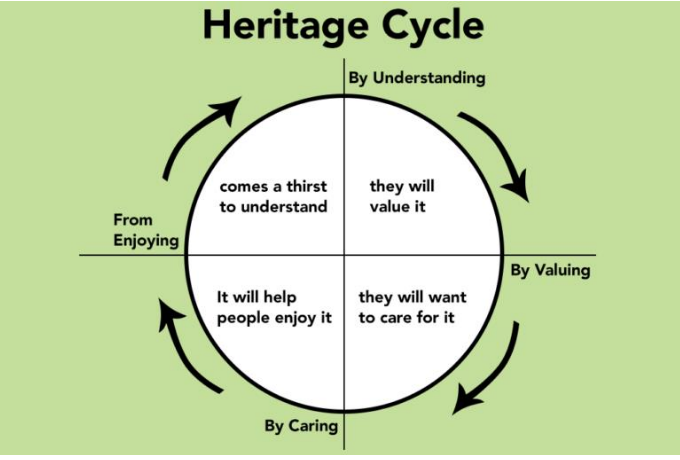

Fig 2. The Heritage Cycle Diagram. A graphic originally developed by designed by cultureindevelopment.nl

4. SUSTAINABILITY & GROWTH

Actually, the participation of the public, including divers and non-divers, locals and visitors, as well as the various type of stakeholders involved, comprise strong allies not only in long-term sustainability of UCH sites but also in the economic prosperity of a region. Indeed, according to the 2013 United Nations Resolution on Culture and Sustainable Development (United Nations 2014), culture is a key factor of sustainable socioeconomic development on a national, regional and local level. It is a current growing belief that cultural heritage can contribute significantly to the overall socioeconomic development of society and along with environmental sustainability and social and economic development, these are considered as indicators of sustainable growth. Growth refers to economic benefits as well, granted that the integration of cultural heritage to society offers an added economic value. The investment on the promotion of underwater cultural heritage can increase the number of people visiting the sites and as a result generate financial flows for the local community. The first thing that comes to mind is that tickets generate revenue for the maintenance and operation of the sites. However, the greatest added value of a UCH site is the economic activity that is developing throughout the whole region and eventually offers a high beneficial return directly to the local community.

Taking advantage of the emerging trend of alternate forms of tourism (Dwyer et al. 2008) and the development of diving tourism globally (PADI statistics), the attraction of divers to UCH sites can increase the economic activity in coastal or island areas, that normally depend on short touristic periods. It is worth noting that divers visiting submerged sites spend longer time in a region than tourists visiting land museums (UNESCO 2018). In addition, when they travel from distant countries visiting two or three countries for at least a week each, significant indirect revenues usually are generated, such as on food or accommodation. Consequently, the divers' profile of a high spender at off-season weekly destinations fits the parameters of sustainable growth for areas with underwater cultural wealth. Therefore, the UCH exploitation can contribute significantly to local economic growth, including profits for businesses and increase of income for local coastal and island economies, such as new employment opportunities in the tourism sector. This is the case for example at the Vasa Museum in Sweden or the Thunder Bay National Marine Sanctuary in the USA (Delgado et al. 2015). Most importantly, it is expected to create a competitive advantage for local communities on a Glocal scale, since they will highlight their unique cultural and natural wealth internationally.

From a different perspective, an investment on the promotion of the UCH will not have any negative effect on the touristic profile of a region, since it has a low environmental impact. On the contrary, the opportunity for a coastal or island region is to combine different regional assets, more particularly, the natural and cultural underwater wealth and organize actions to educate the public on their protection. Such examples are the Florida Keys National Marine Sanctuary, which protects North America's only coral barrier reef and offers home to a unique marine life or the SS Yongala Shipwreck in Australia located in the Great Barrier Reef Marine Park. In Greece, the National Marine Park of Alonissos North Sporades is the largest marine protected area in Europe and the nature reserve for a series of rare species and remarkable archaeological underwater heritage. Such combination of assets can support operation sustainability for both parties and thus foster protection, considering that the seabed attracts the interest of divers in general and possibly will raise awareness and attract on the protection of underwater cultural heritage.

Granted that the sustainability of an intervention plan depends on the socioeconomic environment, the support of local stakeholders and a strong cooperation network among local institutions are key factors towards this goal. The model in the Thunder Bay National Marine Sanctuary in the USA is based on the participation of the local community in the decision-making process, and has actually generated a sense of responsibility and pride of the local community on their heritage (Delgado et al. 2015). In fact, the community engagement and active management are considered among the elements of

Fig.3 The classical wreck of Peristera in Alonissos, Greece. © MCG, EUA

success of such a bottom-up approach (Scott-Ireton 2006).

5. A BOTTOM-UP INITIATIVE

An example of a bottom-up initiative and active cooperation among stakeholders with the purpose to protect and promote the underwater cultural heritage has been developed over the past years in Greece. It is about a long-term effort that initiated in 2006 and has led recently to the first accessible UCH site of the Peristera classical wreck of around 425 B.C. in Alonissos Island, in North Sporades Archipelagos of Magnisia, open to the public from the summer 2020 onwards. It all started with the Prototype Innovative Development Plan 'Ano Magniton Nisoi', an awarded integrated intervention plan that structured on a multi-stakeholder partnership that involved state authorities as well as local-civil society's bodies and private associations. Indicatively, such are the Hellenic Ephorate of Underwater Antiquities, the Hellenic Organization for Tourism, the Hellenic Center for Marine Research, the Hellenic Institute of Marine Archaeological Research, the local municipalities of Alonissos and Skopelos islands. It aimed to highlight different features of this island region, such as the National Marine Park of Alonissos Northern Sporades and the submerged wrecks in the area, therefore it is an example of a good practice aiming at sustainable local economic development and environmental upgrading of a region. The plan proposed the creation for the first time in Greece of pilot accessible underwater archaeological sites combined with diving parks where qualified diving centers would support their operation. The main idea was to highlight the underwater cultural and natural heritage in situ, promoting public accessibility and thus supporting archaeological survey with the operation of a Research Center for Marine Archeology. Equally innovative was the idea of the integration of innovative technologies for the non-diving audience, a goal that was not to be realized until recently.

What followed was the "Operational Plan for the Construction of Underwater Museums & Diving Parks in the Sporades Islands & Western Pagasitikos", a flagship project under the National Strategic Reference Network 2007-2013. It actually proposes the creation of a network of accessible underwater archaeological sites in an extended area of intervention at the Magnisia region. The planning was based on the promotion of at least five sites as a total, in order to create a weekly diving tourism destination with a prosperous competitive advantage of a Glocal character. Currently, the plan is to be developed under the framework of the Partnership Agreement 2014-2020 with the implementation period starting in October 2019, while it incorporates 4 different projects that are addressed to the Ministry of Culture (960.000€ budget), the Municipality of Alonissos (1.350.000€ budget), the Municipality of Almyros (1.200.000€ budget) and the Region of Thessaly (600.000€ budget).

In order for the original idea to become a reality, the Euro-Mediterranean project BLUEMED, developed under the European Interreg 2014-2020 Programme, had a decisive role (https://bluemed.interreg-med.eu/), as it is implementing the design of accessible Underwater Archaeological Sites in three different Mediterranean countries, including Greece. More specifically, the sites of the project are the Baia Underwater Archaeological Park and the Capo Rizzuto Marine Protected Area in Italy, the Cavtat Underwater Archaeological Site in Croatia and 4 underwater archaeological sites in Magnesia, Greece: Peristera in Alonissos and Kikinthos, Akra Glaros and Telegraphos wrecks on the west coast of the Pagasitikos Gulf. The project proposes physical dive or virtual trails with enriched information provided on both archaeological and the marine ecosystem features. An Augmented Diving System improves the diving experience while interactive applications are also available at the Knowledge Awareness Centers (KACs), where the visitors can enjoy a virtual diving experience at the sites and the digital exhibition of selected finds. The advantage of KACs is that since they are established in situ where the sites are also located, they enhance public awareness to locals and tourists on the value of the protection and preservation of underwater cultural and natural heritage. In addition, granted that KACs provide all information in a digital form, they can be easily installed at various points such as airports, museums or international exhibitions. As a result, they can attract visitors thus disseminate information about other sites too, through an international dynamic network. At the same time, the project has developed an online platform (http://meddiveinthepast.eu/) that not only offers the opportunity for virtual diving but also provides archaeological information about the project sites, the nearby diving centers and other related information about other Mediterranean UCH sites. In this context, the platform is creating a network across the Mediterranean of underwater cultural heritage tourism destinations.

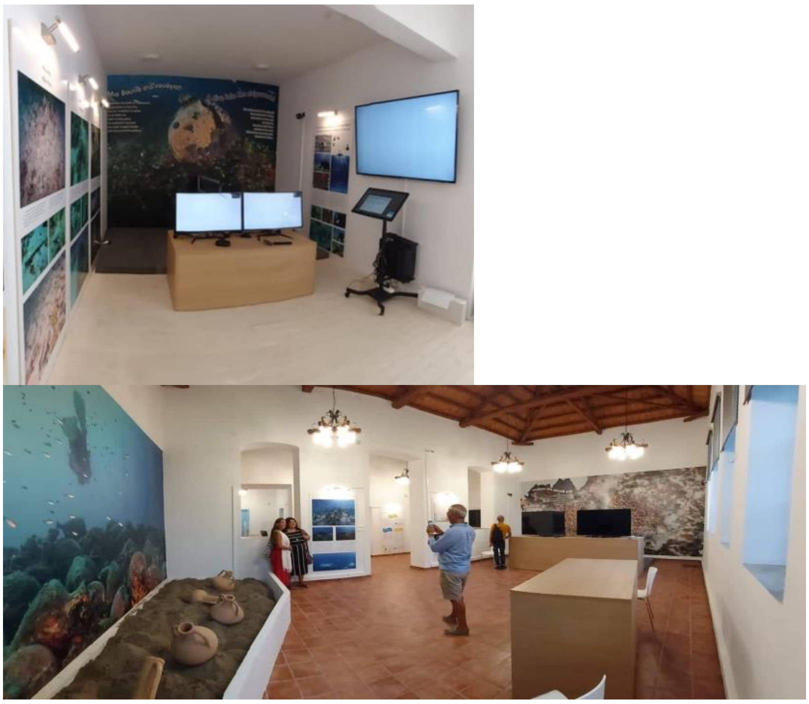

Fig 4. Knowledge Awareness Centers in Amaliapolis and Alonissos respectively, Greece.

The management model proposed in the case of Alonissos in Greece aims at the sustainable operation of the accessible underwater archaeological site and the two Knowledge Awareness Centers established in Alonissos and Amaliapolis. Except for the tickets, sustainability is based on the fact that the operation management lies not on a newly founded organization but on already existing bodies, in particular the local municipalities of Alonissos and Almyros, the Region of Thessaly and the Ministry of Culture and Sports. It is in fact a triple helix cooperation based on a trilateral programmatic agreement that sets clear the responsibilities of each body. More particularly, the Ministry of Culture is responsible for the protection of the sites and the visits to the sites, while the Municipalities are responsible for on-land operation issues such as the operation of KACs. The Regional Authority is responsible for the financing, monitoring and therefore viability of the operation of KACs and sites. A crucial element for the sustainability of the proposed model is the role of diving clubs. The Ministry of Culture will train and authorize local diving centers to accompany scuba divers to the sites in a way that will follow the operational framework of the sites towards their protection and yet satisfy and inform the visitor.

6. CONCLUSION

The long-term effort in Greece indicates how local initiatives could be effective when they develop on the fruitful collaboration among local, regional and national stakeholders of a public, civil and private character– in this case in the form of a quadruple helix partnership. It is also an example of a better practice for blue growth in the Mediterranean region, being a model compatible with the sustainable touristic model of the Med that can offer multiple cultural and socio-economic benefits to the local communities, especially at island and coastal areas. Responsible in situ accessibility and public awareness are strong preconditions in the protection and promotion of UCH; as a result, Knowledge Awareness Centers and innovative technology contribute to the participation of the public and most importantly foster the inclusion of the diving community and non-divers as well. The establishment of at least five underwater cultural sites is a parameter of operation sustainability of the sites as well as the increase of the economic activity in the region, in terms of diving and tourism in general. As a result, all benefits of this relatively low investment are directly attributable to the local communities. Future planning should incorporate the promotion of both ancient and modern underwater cultural heritage while impressive finds urge for the enhancement of further research, study and mapping of the sites at a regional level. What is more, UCH should be taken into account in terms of maritime spatial planning. With the support of Municipalities, Regions and Ministries of Culture and Tourism, the Underwater Cultural Heritage should be also included in the RIS+ in the next Programmatic Period and take advantage of funding opportunities (ERDF, Interreg or Fisheries Funds).

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Protecting marine biodiversity at accessible Underwater Cultural Heritage (UCH) sites and UCH diving parks

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Underwater Cultural Heritage (UCH) sites and UCH diving parks are typically found in coastal areas, which also happen to be some of the most biologically diverse areas on Earth, harbouring many of the world's plant and animal species and providing important ecological services. The high biodiversity and abundance of marine species found in these areas is often one of the factors that constitutes them very attractive to tourists, as well as snorkellers and divers. However, the increased attractiveness and visitability of these sites, inadvertently increases the pressure on the marine ecosystem leading to possible negative impacts and possible damage. Managers of UCH sites and diving parks should record marine biodiversity and abundance prior to opening the UCH sites to visitors as to create a baseline dataset for their ecosystem and continue monitoring on an annual or bi-annual basis if possible, in order to observe and changes and deviations. Further, managers should promote responsible snorkelling and diving and adopt good practices in order to protect and preserve the integrity of the ecosystems and species and attract visitors, thus sustaining the high-quality visitor experiences that will ensure the ongoing financial viability and economic health of local communities.

Keywords: marine biodiversity, diving surveys, photoquadrats, protection of marine diving sites, diving best practices

Diving into a sea of history. Communicating the Underwater Experience in a Museum: an Analysis of ARQVA's Interactive Media.

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Abstract: Museums are among the places that can offer dry dive experiences to non-divers. The mission of the Museo Nacional de Arqueología Subacuática.ARQVA (Cartagena, Spain) is to increase public awareness, appreciation and protection of underwater cultural heritage and to make public the activities of professionals who work for it, placing the focus on the concept of "archaeological site".

Some interactive stations are placed along the halls of the museum, with the aim of involving different types of visitors and bring them closer to the experiences of underwater archaeology; a summative evaluation that we've carried out at the museum in 2017 explore the relationship between visitors and these mediums and the different levels of engagement on the road to knowledge.

Keyword: Underwater archaeology; Public archaeology; Museum design; Interactive exhibits

1. IMMERSE YOURSELF IN OUR UNDERWATER CULTURAL HERITAGE

The Museo Nacional de Arqueología Subacuática, or ARQVA, in Cartagena (Murcia, Spain), is one of few museums in the world entirely dedicated to underwater archaeology. Unlike other similar institutions, however, it does not merely guarantee the conservation, use and promotion of a series of underwater finds.

As clarified in its founding statement2, ARQVA has set itself the goal of communicating the value of our entire underwater cultural heritage, promoting a greater awareness of its riches and the professional activities that work to foster its protection and conservation.

To do so, as the first panel in the exhibition space states, the museum "invites visitors to immerse themselves in our underwater cultural heritage."

The museum's architectural choices (VÁZQUEZ CONSUEGRA 2008) evoke in visitors the idea of a dive before their visit even begins; one of the museum's outer walls is made entirely of glass, allowing the public to view the finds from above.3 The entrance plaza is thus transformed into the surface of the sea, and visitors are conducted down a long ramp on their suggestive descent toward the artifacts.

The exhibition space is divided into three sections: "Patrimonio Cultural Subacuático" on the right, and "Mare Hibericum" and "Del Mar a los Oceanos" on the left. At visit's end, the walk back up the same ramp communicates the return to the surface after a dive.

The museographic project develops in a direction that is strongly connoted by this suggestion. In the sections "Mare Hibericum" and "Del Mar a los Oceanos," models of an ancient Greek kyrenia and a medieval coca float beneath the vaulted ceiling next to the large wall of glass. This reinforces the idea

2 Real Decreto 1508/2008, http://www.boe.es/boe/dias/2008/10/14/pdfs/A41176-41178.pdf
3 The exhibition level is built underground in an area which, until the mid-19th century, was under the sea.

that visitors are strolling along the seafloor and, by looking up, are seeing the water's surface on which the two ships are sailing.

Center stage in the "Patrimonio Cultural Subacuático" section is occupied by the to-scale reconstruction of the Phoenician ship "Mazarrón 2"; the entire right-hand side of the space presents an enormous LED wall that recreates themes and atmospheres from the marine world. This wreck, immersed in a virtual sea, is surrounded by reconstructions of a group of large buoys, whose red color is extremely eye-catching (Fig. 1). The buoys are actually interactive devices, both mechanical and digital, whose goal is to bring visitors closer to the experiences of underwater archaeology. They constitute a response to today's public's growing demand for spaces designed for practical, experimental learning, capable of creating an interaction that brings out the scientific and historical content the exhibition wants to communicate.

To analyze the functioning of these expository elements and assess their degree of attractiveness and usability, in 2017 a summative evaluation[4] was carried out via direct observation and questionnaires which has made it possible to define their strengths and weaknesses (COSSEDDU 2018). The evaluation's results allow ARQVA, as well as other museums and operators in the sector, to gain more in-depth knowledge of the variables present in the complex relational system between the public and a museum's interactive media.

Fig. 1. The to-scale reconstruction of *Mazarrón 2* surrounded by the buoys

4 The aim of this evaluation, conducted thanks to the collaboration and availability of the director and the entire museum staff, was to verify the effectiveness of the expository choices adopted.

2. THE UNDERWATER EXPERIENCE THROUGH INTERACTIVE MEDIA

The five buoys of the Patrimonio Cultural Subacuático[5] are dedicated to the topics of diving and the techniques of excavation, recovery and analysis in the undersea world. The goal is not only to take visitors down into the marine depths and show them how underwater archaeologists work, but also to explain the scientific principles that regulate the latter's activities.

All the buoys have the same structure: above a reddish-orange hemispherical base stands a cylindrical glass column full of water, inside of which the phenomenon in question takes place. Beside the columns are the command buttons and the screens that explain the phenomenon represented.

Buoy 1. Diving is easy (Fig. 2).

-Typology: digital and mechanical interactive device.

-Theme: the dive.

-Description: the column contains a small diver and a seafloor with a wreck.

-Functioning: the visitor begins the interaction by pressing a button that activates the diver's descent toward the wreck. When surfacing begins, the screen (Fig. 3) shows a comparison between the time spent in the marine depths and the relative decompression phases, inviting the visitor to wait the necessary number of seconds – the time displayed passes more quickly than normal, of course – to carry out the various phases correctly, and then to press the button again to continue the ascent to the surface.

-Data on usage: "attraction power"[6] was 0.79, the average stop time was roughly 1 minute and 30 seconds, while "holding power"[7] was 0.44.

Of the 89 people who stopped in front of the device, only 72 used it. 8 visitors used it more than once (the second-ranked element in this category), while on 6 occasions a discussion occurred between visitors in the same group with regard to its functioning.

It was also one of the 8 elements in the museum (out of a total of 65) toward which the 113 visitors surveyed showed clear and evident signs of annoyance.

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5 Another buoy, separated from the other five, is dedicated to the theme of the side-scan sonar surveys.

6 The ratio of visitors that stopped in front of the interactive element to the total number of visitors (SHETTEL 1992).

7 The ratio of the time spent by visitors with the interactive element to the time necessary to use it in a correct and complete manner (SHETTEL 1992)

Fig. 2, 3. Buoy 1. Diving is easy. The screen shows a comparison between the time spent in the marine depths and the relative decompression phases

Buoy 2. Objects change color under water.

-Typology: mechanical interactive device.

-Theme: the progressive absorption of color under water.

-Description: a luminous ball is present inside the column.

-Functioning: the ball descends toward the base, gradually changing color.

-Data on usage: "attraction power" was 0.69, the average stop time was roughly 55 seconds, while "holding power" was 0.66. Of the 78 people that stopped in front of the buoy, 67 actually used it (4 of them as viewers of others who were using it).

Buoy 3. The underwater vacuum.

-Typology: mechanical interactive device.

-Theme: principles regulating the functioning of the underwater vacuum

-Description: the water column is divided into two parts, one of which contains, on the bottom, the reproduction of marine sediment where the mouth of the underwater vacuum is present.

-Functioning: the vacuum removes the sediment and unloads it into the other part of the column.

-Data on usage: "attraction power" was 0.56, the average stop time was roughly 38 seconds, while "holding power" was 0.77.

Buoy 4. When objects speak (Fig. 4).

-Typology: digital interactive device.

-Theme: investigating the different types of objects that can be discovered under water.

-Description: the water column contains a bottle of Coca Cola and a fragment of a Roman amphora. At the base of the column is an interactive digital screen.

-Functioning: when visitors click on the button, they have two minutes to take a quiz about the two objects.

-Data on usage: "attraction power" was 0.63, the average stop time was roughly 71 seconds, while "holding power" was 0.71.

Buoy 5. The lifting balloon (Fig. 5).

-Typology: mechanical interactive device.

-Theme: recovery of objects from the seafloor.

-Description: in the water column is present a lifting bag attached to a basket with a small amphora.

-Functioning: when the bag fills up with air, it floats upward and brings the basket with the amphora inside with it.

-Data on usage: "attraction power" was 0,48, the average stop time was roughly 52 seconds, while "holding power" was 0.62.

Fig.4. The buoy 4. When objects speak

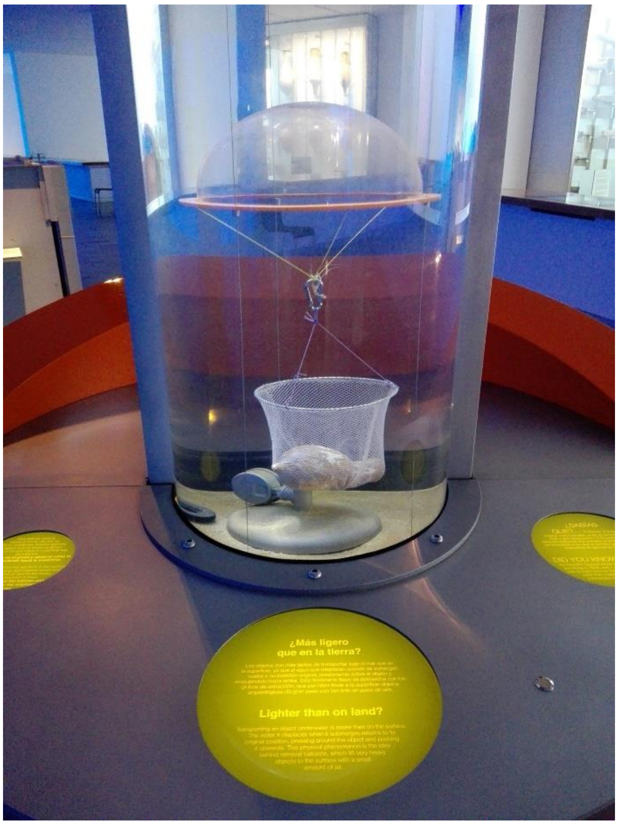

Fig. 5. Buoy 5. The lifting balloon

3. CONSIDERATIONS

Analysis of the visit itineraries in this section (COSSEDDU 2018, pp. 284-285) has shown that the buoys significantly influence the choices of visitors, who prefer them to the panels and videos.

The evolution of the interactive media's "attraction power" however, reveals a gradual diminishing of their usage, which goes from 0.79 for the first (nearly four out of every five visitors) to 0.48 for the last (less than one out of every two visitors). This datum indicates that the public was not entirely convinced by the experiences proposed.

The questionnaires given to visitors to evaluate elements of the museum also appear to confirm this finding: the buoys achieved a score of 5.98/7, which in theory is a good result, but actually positions them only in fourth place (out of a total of eight typologies of exhibition elements investigated) in this special visitor approval classification.

What's more, the interactive elements were the second most-criticized category; some felt they were too simple, indeed more suitable for a public of children, while others complained that the phenomena were not represented with sufficient clarity.

This contrasting picture is the sum of particularly positive aspects and others that, in order to reach their goal, would benefit from various modifications.

Among the factors that have a positive impact on the use and comprehension of the buoys are their closeness to one another and the recognizability of their design; in fact these stations are positioned around the wreck of the "Mazarrón 2", almost as if to mark it out on the surface of the museum-sea, and are also distinguished by their identical color and design.

Physical accessibility is guaranteed by a height appropriate for both adults and children, while the lack of archaeological finds in this section8 makes it possible to avoid one of the most frequent problems for museums equipped with interactive elements: the competition between these types of media and the finds on display, which often end up being obscured.

By choosing to tackle the scientific principles at the foundation of underwater archaeological fieldwork, the museum has also diversified its target audience, speaking not only to those interested in history, but also to visitors fascinated by the technical and scientific aspects as well. Also interesting in this sense is the museum staff's attempt to respond to hypothetical questions visitors might ask themselves, putting themselves in the public's shoes and making sure the visitors are at the center of the museum experience, even at a preliminary, organizational phase.

Moving on to the negative aspects, the most important of them is certainly the scant level of interaction generated. Visitors do not have the chance to choose between various options, they are not challenged, but are merely asked to activate a demonstration by pressing a button and then be passive spectators, which risks creating possible feelings of frustration or boredom. The only genuine exception is interactive digital element n. 4, which registered an elevated "holding power" despite requiring a stop of at least two minutes.

Another factor that limits the use of the buoys, despite the presence of the digital screens that explain the phenomena investigated, is the lack of simple and direct communication. Museum visitors are notorious for their impatience with reading instructions, preferring to proceed by trial and error (HEIN 1998). This phenomenon manifested itself particularly with interactive element n. 1, where the public is invited to wait the necessary time for the decompression stops before proceeding with the surfacing maneuver, yet almost no one did so.

It is also possible that uniformity in design alone is insufficient to clarify the relationship between these media. A different communicative choice could have made visitors aware that they were beginning a journey through the scientific phenomena at the foundation of an underwater dig, and thus increased their comprehension and engagement.

A final aspect that should be strengthened is the relational context. Many visitors choose to go to museums in a group, using the visit first and foremost as a social experience (FALK, DIERKING pp. 146-172). ARQVA's buoys, however, can only be used by one person at a time; thus one person is the

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8 The few artifacts present in the section, rather than communicating their own particular historical/archaeological contexts of provenance, have the function of recounting the phases of excavation, recovery and conservation.

protagonist, and all the others have to settle for being spectators. This problem could be remedied by recreating, inside the museum, the relationship formed between dive companions; the many procedures the latter undertake together (dressing, checking equipment, using communication signals in the water, the ways of conducting diving activities and, more generally, the constant mutual surveillance) lend themselves perfectly to the creation of interactive group activities.

After all, since for reasons of security and enjoyment it's better to go on a dive with a companion you can trust, it's equally preferable to share a museum visit, taking advantage of that cognitive accelerator provided by the participation in new group experiences.

4. FINAL REFLECTIONS

To communicate the experience and emotions of underwater archaeology to the public without leaving the rooms of a museum, ARQVA relies on precise architectural choices and a wide range of communicative techniques in which interactive media play a central role. These tools, which have now been present in museums for many years, continue to evolve and multiply, because they allow the public to participate actively in the learning process that develops during the visit.

By choosing not to use every space in the hall to exhibit objects from its collections – a painful choice for many curators – ARQVA shows that it has overcome the old conception of the "object-centered" museum, whose principal end is to catalogue objects in order to conserve them. The Spanish museum, on the other hand, was created with the aim of being "discourse-centered" and putting narration at the center of its museological project (PUJOL TOST). This type of approach makes it possible to overcome the barrier erected due to the intellectual effort necessary to understand and codify the artifacts exhibited. The interactive elements dedicated to the dive experience also enable it to overcome another taboo common to many art, history and archaeology museums: the possibility of tapping into visitors' interests by transmitting ideas that can have practical applications.

The investigation conducted at ARQVA shows, however, that in the case of interactive elements it is necessary to make further progress to effectively transmit the museum's cultural authoritativeness and riches to visitors, allowing them, via interactive activities and the possibility of making autonomous choices and a more extensive social usage, to determine the outcome of their experience and share it with the rest of their group.

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Raising the awareness about underwater archaeological heritage through Edutainment and Virtual/Augmented Reality

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***Abstract*:** The recent developments of underwater photogrammetry have brought to a wide diffusion of the practice to digitally record the 3D models of submerged cultural assets. These 3D models can be used to implement software applications devoted to improve the digital accessibility to both scholars and the general public, interested in having a better grasp of underwater sites and maritime archaeology. This kind of applications can benefit from the edutainment approach in order to educate, entertain and inspire the wider public through creative storytelling and self-motivating learning.

In this context the Horizon 2020 i-MARECulture project (Advanced VR, iMmersive serious games and Augmented REality as tools to raise awareness and access to European underwater CULTURal heritagE), funded under the call 'Virtual museums and social platform on European digital heritage, memory, identity and cultural interaction' (CULT-COOP-08-2016), aims to develop and integrate serious games, interactive storytelling, immersive technologies and underwater augmented reality for supporting the wide public in acquiring knowledge about the European maritime cultural heritage.

This paper will focus on two of the various applications developed in the i-MARECulture project and in particular to the ones focused on the case-study of the underwater archaeological Park in Baiae near Naples. The first application is a Virtual Reality dry visit experience that enables every user to explore the "Villa con ingresso a protiro" without the need to conduct a proper dive. Furthermore, the same hypothetical reconstruction of the Villa can be enjoyed by divers directly underwater by means of an Augmented Reality system based on a specially designed underwater tablet that will serve as a virtual guide for divers that visit the underwater archaeological sites.

Keywords: i-MARECulture, Virtual Diving, Underwater Augmented Reality.

1. INTRODUCTION

1.1. Scope

The main goal of the i-MARECulture [1][2] project is to raise public awareness of European identity by focusing on maritime cultural heritage, which by default brings together different civilizations. In particular, the project aims in bringing inherently unreachable underwater cultural heritage, within digital reach of the wide public, by implementing virtual visits, serious games with immersive technologies and underwater Augmented Reality (AR). Scope of the project is to design, analyze, develop and validate pioneer applications and systems in the context of Virtual Museums through collaborative and innovative research from a diverse group of scientists, researchers, archaeologists, experts and museums. The project merges the advancements in Virtual and Augmented Reality (VR and AR) with the underwater environment. By using existing technology, it is already delivering through its new website (www.imareculture.eu) breakthrough applications and digital experiences in the area of Virtual Museums, empowering different types of users to engage with European underwater cultural heritage digital resources.

1.2. Approach

Submitted in the call 'Virtual museums and social platform on European digital heritage, memory, identity and cultural interaction' (CULT-COOP-08-2016), the i-MARECulture project investigates and delivers new ways to personalize the museum visit for a digital or physical visitor, while supporting social cohesion and European identity. Virtual museums are particularly strong in visualizing CH that is either intangible, does not exist anymore, is partially destroyed or is remotely located. Ancient maritime commerce represents a perfect example of civilizations' interaction and cultural exchange, but unfortunately not easily exhibited to the wider public. Ships, shipwreck sites and underwater sites in general are far from public's reach and understanding. Enabling immersive technologies to allow for content enhanced dry visits of visitors on such sites, i-MARECulture project is raising public's awareness and stirs further interest about maritime culture.

One of the main goals of the project is to bring shipwreck sites to the reach of the wider public, so that they can have a personalized and interactive dry visit using VR headsets from the comfort of their house. Museum visits could be further enhanced by using immersive technologies, such as VR caves and holographic screens. The latter allows for all visitors to witness an interactive 3D experience of another visitor, since they carry no special glasses or any other equipment while freely walking around the objects under investigation. Regarding these dry VR visits, the focus is given to the quality of immersion into the virtual world, using as much detail as possible and high-end equipment.

Moreover, within the project, AR applications are developed in order to enhance the underwater experience of diver visitors, as there are submerged archaeological sites. Specially designed underwater tablets and smartphones provide assisted navigation to the diver/visitor and, using AR and custom applications, give additional information about specific exhibits based on proximity and diver's preferences. After the end of the project, these AR applications will be used to explore a sunken city, where the AR tablet will provide the diver with conceptual designs of the original status of villas and related constructions, which are now laying in ruins.

Following the need to extend any visit, serious games and storytelling encourage and surround the physical visit both before and after it. As a pre-visit experience, users will be able to participate in a seafaring game, sailing between ancient ports for commerce, using the limited resources and limitations of that specific time period. Similarly, as a training tool for archaeologists, experts will be able to partner up for a virtual excavation dive on an ancient shipwreck, with all limitations and problems that such dives have, and learn the use of the airlift.

Three sites have been carefully selected for project's implementation, based on their potential to support the context of each action, as well as their data availability, so that no assets were to be allocated on data acquisition: the Mazotos shipwreck site, the Xlendi shipwreck site and the Baiae underwater archaeological park.

Lately, i-MARECulture project delivered two libraries of 3D ship models and amphorae of the studied period. The 3D objects of these libraries are used in serious games. The libraries are designed with ontology, so that they can be useful for further archaeological archiving and are released to the public through the webpage of the project: www.imareculture.eu. All actions are being evaluated in order to attain measurable results and are enhanced by appropriate storytelling. It should be also mentioned that the experienced maritime archaeologists involved in the i-MARECulture project ensure the historic accuracy of every aspect, both through storytelling as well as realistic representations and game scenarios.

2. STATE OF THE ART

VR and augmented reality have been used in a number of occasions for allowing users/tourists to explore cultural heritage as well as educating them [9][21]. For underwater cultural heritage there have been fewer applications, due to the difficulties of the environment.

For exploring underwater cultural heritage in VR, geolocated and multi-resolution textured 3D models of underwater archaeological sites have been used [11]. In another study, more specific methods for realistic modelling and VR presentation of underwater archaeological assets were presented based on the Mazotos shipwreck site [17].

The virtual diving exploration of Cala Minnola shipwreck site [24] allowed users to perform an entertaining and interdisciplinary learning experience by receiving archaeological, historical, and biological information by means of a number of points of interest (POIs) and a virtual dive buddy that guides the users during the exploration of the digital replica of the submerged site.

Moreover, educational applications were proposed such as a training system for real-time underwater excavation in VR [16] and another one to teach the basics of photogrammetry to maritime archaeologists [14].

Conceptual gamification framework is proposed in [3] as framework for VR applications based upon the use of game elements in a 360-degrees video environment to enhance user interaction with a case study of the cultural heritage site, in Rethymno city, Greece. This application uses 360-degrees video to convey information about this historic place.

Russian Hermitage Museum [4], has produced the application called The Hermitage VR Experience. This novel VR experience for visitors is a 19-minute movie in 360-degrees format, where the actors and the narrator are performing selected scenes from Hermitage palace's history.

In Livia's Villa Reloaded [5] actors are telling the story in the 3D reconstruction of the Livia's Villa.

A Night in the Forum is an Educational Environmental Narrative Game that uses PlayStation®VR to take the users back in time to The Roman Forum during Augustan rule [6]. The game is happening in the virtual reconstruction of the Roman forum, where the user has a role of a guard and carries out assigned tasks through which he/she learns stories of Augustus and about Roman citizens during a time.

VR storytelling is also used in [3][7][8] demonstrating how this way of communicating information is efficient, engaging and attractive to the users. To our knowledge, this storytelling methodology has not been used by now in UW applications.

Concerning underwater AR applications, the first one described in literature was developed in 1999 [15] where an HMD for Navy divers was presented. A more sophisticated system was presented in 2009 by Morales et al. [18]. It consists in an Underwater Augmented Reality (UWAR) system that provides visual aids to increase commercial divers' capability to detect, perceive, and understand elements in underwater environments. The AREEF system which allows people to discover underwater word of corals, fishes or fairy-tale wrecks in a swimming pool in a comfortable and safe way [10]. Successively, in 2013, the AREEF system was improved in order to be used by more than one person [19] and also by children [20].

3. DRY VISIT IN VIRTUAL REALITY

The dry visits application consists in a Virtual Reality experience that enables the users to simulate a real diving session from the scuba diving viewpoint and explore the 3D digital replica of the three pilot sites selected for the i-MARECulture project. Since this paper focuses on the case-study of the Baiae underwater archaeological park, this section describes the dry visit applied to the scenario of "Villa con ingresso a protiro". Nonetheless, it is worth to point out that the dry visit application has been designed and developed to enable the users to explore all the three underwater archaeological sites' scenarios, which will be dynamically loaded in runtime from a single application. Starting from a virtual environment menu, the user can select the site to explore, view the related video-interviews, play the tutorial and start the virtual diving experience. The user wears a Head Mounted Display (HMD) to navigate the virtual environment and interact with some 3D objects to receive historical and archaeological information about the submerged artefacts. The light-weight helmet isolates the user from the distractions of the actual physical environment and encompasses the entire field of view. It contains a high-resolution stereoscopic display; adjustable optics; an optical tracking system capable of tracking both the position and the orientation of the user's head; and a stereo audio output. Moreover, the HMD is usually coupled with one or two wireless handheld controllers equipped with several buttons, joystick and a touchpad as a means of human-computer interaction.

Fig. 1: A user interacting with the VR system to explore the underwater area of "Villa con ingress a protiro".

The interactive virtual scenario of the "Villa con ingresso a protiro" has been created starting from the 3D reconstruction of the underwater archaeological area. This digital replica of the submerged site has been enriched, by means of the Unity editor, with the surrounding seafloor, flora and fauna, the terrestrial environment (coastline, etc.), and additional 3D models (boat, buoy, etc.). Furthermore, graphical effects have been added to the scene to simulate the underwater environment, thus enhancing the realism of the experience. In particular, these effects include physical accurate simulation, such as light rays, refractions, fog, caustics, particles and bubbles. Moreover, the 3D models of the flora and fauna replicate the plants and fishes who populate that specific marine ecosystem, i.e. the

Mediterranean Sea. In order to maximize enjoyment and engagement by capturing the interests of the users, the virtual scenario has been then populated with 3D models that represent the points of interest with associated multimedia data. In particular, they can contain: audio files that provide archaeological, historical and biological information; the activation of a 3D hypothetical reconstruction of the "Villa con ingresso a protiro"; 360-degrees videos settled in the hypothetical reconstruction scenario. In order to simplify the management of the multimedia contents, they are stored into a remote database and they can be accessed from the dry visit application by means of a web service and a RESTful API.

The hypothetical reconstruction is a 3D virtual environment that shows the complex of "Villa con ingresso a protiro" as it appeared in the past [23]. It has been achieved by means of a theoretical and multidisciplinary scientific approach [23] that exploits the 3D data together with drawings and other historical and archaeological information in an iterative feedback reconstruction process. This process involved several professional figures and consisted in several phases. It started with the gathering of data (historical documentation, 3D models, scientific literature) and its analysis that led to the formulation and the investigation of different interpretation hypotheses. Then, the architectural remains have been modelled and validated by means of an iterative critical revision. In particular, this process is based on interleaving a phase of technical reconstruction with a strong critical revision to generate a feedback process, iterating the construction/correction loop as much as needed. The result is the final 3D reconstruction, as it appeared in the past, of the "Villa con ingresso a protiro" (Fig. 2). It's worth to point out that, thanks to the abovementioned iterative feedback process, the hypothetical virtual reconstruction has been examined and approved by the scientific experts [23].

Fig. 2: Different portions of the 3D hypothetical reconstruction of the Villa: the impluvium (a), the room with the pelte mosaic (b), garden (c), columns (d).

The game logic of the dry visit application presents three distinct elements: exploration, storytelling, and interaction. In order to simulate a real diving session, the exploration starts above the water surface, where the user can see the coastline that overlooks the archaeological site, as well as additional 3D models representing the boat and the buoy. Once the user dives in the submerged virtual environment, he/she can explore the underwater area and interact with the POIs that provide historical and archaeological information. A virtual dive buddy guides him/her among the six 360-degrees short videos that have to be played in a very specific order, since they compose a story settled in the ancient Baiae. Moreover, as already specified above, a special POI enables the user to switch from the 3D representation of the Villa to the reconstruction of its ancient status. Once activated the virtual hypothesis environment, the user can "walk" into the Villa and explore its original magnificence. The user interaction occurs by means of an HMD technology to look around and one or two wireless controllers that enable the user to explore the virtual environment and interact with the POIs. Moreover, a directional arrow and the virtual dive buddy show the direction to reach the underwater archaeological area and related multimedia content.

The results of the preliminary tests have shown that this virtual experience represents an effective tool to enable the citizens to access to the Underwater Cultural Heritage, in particular to the "Villa con ingresso a protiro" in the underwater archaeological Park of Baiae.

3.1. 360 Storytelling

In order to introduce the users with the life during the Roman Empire, we created a set of 360-degrees videos according to the scenario proposed by the archaeologists. The story is about a rich aristocrat who is buying a statue from a sculptor to decorate the garden of his luxurious villa. As parts of the story are activated during the VR exploration in different locations in the underwater Villa remains, we divided the plot in the following segments:

- the intro story consists of a 360-degrees video sequence of Baiae remains on land with a voice over introducing the viewer to the city and its historical significance, as well as the place where the plot is set;
- the sculptor's workshop scene where all characters introduce themselves (the sculptor, his apprentice, the aristocrat, and the slave);
- the street with shops scene where the sculptor tells his apprentice how beautiful is Baiae and prepares him for the meeting with the aristocrat;
- the villa entrance scene where the sculptor and his apprentice are greeted by the doorman and let inside the villa;
- the room with mosaics scene where the slave announces the visitors to the aristocrat;
- the atrium scene where the sculptor is introducing his apprentice to the villa;
- the discussion of the sculptor and the aristocrat about the statue design and price.

The stories (except the intro) are combinations of actors recorded against the green screen with computer generated backgrounds. Background images are renders from 3D villa reconstruction model, as well as 3D models of a generic street with shops and sculptor's workshop. The video is accompanied by 3D sound in order to obtain the full user immersion.

The main challenge of VR storytelling was to direct the story in a way that important replicas or parts of the plot do not remain unnoticed by the viewer, as he/she can now turn around and his/her field of view is not limited anymore, as in the case of classic video. However, this possibility increases user immersion in the scene and provides an opportunity for exploring the details of the environment, which is particularly useful in virtual cultural heritage reconstructions. The stories have, apart from giving the users a hint on the life in ancient Baia, also enabled them to perceive the decorations and various details of “Villa con ingresso a Protiro”, creating impressions that they are really there.

Fig. 3 shows the work of various professionals involved in stories production (director, producer, cameraman, actors, make-up artists, graphic designers), while in Fig. 4 are presented screenshots from some of the stories.

Fig. 3: The stories production team.

Fig. 4: Screenshots from Baiae VR storytelling.

3.2. PRELIMINARY TESTING

Informal testing has been performed for the VR Baiae dry visit application. In particular, the application was shown to 6 VR experts as well as 6 VR students. Initial results indicate that the application is immersive and interesting. Some minor issues were spotted including scaling of the interactive storytelling actors/agents. Overall, the experience was rated as positive and a formal evaluation with questionnaires is currently on its way.

Specific study was conducted to evaluate if the use of actors contributes to the immersion and edutainment of the VR cultural heritage application [22]. First, we have performed a heuristic evaluation (HE) by 5 experts in the field of VR/AR development and UX experience. The results of the HE facilitated design of the questionnaire for user experience study. The study involved 23 participants, and evaluation included both quantitative and qualitative part. Perceived user experience was measured with web-based structured questionnaire, and the evaluators were observing the study participants while they were engaged in the VR digital stories.

Our study showed that the use of actors in VR storytelling contributed to the quality of user experience and evoked positive level of immersion and indicated beneficial effect for edutainment, since users learn through the empathy with actors. The results brought to our attention significance of eye-contact with the actors for immersion and of proper use of cues for directing the user attention in 360-degree videos.

4. UNDERWATER AUGMENTED REALITY

As evidenced in section 2, the experimentation of Augmented Reality (AR) in underwater environment is a challenging research field and, however, it has been never done in submerged cultural sites mainly because several technical challenges need to be resolved for implementing a sufficiently accurate method for absolute localization and tracking in the marine environment.

In the i-MARECulture project two different systems have been developed to perform an augmented visualization representing the hypothetical 3D reconstruction of the archaeological remains as appeared in the past by means of a commercial tablet housed in a waterproof case. The first system integrates a marker-based tracking with inertial sensors, while the second one adopts a marker-less approach that integrates acoustic localization and visual-inertial odometry.

4.1. MARKED-BASED AR

Estimation of the user/diver position in AR is one of the most challenges issues. Even if nowadays there are a number of good approaches for terrestrial applications, in underwater environments the situation is very different. Sensor based approaches are typically limited to acoustic tracking but one the main disadvantages, amongst others, is the cost of the sensors. On the other hand, computer vision approaches can be also used with a promising result. The focus of this research is to develop AR interfaces for underwater environments for different weather/turbidity conditions. This was a big challenge due to the variability of the underwater visibility conditions.

We introduced a new method [12][13] based on white balancing that enhances underwater images to improve the results of detection of markers. To assess the effectiveness of our results, a pilot underwater testing was performed in underwater archaeological park of Baiae. The focus of the testing was limited to one building that lies on the sea bottom: "Villa con ingresso a Protiro", with a characteristic mosaic in one of the rooms. Divers were able to perceive the abovementioned 3D hypothetical reconstruction of the villa in AR. Fig. 5, illustrates screenshots of preliminary user testing at Baiae.

Four current methods of underwater image dehazing that restore the visibility decreased by underwater environments were implemented and evaluated for their capability to improve marker detection for augmented reality. The evaluation of dehazing techniques was carried out by comparing the number of successful marker detections in several test videos. Results show that the marker tracking performance may differ greatly according to depth, location, and the actual light and turbidity conditions. Our method (underwater white balancing) combined with a fast marker detector gives better results than more sophisticated marker detector that runs much slower [12][13].

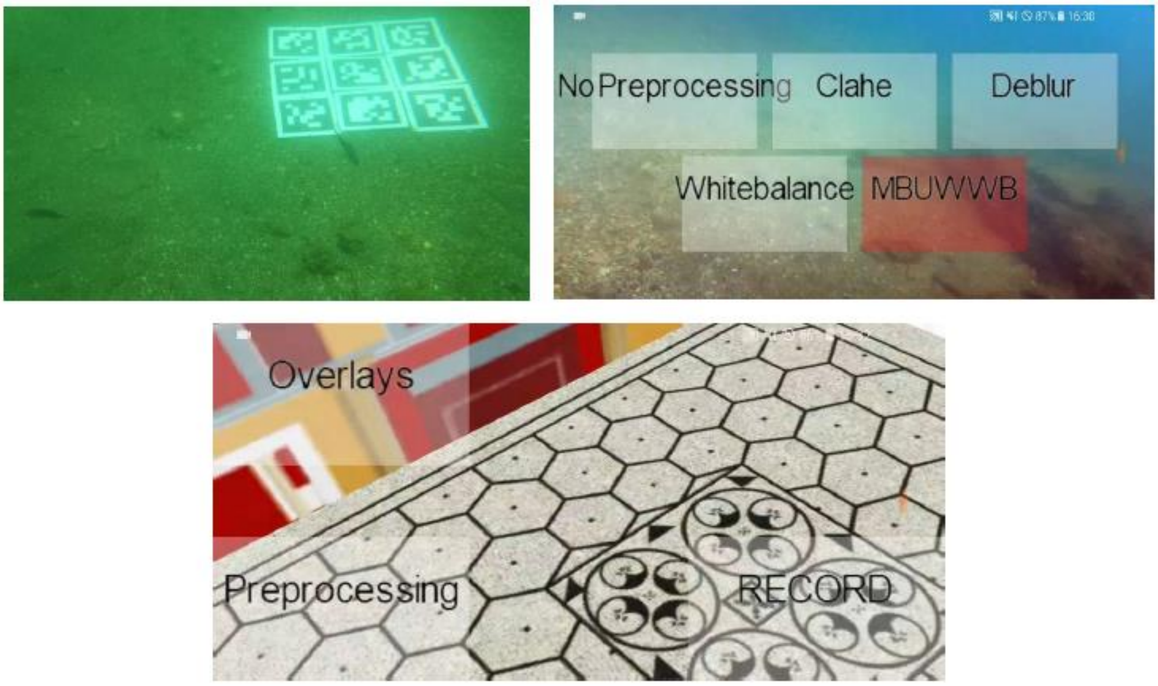

Fig. 5: Upper left: markers detected by iMARE Demo June18, placed in the grid of 3x3 markers. Upper right: multiple image processing methods, selected Marker Based Underwater White Balancing. Lower: 3D model of Villa placed on the location of markers.

4.2. MARKER-LESS AR

The marker-based UWAR approach requires to prepare the environment by placing fixed visual markers on the seabed, in order to estimate the orientation and position of the device with respect to the real world and to perform the superimposition of the virtual elements in the scene. During the i-MARECulture activities, a marker-less approach that employs a more general underwater localization and eliminates the need of markers for the localization of the device has been developed too. The Global Positioning System (GPS) is capable to provide geolocation and time information almost everywhere there is an unobstructed line of sight between a GPS receiver and four or more GPS satellites. Unfortunately, the radio GPS signal is strongly attenuated by the water and thus it cannot be employed for underwater localization. Instead, localization systems based on acoustic signals are used in this context. These systems employ the trilateration technique to calculate the position of a target using the distances calculated between the target and three or more acoustic transponders placed in known locations. The quality of the augmented visualization provided through a marker-less approach is strictly related to the precision of the underlying diver's position tracking, and consequently to the underwater acoustic positioning systems which suffer from low update rate and low accuracy. Since AR visualization requires a high frame rate to operate properly, it is quite evident that such acoustic localization systems alone are inadequate for this purpose. In fact, the update rate of the acoustic positioning system alone is around 0.2 Hz, and this is too low to deliver a seamless AR experience due to the long delay between two subsequent positions provided by this system. In order to overcome this limitation and improve the performance of the proposed UWAR technology, the acoustic positioning system has been integrated into a hybrid tracking system which merges positioning data, generated by the acoustic system, with data coming from a Visual Inertial Odometry (VIO) framework. In particular, given the low update rate of the acoustic system, it has been implemented a data fusion strategy aimed to fill the gaps between two consecutive acoustic positioning data. This enables a consistently high frame rate and provide to the user a consistent and smooth AR visualization.

The hybrid tracking system has been integrated in a cross-platform application made using Unity 3D, a game engine developed by Unity Technologies mainly used to develop videogames and simulation for several devices. This application, namely the UWAR app, exploits the hybrid tracking to help the divers to locate themselves during the exploration of an underwater archaeological site, allowing to obtain information about some point of interests and to see the original structures superimposed on the current status of the seabed. The UWAR app runs on an underwater tablet which is composed of a waterproof housing where a commercial tablet is placed. The app is provided with an Augmented Reality (AR) feature that enables the diver to live a new and more immersive experience compared to a classic recreational dive. The AR allows the diver to view the hypothetical reconstruction of the structures and artifacts that are superimposed on the present status of the underwater archaeological site. The diver can switch from the actual state of the archaeological site to the hypothetical reconstruction using a dedicated button in the User Interface (UI). For the sake of clarity, this button has been highlighted in **Fig. 6**a; the label "Present" suggests to the user that he is visualizing the actual state of the underwater site. In this case, the actual state of the underwater site is rendered through a planimetry where the different areas of the villa are easily recognizable.

(a) **(b)**

Fig. 6. UWAR app UI. (a) Top-view visualization of the underwater site planimetry; (b) First-view visualization of the hypothetical reconstruction.

Once the user pushes the button highlighted in **Fig. 6**a, the concerning label switches its text to "Past" indicating that the user is visualizing the hypothetical reconstruction of how probably the site looked in the past. The diver can choose the type of visualization between the top-view (**Fig. 6**a) and the first-person view (**Fig. 6**b). The top-view is especially suitable to orientate in the underwater environment whereas the first-person allows to fully enjoy the AR view modality. While in AR modality and first-person view, the user can move around the tablet, rolling and pitching, in order to change the point-of-view of the camera.

A validation test on the field of the UWAR application has been performed both before and during the official test session held in Baiae in June 2018 and June 2019 (**Fig. 7**). Different users that belong to the partnership of the i-MareCulture project tested the UWAR application by employing it for the augmented exploration of the underwater archaeological site of "Villa con ingresso a Protiro". All these users have been requested to evaluate the overall usability of the application, the ease of use of the UI and the interactions with the AR features.

Fig. 7. Pictures from the official test session held in Baiae in June 2019.

5. CONCLUSIONS

The paper has presented novel VR and AR systems that can improve the accessibility of the submerged archaeological sites by both divers and non-divers tourists. In particular, the VR dry visit application, developed in the H-2020 funded iMARECulture project, and here presented, provides to the large public the possibility to enjoy a dry dive in the Italian pilot site of the project that is the "Villa con ingresso a protiro" in the underwater archaeological park of Baiae. The VR experience is enriched with 360-degrees videos for providing additional contents through the storytelling approach.

The tablet-based AR system is addressed to support the divers' visits by showing them their position over the 3D map of the underwater archaeological site. The tablet also provides an augmented visualization representing the hypothetical 3D reconstruction of the archaeological remains as they appeared in the past during the Roman era.

Two different tracking technologies are described: the first uses an acoustic localization device and the second an optical maker-based approach. Although the latter is the most cost-effective solution, since it does not need the acoustic device, it requires the area to be populated by artificial visual markers and to keep them clean since just a few days are sufficient to be covered with a thin layer of biofouling that makes them completely unintelligible.

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Results of the "Sommergiamoci" Project in the MPA Gaiola Underwater Park

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***Abstract*:** This work is aimed at presenting the results of the "Sommergiamoci" (Let's dive) project carried out in the Marine Protected Area Gaiola Underwater Park (Bay of Naples, Italy). The project started in 2015 and it was focused on the implementation of a new sustainable and non-invasive system for the visit of the underwater archaeological and environmental heritage of the Park. Particularly, the Gaiola Underwater Park preserves the remains of a I century BC Roman Villa (part of the Pausilypon archaeological complex) and a very rich marine fauna. The goals were to both develop a system that could guarantee a sustainable and not invasive access to the underwater ruins, and, at the same time, to allow those that will never SCUBA dive to experience something that otherwise would be totally un-accessible. Thanks to the development of an innovative technology, which allows the direct audio/visual communication between a SCUBA diver and public on land, now 35 visitors per time can enjoy a dry dive experience. The result was obtained through the realization of a highly technological room in the visitor center of the Underwater Park, where a 3D immersive audio-visual communication with the SCUBA diver is obtained thanks to the use of wireless technologies. The project was realized by the Centro Studi Interdisciplinari Gaiola onlus in collaboration with the Campania Archaeological Superintendence, the Universities of Naples Parthenope and Federico II. In this work, we will present both the results in terms of public accessibility and in terms of technological development, explaining the difficulties and the challenges and how they were solved.

Keywords: Underwater Park, sustainable tourism, SCUBA diving, accessibility, dry dive experience.

1. INTRODUCTION

The "Sommergiamoci" (Let's dive together!) Project was carried out in the Marine Protected Area "Gaiola Underwater Park" in Naples (Italy). This Marine Protected Area (MPA), instituted in 2002 with the Inter-Ministerial Decree 78/2002, is the smallest in Italy and it is named after the two small islands located in the North-Western side of the Bay, along the Posillipo Coastline.

The Gaiola MPA is characterized by relevant biological and geological evidence, moreover, because of the intense geomorphological activity of the area, which caused the lowering of the coastline throughout the centuries, the seabed of the MPA is rich in archaeological ruins, part of a rich Roman villa dating to the I century B.C. "Simeone and Masucci (2016)". Since 2005, the Centro Studi Interdisciplinari (CSI) Gaiola onlus, in agreement with a local body of the Ministry of Culture, is in charge of the preservation, scientific dissemination and promotion of the important environmental, geological and archaeological heritage of the Park. The CSI Gaiola onlus is a National NGOs instituted to promote scientific research, preservation and dissemination of the environmental and archaeological heritage, with a special focus on the Northwestern side of the Bay of Naples and the Posillipo area.

The Gaiola MPA, in fact, is located in the densely inhabited city of Naples and still today the main challenge in managing the Park is to find a balance between sustainable accessibility and preservation of the environmental and archaeological heritage "Simeone and Russo (2005)". Even if, since 2007 a positive trend on the registration of illegal activities in the MPA has been recorded, the difficult social and economic context of the city is still characterized by a general lack of awareness on the importance of this Underwater Park. In fact, in 2015 it was demonstrated how there still was a lack of awareness on the existence of the underwater heritage in the Gaiola MPA, because of the difficulty in accessing what lies underwater and in recognizing to the underwater heritage the same value of the onland sites "De Vivo (2015)". This problem is obviously not related only to the Gaiola MPA, but to any underwater site preserving environmental and archaeological heritage and this is the reason why many studies and strategies have been carried out to find solutions and to make underwater heritage more accessible "Davidde (2004)".

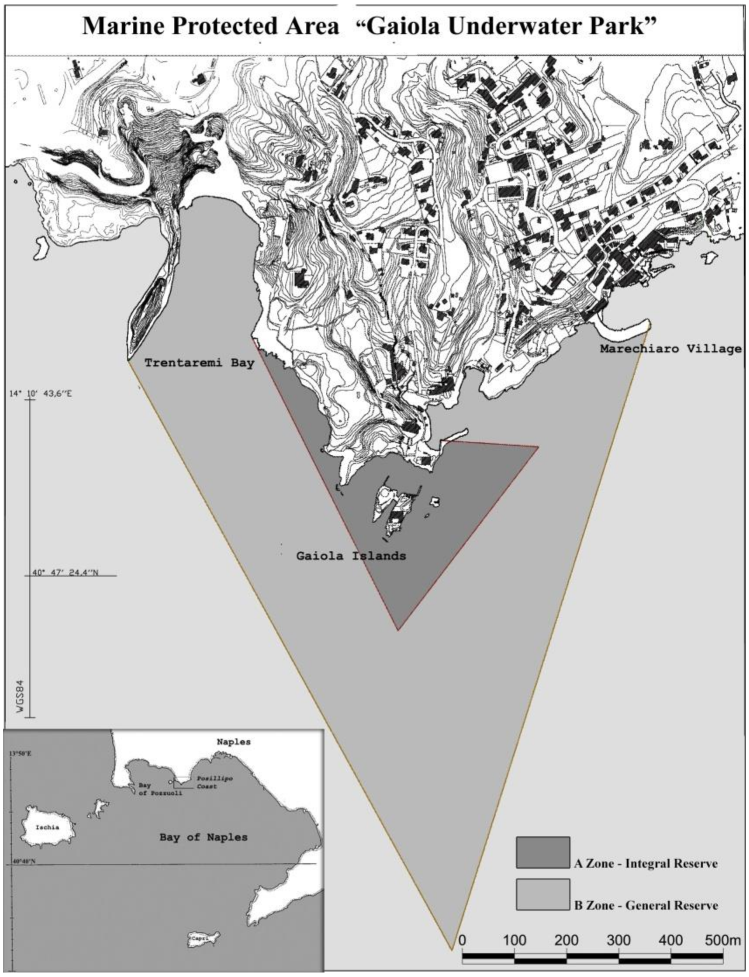


Fig. 1: Map of the Marine Protected Area Gaiola Underwater Park

Being aware that public awareness and participation are fundamental to guarantee the protection of this kind of site, as also prescribed by the 2001 UNESCO Convention on the Protection of Underwater Heritage "UNESCO (2001)", it is crucial to work on the awareness of the new generations. In fact, since 2006 the CSI Gaiola onlus carries out the environmental and heritage education project "The Sea of Naples" addressed to schools and, at the same time, collaborates to study programs with Neapolitan universities. Since 2006 an always increasing interest of students and teachers it has been recorded for educative programs aimed at the acquisition of competences through a "learning by doing" approach (Chart 1).

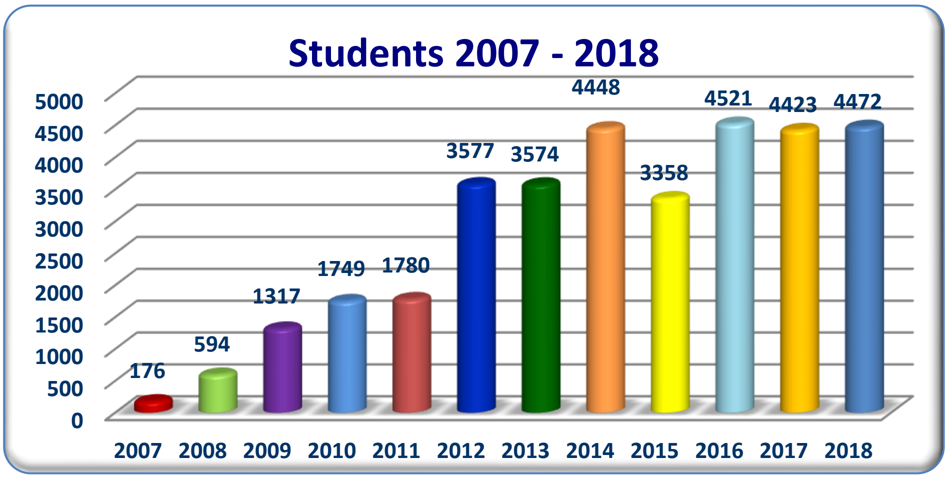


Chart 1

Despite this need of the schools, the accessibility of the MPA is limited because of logistic problems. In fact, the accessibility of the underwater heritage requires a confidence with the marine environment that not all the students naturally have. Particularly, snorkeling and SCUBA diving still have a limited audience and most Italian teachers would not feel comfortable to let students practice these activities under their responsibility. Moreover, due to climatic conditions, the request for didactic programs in the MPA is mostly concentrated in the late spring and summer months, which is a problem for the sustainable accessibility of the site.

At the same time, if it is true that the underwater heritage is still considered difficult to access, it is also true that the increasing of the underwater tourism is always more in conflict with the preservation needs of MPAs "Hawkins and Roberts (1992)2; "Agnesi et al. (2001)"; "Cattaneo-Vietti and Tunesi (2007)", especially as regards special biocoenosis, Total Reserve Areas and areas particularly at risk of damages related to mass tourism. As regards underwater archaeological ruins, there is deep knowledge of the damages caused by human impact on archaeological heritage "Palumbo (2002)".

Therefore, the Project "Sommergiamoci" was aimed at increasing the level of awareness, especially of the young generations, on the archaeological and environmental heritage of the Park, by using innovative technologies and methodologies which allow to have a direct dry dive experience of the underwater environment in a non-invasive way. Moreover, the project allowed to experience and to discover underwater areas where it is necessary to limit the access of the public for preservation needs and could be a useful research tool both in the fields of archaeology and marine biology.

Partners of the Project were the Soprintendenza Speciale per i Beni Archeologici di Napoli e Pompei (a local body of the Italian Ministry of Culture), as manager authority of the MPA; the Science and Technology Faculty of the University of Naples Parthenope and the C.d.S. on Biology of the Marine Production of the University of Naples Federico II.

2. MATERIALS AND METHODOLOGY

The Project was aimed at testing an easy to use, high quality and low cost wireless audiovisual transmission system from the underwater environment and a special room in the Researchand Visitor Centre of the MPA (CeRD) from where students and visitors can virtually visit the underwater environment of the MPA by observing in real time and with a 3D perspective the images filmed by

SCUBA divers. During the observation, the visitors can interact directly with SCUBA divers guided by archaeologists and biologists that are in the room in the Visitors' Centre (Fig. 2-2). The audiovisual signals coming from the SCUBA divers can be seen in streaming, with the possibility to create a direct connection with video conferences in Universities, schools,etc..

The Project started in 2015 and it was developed in three steps: 1) development of the audiovisual transmission system and set up of the "underwater room" in the CeRD; 2) testing of the system with target groups (visitors, school and university students, researchers;3) dissemination of the results. During the first step, several transmission tests were carried out by using several wireless systems (over IP, up-link dsng, JSCC) trying to guarantee the SCUBA diver to move easily in the space and to easily use the transmission tools.

As regards the typology of the video signal, the aim was to use full HD 3D to give the audience a better experience. The setting of the room was planned trying to give the audience the best possible experience. For the second part of the project school and university students were involved; after the test,the students had to answer an appreciation questionnaire, the answers were then used to improve the system. The third step of the Project was the realization of a webpage, www.sommergiamoci.it, through which it will be possible, by entering a reserved section, to connect and to give students and everyone who cannot access the MPA's Visitor Center the chance to experience the underwater environment.

3. RESULTS

3.1. Didactic activities

The test and set up part of the Project lasted 2 years, involving 1296 school students and 468 university students. At the end of the 2 years, the audiovisual 3D wireless system and the "Room under the Sea" were ready to be used.

The technological tests lead to the development of a modular system constituted of: 1) SCUBA diver with a 3D video cameralocated in a water proof diving case and full-face communication system; 2) floating transmission module, connected to the SCUBA diver with a wire on which it is installed the audiovisual system; 3) receiving station located on the roof of the CeRD and connected to the "Room under the Sea" and equipped with a domotic system for the synchronization of the light and audio effects of the underwater images (Fig. 2).

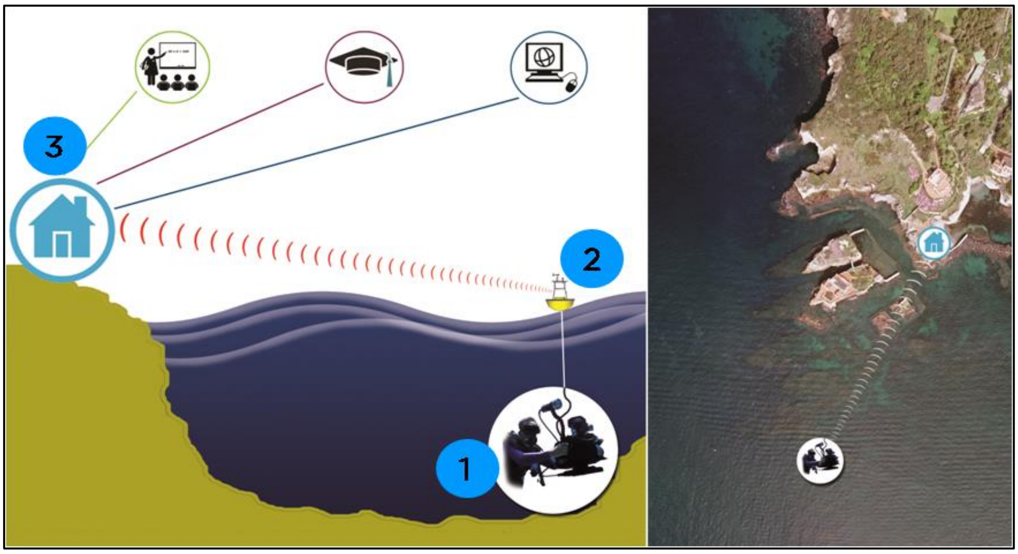


Fig. 2: Synthetic representation of the transmission system "Sommergiamoci"

For the long distance wireless transmission of the 3D video signal the Connex FPV was used. The system, created for drone flights, well adapted to the Project's need, guaranteeing high quality (1080p/60), transmission stability and very low signal latency (less than 1 ms). For the wireless audio transmission from the underwater environment, an already existing Bluetooth system was adapted which is connected to a mobile phone located in a water proof floating case. The whole system is located in a small and light floating module connected to the SCUBA diver by a wire, which allows the SCUBA diver to move around easily (Fig. 3).

Fig. 3: SCUBA diver using the floating module

The tests of the system gave excellent results. To all the students participating to the tests were distributed questionnaires framed to evaluate the appreciation levels and to help to better implement the system.

In the following charts the results of the surveys will be discussed.

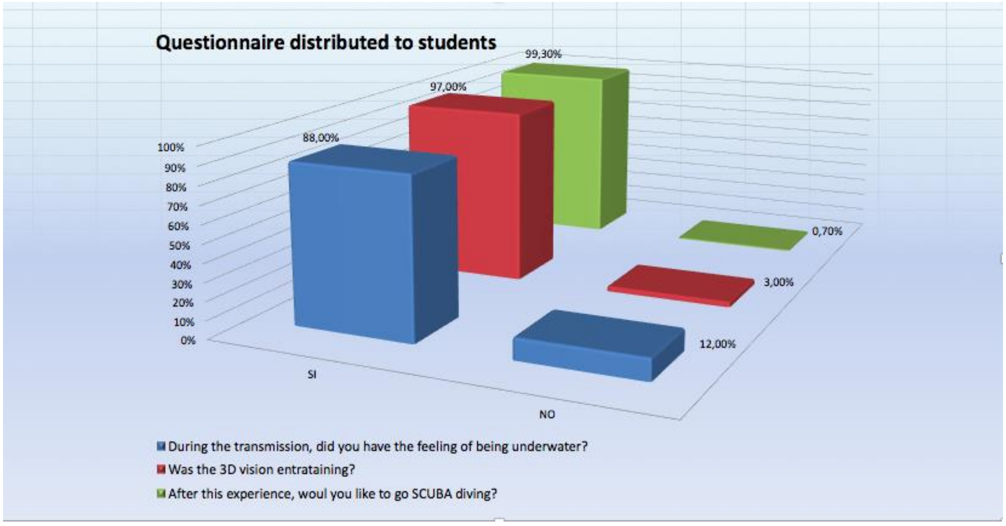


Chart 2

Chart 2 shows the answers to the questions on the perception of the 3D transmission and on the appreciation level. 88% of the participants had the feeling of being for real with the SCUBA diver; the 97% of the students declared that the 3D vision helped to improve the experience and the 99,30% stated that the experience let them think about the possibility to take the SCUBA diver licence. Also the sounds and light effect implemented through a demotic technology helped to genereate a real immersive experience.

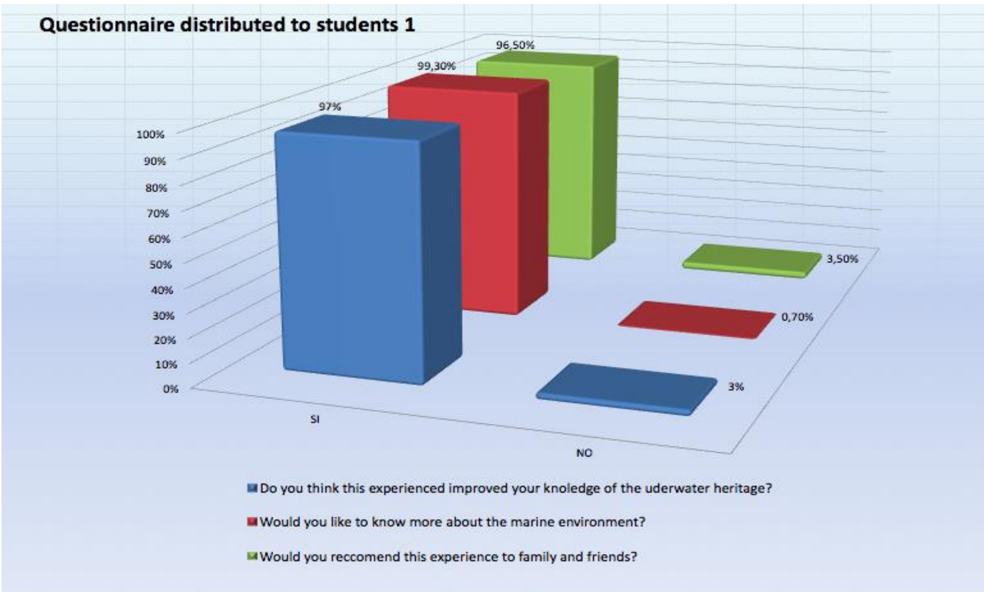


Chart3

Chart 3 shows the results on the increase of knowledge and awareness on the underwater environment of the participants to the tests.99,30% of the participants stated that the curiosity towards the marine environment increased, and this is a very important result, since, often, as previously stated, the marine environment is perceived as unaccessible and distant.

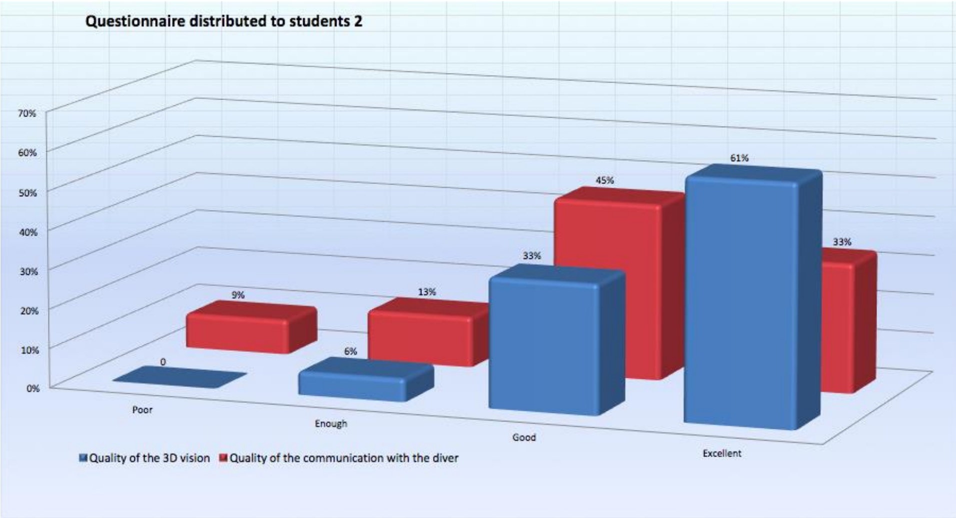


Chart4

The last chart (Chart 4) shows the results to questions specifically addressed to test the technological development and the transmission system. It is evident how, if the video transmission was excellent since the beginning, there were some problems with the audio transmissions. In fact, it was necessary to add an audio mixer in the room, to clean the sounds coming from underwater. It was evident that SCUBA divers with a higher voicetimber could transmit a better sound than those with a lower voice timber.

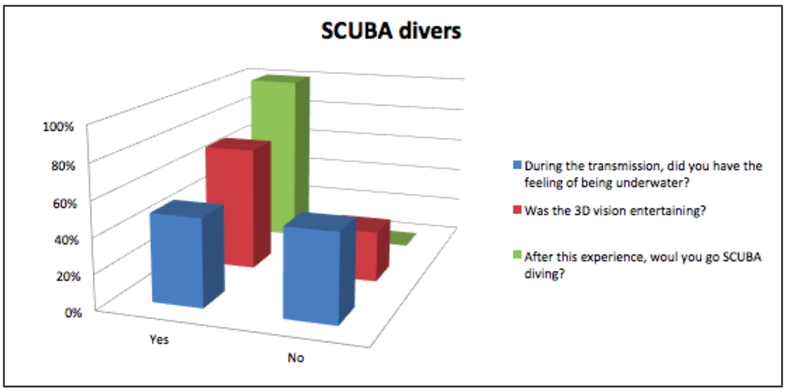
Fig. 4: Students participating to the "Sommergiamoci" Project

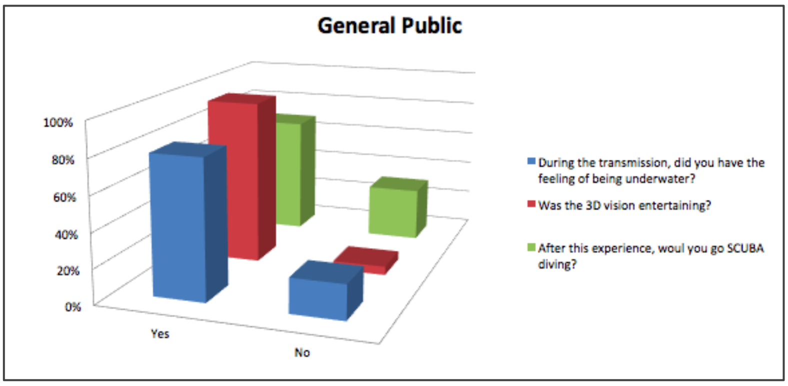
3.2. Research

The system was mainly developed to let young citizens discover the marine enviroment, but it proved to be extremely useful also for research purposes. In fact, it is now normally used during the monitoring campaigns of the MPA's seabed, allowing the SCUBA divers to directly communicate with the collegues on the surface. This system allows to improve the quality of the collected data during the monitoring campaings, to produce higher quality images and to lose a lower quantity of data.

3.3. Cultural and Tourism activities

The last test was targeted to a more general audience made of normal visitors, in order to evaluate if the system can be used also with this kind of public to develop a less invasive system to let people visit the MPA. The target was made of both general visitors and SCUBA divers who well know the feeling of a real SCUBA diving experience.The results of the two targets were very different (Charts5-6).





Charts5 - 6

In fact, the answer to the question "Did you have the feeling of being underwater" was negative for many of the SCUBA divers; nevertheless, a high percantage of the SCUBA divers enjoyed the experience.

4. CONCLUSIONS

The project "Sommergiamoci" gave the Gaiola MPA an easy to use, low cost and innovative system to improve the accesibility of the MPA in a non-invasive and sustainable way. Thanks to the "Room under the Sea" there is the chance to have just 1 SCUBA diver for 35 people that do not have any impact on the underwater environment and can experience and discover the underwater heritage of the MPA. Moreover, the possibility to use the streaming allow to increase the people that can enjoy the underwater environment with just 1 person SCUBA diving. Nevertheless, it is evident that the full 3D HD system and the other technological tools help to have a better experience especially for those that are in the "Room under the Sea".

The system proved to be a very effective tool to let students almost directly experience the marine environment and develop their level of awareness on the underwater environment, but it also proved to be a very interesting solution to give all the people that not feel comfortable with the marine environmentor that, will never be able to direct access the marine environment for health issues, to experience the underwater environment.

Moreover, the deveoped system can be a valid solution to make the underwater archaeological and environmental heritage accessible, even if, for special preservation needs, people cannot have a direct contact with it. Finally, the system proved to be extremely useful as a support for the scientific and monitoirng activities constantly carried out in the MPA.

The hope is that the development of this kind of approach will increase, also by sharing the results of this project, since the need for a more sustainable way to approach our heritage is highly needed, especially in very delicate and fragile environments. Moreover, it has been proved, also by other experiences, as the one of Arles "De Vivo (2018)", that increasing the awarness of local population on the importance of preserving the underwater heritage is fundamental for the sake of its preservation and that, very often, the lack of awareness is simply due to a lack of knowledge that can be solved, even for difficult to access sites, thanks to models as the one presented with the "Sommergiamoci" project.

Finally, it is important to remark that the "Sommergiamoci" Project could be considered a good practice to fulfill one of the prescription of the 2001 UNESCO Convention on the Protection of the Underwater Heritage. In fact, as written in Rule 1: "The protection of the underwater cultural heritage though in situ preservation shall be considered as the first option. Accordingly, activities directed at underwater cultural heritage shall be authorized in a manner consistent with the protection of that heritage and subject to that requirement may be authorized for the purpose of making a significant contribution to protection or knowledge or enhancement of underwater cultural heritage", "UNESCO (2001)". The project also fulfills the aims of the Council of Europe 2005 Faro Convention on the Value of Cultural Heritage for Society, which insists on the importance that cultural heritage is recognized as such by the living communities.This is a point we totally share, since it is fully recognized that aware and well informed citizens are the best guardians of both environmental and cultural heritage. Moreover, cultral heritage, without a communithy that appreciate and understands its value simply becomes none's heritage.

The "Sommergiamoci" Project proved to have very good results in terms of increasing of the in situ accessibility of the site, sustainable access of the heritage and increasing of the awareness on the local population. Further studies will be carried out to test, through the years, the positive effects of the increase of citizens' awareness on the preservation of the environmental and archaeological heritage.

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An innovative platform for virtual underwater experiences targeting the cultural and tourism industries

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***Abstract*:** Although, the underwater environment is of great scientific interest regarding all fields of marine research, it has not been exploited broadly yet for cultural and tourism purposes. At the same time, technology in the fields of virtual and augmented reality has undergone considerable development by providing technical solutions for environments that their modelling has been problematic or non-operational for a variety of spatial scales. To this end, we report on our recent progress in developing an integrated interactive framework for exploring natural (augmented reality) and virtual (virtual reality) environments in regions of touristic and environmental interest (eg. Submerged cities, shipwrecks, sunken harbors and diving parks, marine parks etc.) in order to enrich travel experience and promote specific and diverse forms of tourism. In particular, the designed solution combines high-resolution data acquired and processed with state-of-the-art technologies (swath mapping systems, underwater vehicles, unmanned aerial vehicles) so as to create a synthetic topographic relief basemap and to analyze all its particular geomorphological and ecological structures as well as anthropogenic interventions. Moreover, through a set of special designed tools for multimedia content management, it is possible to write narrative scenarios and produce interactive experiences in virtual reality. In this way, users are able to assimilate to real (or even imaginary) environments through different media (e.g., tablets, virtual reality glasses, etc.). The integration of research knowledge into interactive narrative systems will furthermore result into the development of innovative research and teaching products to promote the complex, challenging, magnificent underwater environment and also to attract tourists of general or special interest. The developed digital platform, named VIRTUALDIVER, will enable users to navigate virtually in environments accessible only by underwater vehicles and in cost-intensive, research and scientific missions and make known the underwater cultural heritage.

Keywords: digital platform, underwater experience, virtual reality, cultural heritage

1. INTRODUCTION

The Greek seabed is rich in biodiversity and has intense geomorphological structures, while numerous shipwrecks exist there as well as immersed infrastructure and ancient harbours, which, although are of huge touristic interest and are the subject of specialized scientific research, have not yet been highlighted. Although there have been attempts to promote submarine areas in the past, most of them are audiovisual productions such as documentaries, which are usually implemented by foreign corporations (for example, the underwater village of Pavlopetri in Laconia, the shipwreck of Antikythera etc.) (Mahon et al., 2011; Christopoulou et al., 2012).

The use of new research knowledge and innovative technologies to promote the Greek seabed, as well as the free access to scientific data and the transfer of scientific knowledge to the general public, is now possible and can lead to the development of new tourism products, services and activities, which can later attract tourists of general and / or special interest. At the same time, the introduction of virtual and augmented reality technologies into the particularly interesting and hardly accessible underwater environment is a challenge for the niche market and creates new investment opportunities.

VIRTUALDIVER aims at designing and developing a complex Digital Platform -initially- for the promotion of the underwater wealth of Greece using new technologies. This product will be a tool for supporting businesses and professionals operating in the field of Culture and Tourism, enhancing special aspects of tourism such as cruises, diving, scientific and other. The platform will use digital bathymetric data, data from Remotely Operated Vehicles (ROVs), as well as topographic terrestrial photogrammetry data from unmanned helicopters (drones) to synthesize 3D digital images of specific areas of tourist interest in high resolution. We will write narrative scenarios and produce interactive experiences. The platform will be able to assimilate real (or virtual) environments with the help of different media such as tablets or virtual reality glasses, as well as more specialized peripherals.

The Santorini volcanic complex was chosen for the application of the interactive platform, for several reasons. It is one of the most visited destinations in Europe. It is a unique "open geological museum" with the largest caldera in the world. The Minoan eruption that took place in 1615 BC is the largest of the last 10,000 years and is among the most famous eruption across the world (Freidrich et al., 2006). The caldera has always concealed the legend of the "Lost Atlantis" and gives birth to new volcanic eruptions. The Kolumbo submarine volcano, 7 km NE of Santorini is the most active in the entire Mediterranean Sea today (Nomikou et al., 2012).

This project aims at the following:

- The development of an innovative product for the provision of specialized services in tourism, with emphasis on marine, diving and cruise tourism.
- The combination of research results of underwater surveys along with terrestrial data and their exploitation in the creative – cultural industry.
- The creation of a complex Digital Platform for the realization of Virtual Experiences and the narration of various narrative scenarios.
- The development of a Mapping System and 3D Visualization of the underwater area, emphasizing on the interpretation of the geological / geomorphological structures of the Greek seabed and its spatial connection to the coastal surface for the needs of Virtual and Augmented Experience.

2. METHODOLOGY

Within the framework of the proposed project, Geomorphology, Photogrammetry, Computer Vision and Human-Computer Interaction will be combined.

Until today, a typical problem with adoption of technologies (VER) in mass applications is the cost as well as the simulator sickness, which is due to the lack of visual preciseness of the virtual environment and the poor computing capabilities of portable devices that cause image and conception incongruity.

In VIRTUALDIVER, we will deal with specific conditions in relation to the current level of innovation due to the underwater environment, which we will work out through single bottom mapping in areas of interest, accurate 3D reconstruction of details and high-resolution texture.

For the Mapping System and the visualization in VR the following will be developed : i) methodology and the system of collecting heterogeneous-bathymetric, visual and multi-spectral data, ii) novel Structure-from-Motion algorithms taking into account the refraction for 3D reconstruction of underwater images and adopting incremental approaches to deal with a large number of images, iii) co-registration algorithms to combine heterogeneous data for the creation of novel texture for the reconstructed 3D models and photomosaics, iv) classification of multispectral data using deep learning algorithms for recognizing geological materials. In addition, Augmented Reality applications will be developed for the coastal areas, the quality of which is a function of the detection process and "rendering" on a screen.

In particular, the extensive mapping of the seafloor will be conducted with high-resolution bathymetric systems (multibeam systems), whereas the acquisition of optical and multispectral data with submarine and aerial remote-controlled vehicles (ROV and UAV), which can accurately capture the volcanic geomorphology and the steep internal slopes of Santorini's caldera. The 3D Virtual Representations (single elevation model, 3D detailed models and RGB and geological maps) will be of a high-resolution but simplified geometric structure in order to constitute the detailed background of the Interactive Platform for the implementation of Virtual Experiences (Fig.1).

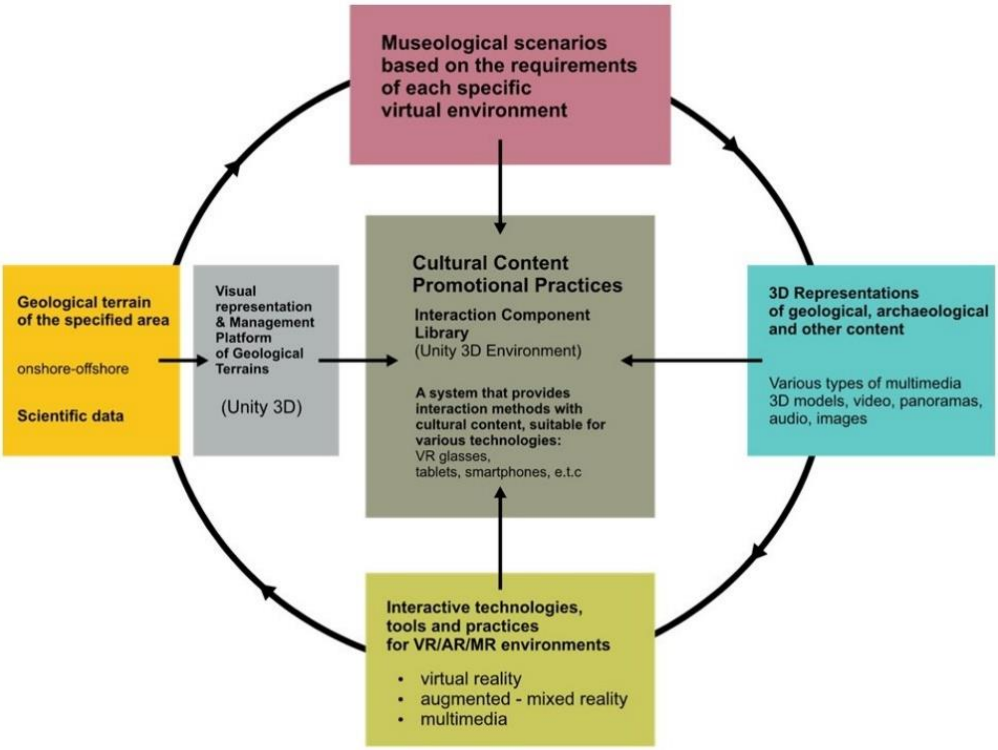

Fig. 1. The overall structure of the developed VIRTUALDIVER framework

Aiming to a both photorealistic and accurate digital representation of the Santorini's terrain in a VR environment, our team have developed a robust and fast workflow to capture, integrate and combine geospatial data of different modalities. The proposed methodology initially considers the needs of the User and the essential characteristics of the desired geospatial background, the 3D models on it and the other required figurative products. Existing geospatial data were also exploited. In particular, bathymetric data (Nomikou et al., 2014;2016; Hooft et al., 2017) and imagery from ROV missions (Carey et al., 2013; Camilli et al., 2015), both provided by previous works of the team, and open source data as well (EMODnet data) were used for the off shore 3D model. Regarding the on shore, SRTM, satellite imagery from the WorldView4 and LIDAR data describing Kameni Island were combined (Nomikou et al., 2014). The mentioned dataset was exploited in order to create a truly detailed and of high accuracy 3D model of Santorini Island which later was processed in Unity3D (Fig. 2).

Innovative methods developed by our team for drone imagery collection and processing were applied and ROV missions with top-notch camera equipment are on-going. This will lead to a more accurate 3D reconstruction of high interest scenes. In addition to this, GNSS measurements provide the necessary georeference of the 3D models and later will assist the matching between the Points of Interest in real world and the VR environment. Finally, panoramic images and videos add a rather realistic point of view for the User into the VR environment.

The methodology developed by our team consists of three main steps. Initially, bathymetric and SRTM data were scaled down to meet the smallest resolution of our dataset (LIDAR). Afterwards, the elevation data is combined based on the slope of the relief which also considers a buffer area aiming to a smoother terrain. Although this minimizes the spikes and the steep effects on the terrain, it can lead to ambiguities, so particular attention is required. Finally, the surface data and the WorldView4 imagery are combined applying the well-known nearest neighbour matching technique leading to the final terrain background (Figure 3).

Then, images captured by drone and ROVs using open-source 3D reconstruction software (Colmap, Meshroom), combined with algorithms which our team's team have developed in the past, were processed. The result is exceptional and gives a detailed representation of parts of the island's points of interest (Figs 4 and 5). Panoramic views and videos complete the visual representation of the Santorini Island.

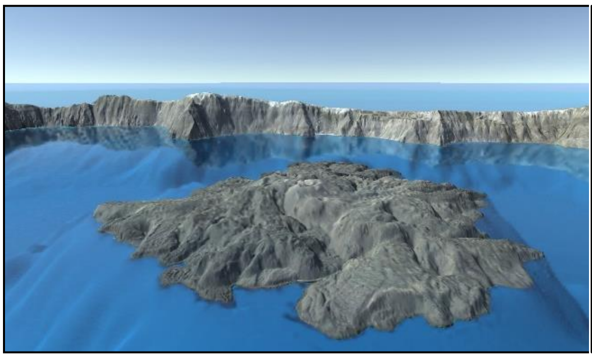

Fig. 2. WorldView4 imagery combined with surface data.

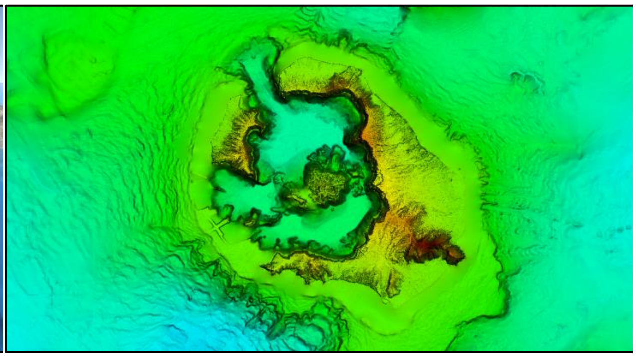

Fig. 3. Combination of bathymetric (Nomikou et al., 2016; Hooft et al., 2017), LIDAR and SRTM data.

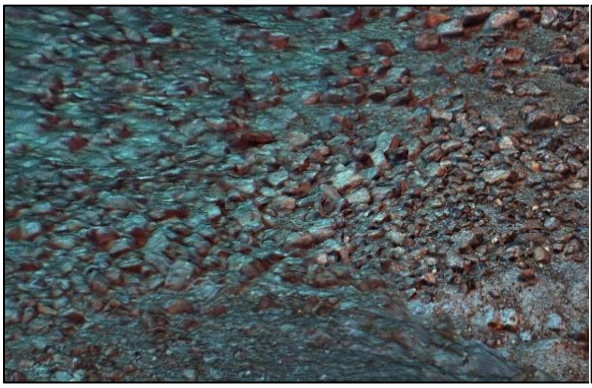

Fig. 4. 3D reconstruction of ROV images.

Fig. 5. 3D reconstruction of Oia village.

In VIRTUALDIVER, the platform is being developed on the Unity 3D technology, one of the most widespread platforms for designing, development, and implementation of interactive 3D environments, and will consist of two interconnected systems:

(i) management of 3D terrains and their relevant metadata

(ii) implementation of narrative scenarios. The aim is the management unit of the 3D terrains to be able to import and manage single seabed and terrestrial topography, while subsequently the interactive platform will be able to provide a range of tools to produce interactive experiences. These tools will offer the ability to manage multimedia content in a simplified way without requiring specialized programming skills. For this purpose, a methodology for implementing an interaction template library (interaction templates) will be developed based on the use of visual programming scripting (drag- n-drop visual scripting).

The most important advantage of using visual programming is the commonly accepted way of managing multimedia by an experienced design team composed of many different scientific fields. The library will offer the possibility of managing (add new / edit / delete) the ways of interaction with visual material both on different media (tablets, virtual reality glasses, as well as more specialized peripheral devices) and in different environments (virtual reality, augmented reality, etc.).

VIRTUALDIVER aims to: i) massive development and dissemination of virtual experiences of coastal and underwater space by creating a composite digital Interaction Platform, ii) differentiate the product in relation to the international standards, and iii) promote the underwater environment and innovative technologies as essentials to map the coastal and, above all, the marine space, enhancing experiences through the geological interpretation of the volcanic relief of Santorini.

3. DEVELOPMENT PROGRESS AND RESULTS

3.1. Defining Functional and Technical Specifications of the Platform

The functional requirements of the end users of Virtual Experience have been recorded and analyzed based on international experience, the Companies' experience in related projects, and the Advisory Committee's view. Within this frame, the expectations of the User related to his virtual Tourism-Cultural interests and the forms of interaction that are currently available with Virtual and Enhanced Reality devices have been recorded.

3.2. Technical Specifications of VIRTUALDIVER Platform

The technical specifications of the Interaction Platform and the Geomorphological Mapping System and 3D Visualization System have been determined. In this delivery, one-to-one operational requirements of the Functional and Technical Specifications of the Platform have been met, as well as the technical requirements for accurate and spatial data analysis, interaction files connecting the work packages, device capabilities, etc.

3.3. Website

For the dissemination and publicity needs of VIRTUALDIVER, an appropriate Project Website has been created, to promote the activities and outputs of the project (www.virtualdiver.gr) and also all public deliverables. Additionally, website will communicate directly a Twitter, Slideshare and Facebook page, using the "Network Publisher" plugin for WordPress.

3.4. Planning and collection of heterogeneous data

Planning and collection of heterogeneous seafloor, coastal and onland data (ROV, UAV). The main data is multi-spectral and RGB, and at the same time other receivers for georeferencing and mapping of heterogeneous file data (EMODNET data, Copernicus Marine Services, etc.) have been deployed as well as geological data.

3.5. User Interface Design

This section concerns the concept, the design and the development of a user interface (GUI), taking into account best practices of User Experience (UX) modelling in the sectors of 3D interactive representations and story-telling. This task refers both to the "3D World" management and scenario implementation modules of the platform, as well as to the part of the platform with which end-users will interact with. It includes the set of widgets that appear on the screen of each digital device (e.g. PC, Tablet, VR Headset) and can be used to interact with this device.

3.6. Creation of geo-ecotourism scenarios, educational material and productions and their interconnection through the interactive platform

Narrative scenarios, multimedia educational material for selected points of interest, and a series of dramatized productions are being created to be used to produce interactive experiences.

4. DISCUSSION AND CONCLUSIONS

VIRTUALDIVER intends to promote technical and financial constraints on the creation of Virtual Experiences in the exciting submarine world, in order to be an attractive entertainment and cultural product that will be deployed by tourism and cultural institutions in Greece. The proposed approach concerns the development of an Interaction Platform that will simplify the process of implementing the Integrated Virtual Experience - narrative scenarios, productions and educational material – on the one hand for non-experts and, on the other hand, the creation of geospatial backgrounds and 3D visual information. The Interaction Platform will be fed by the innovative Mapping System and 3D visualization of submarine areas with an emphasis on the interpretation of geological/geomorphological structures and the spatial connection to the coastal area for the needs of Virtual and Extensive Navigation. The digital platform is based on the unique, complex and extremely interesting volcanic area of Santorini, which is of great value as a tourist product.

The contribution of VIRTUALDIVER to the sector of "Tourism, Culture and Creative Industries" is crucial, as it addresses private (or non) operators with an innovative B2B service in order to boost their commercial value through the creation of a unique tourist product - experience of impressive virtual environments. Moreover, it will establish a new approach to promoting the cultural and environmental supplies through enhancing special forms of tourism. Regarding the underwater environment, which is hardly accessible to the average visitor in Greece, VIRTUALDIVER will serve as a mediator for the perception of this particular aspect of the world that surrounds us.

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Deep-Sea archaeology in the Exclusive Economic Zone (EEZ) of Cyprus

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***Abstract*:** Conducting deep-sea surveys beyond the Territorial Waters of a state for Underwater Cultural Heritage (UCH) is often beyond the capacity of national heritage agencies and university-based researchers due to its great expense. The result of this is that research in maritime archaeology has largely been focused in more 'convenient' and 'accessible' areas such as the shallower waters of the Territorial Seas. This is unfortunate as several pioneering projects have demonstrated that UCH finds are possible both in the waters of the Exclusive Economic Zone (EEZ) and beyond. Many more are likely to exist, the majority of which either remain unexplored or are potentially under threat from illegal salvagers and other commercial-sector companies. Nevertheless, it is the intention of this paper to demonstrate that is possible to conduct research, and hence disclose new and unpublished information regarding UCH in the deep seas by taking advantage of datasets produced by the oil and gas industry and other commercial sector companies. This approach is in its infancy and as a result of this, national heritage agencies are yet to fully exploit the potential in fully utilising deep-sea UCH datasets for outreach purposes. Consequently, the second element of this article is to present previous projects pertaining to the management, accessibility and outreach for deep-sea UCH sites.

Keywords: UNESCO, "in situ" visits, sport divers, raising awareness, Roman Shipwrecks

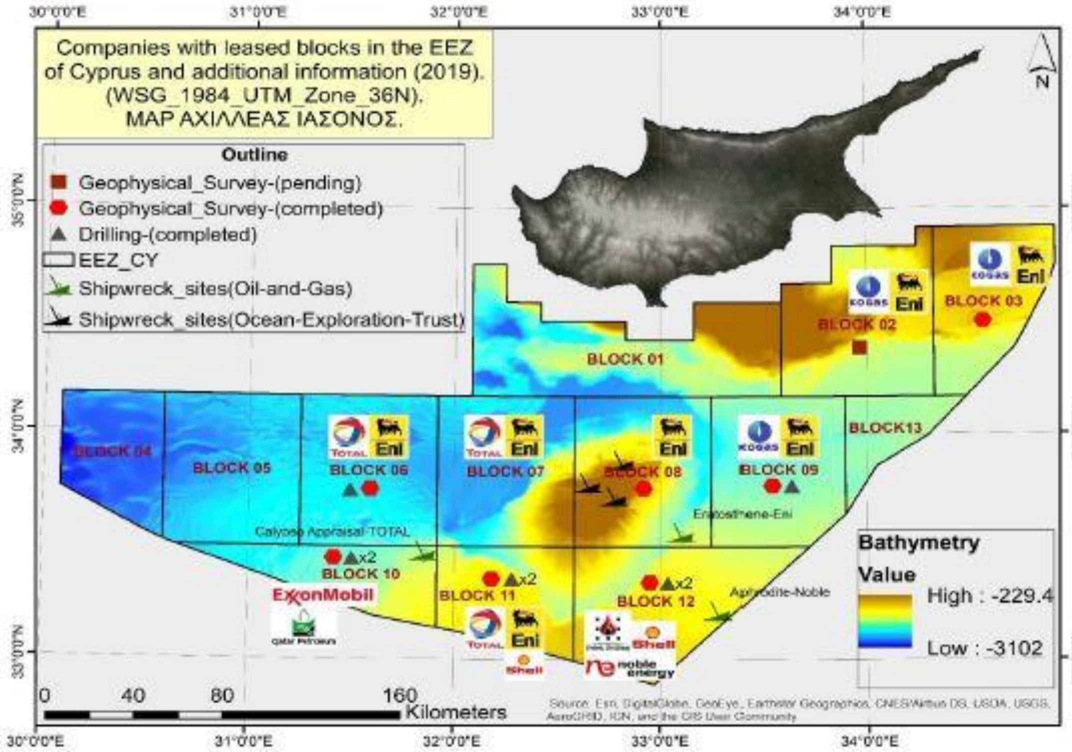
1. INTRODUCTION

Deep-sea exploration for the purpose of detecting natural resources in the EEZ of Cyprus and the wider Eastern Mediterranean Sea is on the rise. This is principally because it is now economically and technically feasible to exploit oil and gas fields situated in more extreme, hostile, and hard-to-reach environmental conditions (Shukla and Karki, 2016). Consequently, the oil and gas industry has been increasingly focusing on detecting untapped deep-water fields to keep up with the ever-increasing demand for energy. In the Eastern Mediterranean Sea, this has been ongoing since Israel discovered the first natural deposit in 2009 (Ratner, 2016). Subsequently, a series of deep-sea Natural Resource Surveys (NRSs) have followed, leading to the discovery of the Aphrodite and Glafcos-1 deposits within the EEZ of Cyprus in 2011 and 2019 respectively (Fig. 1, blocks 10 and 12), as well as the Zohr deposit of 2015 in the EEZ of Egypt (ibid., 1). This is currently a rapidly developing field—in the EEZ of Cyprus alone, from a total of 13 blocks available, 8 blocks are now licensed, and one is pending geophysical survey. In addition, announcements in 2019 suggest that there are plans for at least five additional geophysical surveys, in blocks 6, 7, 8, 10 and 11 (Fig. 1).

The discovery of two exploitable deposits so far, and the probability of discovering more, has significantly enhanced the role of Cyprus in the Eastern Mediterranean Sea as an emerging energy hub (Karbuz, 2012). From a maritime archaeological perspective, this raises the probability of new discoveries of UCH in these deep waters and the opportunity for scholars to investigate them and publish their results. For example, recent deep-water surveys for exploration and education purposes have discovered UCH (Ballard, et al, 2017), demonstrating the potential for the extensive and systematic NRS to reveal further sites of importance.

Unfortunately, while discoveries are made in the context of these surveys, a disconnect exists between the wider offshore industry and academia that results in information about them not making the transition from data producer to the academic and public consumer. This has a negative impact on the field of maritime archaeology since valuable information are either ‘lost’ within unreleased corporate datasets or else are bound to remain ‘unknown’, concealed by confidentiality agreements between companies and coastal States. This article concerns the EEZ of Cyprus and seeks to evaluate what the current state of knowledge of discoveries of UCH are in this area. In addition, I will give account of previous projects pertaining to the management, accessibility and outreach for deep-sea UCH sites.

Fig. 1



shows the state of oil and gas explorations in 2019 in the EEZ of Cyprus. Additional information about deep-sea UCH discoveries. The information presented here is subject to alterations.

2. OCEAN EXPLORATION TRUST (OET) UCH DISCOVERIES IN THE EEZ OF CYPRUS

In 2010 the American OET, whose president and principal investigator is Robert Ballard, conducted two survey seasons in the EEZ of Cyprus for the purpose of recording the bio-ecological and geological nature of the Eratosthenes Seamount1 (Fig. 2). Although archaeology was not part of the survey agenda, a wide array of scattered archaeological materials (mainly amphoras) were accidentally recorded. In total, 70 isolated amphoras were surveyed (Ballard et al, 2017, 1), out of which 38 were securely identified; the earliest amphora dated to the Iron Age (8th to 7th centuries BC) and the latest to the Byzantine period (Cornwell, et al, 2013, 42). Adding to the catalogue of discoveries, two shipwreck sites were noted and dated approximately to the 19th century (ibid., 30). From the results of the 2010 survey expedition, it became clear that the Eratosthenes Seamount not only offered ideal conditions for the preservation of UCH, but also confirmed it as an area of archaeological importance. The result of this was that the 2012 survey agenda was expanded to encompass the recording of archaeological materials, which marked the first deep-sea survey within the EEZ of Cyprus where archaeological documentation was officially part of a project’s agenda. The survey lasted for nine days, taking place between the 14th and the 25th of August of 2012, where the underwater seabed was further surveyed via a deep-tow long-range side-scan-sonar (SSS), with the most promising targets being visually assessed using an ROV (Mitchell, et al, 2013, 37). As a result, 149 isolated amphoras were revealed, out of which 91 were successfully dated from the Hellenistic to the Byzantine periods (Cornwell, et al, 2013, 42). Additionally, a Hellenistic shipwreck, named Eratosthenes C, with roughly 100 visible amphoras and two pithoi was discovered and dated to the 4th to 5th centuries BC (ibid., 43). The results of both expeditions of the OET were published (Wachsmann, et al, 2011; Cornwell, et al, 2013; Ballard, et al, 2017), with Ballard's article 'Deep-water archaeological discoveries on Eratosthenes' being the only one to present all of the results in a coordinated manner. The generated data from both of the expeditions were submitted to the author, by the Department of Geology Cyprus (DoGC) and are included in a developing ArcGIS geodatabase of UCH finds in Cypriot deep waters (Figs. 1 and 2). For further information about wreck-sites of Eratosthene C and Ottoman Pistol may be found on YouTube2. Although it is clear that these videos introduce some information intothe public domain, there are much more evidence and datasets remaining unpublished, understudied and unseen.

As these pioneering projects have demonstrated, UCH finds are possible in the waters of the EEZ of Cyprus. Yet, it is important to note that despite the potential demonstrated by these projects deep-sea UCH investigations in the Levantine Sea are rarely mounted. One possible reason for this is that deep-sea investigations for the purpose of surveying UCH are notoriously expensive. Ballard in 2008 stated that the operational cost for using an ocean-class research vessel starts from \$20,000 cost per day (CPD)' (Ballard, 2008, 3), and increases by \$10,000 CPD, depending on how many different geophysical technologies are used (ibid., 3). More recently, Søreide proposed that the cost of a work-class ROV vessel and its crew begins at \$50,000 CPD (Søreide, 2011, 21) and in some cases, depending on the complexity of the job, the cost can average up to \$250,000 CPD (Krieger and Buxton, 2012, 272). Bearing these figures in mind, it is clear that cost constitutes the principle obstacle to the development of deep-sea UCH investigations. For this reason, Bass accurately points out that 'because of the expense of excavating (or surveying) at great depth, however, perhaps a new model is needed' (Bass, 2013, 16): his statement is ground-breaking and acts as a reference point for this study.

2.1 UCH discoveries in the EEZ of Cyprus during NRSs

Besides deep-sea UCH discovered as a result of exploration activities by universities and research institutes, many more important sites have been surveyed in recent years during the exploration, development, and production of oil and gas resources. Globally, it is estimated that between three hundred and four hundred shipwrecks have been discovered during oil-and-gas-related activities (Søreide, 2011, 27; Ford, et al, 2010). This was first demonstrated in the Gulf of Mexico, when Warren in 2007 published in detail the results of the geophysical survey of the Mardi Gras shipwreck (Warren, et al, 2007). The site was accidentally discovered during offshore pipeline reconnaissance and was then partly excavated as a part of a mitigation agreement between Okeanos Gas Gathering Company and the US Minerals Management Service, with the results published in detail by Ford in 2010 (Ford, et al, 2010; BOEM, 2008). Since then several new shipwreck sites have been discovered in the area as a result of NRS and other pipeline activities, with some of the results mentioned in Warren et al (2007). With that in mind, it is worth asking: How does the oil and gas industry conduct NRS and at which phase is UCH confirmed? Naturally this leads on to the question: Is the oil and gas industry in the EEZ of Cyprus coming across more deep-sea UCH sites than have already been published?

A NRS, in general, has two main phases to its workflow. Phase 1 entails a seismic survey (or seismic data interpretation), which aims to narrow down specific locations where prospection drilling will take place. For the specific locations selected during phase 1, a second phase of supplementary hydrographic surveys via various geophysical means is undertaken. Technically, these include surveys using multibeam-bathymetry-echosounder (MBES) with or without backscatter-data (Woods Hole Coastal and Marine Science Centre, 2019, website), SSS (Burguera and Oliver, 2016), and sub-bottom-profiler (SBP) (Woods Hole Oceanographic Institute, 2019, website). The purpose of these localized-hydrographic-surveys is to determine the nature and character of the seabed and the subsoil, and secondly to note, and hence avoid, any potential nearby geohazards. In addition, Quinn suggests that these supplementary surveys are also conducted in order to define a wider 'clear zone' that is topographically and geologically suitable for the installation of the anchors of the drilling platform and any succeeding pipeline to connect the oil and gas field to a landfall site (Quinn, 2004, 26). Upon the completion of this supplementary hydrographic phase, any potential unidentified or peculiar anomalies (i.e. acoustic shadows and topographical irregularities) are noted and visually inspected either by Remotely Operated Vehicles (ROV) or Autonomous Underwater Vehicles (AUV). It is in this ground truthing phase that sites of UCH are confirmed.

The potential to conduct deep water research using geophysical and visual datasets derived from NRS is an exciting one that offers a low-cost solution to a notoriously expensive form of maritime research (Calvo, et al, 2009; Trobbiani, et al, 2018). This is because the data are already being produced by companies operating in the oil and gas sector to which archaeologists and heritage managers simply need to gain access. To demonstrate the potential of this approach, accidental finds from oil and gas companies operating in the EEZ of Cyprus since 2011 have revealed three new shipwreck sites (Fig. 1) and approximately 30 scatters of materials. These wreck-sites along with the additional scatters of materials are examined in the author's DPhil thesis, where a detailed analysis of the observable cargo is undertaken to propose an approximate date for the wrecking of the ships. The composition of the cargo also provides information pertaining to the ship's original route and possible destination. The location of the sites as well as associated visual, photographic and geophysical data are managed in an ArcGIS geodatabase, developed by the author on behalf of the Department of Antiquities Cyprus (DoAC). For further information about the wrecks see the author's DPhil thesis (Iasonos, forthcoming)

The interest of the oil and gas sector in deep-sea explorations will increase as new exploitable deposits are discovered. Hence, this means that more surveys for natural resources, or other oil and gas related activities (i.e. pipelines, cables etc.), are more likely to occur in the near future. Therefore, we are facing a scenario where deep-sea explorations may lead potentially to new environmental, geological, biological and archaeological discoveries. From that it can be stated that the size of the developing ArcGIS-database of the author is expected to grow in the following years. So far, the DPhil thesis '*Deep-sea Archaeology in the Exclusive Economic Zone of Cyprus*' has gathered a total of **1Terabyte** of data and includes: **A)** Data on six shipwreck-sites (of which five in the EEZ of Cyprus and one in the EEZ of Egypt), **B)** Approximate 26 side-scan-sonar targets of high archaeological potential, in the seas of Egypt, Cyprus and Israel, **C)** Environmental, geological and biological data (i.e. photographic material) displaying the diverse nature of the Eratosthenes Seamount, **D)** Photographic material on 300 scatter materials (i.e. amphoras) and **E)** 290Gigabyte of geophysical datasets (i.e. multibeam-bathymetry, SSS and Subbottom-profiler).

3. MAKING THE INACCESSIBLE ACCESSIBLE. DEEP-SEA UCH AND OFFERING A DRY DIVE EXPERIENCE TO A WIDER AUDIENCE

The remoteness of the deep-sea leads to a heavy reliance on technology to provide the information needed to carry out forefront research, and as equipment has improved over the years, we have begun to see the deep-sea environment with increasing clarity' (Cochonat, et al, 2007, 5). This is an ever-changing field due to advances in control platforms such as Autonomous Underwater Vehicles (AUV's) and ROV's, geophysical sensor machinery and software technology – much of it generated within the oil and gas sector – and thus, has enabled higher resolution mapping in previously inaccessible parts of the ocean, at depths up to 6000 m. This brings around 98 % of the world's ocean floor within reach and dramatically increases the possibility of discovering deep-sea shipwreck sites (Foley and Mindell, 2002). From an outreach perspective, the very same technology used for scientific deep-seabed surveying (i.e. ROV video recording or AUV geophysics) has also been utilised to provide in situ public access to deep-sea UCH (Ballard, 2008).

3.1. Live streaming and underwater CCTV

ROV technology for outreach purposes was first utilised in 1989, in the central Mediterranean Sea, when Robert Ballard conceived and directed the JASON Project for the education of students in the sciences and archaeology (McCann and Oleson, 2004; Abbott, et al, 1997). The JASON Project involved the survey and excavation of a 5th century Roman trading ship sunk in approximately 1000 metres of water, at an area known as the Skerki Bank. The live broadcast was presented through the lens of the most up-to-date communication technology and was transmitted through a network of universities, museums, research institutions and other centres to an audience of schoolchildren. According to McCann and Oleson, the broadcast reached some 225,000 children in both USA and Canada, and inspired the education of students through real science and exploration during a period when 'it was not fashionable to study science at school' (Abbott, et al, 1997, 111; JASON Learning, 2019, website). From a technical point of view, the JASON Project has successfully demonstrated that deep-sea UCH can reach out to a wider audience via telepresence technology; to this day, it remains an invaluable concept and has been successfully applied in numerous deep-sea UCH exploration projects (i.e. Nautilus Live, 2019, website; Ballard, 2008; Schmidt Ocean Institute, 2019, website). Since 2018, live streaming has been implemented in social media platforms (such as YouTube, Facebook and Instagram), providing deep-sea survey teams the opportunity to combine both live streaming and social media presence. As such, deep-sea survey companies such as the R/V Petrel3 and the Schmidt Ocean Institute4 have adopted this model and have been broadcasting their expeditions live through social media pages, reporting an overall public following of more than one million, with an average audience ranging roughly around forty to fifty thousand people per live streaming (R/V Petrel, 2019, personal communication with author; Schmidt Ocean Institute, 2019). Such outreach is impressive for companies with only thirty-five thousand followers; and implies that Ballard's idea of live streaming, provides a new opportunity for public relations and outreach. Indeed, social media live streaming makes it possible to outreach to a wider audience, yet it also makes it necessary to redirect the audience keen in knowing more to other educational and possible interactive platforms (i.e. virtual museums and thematic maps).

With advancements in satellite communications, live broadcasting from the deep seas has become mainstream. Since 2003, scientists of the Institute for Exploration have been capitalising on the potential of live streaming, in an attempt to develop new ideas for public access, management and monitoring (Ballard, 2008). In 2004, after rigorous research and systematic planning the Immersion Institute project installed the first underwater CCTV in approximately 15 m of water at the National Marine Sanctuary in Monterey Bay, California. The project began when two stanchions were placed underwater to support the setting up of a small ROV which carried LED lights and a colour video camera. A fibre-optic cable powered the ROV and enabled live transmission and operation from a shore-side hub. According to the OpenOceans Global website, the CCTV system was installed to monitor the kelp forest in order to identify and better understand potential changes in the ecosystem (OpenOceans Global, 2019, website). The overall goal of the National Marine Sanctuary telepresence network is to ensure long-term preservation of the site, as well as to provide public access for both natural and cultural sites beneath the sea (Ballard, 2008). Due to the project's success, a new collaboration with the OpenOceans Global5 non-profit organisation and the National Oceanic Atmospheric Administration (NOAA)6 in 2006 authorised similar telepresence networks on coastal locations, underwater and deep seas sites, on research vessels, aquariums and other ocean-related places. The live network is accessible via OpenOceans Global website under the tab 'Ocean Web Cams' and provides live streaming access to roughly 70 different sites, with approximately half of them related with marine life or the underwater environment. The potentials of underwater CCTV are enormous and can lead to new strategies for safeguarding UCH. As the technology develops further, we can only be optimistic that live streaming and CCTV will be used to monitor deep-sea heritage sites, so as to ensure long-term safeguarding, preservation and public accessibility to imperative sites such the RMS Titanic, the Thermal Dome of Costa Rica, the hydrothermal vents of Pescadero and the Eratosthenes Seamount.

3.2. Thematic Maps and Databases

Besides live-broadcasting and CCTV monitoring, outreach projects have effectively demonstrated that Geographic Information Systems (GIS) can recreate an informative and educational experience for a wider audience. Rooted in the science of geography, GIS allows users to explore thematic maps by selecting spatial attributes (i.e. coordinates) and reviewing non-spatial data/information (i.e. videos, photographs, reports etc.), while navigating in an interactive environment as presented from satellite imagery and geophysical data (Conolly and Lake, 2006).

There are several shipwreck databases online, with each one of them offering a different interactive experience. This depends on parameters such as: what is the purpose of the database, what is the target audience, as well as what technologies were available when the database was developed. For instance, *The Oxford Roman Economy Project7* is the largest and most informative open-access shipwreck database on ancient wrecks, listing more than 1,700 sites. It was developed from 2005 to 2010 and addresses the fundamentals of the Roman economy using quantifiable bodies of archaeological data from the Mediterranean world (The Oxford Roman Economy Project, 2019, website). Furthermore, it has also been proven to be a valuable source for data submission, management, and archiving, since seven additional databases related to the general theme of the Roman Economy have been added since 2006 (ibid). Based on the fundamental principle of 'dot mapping' and information reading, the database provides a very basic but user-friendly experience to its audience. However, because the database targets academics, the interactive visual and storyline component has been replaced with the visualisation of qualified data and the exporting of information in map, table and chart formats. So far fourteen books and numerous articles have been published and seventeen conferences have been organised, highlighting quite effectively that the database has been very popular among academics but less favoured by the general public.

The interactive component is essential for reaching out to different audiences. As such, map navigation, clicking on spatial data, viewing images and videos and reading information has become more or less the conventional approach for developing open access interactive maps for reaching out to the general public (i.e. Australian Ocean Data Network8, the Marine Geoscience Data System9, 'SQUIDLE+'10 etc.).

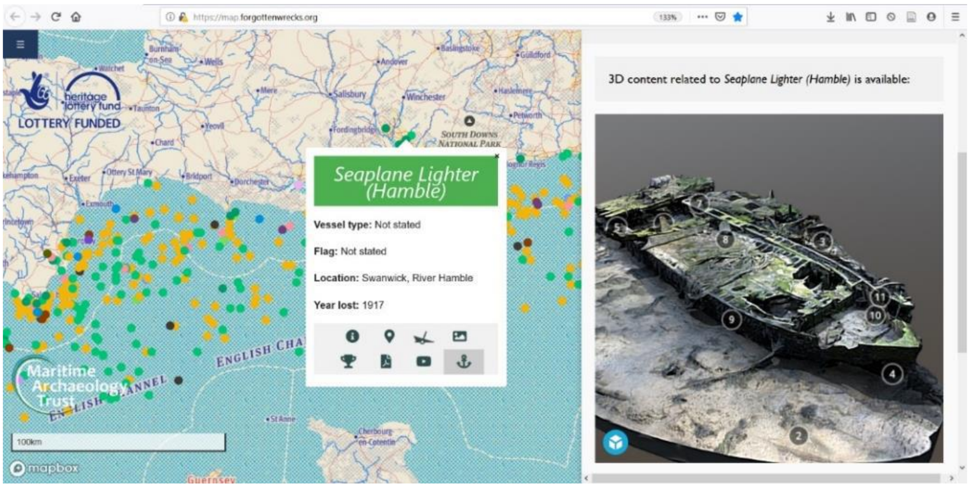


Fig. 3: shows the interactive map of the Forgotten Wrecks of the First World Warwitha 3D model of a shipwreck site. Screenshot via https://map.forgottenwrecks.org/[accessed 21-05-2019]

The database of the 'Forgotten Wrecks of the First World War' (FWWI) has shown that it is possible to provide an even more hands-on, immersive experience to interactive maps by associating spatial data with 3D models. Funded by the Heritage Lottery Fund and developed by the Maritime Archaeology Trust between 2014 and 2018, the FWWI database aims to raise the profile of British naval history by presenting shipwreck sites of the Great War from the south coast of Britain.

The database includes 'merchant and naval ships, passenger, troop and hospital ships, ports, wharfs, buildings and foreshore hulks which are often unrecognised and unprotected and have been degrading and deteriorating due to natural and human processes, for approximately 100 years' (Forgotten Wrecks of the First World War, 2019, website).

The FWWI interactive map is based on the conventional 'dot mapping' system, in which spatial data are linked with non-spatial attributes in 9 different tabs. Each tab contains accumulated research including photos, geophysics, video and 3D models on the wrecks and sites from the project. By selecting the '3D model tab', a small window appears on the right-hand site of the screen and loads the model through Sketchfab (Fig. 3). The models are usually interactive, allowing free navigation around them, zooming in and out on features, and selecting hotspots which contain specific information about each wreck. Overall, FWWI provides a very real educational and outreach experience to its audience with some immersive components. It puts forward an updated model for interactive maps and brings together the traditional 'dot mapping' system and the new immersive 3D experience.

3.3. Virtual Museums/Tours

Recent advancements in 3D modelling and virtual reality (VR) provide a unique opportunity for digital accessibility of deep-sea UCH sites both for scholarly and outreach purposes (Liarokapis, et al, 2017). This is because VR allows the user to enjoy a highly educational and hands-on experience while being in an immersive virtual environment from his/her device, thus making 'cultural heritage digitally accessible, especially when physical access is constrained' (Bekele, et al, 1). A good example demonstrating this is the Virtual Archaeology Museum11 (VAM) for deep-sea UCH developed by the Bureau of Ocean Energy Management12 (BOEM), USA. The VAM was lunched in the second quarter of 2019 and presents five shipwreck-sites which were discovered in the course of oil and gas exploration (BOEM, 2019, website) and were resurveyed in 2012 during the *Okeanos Explorer13* expedition. The VAM presents the results of this expedition in high-quality interactive 3D models with hotspots, videos, photographs and mosaic-maps— suggesting that deep-sea UCH when discovered by the oil and gas industry and resurveyed in detail with the appropriate technology can be advanced to an immersive by-product for outreach and education. BOEM's VAM has demonstrated that *in situ* deep-sea UCH can provide a memorable, informative and highly interactive experience and indeed it has successful captured a new level of immersion, as it has managed to increase the curiosity for maritime heritage, and it is expected to promoted an appreciation about the importance of deep-sea UCH to millions of users worldwide (Bekele, et al; UNESCO, 2019, website). Both the VAM and the FWWI present components appealing for public outreach, demonstrating quite effectively that deep-sea UCH accessibility goes together with education and awareness.

4. CONCLUSION

In this article I argued that academic studies regarding the deep seas are possible only when datasets can make the transition from data producer to academic and public consumer. In this instance, because datasets are making this transition, it is therefore necessary to utilise them in the context of an outreach project. The projects evaluated above suggest that outreach for deep-sea UCH can be done quite effectively through interactive maps, 3D modelling and virtual museums and indeed, this could also be the case for the deep-sea UCH of Cyprus. Ideally, utilising the data along the lines of the aforementioned will make it possible to raise awareness and promote public outreach on both local and European levels in regard to the rich and diverse heritage of the deep seas of Cyprus.

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Technological protection of an underwater archeological site; a newly discovered Roman shipwreck from the 1st century BC, on the island of Pag, Croatia

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***Abstract*:** Underwater archaeologists, in their efforts to explore and present archaeological sites, must balance multiple competing factors to successfully excavate a wreck. Archaeological research with scientific integrity requires control and protection of a site; however, public access and information are important to build local support as well as to establish a broad financial foundation. One recurring problem is how to protect a site from the threat of unauthorized visits. The ability to continuously monitor a site before, during and after an archaeological intervention would maintain site integrity, preserving cultural heritage for future generations. The aim of this paper is to present an idea for using a new approach and technology in the protection and monitoring of Underwater Cultural Heritage sites. The paper will emphasize the importance of an interdisciplinary approach to maximize tourism potential while minimizing the risk to the site. A newly discovered Roman shipwreck from the 1st century BC, located near cape Letavica on the Croatian island of Pag, will be used as the case study.

Keywords: Underwater Cultural Heritage, 1st century BC Roman shipwreck, *in situ* preservation, acoustic sensors, monitoring.

1. HISTORY AND PRATICE IN PROTECTION OF UNDERWATER CULTURAL HERITAGE IN CROATIA

Based on the principles of the 2001 UNESCO convention, protection of underwater cultural heritage through *in situ* preservation shall be considered as the first option. Additionally, activities directed at underwater cultural heritage shall be authorized in a manner consistent with the protection of that heritage, and subject to that requirement, may be authorized for the purpose of making a significant contribution to either protection, knowledge or enhancement of underwater cultural heritage.[9]

The Republic of Croatia has practiced the protection of typologically similar underwater sites (shipwrecks with amphora cargo) using physical protection in the form of a metal cage installed over an entire wreck site (Fig. 1). This practice was even included in the UNESCO manual for activities directed on Underwater Cultural Heritage. However, the cages prevent access for systematic archaeological research, while sea growth on the cages blocks visibility, detracting from a visitor's experience. Additionally, the cages are expensive and require maintenance; they are not the perfect solution.[10]

[9] MAARLEVELD et al. 2013.
[10] RADIĆ ROSSI 2014.

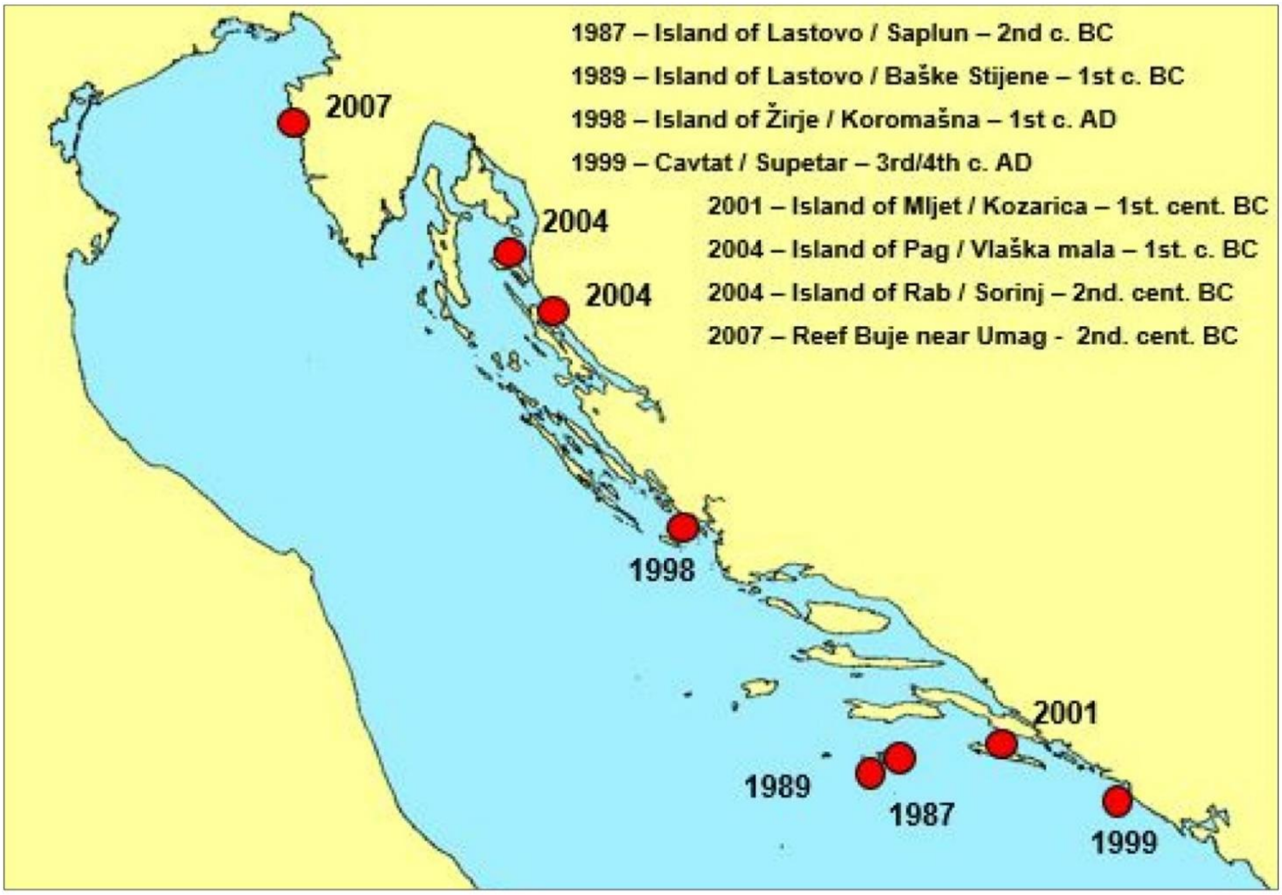

Fig. 8: Position of the underwater cages and chronological order of the construction. (I. RADIĆ ROSSI and V. DORUŠIĆ, 2018, 12, Fig. 13).

One of the reasons why experts decided to protect underwater sites with this type of protection is connected to the idea that these sites can be used as diving attractions and managed through the system of diving concessions. Diving concessions, offering access near specific caged wrecks to only one diving center for a fee, were created as a system that could be used to control the total number of site visitors, in hopes of building a self-sustainable system that can generate money to be used as a further investment in Underwater Cultural Heritage sites. In the case of the Croatian cages, a general problem was the fact that while eight sites were protected in this way, only one is used by local diving center through the system of diving concessions. The major reason for this and the biggest problem to overcome is that the majority of site locations are very far from normal diving routes and trails. Also, another problem arose with cage maintenance and general cage life span. The cages rapidly corroded and also became thick with sea growth. Many times, divers and archaeologists visiting the sites informed government officials about the cage conditions. Some of the cages were replaced, but the corrosion and sea growth continued on the new cages (Fig. 2).[11]

[11] RADIĆ ROSSI 2014

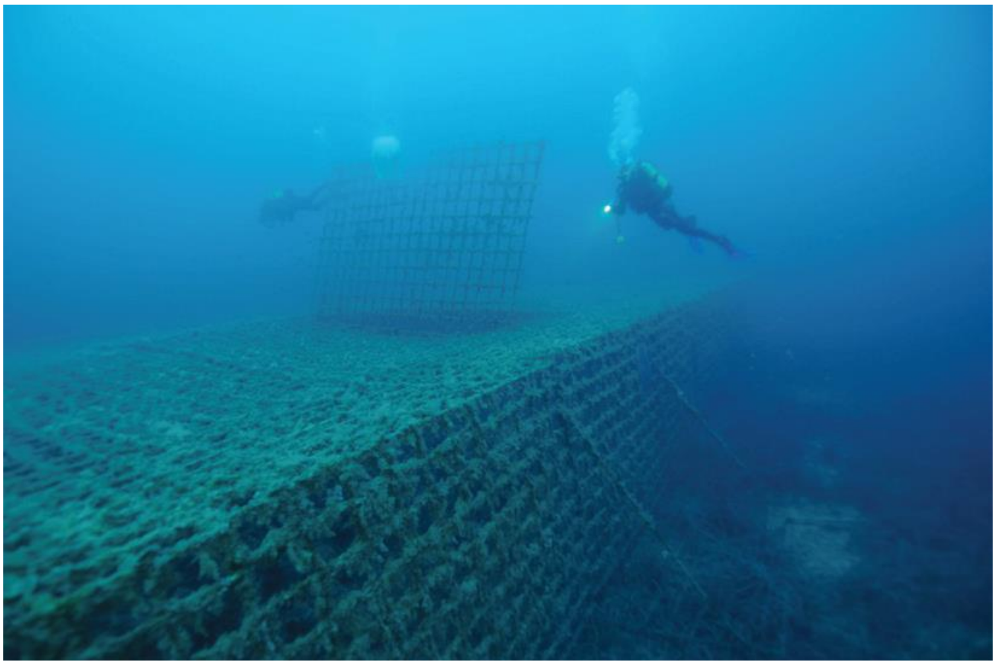

Fig. 9: Underwater Cultural Heritage site Pličina Velika near Cavtat, Croatia, protected by the metal cage. Cage is covered with the sea growth (photo: D. Frka).

2. ROMAN SHIPWRECK FROM THE 1ST CENTURY BC; NEW CASE STUDY IN THE PROTECTION OF AN UNDERWATER ARCHEOLOGICAL SITE

In the summer of 2018, Croatian institutions in charge of cultural heritage got a rare opportunity to develop and use a new approach in the protection of submerged cultural heritage. The discovery of a Roman shipwreck dated to the 1st century BC on the island of Pag near a local scuba center highlighted the problem of combining site access, archaeological research and site preservation.

2.1. Finding a 1st century BC Roman shipwreck site

The Island of Pag is abundant with archaeological sites from various periods of time, among which the Roman sites are particularly notable. Judging by the writings of the Roman scholar Pliny the Elder, who wrote the Encyclopedia of Natural History in the 1st century BC, during ancient times the Island of Pag was called Cissa or Cissa Portunata, i.e. Cissa naturally endowed with a port. Although it has not yet been proven that the adjective 'portunata' in Pliny's work undoubtedly refers to the Island of Pag, the geographic and geomorphological features of the island support this assumption.[12]

A very active seafaring role of the Island of Pag was confirmed when a new Roman shipwreck site from the 1st century BC was discovered in 2018 by Vedran Dorušić, the owner of local diving company and the president of the Diving Tourism group in the Croatian Chamber of Commerce. Since 2007, Dorušić has been working and participating in various archeological projects involving ancient shipwrecks, so he was very aware of the importance of his find.

His first reaction was to notify the authorities about the new discovery. To ensure a prompt response from responsible institutions, preliminary studies of the archeological site were quickly performed, including measurements and recordings to archaeological standards. Video footage and preliminary 3D documentation were delivered to the local Conservation department in Zadar. After receiving these materials, the Conservation department in Zadar sent an expert archaeologist to confirm the find, so

[12] RADIĆ ROSSI and DORUŠIĆ 2018

the newly discovered shipwreck site could be registered, and preliminary protection put into place (Fig. 3).

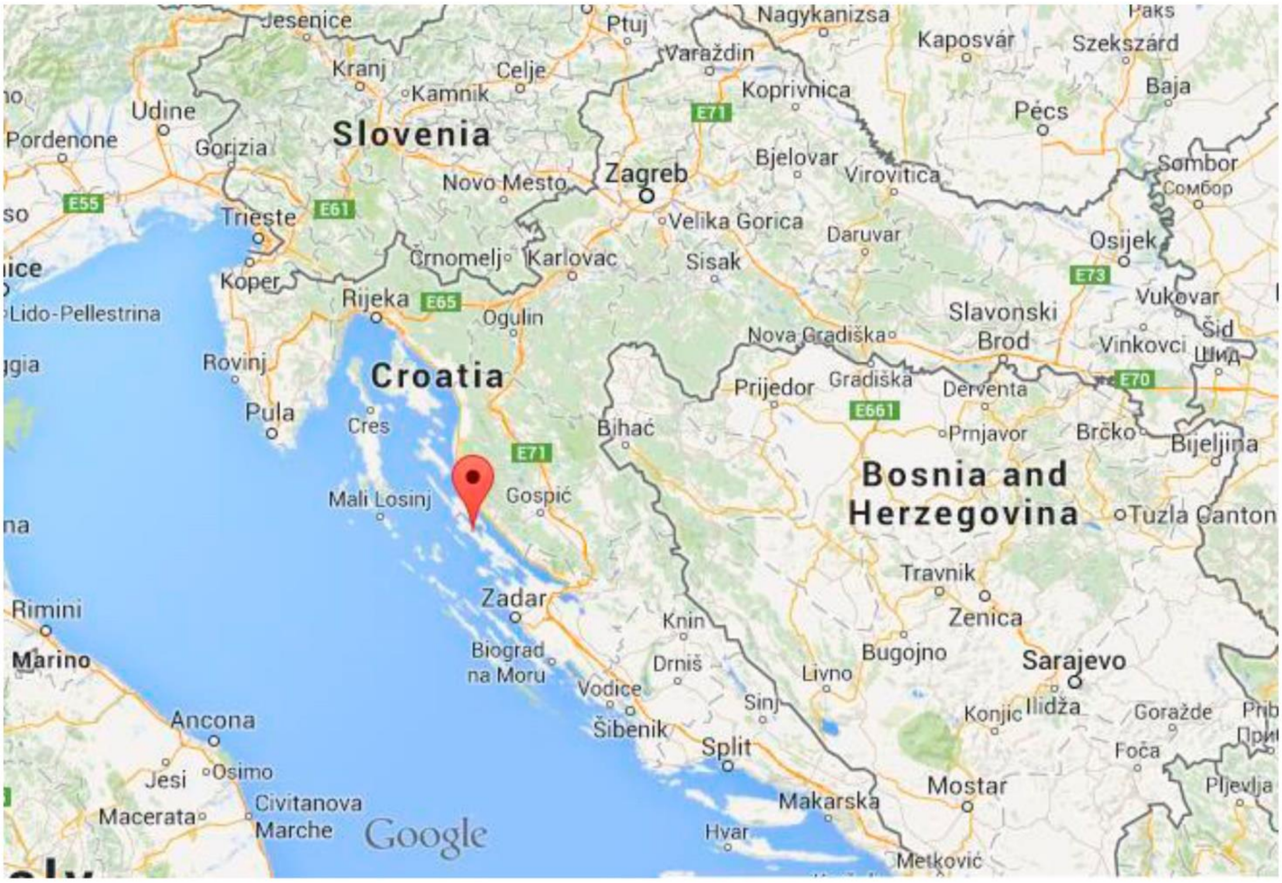

Fig. 10: The Island of Pag with the Letavica shipwreck site position.

The next step was to gather interested parties to formulate a plan for the project. After meetings in the Ministry of Culture, the local authorities and governmental bodies decided to encourage cooperation between different institutions. The inclusion of multiple institutions generated valuable discussion regarding possible project goals. Ultimately, the first task in the new project became how to create an alternative workflow to more effectively deal with the old problem of site protection using new technologies. A preliminary campaign to validate site potential was planned for October 2018.

2.2. Preliminary campaign in October 2018

Preliminary research was carried out in cooperation with underwater archaeologists and experts from the University of Zadar, the Croatian Conservation Institute from Zagreb, the Archaeological Museum of Zadar and the UNESCO International Center for Underwater Archaeology (ICUA) in Zadar. Logistic support was provided by tourist Camp Šimuni on the island of Pag and by Foka Ltd dive company.

The shipwreck site lies at a depth between 37 and 39 meters, on a sandy bottom at the edge of a rocky slope about 130 meters from shore. The site consists of a group of about 400 visible amphoras, typologically classified as the Lamboglia 2 type, present in several variants (Fig. 4). Judging by the basic shape characteristics, these amphoras can be dated to the 1st century BC, i.e. at the time of the late Roman Republic. The amphoras are mostly intact, covered with sea adhesions and accreted together. Only a small number are slightly offset from the main concentration of the finds.[13]

[13] RADIĆ ROSSI and DORUŠIĆ 2018

Fig. 11: Preliminary work and documentation on Letavica shipwreck site. The site consists of a group of about 400 visible amphoras, typologically classified as the Lamboglia 2 (I. RADIĆ ROSSI and V. DORUŠIĆ, 2018, 5, Fig. 2).

About 38 meters from the main amphora pile to the north-east there is a 1.6 meter long lead anchor stock that is associated with the same ship remains. In the immediate vicinity of the stock lies the base of a larger ceramic vessel. The general layout of the finds at the sea bottom indicates that the cargo did not diffuse from the ship during the sinking, but in effect sank together with the entire ship as a cohesive unit. The length of the main amphora concentration is about 23-24 meters, which indicates a ship approximately 25-30 meters long.14

The site position and depth required the development of specific diving procedures. Enriched Air Nitrox 28 was picked as the bottom diving gas mixture and 100% oxygen was used for the decompression gas. Special technical solutions were made and developed especially for this research. One example was the creation of a special breathing apparatus used for breathing oxygen to decompress at a specified depth. The diving work involved a total of 18 divers organized in diving pairs. Diving operations were conducted twice a day, and due to the depth of the site and diving gas mix, bottom-time was limited to 20 minutes.
General working tasks were divided in two groups. One was focused on cargo and shipwreck site documentation, while the other focused on the area with the lead anchor stock. Foka Ltd. facilities were used to store necessary equipment and tools, to host work meetings, and for the processing of documentation and finds.[15]

In a week campaign, the site was fully documented with 3D photogrammetry and a detailed site plan was generated. Also, archaeologists set up fixed reference points, so any future documentation can be georeferenced and seamlessly added to the existing site plan. At the end of the preliminary archaeological campaign, one of the Lamboglia 2 amphoras was recovered and sent to ICUA for conservation and further analyses.[16] Of note, this was not a 'rescue' archaeology excavation; the site remains largely undisturbed and available for future study.

[14] RADIĆ ROSSI and DORUŠIĆ 2018
[15] RADIĆ ROSSI and DORUŠIĆ 2018
[16] RADIĆ ROSSI and DORUŠIĆ 2018

3. NEW TECHNOLOGICAL SOLUTIONS FOR THE PROTECTION OF UNDERWATER CULTURAL HERITAGE

As previously mentioned, the Republic of Croatia has long followed UNESCO guidance by protecting Underwater cultural heritage in situ. In addition to re-covering sites after an excavation campaign, another tool used for this purpose was quite unique – a giant metal cage placed over the site. This practice was applied to topologically similar sites, but not without some major issues. After applying this kind of protection, potential future research becomes extremely challenging due to various technical limitations and safety issues.17 Based on this past experience, institutions in charge of Letavica shipwreck protection started to seek more suitable solutions. Knowing the limitations of the old passive protection system, the authors of this paper proposed something different: a system based on new technology that is completely complementary with the nature of the underwater archaeological site.18 For this unique scenario (a shipwreck near shore and near a dive center) a system of cameras and sensors with a marine buoy as the main power source was proposed as a superior and more active substitute to the old cage approach. Such a system would allow shipwreck research in parallel with monitored public access, all while protecting the site.[19]

3.1. Demo testing March 2019

Just prior to the preliminary archaeological campaign, the interdisciplinary conference and workshop Breaking the Surface (BTS) was held (September 2018). At this international conference, the authors together with dr.sc. Irena Radić Rossi from the University of Zadar presented the newly discovered site and discussed their desire to use this new site for technological demonstration. Among many excellent engineering companies and experts involved in BTS workshops, Kongsberg Marine representatives were particularly interested in the situation. Kongsberg Maritime is a Norwegian company specializing in cutting-edge marine technology, and after initial talks they agreed to use the Letavica site as a test bed for their new equipment.

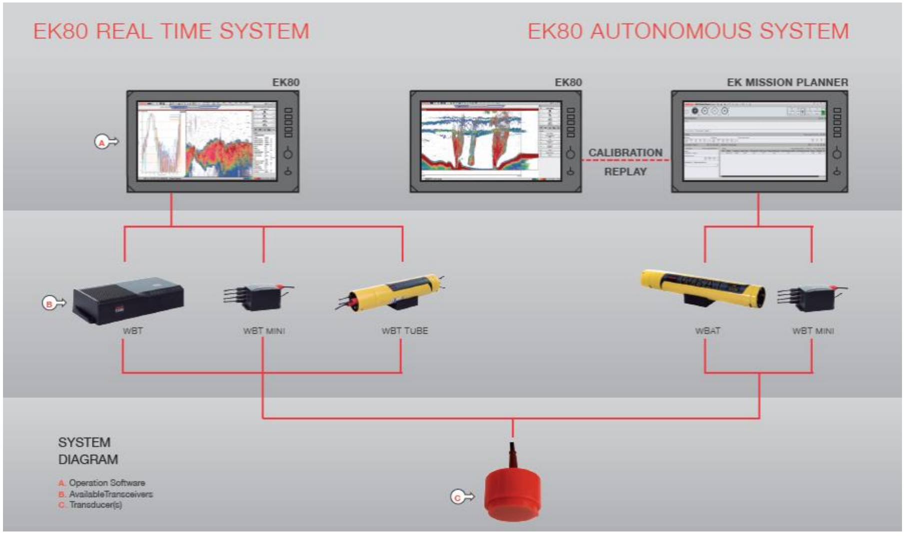

Fig. 12: The Simrad EK80 system.

The general idea was to develop a system that could protect the site from incursions by unauthorized divers, reducing the threat from looting activities. Using specially designed high frequency acoustic

[17] RADIĆ ROSSI and DORUŠIĆ 2018
[18] SELVAGGIO et al. 2009
[19] SELVAGGIO et al. 2009

sensors, made by Simrad, the site could be monitored 24 hours a day. This technology can detect a diver that swims through an acoustic beam and generate a message to alert authorities of the incursion.

The first equipment testing was performed in March 2019 and included participation from all the organizations involved with the preliminary archaeological campaign in 2018. The Norwegian team divided their work into two days, one day to collect data on the site location using divers as a target, and one day at the office to review the data and to discuss the possibilities to convert this system for real time usage, including an evaluation of potential system limitations.

The team selected the Simrad EK80 system to employ as a test system. This system consists of one or more acoustic transducers coupled with wideband transceivers, a computer unit and acquisition software (Fig. 5). When used with the EK80 real time acquisition software, the system is operated by a Windows-based processor. Also, the system normally requires input from auxiliary sensors such as GPS and motion sensors. The Simrad EK80 is a high precision scientific echo sounder with high dynamic range, raw data recording, low self-noise, high ping rate and multi frequency application for species identification. The Simrad EK80 can operate over a large number of frequencies simultaneously ranging from 10 to 500 kHz.[20]

For this test, a Simrad ES70-18CD depth rated transducer was paired with a Simrad Wide Band Transceiver Miniature (WBT Mini) provided to transmit acoustic energy into the water and to receive echoes from objects in the water column (Fig. 6). The Simrad ES70-18CD is a depth rated wideband split beam transducer designed for fishery research applications. It has a beamwidth of 18 degrees at nominal operational frequency 70 kHz.[21]

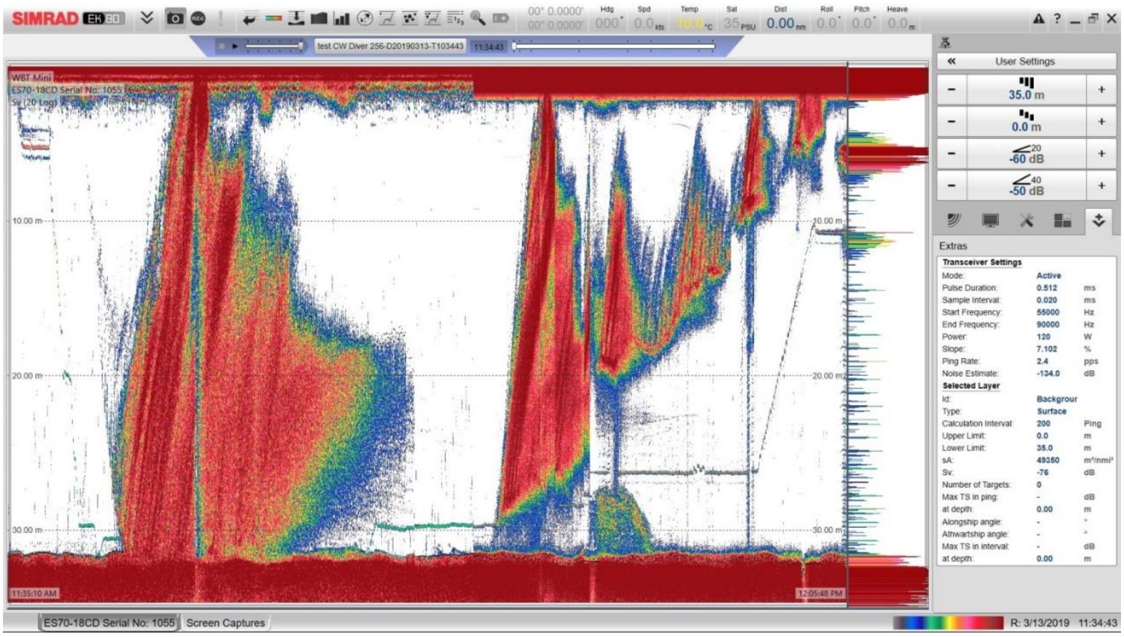

Fig. 13: Graphic representation of a data collected with a Simrad Wide Band Transceiver Miniature (WBT Mini). Transceiver transmits acoustic energy into the water and receives echoes from objects, in this case a diver, in the water column.

After two days of site testing results had been processed and assessed, all sides started to discuss future system possibilities. One intriguing idea was to use a different system, a Simrad WBT mini, as an "EK80 Autonomous system" instead of an "EK80 real time system" to save battery consumption. With this concept, a buoy with the solar system could be used as a power supply and as a potential

[20] https://www.simrad.online/cat/scientific_all_a4_en_hires.pdf
[21] https://www.simrad.com/www/01/nokbg0240.nsf/AllWeb/CC83A234F868D05AC125818C0059CD50?OpenDocumet

Closed-Circuit camera stand.[22] Combining underwater acoustic sensors with CC cameras offshore, then using their output in an alarm and surveillance system at an onshore site could ensure an underwater heritage site would be actively protected around the clock (Fig. 7).

Fig. 14: The idea of combining underwater acoustic sensors with CC cameras mounted on buoy offshore, then using their output in an alarm and surveillance system at an onshore site (I. RADIĆ ROSSI and V. DORUŠIĆ, 2018, 13-14, Fig. 14-15).

4. CONCLUSION AND FUTURE PERSPECTIVES

A newly discovered 1st century BC Roman shipwreck on the Croatian island of Pag was used as a case study to evaluate a new, interdisciplinary approach in underwater archaeological site protection. Superb cooperation between cultural institutions, local authorities and the diving community led to a promising new solution in cultural heritage site active management. The first steps toward implementation of this technology were made during a preliminary archeological campaign in 2018 followed by proof-of-concept technological testing in 2019. Future efforts will continue to enhance this monitoring capability, to include evaluation of a CC camera system installed on land at the local diving base facing the site location. Initial results were very promising, and while additional work and testing are required, clear progress was seen toward site monitoring in parallel with site access. The potential of this type of system is now clear; to maximize underwater cultural heritage site protection while allowing public visitation, this technology requires rapid testing and development followed by prompt field deployment.

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[22] CHEN at al. 2018

Theraic Sea: A bottom-up initiative for marine conservation and sustainable development in the Aegean Sea, Greece

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Abstract: Following a Cousteau Divers initiative in 2010 which raised local interest in the establishment of a no-take Marine Protected Area (MPA) in Santorini Island, efforts have been concentrated on identifying priority areas for conservation. Scientific underwater surveys have been conducted to provide rigid ecological baselines, and several follow-up steps have been taken to build further local, regional and national support for the establishment of the MPA. According to the scientific data collected, the proposed MPA - part of which within the impressive volcanic caldera- comprises a rich habitat and species diversity, and seascapes of complex topography and high aesthetic appeal. No anthropogenic pollution indicators were detected, but shallow rocky reefs presented clear signs of degradation due to historical overfishing, thereby furthering the need for marine protection. Although significant stakeholder support has been gained during the past decade (i.e. Thira municipality, Santorini Fishers' Association, local diving centres, concerned citizens etc.) and a general agreement in the establishment of a MPA along a ~9.8 km coastal stretch of Akrotiri Peninsula (~4.21 km2) has been reached, the lack of political will and accessible legislative tools have prevented its implementation. We argue that such initiatives, i.e. the establishment of bottom-up MPAs, are essential in offering a much-needed boost to the rapidly declining Mediterranean marine environment, as well as several responsible economic alternatives to ensure sustainability of local communities.

Keywords: marine reserve, participatory processes, community-based marine protected areas, fisheries management, sustainable tourism

1. INTRODUCTION

Coastal seas comprise some of the most dynamic, productive and diverse ecosystems across the globe, while at the same time they are increasingly exposed to numerous anthropic pressures (pollution, urbanization, exploitation, climate change). Among these, historical overfishing (and resulting ecological extinctions) has been acknowledged as the primary and most profound cause of marine ecosystem degradation worldwide (Jackson et al. 2001). To address this issue, Marine Protected Areas (MPAs), where all or some fishing activities are fully or partially restricted, have been traditionally used to conserve or restore declining marine resources. Yet fully protected areas hardly account for 1.44 % globally and less than 0.04 % in the Mediterranean Sea, falling far short of the 10 % Aichi Target set by the Convention on Biological Diversity for 2020 (PISCO & UNS, 2016).

Santorini island, despite being a worldwide renowned destination for its exceptional natural beauty, enjoys no level of marine protection. Although a NATURA 2000 SCI covers its mountainous SE side and the uninhabited rocky islets of the volcanic caldera, only terrestrial habitat types have been considered in this designation. Lack of sound and effective fisheries management plans is strongly reflected in local artisanal fishers' persistently decreasing catches (reporting up to five-fold decrease within two decades time; Pennewiss, 2004), as well as costal fish biomass surveys performed in the wider Cyclades region (Giakoumi et al. 2012).

On these grounds, a Cousteau Divers Initiative (Cousteau et al. 2010) envisioning the creation of a Marine Reserve aimed to improve local small-scale fisheries while also enhancing nature-based alternative tourism, brought together the local and scientific community to identify suitable areas and criteria for protection.

A scientific survey to assess the state of the proposed coastal sites (Salomidi et al. 2016), as well as several follow-up stakeholder consultation and administrative procedures toward the goal of protection revealed certain underlying ecological and political issues hindering this commonly agreed cause to this day.

2. METHODOLOGICAL FRAMEWORK AND RESULTS

2.1. Scientific Surveys

To assess the current ecological state (baseline) of the proposed areas and investigate their potential and suitability for the establishment of a MPA, a total of 18 coastal sites were surveyed (Figure 1), taking into account ad hoc biotic metrics and indices along the lines of the Habitats (HD, 92/43/EEC), the Water Framework (WFD, 2000/60/EE) and the Marine Strategy Framework (MSFD, 2008/56/EC) Directives. Surveys were based on the ecosystem-based approach, integrating benthic habitats (coastal reefs and Posidonia seagrass beds) with associated fish communities and keystone invertebrate species, along three replicate (25 m × 5 m) transects and two (5 m and 15 m) depth contours per site (Salomidi et al. 2016).

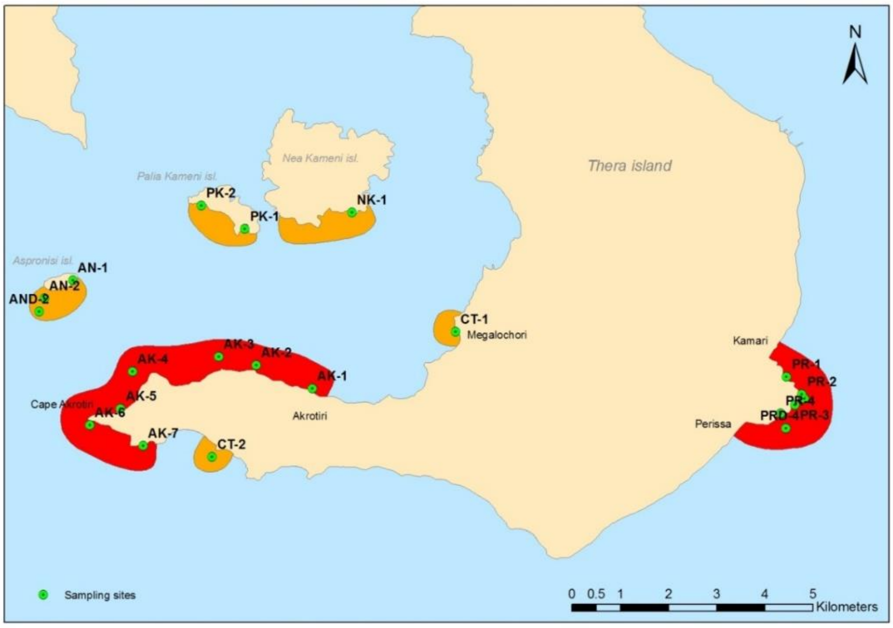
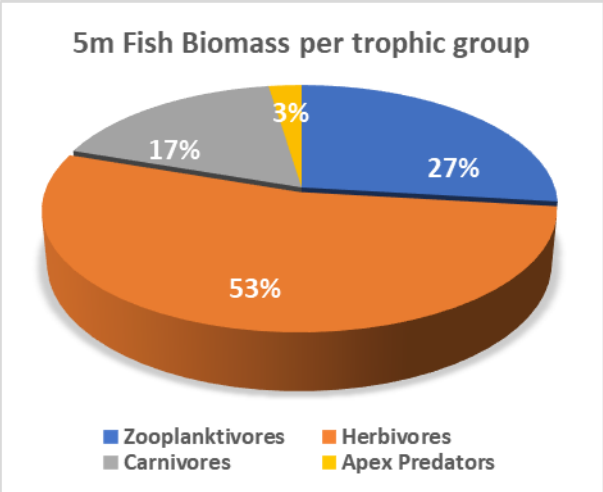


Fig. 1: Map indicating stations within the Perissa-Rock and Akrotiri MPA candidate areas (in red polygons). Orange polygons indicate several scattered control sites (from Salomidi et al. 2013)

Among the most important findings in the wider study area, were the low total fish biomass, largely dominated by herbivore and hardly represented by large apex predator fish species, as well as the abnormal structure and composition of the vegetation, with ephemeral turf -rather than the Mediterranean typical perennial canopy and bushy algae (Thibaut et al. 2005; 2017)- monopolizing the algal communities. This evidence, especially pronounced at the 5m rocky infralittoral habitats (Figures 2a, 2b), strongly suggests a coastal ecosystem depleted from large fish predators, thus allowing for an overabundance of herbivores (in this case the alien spinefoot fishes Siganus spp. accounting for 82% of total herbivore biomass) and their consequent overgrazing effects on native algae to the point of key structural species collapse (Salomidi et al. 2016).



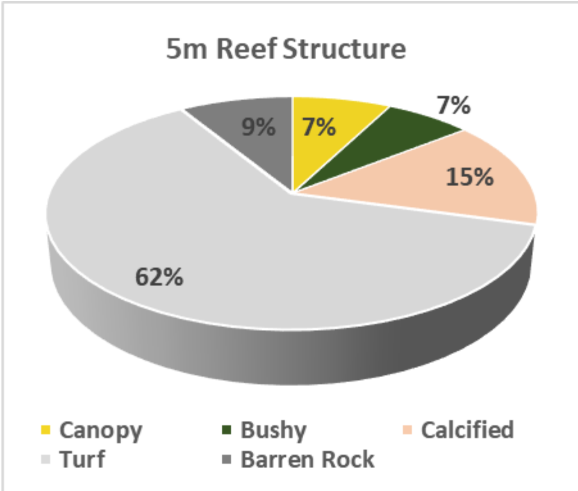


Fig. 2: Structure of a) coastal reef fish community per trophic group, and b) reef benthic cover (mean values for all stations studied at 5 m depth)

With few exceptions, biotic indices applied on both Posidonia oceanica meadows and the upper infralittoral algal communities reflected no signs of anthropogenic pollution across the examined sites. Higher heterogeneity at relatively small scales accounted for a higher habitat diversity (sandy bottoms, gravel, boulders, shallow reefs, seagrass beds, coralligenous formations, submerged or semi-submerged caves) along the volcanic caldera and the southern coast of the Akrotiri peninsula, indicating this area's higher restoration potential upon implementation of sound management plans. A provisional management plan was in turn carried out for this area (SUBMON, 2013).

2.2. Consensus Building

To effectively communicate scientific findings and build further consensus to the cause of protection, several public discussions, events and consultation meetings have been organized to actively engage the Santorini Fishers Associations, public authorities (Santorini municipality and port authority), the administrative Region of the South Aegean Sea, various local associations and unions (Santorini Recreational Fishers Association, Cultural Association of Akrotiri, Union of Santorini Boatmen), diving centres, and the general public in the planning process. Up to 2014, a general agreement was reached among all key stakeholders for the creation of a protected area along a ~9.8 km coastal stretch of the Akrotiri Peninsula, covering a marine surface of ~4.21 km2 (Figure 3). Furthermore, an association of concerned citizens "The Theraic Sea" society, and a non-formal Management Body (consisted of representatives from the Municipality of Thira, the Santorini Fishers Association and the Hellenic Centre for Marine Research) were ad hoc formed to support and promote the MPA's legal establishment.

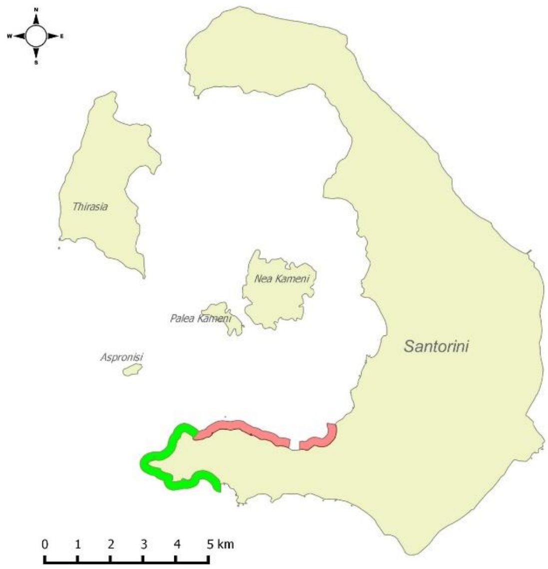


Fig. 3: The bottom-up agreed area for the establishment of a MPA in Santorini isl. In red: the area initially suggested by the local Fishers' Association (2013), in green: extension added to include important marine habitats and features, following consultation and discussion with the local community (2014)

2.3. Legislative procedures

According to the European and National Law, several legal tools exist for the establishment of MPAs, among which the Habitats Directive (HD, 9243/EC) (i.e. the Natura 2000 Network), the PD 67/81 and the L. 3937/11 being the most widely applied in Greece. These tools however are rather biodiversity conservation orientated and can rarely apply for fisheries exclusion (no-take zones) or adaptive management purposes. Much more suitable to this cause, the Mediterranean Fisheries Regulation (Council Regulation EC 1967/2006) foresees the designation of "Fishing Protected Areas (FPA)" defined as "sea areas where all or certain fishing activities are temporarily or permanently banned to improve the conservation or exploitation of aquatic resources and the protection of marine ecosystems".

In this light, the mayor of Santorini, the president of the fishers' union, representatives of the "Theraic Sea" Association and the Cousteau Divers jointly appealed to the competent Directorate General for Fisheries (Ministry of Food and Rural Development) in December 2017, submitting all relevant documentation along with a formal request for the establishment of a FPA in Santorini isl. One year later (October 2018), the Directorate replied rejecting the request on the grounds that "the need for protection is not duly substantiated for Santorini island". Albeit repeated attempts to obtain clear answers as to the procedural and documentary requirements for such a substantiation no further response has been provided since.

Nine years after the project's inception (Figure 4), this bottom-up small-scale conservation approach is still hindered by centralized environmental decision making, largely inconsiderate of social concerns and objectives.

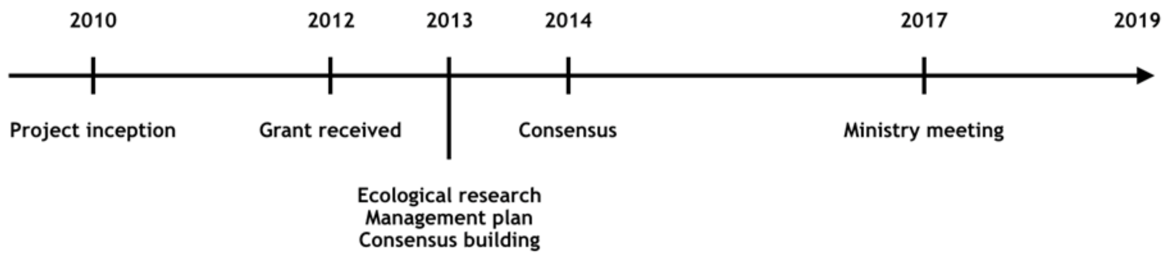


Fig. 4. Timeline for activities in the pursuit of the Santorini MPA establishment

3. DISCUSSION

Over the last four decades Santorini has become a globally renowned touristic destination with millions of visitors annually (Delitheou & Georgakopoulou, 2017; Peeters et al. 2018). This constantly increasing flow of visitors has been identified as the "shining example", a paradigm to replicate by the Greek tourism sector. During the Greek financial crisis, since 2010, tourism has been even more significantly contributing in the country's GDP (Ikkos & Koutsos, 2019), and is posing as a one-way exit from the austerity and repercussions of the memoranda. This prevailing developmental course was further consolidated by a significant step back in nature conservation legislation and the establishment of fast-track licencing procedures in environmental authorisation (Christopoulou et al. 2015).

Within this state of play, sustainability along with environmental, landscape and resource preservation have been demoted to posteriority on a national scale. Especially in Santorini, the tourism developmental model has taken a considerable toll from the island's resources (Delitheou & Georgakopoulou, 2017), putting immense pressure on the limited infrastructures (Peeters et al. 2018), and leading to a potential irreversible degradation of the natural environment. This latter is now especially pronounced for the island's marine ecosystems, practically collapsing under the combined effects of overfishing and climate change (Salomidi et al. 2016 for Santorini but see also Giakoumi et al. 2012; Sala et al. 2011; 2012 for the Cyclades and the wider Eastern Mediterranean).

The whole approach of the process described herein, aiming at the designation of a no-take MPA in the waters surrounding Santorini, stems directly from the factual necessity to demonstrate that an alternative, sustainable and nature conservation centred future is possible. All involved parties and stakeholders explicitly voiced this necessity during the bottom-up processes and the deliberations to develop and document a joint proposal. The formal request of the "Theraic Sea" seeking a legal designation of the proposed area reflects the commonly shared vision for a viable, environmentally and financially sustainable future for fishers, professionals of the sea, marine users, local inhabitants, visitors, but also for the marine natural environment suffering from overexploitation and anthropic degradation. Such demands have been also expressed by other interested parties that have clearly illustrated the ill-fated results of the current developmental model of Santorini (Ermogenis, 2018). This unconventional approach used in Santorini to achieve consensus and unanimity among seemingly contradicting opinions and stances (e.g. between fishers and conservationists) is not foreseen as a formal process to develop nature conservation measures. On the contrary, the Greek legislative framework for establishing protected areas is solely based in time consuming, bureaucratic and centrally designed procedures that utterly exclude bottom-up, participatory and adaptive approaches (WWF Greece, 2018).

International practice in bottom-up conservation approaches, has shown that early engagement of stakeholders, especially fishers, in decision-making processes significantly boosts MPA success and performance by incorporating local knowledge and increasing compliance (e.g. Ferreira et al. 2015, Campbell et al. 2012, Guidetti et al. 2010; Said et el. 2018). It is a widely acknowledged fact that well-managed MPAs support fisheries (Lubchenco & Grorud-Colvert, 2015; PISCO & UNS, 2016; Sala & Giakoumi, 2018), and ensure healthy and productive seas which boost coastal and maritime tourism and generate multiple socioeconomic benefits accounting for up to EUR 3.2 billion yearly (as estimated for 10 % of sea surface protection) (European Commission, 2013). Depleted seas, on the other hand, jeopardise the sustainability of most economic activities based on the coastal zone, which is particularly the case for small-scale fisheries in the Cyclades and the wider Mediterranean region today (Said et al. 2018). Meanwhile, small-scale fishers in their despair, seek to ensure their catch in ways that would otherwise appear unacceptable through the prism of their Traditional Ecological Knowledge (see Gasalla & Diegues, 2011), thereby trapping themselves in a vicious circle.

The ensuing and commonly shared goal of the Santorini initiative is to establish a MPA and an inclusive nature management scheme that will provide specific socio-economic benefits and livelihood resilience through numerous alternative economic activities and opportunities, such as responsible artisanal and recreational fishing activities, boating and diving tourism, as well as high quality sustainable locally and ethically sourced seafood. The effectuation of this vision is not unrealistic even for a mainstream touristic destination with an established global brand as Santorini.

As this has been the case in the past, the island's character has already been shaped once socially and economically by tourism (Delitheou & Georgakopoulou, 2017). Diversified, eco-friendly and responsible tourism activities have already started to thrive on the island (hiking, mountain biking, kayaking, fishing tourism, SCUBA diving etc.), while the EU and the international tourism sector is gradually steering towards sustainable and responsible services regarding their impacts in resources, nature and biodiversity (Communication from the Commission - Agenda for a sustainable and competitive European tourism, 2007).

Decentralised, small-scale, bottom-up and inclusive approaches seem to be the only alternative to avoid a further and irreversible degradation of the natural marine and terrestrial environment. Especially for Santorini such initiatives can serve as a true "shining example" that can be easily transferred and replicated throughout the Aegean Archipelago and beyond.

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Towards the Creation of Accessible Underwater Archaeological and Historical Sites in Fournoi and Leros (Eastern Aegean): an Interreg VA, Hellas- Cyprus 2014-2020 program under development

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The program "Diving routes to marine protected areas of the eastern Mediterranean - Development of a diving tourism network" approved by the Cross-Border Cooperation Program Interreg VA, Greece - Cyprus 2014-2020, aims at exploring the potential of specific regions of Greece and Cyprus to develop their tourism dynamics relying on diving tourism.

The involvement of the Hellenic Ephorate of Underwater Antiquities in this proposal is to investigate the possibilities of the marine areas of the Fournoi archipelago and Leros in the Eastern Aegean, towards the creation of accessible archaeological sites in the future. The archipelago of Fournoi, following the systematic underwater survey of the Ephorate during the years 2015-2018, has emerged as one of the richest archaeological sites of the Mediterranean with an exceptionally large stock of ancient, medieval and post medieval shipwrecks. In contrast, Leros was the area of extensive naval and air strikes between the Allies and the Axis forces during the Second World War, offering so a large number of wrecks that have still be documented and evaluated.

The project aims to produce an integrated proposal that will make some of these shipwrecks accessible to the public via organized diving tours, on the benefit of sustainable development of less known and promoted areas of the Eastern Aegean.

Keywords: ancient shipwrecks, 2nd W.W. Shipwrecks, sustainable growth, raising awareness, Fournoi, Leros

Project blueHOMER

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Abstract: Most people do not know how to dive, have no licenses or are not prepared to physically withstand demanding dives, but would like to feel the freedom of moving under the sea. They would like to see some of the famous diving sites, hear the relaxing underwater sounds. Everyone, completely healthy, and those with some physical disadvantages - should get the chance. They should get a chance to experience dive into the depth, without risk. We will make it happen.

In the pool, under fully controlled conditions, they will be able to select one of the virtually replicated dive sites from the Program. Trough real diving suit with all the equipment, will be able to feel water resistance. In a dry diving helmet with compressed air regulator, Virtual Reality screen and headphones will have the impression that they are deep under water, in front of a known shipwreck that have only seen in the picture so far. Even vision impaired persons will be able to feel real-life replicas with hand-sight gloves, the narrator will describe the objects and the dive site into the details. Imagine how huge gap the blind person passes when he can get the real dive into virtual depths, when he can touch the amphora at the seabed and at the same time find out all about the hydro-archeological location, origin, and purpose of use.

The entire Program would be able to relocate anywhere in the world if there is a swimming pool. In this case, all over the world, people will enjoy the underwater magic, regardless of their age, their physical abilities and their distance from the places they want to dive. Then, such dive sites will be protected and preserved for future generations.

Keywords: Diving, Dive sites, Virtual reality, Perception, Quality of Life.

1. DIVING

Diving with an autonomic diving device is known as a relaxing activity that often raises the level of adrenaline. However, it is still a "dangerous sport" for uninitiated people, and even many divers do not know that diving has many positive effects on health. The expansion of diving sports (tourism) has raised the level of awareness and responsibility of instructors and organizers of diving, and today acute incidents are not as frequent as they were in the previous years (in relative relation to the number of divers and dives). The interest of chronic professional anxiety and illness originated firstly from professionals and was inspired by insurance companies. However, in modern times, the frequency of the dive of recreational divers has reached professionals, and all diving techniques, sometimes reserved for underwater work or military activities, have become accessible and enjoyable among recreationists. Medical doctors and diving physicians significantly increased interest in these topics, and scientists were given the incentive for more detailed research.

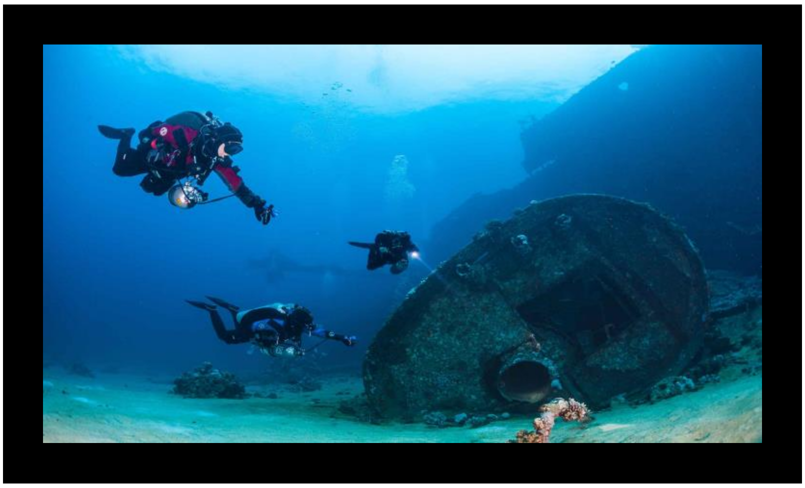

Fig. 1: Diving

1.1. Positive medical part of diving

Breathing is slow and deep in diving, especially for experienced divers, which optimize the consumption of respiratory media from the diving bottle. Such a breathing mode works favourably on the lungs and allows better air circulation through the lung alveoli. The production of mucus decreases, and even breathing has a positive effect on both the trachea and the throat. When entering the water, our heart starts to pump rapidly (due to adrenaline and temperature difference), and since diving is most often in waters that are colder than body temperature, the peripheral blood vessels are compressed in order to preserve the temperature of vital organs. All this leads to a mild increase in blood pressure. Consequently, after diving, the peripheral blood vessels widen and slowed down the heart, leading to a reduction in blood pressure and stabilization. That change positively affects the balanced heart rate and blood pressure. Moving through the water is much harder than in the air. Diving muscles work hard work during the dive, which encourages them to develop new muscle fibers later, after which they become prolonged and stronger. As almost all muscles are activated during diving, the body is proportionally developed, and moving through a dense media also increases the flexibility of muscle fibers. Diving is often associated with exposure to the sun's rays before and after the dive. This is important for the production of vitamin D, which helps the absorption of calcium and the passage of calcium among the cells. The European Society for Human Reproduction and Embryology confirmed the claims of a Belgian investigator dr. Frank Vandekerckhove, who said that higher temperatures, lack of rain and many suns improve in vitro fertilization results. Dr. Vandekerckhove claims that the increase in vitamin D levels is a key factor in fertility enhancement, and it is known that exposure to the sun is responsible for creating additional stocks of this vitamin. In today's world where more and more women are diagnosed as having infertility problem, and reproduction is becoming more and more stimulated by medical methods, exposure to the sun before and after diving is a very simple and natural way of stimulating fertility. One of the interesting diving phenomena is the beneficial influence of the aquatic medium on the brain. Namely, by completely immersing in the water, we imitate the natural environment of the fetus in the womb, which is a condition that the brain registers as calm, safe and peaceful. This stimulates the sense of well-being and happiness. Also, images of marine life and slow motion under water and natural beauty stimulate positive thoughts, and blue colours seem relaxing, while moderate exposure to the sun's rays stimulate the production of endorphins (a hormone of happiness). Likewise, slow and deep breathing during diving is similar to breathing during meditation, so it is reducing the level of stress and encouraging positive thinking.

1.2. Negative medical part of diving

According to the expert literature, the permanent consequences of diving define the phenomena that are not significantly found in the non - diving population, which are causally related to diving and/or followed by diving incidents even after their treatment and rehabilitation, which cannot be explained by any other cause without any connections with diving, and which significantly affect the deterioration of the general quality of life in divers. The most well-known and best-studied risk is foramen ovale appertum[23]. The occurrence of dysbaric osteonecrosis and visual and hearing disorders are described without prior diving incident. There are more and more studies of the relationship of diving and cardiac disturbances, changes in the liver and eye background. It is necessary to indicate the negative effects of standard dives in order to better explain the difference in relation to the blueHOMER dive.

Specific chronic diving problems that scientists have defined so far are:

• Damage to bone tissue with endangering the functioning of adjacent joints, known as the dysbaric (or aseptic) bone necrosis.

• Neurological disorders are most often the result of decompression disease and barotraumatic gas embolism. Symptoms such as tingling, tremors, vertigo, impaired peripheral nerve function appeared frequently (in 8 to 47% of the examined divers) immediately after saturation diving and lasted for years afterwards. In a significant number of respondents, concentration and memory disturbances, behavioral changes, changes in EEG to epileptic attacks, sexual dysfunction, and others have developed. There is also a clear correlation between the occurrence of neurological symptoms with frequent diving deeper than 40 meters, as well as diving in cold water.

• Research shows significantly more common hearing and tinnitus in divers compared to non-infectious populations, manifesting more pronounced at high frequencies. A frequent consequence of long-term diving is also chronic sinusitis. It is most commonly the result of frequent sinus barium tract, especially in the case of divers who "dive" and when they caught cold, with the use of nasal drops and the excessive Valsalva maneuver[24] that, along with sinuses, damages the ear structures, often and lastingly.

• Differences in the status of the retina of the eye (retina) in divers in relation to control groups of non-dermal individuals have been identified by studying and comparing eye changes. Not only degenerations are more pronounced with divers, but the difference is also observed among them indicating a direct correlation with the length of diving experience and the frequency of diving. The reason for these changes is seen in the obstruction of microcirculation by nitrogen bubbles, otherwise retina is extremely sensitive to the hypoxia. Although one study showed that there was no difference in eye damage to divers who had never had a decompression illness and those who had experienced it, another study showed that non-risk dives do not lead to damage to the retina.

With some deep divers, significant changes in liver enzymes and chronic skin changes have been observed. Particularly, exposure to elevated pressure can lead to hormonal changes, especially for example increased thyroid hormone levels, bone marrow and other glycoproteins that can cause liver damage (Dr. Mario Franolić, 2015).

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23 Foramen ovale appertum - open communication between the left and right heart subsides

24 The Valsalva maneuver is performed by moderately forceful attempted exhalation against a closed airway, usually done by closing one's mouth, pinching one's nose shut while pressing out as if blowing up a balloon.

2. VIRTUAL REALITY

Virtual reality (VR) is the use of computer modelling and simulation that allows the user to interact with the artificial 3D environment. Applying virtual reality to users in a computer generated environment that simulates reality through the use of interactive devices that send and receive information and are worn as glasses, headphones, gloves or suits. In the usual VR format, a user wearing a helmet with a stereoscopic display sees animated images of the simulated environment. The "immersion" (telepresence) illusion is influenced by motion sensors that read user's movements and adjust the view of the screen accordingly, usually in real time (i.e., at the same time as the user moves). Therefore, the user can go through several simulated rooms, and experience a change of view and perspectives that are convincingly linked to his or her head movements and steps. If a user carries data gloves equipped with reverse-force devices that provide a touch of feel, he or she can raise and manipulate objects that see in the virtual environment. Similarly, by providing haptic feedback, gaming controllers vibrate when something happens on the screen. For years, engineers and scientists have found ways to use virtual technology outside the gaming industry. For example, medicine in several of its fields already applies this technology. We have numerous VR therapies, from pain reduction to the treatment of psychiatric disorders such as anxiety or PTSD[25] . A virtual walk through the human body significantly raises the level of quality of the learning process, such as anatomy, but it is also of great use in diagnostics. When examining brain organs, with VR, doctors can get an insight into his condition at a given moment. Virtual reality can be used to rehabilitate permanently or temporarily immobile. It proved very effective in the recovery process. It has even been proven that, for example, in amputated limbs, therapy helps virtual reality to adapt to prosthetics and even to diagnose phantom pain. While for permanently immobile, it allows them to move in the virtual world.

Fig. 2: VR Dive

3. PERCEPTION

"Perception or observation is the process by which we become aware of objects, their properties and relationships through sensory organs. "It is influenced by attitudes and past experience. When we understand the meaning of what we feel, the senses become perceptions. It has a subject character, it is oriented to objects and phenomena, and the selective character, because it separates objects as background shapes. The touch and other skin sensations are an important part of the information about

25 PTSD – post-traumatic stress disorder – a mental health condition that is trrigered by a terrifiying event

the outside world (Stančić, 1991.) For clarification and implementation of this project, it is important to mention: visual, auditive and tactile perception.

3.1. Visual perception

The human eye as a small organ weighing only 28 grams and 2.54 cm long is one of the most important organs in the human body. Over 85% of the information transferred to the brain is of visual origin, 1,200,000 nerve fibers in each eye, transmits data at a rate of 109 Gb/s to the brain. The process of visual information processing begins with the entry of light into the eye. Once the information is encoded in the perceptual processors, it is transmitted to the sensor image store which is part of the working memory, and consists of long-lasting memory parts. Cognitive processes connect information from long-lasting memory with information from the sensor image library and it made decision for reaction. Depth perception is the ability to perceive the world in three dimensions (3D) and to judge the distance of objects. In order to have depth perception, you must have binocular vision, also known as stereopsis. If someone lacks stereopsis, they are forced to rely on other visual cues to gauge depth, and their depth perception will be less accurate.

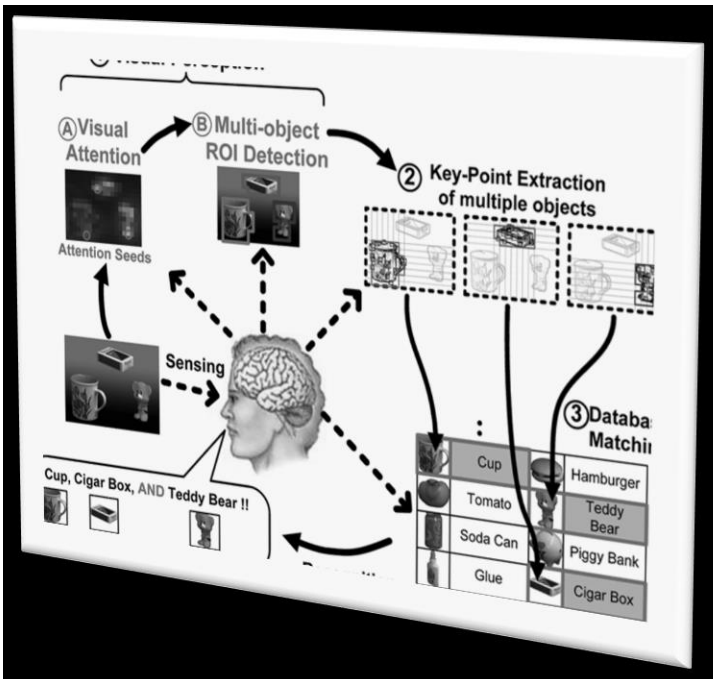

Fig. 3: Visual perception

3.2. Auditory perception

Auditory perception is the function of the hearing system, the perception of sound, or, more precisely, the perception of objects and events through the sounds they produce (Masterton, 1992). The sounds are vibrations of the air molecules that stimulate the hearing system. People only hear molecular vibrations in the range of 20,000 Hz. The amplitude, frequency, and sound-wave complexity are perceived as the volume, pitch, and timber (color) of the sound. According to a theory of hearing, it is considered that the auditory system implements a similar Fourier analysis[26] by decomposing complex sounds to their components.

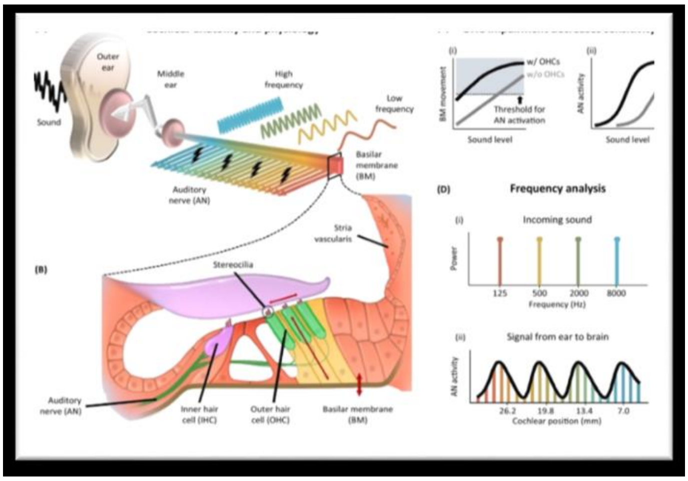

Fig. 4: Auditory perception

3.3. Tactile perception

Touch is the type of object perception and phenomenon based on multimodal and tactile information. Therefore, tactile perception is a feeling through touch, pressure, temperature or pain, due to which the person sees the surrounding reality. With the help of this perception, a person creates first impressions of an object. When we are in contact with the outer skin of the body, we have the ability to know the shape, elasticity, size, roughness or density, coldness or heat that are characteristic of the subject. Thanks to the tactile way of observing information, our skin is able to respond to the physical properties of objects around us, and therefore we get certain information through it.

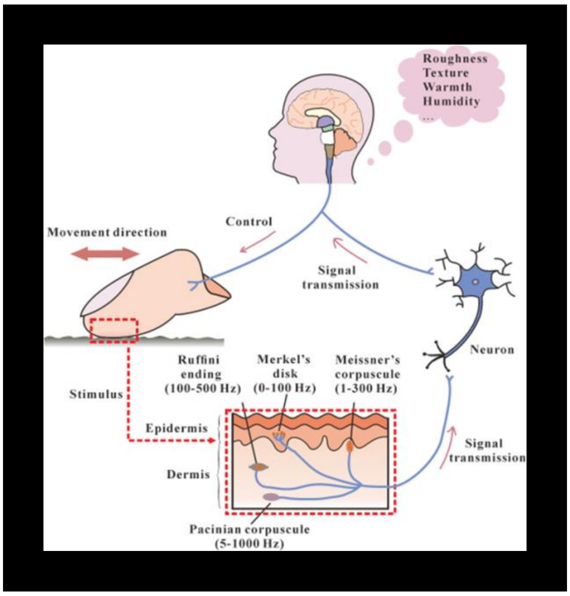

Fig. 5: Tactile perception

26 Fourier analysis is a method of defining periodic waveforms in terms of trigonometric funtions

4. blueHOMER Concept

The blueHOMER project is designed to enable all people, regardless of gender and age, or have a physical defect, a real dive into the virtual depths of the known diving sites. People who once dived at a young age and are not able to visit some desired locations or are not in good physical condition for a demanding dive. Likewise, people who have fear of blue depths, yet again a great desire to feel pressure on the body, see the famous diving sites, learn about submarine that is broadly covered in the surface of nearly three quarters of the total Earth's surface, in controlled conditions to experience it. The concept of blueHOMER is simply a solution that can afford the sea dive to people around the world, regardless of the location of the site, the vicinity of the sea and the weather.

4.1. Equipment

The equipment consists of a software/application in which one of the famous diving sites can be selected, previously photographed and mapped, and made in a virtual world like a FPS video game. Compressed air regulator with predetermined tank (bottle) and buoyancy compensator, VR dry helmet with headphones, in which the 3D effect and virtual reality will be fully experienced by the diving site, while the "narrator" in headphones will describe every important position or object that touches the "hand-sighted" gloves. This allows each person a complete experience of diving into the depths of the sea. It can be said that the maximum impression a person receives with the combination of vision in VR and the explanations which he receives about the selected location through sound support and narrator, and also with the diving suit and its own equipment. In the case that a person has some of the physical hurdles, health disadvantages, he will again receive in that combination the maximum that his brain can process.

Mobility as one of the most important features will enable it in any city that has a pool. Some kind of smaller truck that includes: Compressed air bank of 200 bars and the aforementioned equipment accompanied by few dive instructors.

Fig. 6: Hand - sight VR gloves

5. BLIND AND VISUALLY IMAIRED PEOPLE IN THE SEA

The blind and visually impaired persons have a real obstacle in diving. A smaller number of sports clubs and associations for people with health problems offer a dive service for the blind. Particularly, these dives accompanied by divers cannot completely approach a known diving site for a blind or visually impaired person. In the blind, the most important role in acquainting the subject is the tactile perception within which we distinguish the analytical and synthetic way of cognition. An analytical path involves touching the details and the individual parts on which the image of the object is created, while the synthetic path involves capturing the whole object on which the subject is recognized. These paths complement one another, and are used almost simultaneously. One or more fingers and one or both hands can be used to touch. It is very important to instruct teachers to get far more time to learn through tactile perception than to get to know the sight (Matok, 2011).

One blind person explained that it was easier to concentrate if he "watched" the object he touches, although he was completely blind and did not perceive light. Scientists have confirmed that the directional view helps in haptics, improves the resolution of space, and accelerates the reaction time (Heller and Ballesteros, 2006 according to Kennet, Taylor-Clarke and Haggard, 2001).

The accuracy of object recognition increases when respondents are guided by giving them information on what to choose, about the superior category (for example, about fruit).

It is desirable to keep track of the subject with a verbal description because it is more complete to imagine the subject. For this reason, a blind or visually impaired person will be able to touch with the "hand-sighted" gloves, for example amphorae on the virtual seabed, except for the stimulation of tactile receptors, narrator will describe the history of making and the purpose of the amphorae itself and the interest in the locality where it was found. That person will then have an irreplaceable sense of navigating through the sea while having complete diving equipment and accompanying diving instructors, have all the necessary information that cannot be obtained in ordinary safe dives for persons deprived of the most important senses.

6. CONCLUSION

For all people other than those in a state of complete sensory deprivation[27] or agnosia[28], the blueHOMER concept will allow maximum diving experience. People with hearing impairment or visual disturbance in the combination of visual, acoustic and tactile perception, of course, of that part that is not damaged will be able to feel virtual sea depths in safe conditions. It is important to say that with the already mentioned enhanced secretion of endorphins, for some getting to know a brand new world of underwater, we dramatically raise the quality of life. And today, as it used to be, we live in the four types of surroundings. These are the biological, physical, chemical and social environments. This last is invisible, but is therefore intensely felt. It is the social environment that directly and indirectly participates in the deterioration of health, increasing the incidence of people including the marked increase in malignancies. At the same time, the social environment indirectly and directly affects one form of people's resignation, which determines the quality of their life. It should be said that today we register the fifth environment. It is an extension of social, it includes new determinants and we call it a psychosocial environment. People with an impaired sense of vision or hearing, even para/quadriplegic, consciously or unconsciously often get socially alienated. Such people should help to approach seemingly inseparable things, and thereby raise social awareness and quality of life.

27 Deprivation - the complete deprivation of all sentiments
28 Agnosia - inability to interpret sensations and hence to recognize things, typically as a result of brain damage

Last and not least; by virtual simulation of some of the known diving sites altogether we can protect the underwater heritage, however, we should be aware that this beautiful sea has been provided for safekeeping, especially for future generations and that we have to behave responsibly. As Mahatma Gandhi said, "Earth provides enough to satisfy every man's needs, but not every man's greed".

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The Studies on the Underwater Cultural Heritage of Istanbul from the Anatolian Side to the Prince Islands: The NEMSUS Project

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***Abstract*:** The aim of this study is to determine the underwater cultural heritage of Istanbul between the Anatolian Side and the Prince Islands. For this purpose, underwater surveys are conducted regularly in the region since 2016. Within the scope of the North-eastern Marmara Sea Underwater Survey (NEMSUS) project, a marble carrying ship discovered at the sunken island of Vordonisi in 2016. The wreck was found at a depth of 4 – 6 meters and spread over an area 35 meters. Among the wreckage, 18 roughly quarried marble blocks were found. As a result of mineralogical-petrographic analyses showed that the marbles belong to the Island of Proconnesos. The location of the shipwreck indicates that it was traveling from the marble quarries on the Island of Proconnesos in the Sea of Marmara to the Island of Vordonisi.

Another UCH site was discovered during the seabed dredging at the Kalamış Bay on the Anatolian side in 1989. A number of Yortan vessels dating to the Early Bronze Age were found. In addition, during the dredging in 1989, a number of Yortan vessels dating to the Early Bronze Age were found at Kalamış Bay on the Anatolian side. It is emphasized that the works recovered from this site point to the presence of a sunken settlement here.

It is mentioned by Aristotle that the copper mines were ruins in Heybeliada, which overlooks Kalamış Bay. The ancient name of the island is Chalkitis = Copper is explained by mineral deposits. Çamlimanı, located in the south of the island, must be a copper bed beneath the two fathoms of the sea, which is used to make the sculpture in the Temple of Apollo at Sicyon, which is referred to by Aristotle.

Keywords: Marmara Sea, Vordonisi, Istanbul, Prince Islands, Chalcedon

1. INTRODUCTION

The NEMSUS (the North-eastern Marmara Sea Underwater Survey) project aim to conduct a systematically and comprehensive scientific research with a multidisciplinary approach along the shoreline of Anatolian side of Istanbul and The Prince Islands (Fig. 1).

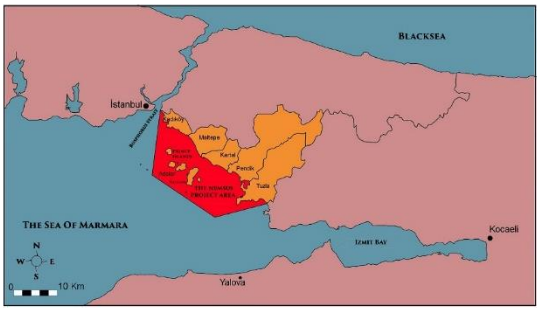


Fig. 1: The NEMSUS Project Area

Prince Islands consist of the Büyükada Island (Πρίγκηπος/Prinkipos), the Heybeliada Island (Χάλκη/Khalkitis), the Burgaz Island (Αντιγόνη/Antigoni), the Kınalıada Island (Πρώτη/Proti), the Sedef Island (Τερέβινθος/Terebinthos, modern Greek: Αντιρόβυθος/Antirovithos), the Yassıada Island (Πλάτη/Plati), the Kaşık Island (Πίτα/Pita), the Sivriada Island (Οξειά/Ohia) and the Tavşan Island (Νέανδρος/Neandros). Additionally, there is a submerged island called the Vordonisi Island, which should be added to this list[29]. With this survey, we attempt to reveal the underwater cultural heritage of the region. The primary focus of the survey was the Vordonisi Island[30] (Fig. 2) an area claimed to contain building ruins from the Byzantine Period, and thus known as Monastery Rocks.

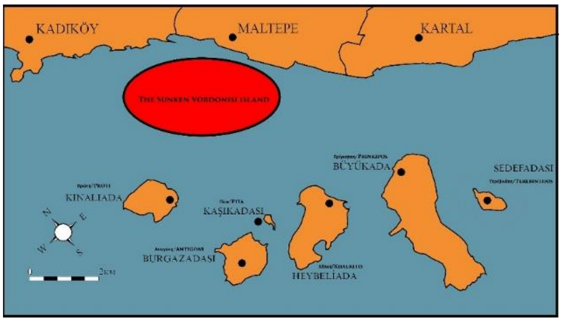


Fig. 2: The Vordonisi Island

Nevertheless, an earlier underwater survey was conducted in Kalamış Bay and the earliest underwater data were obtained from this region. A review of previous archaeological underwater surveys that have been conducted in and around Istanbul showed that a number of Yortan vessels dating from the Early Bronze Age were found in Kalamış Bay in 1989 during a cleaning work on the seafloor. It was reported that the Istanbul Archaeological Museums found stone wall foundations during the rescue dives they performed there. However, their work was terminated because of very poor visual conditions. Studying these remains, Dönmez indicated a potential submerged settlement in Kalamış Bay. Özdoğan also emphasized that the artefacts recovered from this site suggest presence of a settlement underwater. A review of the evolution of the Marmara Sea, which was once a lake, it appears that Marmara Sea met the salt water from the Aegean Sea by crossing the Dardanelles around 7000 BC. The connection of the Sea of Marmara with the Black Sea was probably around 5500 BC[31]. Based on the elevation of the Neolithic settlement of Yenikapı, the sea level was less than minus 6 meters 9-8 thousand years before today. Accordingly, the Sea of Marmara at the beginning phase of the Fikirtepe Culture, which is called the Archaic Phase, should have been at a level 15 to 20 meters lower than the present-day elevation[32]. For this reason, the Prince Islands should have been linked to the mainland during the Neolithic Period[33]. However, Yarımburgaz 4-0 material was reported in Yenikapı today under the Marmara Sea level[34]. The settlements between today's Anatolian coastal

[29] Bilir et al. (2017), 132-150.
[30] Millas (1992), 205-208.
[31] Algan et al. (2011), 30; for relevant arguments see (Ryan et al. (1997); Aksu et al. (1999); Çağatay et al. (2000); Görür et al. (2001); Hiscott et al. (2002)).
[32] Although the exact dating of the finds that belong to the Archaic Phase of the Fikirtepe Culture was not established, similar materials recovered from the Yenikapı excavations are dated to 6400-5800 BC based on C14 data (Özdoğan (2013), 173, fig. 12).
[33] Algan et al. 2011, 44; Özdoğan 2013,175.
[34] For detailed information on the Yarımburgaz 4 layer and materials dating to the Chalcolithic Age, see (Özdoğan et al. (1986), 12; Özdoğan (1990), 382, plt. 246-248, figs. 4a-b, 5b-c, 6a-b.).

borders and Prince Islands should have been flooded during this period[35]. Vordonisi should also have become an island during this period.

2. THE NEMSUS PROJECT 2016 – 2017 CAMPAIGNS

Our archaeological underwater survey within the scope of the NEMSUS project began with the permission of the Ministry of Culture and Tourism under No. 159887 dated 02.09.2016 on behalf of Düzce University between September 20th and October 5th 2016 - June 12th – 23rd 2017 in the area known as the Manastır Kayalıkları (Monastery Rocks), lying 1.5 km southwest of the Maltepe coastline and 4 km northeast of Kınalıada in Istanbul.

2.1. The Vordonisi Island

Most probably due to sea level rise and tectonic movements, Vordonisi should have sunk into the waters of Marmara Sea over time. However, it is not known exactly when the island vanished. Between 858 - 867 AD and 877 – 886 AD, Photios the Patriarch of Constantinople (Fig. 3), was sent to exile to the Armonians or Armenians Monastery in Vordonos[36].

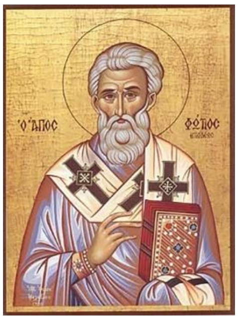


Fig. 3: Saint Photios the Great, Patriarch of Constantinople

There is a strong possibility that the rocky region known among the sailors as Büyük (Big) Vordonos and Küçük (Small) Vordonos was in fact the Vordonisi Island, which was once above the sea level, but sank into the sea due to massive earthquakes and floods over time. An analysis of the earthquakes that occurred in the region and the tsunamis triggered by these earthquakes shows that there was a tsunami in the Eastern Marmara due to an earthquake in 989 AD[37].

Considering that the ancient records of the island are no later than the 10th century, it is probable that Vordonisi inundated during this period. However, an explicit mention of Vordonisi in a map of 1770 (Fig. 4) prepared by J. L. Cowley raises doubts about this probability.

[35] Özdoğan (2015), 15, fig. 6.
[36] White (1981), 36.
[37] Soysal (1985); Altınok et al. (2001), 530.

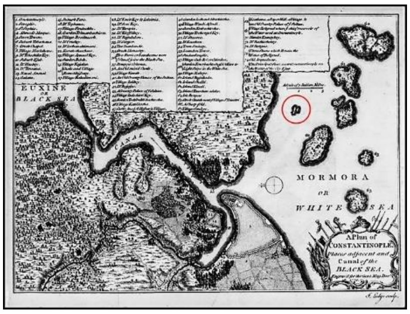


Fig. 4: J. L. Cowley's Map showing Vordonisi Island.

While the earthquake and tsunami that occurred on May 22, 1766 led to damage in the Mudanya Bay and the Bosporus, all this happened before the map of 1770 was drawn. After this date, the first major earthquake that caused tsunami had occurred on July 10, 1894[38]. However, this tsunami did not cause much changes on the Anatolian coastline[39]. It is also better not to rule out that Vordonisi may have been specifically indicated in the above mentioned map to warn sailors against dangerous rocks. In the meantime, these rocks are also referred to by the sailors as the Monastery Rocks. It is clear that the Adalar (Islands) district of Istanbul, also called the Prince Islands, served as a religious and political exile centre during the Byzantine Period. For this reason, this sunken land may be the island where the Patriarch Photios was sent to exile and once the Armonians Monastery was located. In order to prove this from an archaeological point of view, we need to identify the architectural remains of the monastery on the island. Therefore, we wanted to clarify the claims about the presence of Patriarch Photios' monastery and that the island on which it was built had been devastated by an earthquake. We spend efforts to obtain clues about the history of the island. We also aim to register quickly it if remains of such a building are found on the island. Our survey dives focused on four different points of the study area where cliffs rising from the sea are located because we believe that remains should be located in shallows. In addition, when viewed from a satellite photograph, it was observed that most of the settlements in the Prince Islands looked northward, that is, the Anatolian side of Istanbul, and it was estimated that the possible building remains could be on the north facing side of the sunken island.

In particular, our focus was around a large rock on the north-east side of the beacon facing the islands[40]. During these dives, we observed that the sea bottom of the island was covered with shells. The rocks beneath (Fig. 5a) and sticking out of the sea (Fig. 5b) are almost unnatural formations.

[38] Especially in Heybeliada, it was recorded that sea water broke at the shore violently after ebbing approximately 15m, causing the boats in the bay to sink in the south of the island (Altınok et al. (2001), 531).
[39] Altınok et al. (2001), 531.
[40] During the dives, we observed that the depth changes between 0-10 m, and the visibility was clear and the water was around 23- 24ºC. In particular, we would like to mention that the best time for clarity of visibility is the end of September and the beginning of October, the month of our work.

Fig. 5a - 5b: Unnatural rocks beneath the sea and sticking out of the sea.

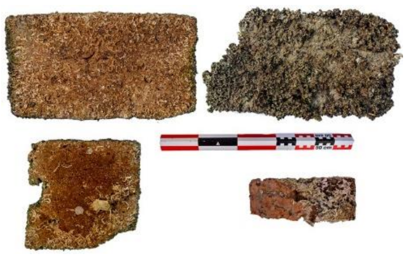
Since the depth was not too much and the visibility conditions were very suitable, we also examined the area using mask and snorkel from the surface in addition to scuba diving. The scan was done systematically by two distant divers swimming in the direction of the route defined, in the wake water of the boat running at the lowest speed at a constant rotation. As a result of the surveys performed on the sunken island, we found a number of amphora handles and body fragments, roof tiles, unprocessed marble blocks, architectural blocks, as well as an anchor. Among the sherds recovered during these surveys, a total of four amphora handles and sherds of various amphorae are noteworthy **(Fig. 6)**. Although we cannot get an idea about the period of handles, they clearly point to a commercial

activity in the region.

Fig. 6: Amphora sherds

2.1.1. Roof Tiles

Among the cultural assets identified, roof tiles have a very important place. In addition to four intact pieces of roof tiles which seem support the presence of a settlement before sinking, we found some



fragments **(Fig. 7)**.

Fig. 7: Roof Tiles

At the beginning, we thought that they belonged to an architectural structure on the sunken island. Eight more roof tiles were found as stacked and welded to each other (Fig. 8.).

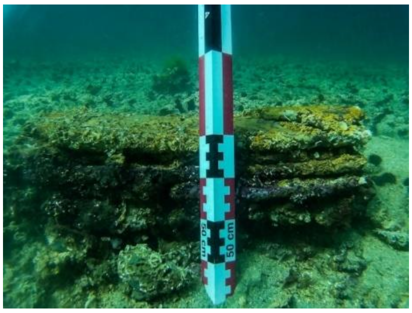
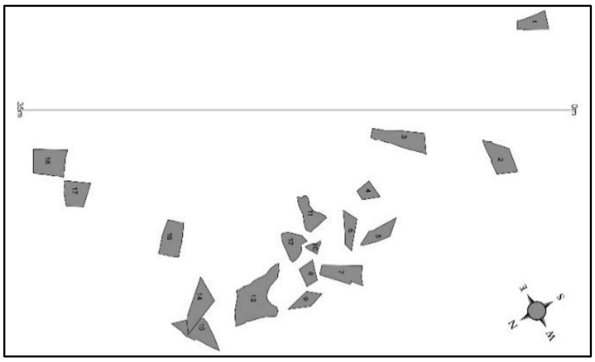


Fig. 8: Stacked roof tiles

All of the tiles found intact are 0.50 m x 0.25 m in size. It is possible to trace these tiles by their size and shape. The size of the tiles that were found in-situ in the dome of one of the rooms of the madrasah in front of the Ilyas Bey mosque, built in 1404 in Miletos by Menteşeoğulları are close to our samples. With a length of 0.50 m, they measure 0.30 m wide on one side, and 0.26 m wide on another. Another example to these roof tiles with a similar dimension was found in Enez. This structure was used as a small Byzantine chapel, but after the conquest of Enez, it was converted into a türbe (shrine) for Has Yunus Bey. The structure is dated before 1456 when Enez was conquered. The tiles in the building are 0.51 m long. They measure 0.30 m wide on one side, and 0.26 m wide on



another. It is believed that similar measurements were used throughout the 15th century[41].

Fig. 9: Marble blocks plan

It is possible to suggest that our samples belong to the 15th century, as in the above examples, although they are of the same width on both sides. In the meantime, we believe that these tiles belonged to a sunken ship loaded with tile that stroke the rocks rather than to a 15th century structure on the island, based on the assemblage of tiles found piled up on top of each other[42].

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[41] Özyiğit (1990), 171, 172.

[42] Based on the stacked tiles seen in Fig. 8, we are of the opinion that these artefacts belong to a shipwreck. However, we have observed that tiles from this shipwreck were scattered around the island. Apart from that, we must take into account

2.1.2. Marble Blocks

Perhaps the most important group of artefacts identified during the survey are the raw cyclopean marble blocks, consisting of 18 pieces (Fig. 9).

They are encrusted with layers of seashells, sea urchins and shipworms. They were not arranged in any particular order, and some were evenly cut (Fig. 10).

Fig. 10: Cleaning and measurement of blocks

Since they were found together and irrelevantly, they give off the impression that they spilled off a ship. It's known that, especially in the busy construction businesses of Istanbul, Proconnesos marble was usually preferred. Sailors trailed the southern shores of Marmara Sea after crossing the Çanakkale Strait in search of protection from the strength of the south-westerly lodos winds. The Vordonisi Rocks to the northeast of Marmara is especially open to lodos and extremely dangerous for sailors. These marbles must be from a cargo that was loaded onto a ship as being cut from marble beds, that hit the sunken island's reefs and sank. Therefore, we can assume that a ship loaded with marble that set sail from Proconnesos sunk after crashing into the Vordonisi Rocks. Additionally, it is known from correspondence between Pliny the Younger, the Governor of Bithynia and Emperor Trajan that the marbles carried over the Lake Sapanca were taken to seaside[43]. Pliny the Younger suggested to dig a tunnel between Lake Sophon / Sapanca and Astacos / Izmit Bay in order to facilitate this transportation network. Even though it's not really clear if this project was ever completed, it's certain that the marbles obtained from the marble beds to the east of Marmara Sea reached Istanbul through the Vordonisi route. Although we were unable to obtain any information about dating from these marble blocks, analysis of fragments allowed us to learn from which marble bed they came from. For this reason, in order to determine the marble bed and take the route of the shipwreck, the samples taken from both the wreck and the Proconnesos / Marmara Island Saraylar Marble Quarries were analysed from the mineralogical-petrographical point of view in the Istanbul Central Laboratory. As a result of the analyses, it was proved that the marble blocks came from the Proconnesos Island **(Fig. 11)**.

that the shipwreck may have been destroyed since diving near the island is not prohibited, and the shipwreck is within the hunting area for fishermen and harpooners.

[43] Plin.Ep, X. 41.

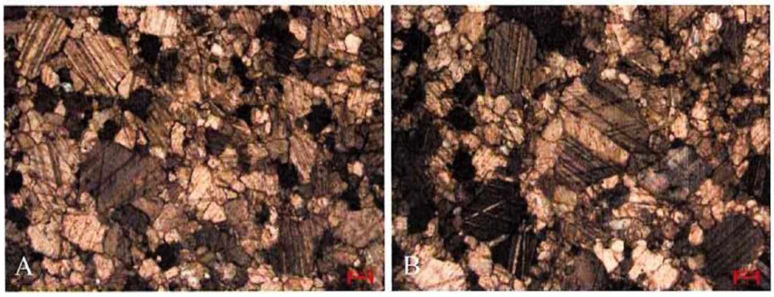

Fig. 11: Thin section image under polarized microscope shows that both samples have the same characteristics.

3. NEMSUS PROJECT 2018 CAMPAIGN

The Underwater Survey of the North-eastern Marmara has been taking place since 2016 on the Anatolian coast of Istanbul and the waters surrounding the Prince Islands. The surveys performed in 2016 and 2017 on the Vordonisi Island continued in the islands of Büyükada (Big Island), Sedef (Mother of pearl) and Heybeliada (Saddlebag) in 2018. A 15-day long survey was carried out between September 3 and 17, 2018. During this period, surveys were performed in the Çamlimanı Bay at Heybeliada Island, at Sedef Island and the Aya Nikola and Nakibey beaches that lie on the eastern shore of the Büyükada Island.

3.1. Sedef Island

The waters surrounding the Sedef Island is off limits to recreational divers due to the presence of sunken national heritage according to the Article 35 of the Law No. 2863 on Conservation of Cultural and Natural properties, except for the scientific dives. Diving was prohibited in the region based on the above mentioned law following removal of a few amphorae from the bottom of the sea by a group of recreational divers who noticed the presence of such cultural heritages in 1981. We first cruised around the island in order to identify any potential architectural remains near the shore. As a result, remains of a historical building was observed on the northwest shore of the island, which is currently occupied by a modern boat yard facility. Since there were many boats at the time that anchored in this part of the island, we performed dives to see whether it was also used as a harbour during Antiquity. We found a white porcelain milk bowl decorated with blue plants at a depth of approximately 18 meters **(Fig. 12)**. In addition to this, an 18th – 19th century metal anchor was found at a depth of approximately 21 meters during another dive to the south of the island. A potsherd was found during

the same dive at a depth of approximately 17 meters.

Fig. 12: A porcelain milk bowl decorated with blue plants.

3.2. Çamlimanı Bay, Heybeliada Island

The Çamlimanı Bay to the south of the Heybeliada Island was our initial site for surveying to identify the remains of an ancient breakwater structure. Since the depth was too shallow, skin diving technique was used for exploration. Scuba diving was required in the following days for explorations inside the harbour due to increased depths. A bell-like metal object was observed at a depth of 1.5 meters. With an opening of 0,50 m, its function was unknown. Another remain that was considered to be a building block was also observed. Among other finds are some potsherds and a column-like object. The most important find of the exploration dives in the Çamlimanı Bay was a green copper ore bed.

3.3. Underwater Copper Ore Bed

We know that in ancient times the Heybeliada Island was named "Khalkitis", which means copper. Thus, it is not very surprising that the copper ore oxidized under the sea turns green. The green copper lode was found at a depth of 4 m **(Fig. 13)**.

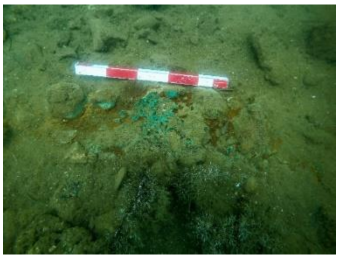

Fig. 13: The underwater copper lode

The four samples that we took from this spot **(Fig. 14)** were delivered to the Directorate of Istanbul Archaeology Museums to be transferred for further analyses to the Scientific and Technologic Researches Applied Sciences Centre at the Düzce University (DÜ- BİT). Analysis results to be published upon completion.

Fig. 14: The samples taken for analysis

Our bibliographic search revealed that it was an important copper mine also mentioned by the ancient philosopher and scientist Aristotle (de mir. Auscult 834. 58.), and it was known as the "diver's copper = khalkon kolymbeten"[44] that was used to be mined during Antiquity by divers from a depth approximately of two fathoms[45]. More importantly, it is reported that the statue of god in the Temple of Apollo in Sicyon was made of this copper.

4. CONCLUSION

The most important UCH findings obtained during the underwater surveys conducted within the scope of the NEMSUS project are the Proconnesian Marble Blocks we discovered on Vordonisi Island and the underwater copper mine in Heybeliada mentioned by Aristotle. The monastery where the Patriarch Photios of Constantinople was exiled, is still not fully identified. We believe that the architectural

[44] Arslan 2010, 21.

[45] 2 fathoms = 3.6576 m. The information on the depth of the ore from Antiquity coincides with our finding at the approximately the same depth.

remains we found on Vordonisi Island belong to this monastery. In order to prove this, an underwater excavation is required on the island.

In addition, the copper production process will be revealed by analysing the samples taken from the underwater copper mine in Heybeliada. Also Lysippos was the famous sculptor born in Sicyon who lived in the same period with Aristotle. Thus, the statue of Apollo, which Aristotle mentions, should have been cast by Lysippos of Sicyon. For this reason, the copper extracted from underwater has a special importance. It is possible to designate Çamlimanı Bay, where the mine was extracted, as the place where industrial diving first emerged.

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Accessing Underwater Cultural Heritage on dry feet: some Sicilian case studies.

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***Abstract*:** Even those who do not practice diving undergo the charm of the treasures and landscapes that the sea can hide. Sicily has paid particular attention to this fact, also thanks to the fact that at present it is the only Italian region with an Underwater Cultural Heritage Department, attentive to the sea areas' environment and culture. This has led to the creation of numerous underwater archaeological itineraries, most of which, since 2004, coupled with control systems that also allows those who do not go underwater to experience the thrill of a dive to visit ancient sunken shipwrecks, while allowing continuous monitoring of the affected area. Such systems were activated in the Egadi Islands and Pantelleria. Today different needs are born because of the ever-increasing technological innovations that allow the development of new applications that span from 3D viewers that immerse the museum visitor in the depth of the marine site or the tablets that illustrate the archaeological finds through the scenes of recovery and archaeological excavation, as realized for different exhibitions.

Keywords: Underwater Cultural Heritage, Mediterreanean archaeology, Aegadian Islands, Pantelleria.

1. INTRODUCTION

Recent decades have seen more and more people approach with passion the world of underwater archeology: the fabulous discoveries of Commander Cousteau, the expeditions of Ballard, Clive Cussler's bestsellers and many movie films have contributed to create the romantic image of the wreck explorer and the sunken treasure hunter, with which every Sunday diver wishes to compare himself.

With the equipment improvement, by the use of respiratory mixtures and innovative immersion techniques, the human technical limits have been extended, allowing divers to explore sites that were previously inaccessible, but for some people that also means to easily remove what the seabed has guarded for centuries: in the nineties the term wrecker was specifically coined to indicate a somewhat expanding phenomenon, the activity of a circle of divers well equipped and exclusively dedicated to wreck diving and the recovery of more or less precious objects, to the hoarding of any heirloom torn from the depths of the sea.

The submerged property has therefore become an easy prey to raids, with heavy damage of the underwater archaeological heritage, as defined by UNESCO, and that in Italy is protected by the Superintendencies; still in the prevailing opinion underwater finds seem to be nobody's things and therefore devoid of any protection, deliberately neglecting the consideration that every intact wreck is a microcosm that contains a myriad of information on the historical period to which it belongs to and bears upon itself the signs of events that dragged it to the bottom of the sea and on the conditions of the navy and passengers of the time.

Dissemination and enhancement of the underwater cultural heritage has been from the beginning one of the most heartfelt activities for the Soprintendenza del Mare, established in 2004, based in Palermo, with duties of protection, management and enhancement of marine cultural heritage in Sicily; it is the first institutional reality in Italy, and among the few in the basin of the Mediterranean, to deal exclusively with underwater cultural heritage. Founded and for a long time directed by our recently lost Sebastiano Tusa, internationally renowned archaeologist and passionate diver, and first Soprintendente del Mare, (Fig. 1) this regional institute pursues the objective of developing a culture of the sea according to a multidisciplinary perspective that embraces tradition and history of the man-sea relationship in its totality.

Fig. 1. The archaeologist Sebastiano Tusa tragically perished in the Ethiopian Airlines plane crash (Sunday March 10th, 2019).

The work of the Soprintendenza del Mare requires specializations and technological endowments, but above all a constant relationship of trust and collaboration with the military forces operating at sea (Port Authority and Coast Guard, Guardia di Finanza, Cultural Heritage Protection Unit of the Carabinieri, State Police), that day after day thanks to their constant vigilance are protagonists of operations of seizure and / or prevention against the plundering of submerged sites.

On several occasions the law enforcement agencies operating in Sicily promptly intervened to interrupt illegal theft of archaeological assets, offering men and vehicles, collaborating in the inspections carried out by the superintendency of the sea (also with the help of the ROV (remote-oriented vehicle, a remote-controlled robot for inspections, analysis and monitoring of the deepest seabeds), contributing to the promotion of underwater archeology education, so raising awareness of divers and operators of the fishing industry to the correct procedures for reporting sites.

Among the numerous activities the Soprintendenza del Mare has designed and inplemented routes/itineraries for underwater archaeological parks that can now be visited in line with the principles of the UNESCO Convention on the protection of the submerged cultural heritage. This initiative is based not only on the knowledge and awareness of experts, but also of the general public. Underwater cultural itineraries are the future of underwater archeology and the first step towards the establishment of submerged archaeological parks: through the creation of guided tours, the archaeological site itself becomes a museum. The exhibits are not decontextualized to end up among the innumerable ones deposited in the warehouses of the Italian museums, but are enjoyed by the public directly in situ, allowing them to enjoy and study at the same time.

The underwater archaeological routes are made with finds discovered and maintained in their original position, according to strict scientific criteria adhering to the guidelines enunciated in the UNESCO Paris Convention of 2001. For these itineraries at first plastic underwater guides have been made that allow divers to visit the sites directly following the path and the relevant historical indications, now mostly substituted by tablet apps. . Already activated in Sicily are various itineraries in Pantelleria Scopello (Trapani), as well as in Ustica (Palermo) and in the Aegadian and Aeolian Islands.

The case studies presented by this paper are the sites of Cala Minnola Levanzo (Aegadian Islands) and Cala Gadir of Pantelleria: both sites have been chosen for the importance and beauty of the archaeological context, and for having been the object of experimentation both through remote monitoring, transformed over the years into a tourist attraction, and for the application of the most recent 3D techniques with virtual visit viewers.

2. ARCHAEOLOGICAL CONTEXT

5.1. 2.1 Cala Minnola di Levanzo (Aegadian Islands)

The underwater archaeological site of Cala Minnola is located on the East coast of the island of Levanzo (Trapani), in the archipelago of the Aegadian Islands, few miles from the west coast of Sicily (Fig.2).

A part from sporadic finds, little is known of frequentation of the archipelago beyond prehistory. The period of the first Phoenician-Punic colonization is still unclear, though full-bodied clues indicate the existence of vast Hellenistic-Roman settlements on all three islands.

In particular, on the southern plateau of Levanzo, on the slope above the inlet of cala Minnola, sheltered by a dense mantle of pine trees sloping towards the sea, there is a large rural settlement with a large water catchment area, where, moreover, there are indications of other installations.

But the aforementioned settlement seems to be of considerable importance as it has mosaic-paved rooms. It would probably be a "villa", home to an agro-industrial control and exploitation structure, almost certainly extended to the whole island. It is certainly connected to the very interesting fish processing factory ("garum" production) located on Punta Altarella (TUSA 2005, pp. 55-57).

Between the 4th and 3rd centuries BC the Carthaginian eparchy creates a system and a network especially between North-Africa, Sicily and Sardinia that provokes the emergence of a maritime force that had full control of the Mediterranean. This control and this strength were based precisely on a close connection between Carthage and Sicily where the Punic cities of Mozia first, and Lilibeo later, prospered, but also Selinunte, conquered after 409 BC, Erice, Panormo and Solunto.

The North African territory and western Sicily were interconnected through a dense network of political, military, cultural and commercial connections.

This geographical pin has its vital fulcrum in its maritime connection through the Sicilian Channel, Pantelleria and the Egadi Islands. The reason for the particular abundance of Punic-Hellenistic testimonies in the Aegadian seas, as well as those of Pantelleria and the Sicilian Channel, is therefore fully understandable. In that period through that sea an intense commercial and military traffic is realized that constitutes the backbone of a power that clutched in an apparently unassailable vice the whole Mediterranean.

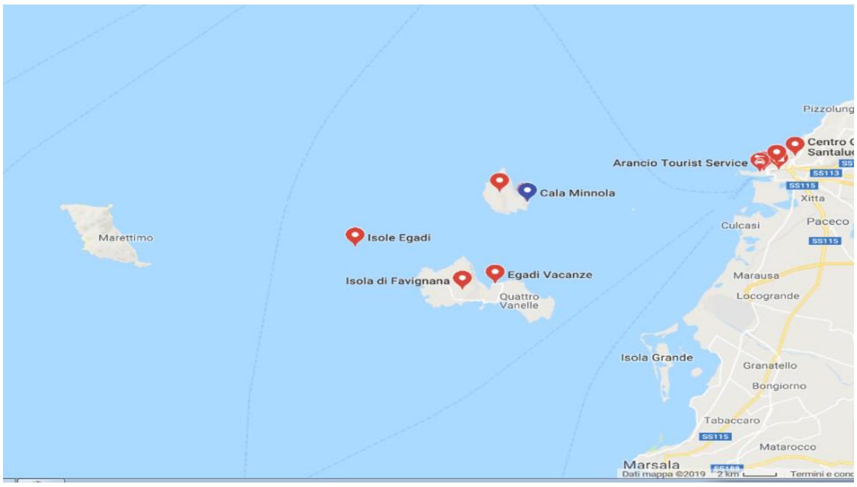

Fig. 2: The site of Cala Minnola, Levanzo, Aegadian Islands.

Similarly, Rome, in fact, pursuing an already consolidated economic and cultural system, built its fortune on a network of nordsud connections to and from Africa of great depth. In this way the presence of archaeological evidence on the territories of the Egadi islands, a true link between Italy and Africa throughout the Roman period, is also justified. The site, extending 200 meters towards N-E from the coast of the island for an estimated area of 750 square meters,   preserves the wreck of a Roman cargo ship at a depth from the sea level ranged from 25 to 30 meters. The area is close to the above mentioned nonPunta Altarella garum plant.where there are the remains of someplastered basins cut into the rock that are belonging to a garum of Hellenistic and Rroman period,.supporting the hypothesis that the ship could have contacts with the plant itself.

The site is characterized by a complex morphology, in fact, the shipwreck lies on a sandy seabed surrounded by a boulder field that rises until a depth of 12 meters. Furthermore, the area is covered by large seagrass beds of Posidonia and presents both strong surface and deep-sea currents.

The Roman ship sunk off the coast of Cala Minnola bay in the first century BC. It was carrying about 50 wine hundreds of amphorae of the Dressel 1B type, a tall cylindrical amphora with angular shoulders, long straight handles and a collar rim. This form is the most important Italian wine amphora of the late Republican period, with a wide distribution around the Mediterranean (with many examples from shipwrecks) and across the north-west provinces. This type of amphora was produced mainly along the Tyrrhenian coastal area of Italy from Etruria to Campania, where a number of kiln sites are known (Manacorda, 1981;Tchernia, 1986; Panella 1989). However, away from this area kilns have also been discovered at Cropani Marina (Calabria), and at Baxos (Messina), in the ager Volterranus and ager Pisanus, Rosignano Marittima, and at Naxos (Sicily). (Fig.4)

The Cala Minnola ship wreck had been known for a long time and had been subjected to frequent looting. With the research carried out in the spring-summer of 2005, what remains has been fully uncovered. These are the remains of the cargo of amphorae (47) and fragments of black painted ceramics (on board pottery). (fig. 3) The presence of the hull was perceived only by intuition through a few wooden fragments and lead fistulas (bilge tubes). The amphorae, lined in pitch, were used for the transport of wine; however it is not unlikely to think that the same amphorae, arrived on the island full of wine, could then be reused to contain the garum produced in the Punta Altarella plant.

Fig. 3: The remains of the Cala Minnola shipwreck.

A similar situation seems to have occurred with regard to the cargo of amphorae carried by the sunken ship near the current tourist port of Porto Palo di Menfi (AG) (Oliveri 2016, pp. 155-159).

In this case the naval load, located about eighty meters from the shore, between 2,50 and 4 meters of depth, consisted mainly of amphorae of the type Dressel 1 A and Punic of the type Ramon T- 7.5.1.1. and Ramon-type amphorae T-7.5.2.2, which allow a dating from the second to the first century BC. These mixed amphorae that make up the dominant part of the entire load, are characterized by having kept a fair amount of content: residues of bones and vertebrae of tuna, but also sardines, crustaceans or other species (used for garum fish sauce, so loved by the Romans). The presence of murex and bones in several "wine - italic" amphorae allows us to hypothesize that the containers could have been reused in a cargo, perhaps returning from North Africa. As for the possible route that the boat might have followed, these elements lead to think that the wreck is relevant to a boat operating in Roman Sicily in the first century. B.C. for small cabotage businesses along the coasts of the island or at most between Sicily and Africa with an intermediate stopover.

During the underwater excavations of Cala Minnola an amphora was found bearing on its shoulder a stamp in whose legible part appears the term PAPIA. It seems very likely that this stamp refers to a wealthy Roman family of agricultural producers, ship-owners and exporters of wine in the Mediterranean, originating from the northern Sannio region, in the area that would later be attributed to the municipality of Aufidena. In particular, it is probable that the stamp belonged to a female exponent of this family: Papia Tertia, who lived around the middle of the 1st century BC and of which the sepulchral monument is known with the inscription bearing her name and the incomplete ones of the husband and son (CIL IX, 2771). (fig. 5)

Fig. 4: Amphorae details from the shipwreck.

Fig. 5. Papia stamp.

It would seem strange to think of a wine trade from Campania toward the South where wine production was already attested. Moreover, in Levanzo surface archaeological investigations have detected the presence of a settlement of the same period whose characteristics seem strongly directed towards agricultural activities. But the wine trade phenomenon towards areas where wine production was present is frequent in Roman antiquity because it responded to economic logics based on the quality and the quality of the products, as well as on fashions and, therefore, on its request by demanding consumers.

The fact that the Cala Minnola amphorae lack the opercula which normally sealed the content has raised the supposition that, once they were emptied of wine, they were reused to contain garum on the way back towards peninsular Italy. In fact, the shipwreck took place exactly in this area where, in the same period, a factory which produced garum, typical seasoning of the Roman and Greek cuisine, made from the fish entrails, was active. This could have meant that the ship had commercial contacts with the mentioned establishment. During the sinking, the vessel broke into two amidships and many pieces of the hull and amphorae were scattered across the seabed.

Already in the 1968, the magazine "Submerged World" had pointed out the presence of the amphorae deposit on the sea floor of Punta Altarella, near the oriental coast of Levanzo Island. The shipwreck was discovered only two years later in 1970, and since then it has been subjected to frequent looting along the years. Regular excavations were carried out only in 2005 by the Soprintendenza del Mare della Regione Sicila, confirming that such finds, Dressel 1B wine amphorae belonged in fact to the shipment of a Roman cargo ship. The remains were covered by a layer of sand half a meter thick that consist in amphorae and fragments of black-painted pottery (ceramics used on board) dated to the first half of the 1st century BC. The research activities went on for half a year and since the July of 2006, the archaeological site is monitored by means of a video surveillance system. Today, it is possible to see on the seabed the original position of the ship's cargo after its rolling over the rocky slope. Few are the traces of the wooden elements of the vessel, and only one lead pipe (belonging to the bilge pipe) is present. A great number of amphorae, about fifty, and fragments of black-painted pottery lie at a depth of 27 meters in the place where the stern sunk. The bow of the vessel sunk 50 meters far from the stern and its position has been identified thanks to the discovery of a large bower anchor.

2.2 Pantelleria (Cala Gadir)

Fig. 6. Map of Pantelleria (Trapani) with the site of Cala Gadir **Fig. 7**. View of Cala Gadir

Pantelleria Island (Sicily) or Cossyra, according to Classical sources, probably inhabited since the Neolithic (5th millennium BC), because of abundancy of obsidian, one of the first materials used to construct objects in ancient times, that attracted the surrounding towns of the Mediterranean, was romanized since the 3rd century B.C., when the island became a strategic control point of the Sicilian channel. Since antiquity, navigation around Pantelleria was challenging due to frequent, forceful winds and strong marine currents (Abelli 2014).

As a result, the seafloor of the island is characterized by the presence of a large number of ancient shipwrecks, most of which date to the Punic and Roman periods. Nevertheless, Pantelleria is located in a strategic position, 38 mi. from Cape Bon in Tunisia and 74 mi. from Lilibeo in Sicily. Especially during the 3rd century B.C. at the time of the First (264–241 B.C.) and Second (218–202 B.C.) Punic Wars, Pantelleria's unique geographical location is one reason why Roman armies fought Carthage for the conquest of Pantelleria (ruled by Phoenicians since the 9th century BC) and the control of the Sicily Channel. The fortune of the island continued in the Late antique age thanks to its strategic position in the naval routes and its ceramic productions (Pantellerian ware) are found throughout the Mediterranean basin.

Examining the coasts of the island of Pantelleria, in search of the most possible and probable ancient landing place for cargo ships coming from the east and south, one cannot help but consider Cala Gadir; the reasons for this attention are justified by the fact that it possesses all the fundamental requirements for having been an ancient port of call. Place of ancient shipwrecks of cargo ships carrying wine amphorae, oil and containing dried or pickled fish of various ages, culture and provenance, it is an excellent natural shelter from all winds, except the east. In ancient times, the sea penetrated for about 200 meters, evidently making the landing even safer. The nature of the terrain, steep for the entire eastern part of the island, is at that point sloping, therefore indispensable for loading the merchandise from the ship and in any case Cala Gadir is, together with the nearby Cala Tramontana and Cala Levante, the only landing place available to ships coming from eastern Sicily, Greece, Malta and the East in general. The use of Cala Gadir as a port of call in antiquity is also proven by the existence, at a depth varying between 18 and 106 meters in an area of thousands of square meters, of multiple traces of wrecks that lay and lie, more or less buried by sand and mud. Of these wrecks are visible above all parts of the load consisting of different types of amphorae and various ceramics and limited wooden parts of the hulls. The typology and chronology of the amphorae allow to deduce that in the area numerous boats passed between the 3rd century BC and the 2nd century AD, pertinent to cultures of different origins. In fact, amphorae that came from the Magna Graecia (of the Greek-Italic type), from various Roman ports of the peninsula (of the Dressel type IA, IB, IC, 2-4) and from the North African Punic environment can be found (fig. 8).

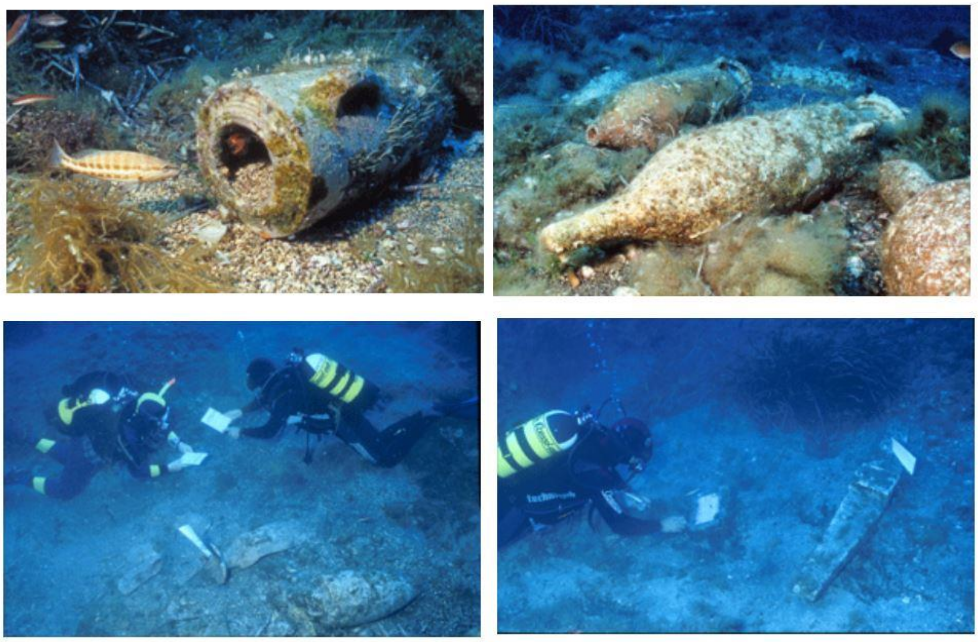

Fig. 8. Amphorae and anchor stocks from different periods checked during the creation of the Cala Gadir underwater itinerary

The itinerary of Cala Gadir was carried out by the Soprintendenza del Mare and by the archaeologist Marco Chioffi, with the Collaboration of the Cultural Heritage Protection Carabinieri group and Divers Group of the Carabinieri, of the Municipality of Pantelleria and of the Diving clubs of Pantelleria .

The route is located in a portion of the seabed that from the inlet of the marina, descends towards the North West until it reaches a depth of about 30 meters. The dive can start from the ground or descending along the vertical line of the buoy located about half immersion. Near the buoy that indicates the route, there is a yellow buoy with a light signal that allows the mooring of boats authorized to make the visit.

It is also possible to reach the spot from the ground: the entrance corridor is marked by yellow / white buoys. Proceeding for about 20 meters in a northerly direction, a rocky ridge at the base of which - at about 16 meters of depth - there is a wooden fragment of a boat half hidden in a crack in the ridge itself is visible.

Continuing north-east, at a depth of about 27 meters there is a group of 6 Punic and Roman amphorae, located a short distance from each other. These amphorae are framed by the cameras of the underwater remote control system installed nearby and which sends the images directly to the web. Continuing in a north-eastern direction, on a plateau at a depth of about 29 meters there is a Roman anchor in lead (3rd - 2nd century BC). Climbing up the southeastern ridge to reach a plateau at a depth of about 24 meters there are various finds including some amphora hills, continuing south, going up about 16 meters, various fragments of pottery conclude the journey and direct the visitor back to the south-west towards the entrance corridor.

3. REMOTE CONTROL SYSTEMS AND VIRTUAL REALITY

Today, the remote control systems constitute an enhancement method and use of non-invasive and at the same time less expensive traditional archeological diving sites, while allowing continuous monitoring of the interested area.

In Cala Gadir (Pantelleria), where the largely robbed, remains of at least two wrecks of the Punic-Hellenistic age lay, the STARS Project (System Integrated for the Protection of Underwater Archeology) ensures 24h monitoring: underwater cameras send in direct images from the archaeological site, located at - 30 meters, to the dedicated website, allowing the user to connect from home. The interactive version also allows the user to scroll the cameras on the tracks and observe the findings from different angles, even with night ligh.

The STARS project intends to create a dedicated integrated system to the protection of underwater archaeological heritage and the dissemination of images and information of the most interesting sites with the purpose of protecting underwater sites and tourist attraction.

Around the selected sites some are installed and fixed at the bottom equipment: cameras with "motion detection" system, ultrasound transceivers, environmental data sensors.

In addition, a camera is installed on the surface. All the signals are encoded and sent via radio to a Control Center. The system is therefore able to signal, combining the signals of motion detection and ultrasonic sensors, any intrusions in the site area. Both the signals from the Control Center arrive alarm that images as well as environmental data. In the event of an alarm a signal is automatically sent to law enforcement mobile terminals (or to those responsible).

The full enjoyment of the finds by distant subjects is ensured by distribution of real-time footage via the web.

To better protect the cameras, removing marine organisms that quickly take root, a completely new ecological antifouling protection has been used and successfully tested by the CNR of Palermo. It is an antifouling agent based on a simple and effective nanotechnologic material that uses a "sol-gel" hybrid paint, developed by the CNR of Palermo. Hybrid means an inorganic material such as silica-based glass organically modified by chemistry; the paint thus forms a hydrophobic film which does not allow marine organisms to adhere on the treated surface. It is an ecomonic and completely non-toxic system which only needs to be renewed periodically every 24-36 months. This system saves considerable human and financial resources necessary for mechanical cleaning cycles of the system used so far, allowing to leave undisturbed the delicate archaeological site and limit the environmental impact.

A remote control system is also active in Cala Minnola (Levanzo, Egadi Islands) consisting of four cameras positioned on the homonymous site, which, through a cable, send images of the in situ wreck from the 1st century to. C., with a load of wine amphorae and anchors, to Favignana, where on the premises of the Municipality a viewing room is set up: this allows both to avoid depredations and also to offer the possibility of enjoying the beauty of marine landscape and to admire the finds even to those who do not want to dive.

Lately, during the exhibition Mirabilia maris. Tesori dei mari di Sicilia, held from November 2016 to March 2017 in Palermo, Norman Palace, Fabio Bruno and his team of the University of Calabria presented and tested on visitors the Cala Minnola virtual dive experience.

The virtual dive experience can be exploited by users in a semi-immersive or immersive manner (fig. 9). The two different modalities are characterized by different hardware architecture and levels of immersion, interaction, and presence (Bruno et al., 2019). The second architecture allows users to perform an immersive experience through the adoption of head-mounted display (HMD) technology. The HMD isolates the user from the distractions of the actual physical environment and encompasses the entire field of view, including the peripheral space. The navigation in the virtual environment is performed by the user by moving his/her head and interacting with a joystick. Compared with the first architecture, which relies on monitors for the visualization, in the immersive environment, users receive audio contents instead of visual information when interacting with 3D objects and points of interest (fig. 10).

The virtual dive system can be efficiently adopted to enhance the large public's awareness about the underwater cultural heritage and to promote the specific underwater archaeological site by allowing non-diver tourists to live a realistic virtual experience of the exploration of the wreck site. In fact, due to the environmental and physical body limitations, not all archaeological sites are accessible to the large public. These limits are more stringent in the underwater environment where only expert tourists, with diving license, can overcome the difficulties imposed by the environment and depth to enjoy the submerged cultural treasures. Then, thanks to the virtual dive system, the user can experience a realistic diving experience in the underwater wreck site.

Fig. 9. Virtual dive experience

Fig. 10. 3D reconstruction of Cala Minnola Site

The fruit of these experiences of collaboration between the Soprintendenza del Mare and international bodies can be exemplified by a new exhibition: [IN] ACCESSABLE (projected by Francesco Spaggiari, GUE Global Underwater Explorers), held in Parma from April to August 2019, with the aim of creating the first AR-VR exhibition of the treasures of the seas of Sicily, through the use of underwater cultural heritage and the marine environment entirely developed through the first virtual diving simulator. The virtual experience is based on an innovative platform composed by the display of archaeological finds connected to a mobile application of augmented reality (AR) and virtual reality stations (VR). The mobile AR application allows visitors to directly access different digital information content concerning the main uniqueness and characteristics of the object being viewed through their smartphone or tablet. The VR workstations are designed to offer the maximum immersive simulation experience of the underwater environment, are divided into two categories according to the technology used. The systems employed inable to have complex 3D models and very high definition 3D360 videos that project the user into an interactive virtual world. The new high-tech tools make the inaccessible accessible (Fig. 11).

Fig. 11. Moments of the exhibition [IN]ACCESSABLE in Parma, APE Monteparma Museo

4. CONCLUSIONS

Modern archeology and an updated museography impose the reading of finds not only through their aesthetic, typological and technological characters, but also through their context, such as bearers of historical values understandable in the relativity of sets.

This does not only respond to updated archaeological investigation criteria, but also to the needs inherent in transposition informative of what the research is bringing to light. There are still very few equipped and usable underwater archaeological itineraries or areas to the public, both Italy and the international field. Indeed, there are many archaeological diving sites, destination of guided visits, by the various local diving clubs, but these are sites that are not protected and, in any case, without any signage and didactic and preparatory organization to the visit.

The world of associations plays a very important role, channeling positively the passion of diving enthusiasts, more and more numerous, towards activities monitoring sites at risk or volunteering in archaeological investigations already underway.

Diving, associations, etc. through reports and collaborate in the identification and protection of marine sites at risk of plundering, defend submerged cultural assets e contribute to spreading a new concept of use of the underwater heritage.

More and more often local associations and diving centers ask the Soprintendenza del Mare for the organization of local courses available to senior diver who wish to learn the most correct way to relate to the submerged cultural find, through greater archaeological awareness, a basic knowledge that allows to recognize the classes of finds and how to carry out in the case of finds, a correct report, accompanied by exact data and photographic documentation, without disturbing the delicate balance of the site.

Furthermore innovative digital technologies fit the Unesco's recommendations for a respectful exploitation of the underwater cultural heritage and represent a concrete and efficient response to the challenge proposed by the European Parliament for a smart, sustainable and inclusive growth of the maritime and coastal tourism. In fact, the VISAS project has been accomplished taking into account both the needs of diver and no-diver tourists in order to provide them with digital technologies that can be adopted inside and outside of the submerged environment. In fact, if on one side the augmented diving system improves the diver tourists' experience in the submerged archaeological site, on the other the virtual dive system makes the underwater cultural heritage the most accessible possible to the general public without any constraint given by distance or time. Archaeological sites accessible also to non-divers.

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Preservation, management and protection of Tangible Underwater Cultural Heritage of Anfeh (North Lebanon)

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***Abstract**:* Appreciating the tangible and intangible maritime culture of coasts is becoming essential for archaeologists working on coastal zones which are among the most confounding and fragile of all ecological systems. The organization of these coasts capes presents various issues and difficulties. The paper focuses on the northern Lebanese coast where a spearheading venture is implementing new means for sustainable development, using not only archeological assets but social and economic parameters as well. It investigates methods for safeguarding the characteristics and the social resources of the coastal town of Anfeh through a multi-disciplinary methodology, handling both the natural and the cultural assets of the site and resulting in the management plan of urban scenes and underwater archeological trails.

Keywords: Management of Cultural Heritage, Coastal landscape, Cultural landscape, Intangible maritime culture, Conservation.

6. INTRODUCTION

Anfeh is a coastal town located 15km North of Beirut the capital of Lebanon. It expands to the west by a 400m long east-west oriented promontory (Fig. 1).

Fig.1: Aerial view of the promontory of Anfeh; © Lebanon Untravelled.

The nose-shaped promontory is separated from the mainland by an 11m deep and 100m long Crusader's moat wrongfully attributed to the Phoenico-Persian period as a dry dock by the local population (Fig. 2).

Fig. 2: Crusader's moat with the spur of the drawbridge seen in the background (© Rita Kalindjian)

Greco-Roman and Medieval vestiges are scattered all around the town, but are unstudied and badly preserved, hence giving way to all sorts of popular interpretations.

Anfeh's identity lies not only in its cultural and historical background, but in two other parameters, namely its geological data which is quite remarkable for the Quaternary and Holocene periods (Elias, in press) and its very rich biodiversity (Figs. 3 - 4).

Fig. 3: Selection of Flora from Anfeh

(© Rita Kalindjian and Nadine Panayot Haroun)

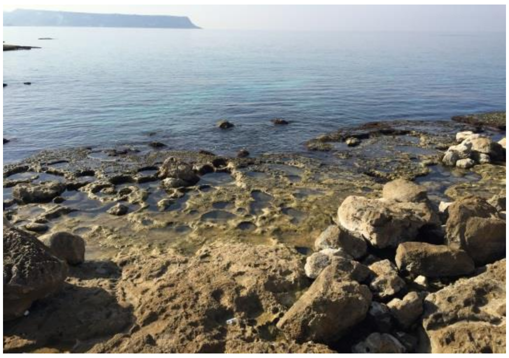

Fig. 4: Vermetid reefs forming Anfeh's peninsula

(©Nadine Panayot Haroun)

The ethnographic campaigns directed by DAM since 2013 identified two different sources of income for the local community. Until the start of the 20th century, the coast and the inland region's economy of Lebanon and Anfeh in particular swung between angling, salt extraction and rural practices. Today the inland's rural economy is practically nonexistent and the waterfront scene is profoundly devoured by the massive travel industry and its unsustainable advancement. Resorts and marinas are filling out the spaces left, imposing an artificial waterfront scene. This is disintegrating the significant social legacy of Anfeh causing environmental aggravation, land-use change, and loss of social cohesion (Panayot Haroun and Trovato 2019) (Fig. 5).

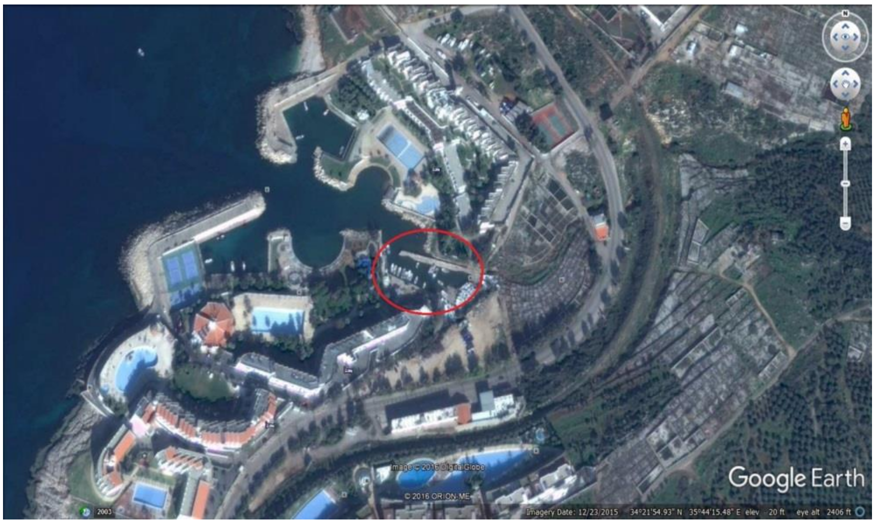

Fig. 5: An aerial view of Anfeh's coast showing the fishermen's port (in the red circle) between two resorts (Modified from Google Earth, 2018).

7. HISTORICAL BACKGROUND AND ARCGAEOLOGICAL EVIDENCE

2.1. Literary sources and archaeological evidence:

The archeological campaigns ashore and submerged conducted by DAM, since 2010, have uncovered the presence of archeological remains proving that Anfeh and its hinterland is a rich and promising site. The outcomes have asserted four noteworthy occupation levels underneath the salt ponds going back to the Chalcolithic Period, which is represented by two funerary jars found *in situ*, followed by a Bronze Age occupation period of Anfeh also known from the 14th century Tell El Amarna letters'. In these letters, Anfeh is identified with Ampi and is referenced several times (Freyha 1972: 6; Salamé-Sarkis 1999: 78). In his correspondence with the Pharaoh, the lord of Byblos Rib-Addi makes reference to the fleet of *Ampi* (EA 71, 72, 76, 95, 102; Collon and Cazelles 1987: 296; Salamé-Sarkis 1999: 78). The Late Byzantine period constitutes the third occupation level at the site revealed by a multitude of religious spaces, such as the chapel of Saydet El Rih (Our Lady of the Wind) which was excavated by DAM in 2011 and 2012. The chapel was first built during the 6-7th century AD, and then expanded during the Medieval Period 12-13th century AD. Furthermore, during the Crusader's period, Anfeh is known under the name of *Nephin* and later during the Mamluk's period as *Anafah*. It was a fortified town popular for its wines also known as "the Citadel". DAM's excavations on the promontory of Anfeh have revealed the rampart's large and embossed blocks and the pavement made of large calcareous slabs. The medieval fort is currently being virtually reconstructed.

2.2. Material culture:

A variety of wine jars found in the fortress brought to light the whole process of wine making dating back to the medieval period. A wine of "high quality" according to the literary sources and making Anfeh famous during the crusades period (Figs.6 and 7).

Figs 6- 7: Wine jars with traces of rope and plaster, used to seal the jars after the fermentation process. 13th c. AD (© Ibrahim Shaddoud)

The question of accessibility to and from the promontory has been addressed by the archaeological maritime team working within the multidisciplinary project of Anfeh. Thus, four different slipways have been identified and give access to the water around the promontory of the fortress legitimately allowing the transportation of wine, perhaps to an adjacent harbor or jetty. Indeed, due to its rocky and heavily eroded interface, locating harbor potentials in Anfeh is a complex task as determined by the maritime team which used a wide scope of field approaches including an investigation of the marine geomorphology and underwater visual and geophysical surveys coupled with several underwater excavation seasons. The results have identified several types of natural harbors at Anfeh such as offshore shallows, reefs, bays, coves, and river mouths (Panayot Haroun and Semaan in press). These common harbors have been used by the local population and were associated with the land settlements throughout the ages. Individuals carved the rock and adjusted the morphology of the terrain to meet their requirements, thus creating protected spaces where they could moor their boats temporarily until they reached larger bays and harbors further North or South of the promontory.

The underwater investigations have localized 58 anchors of three different types, in the waters of Anfeh, holding in either one, two or three holes and varying in weight from 9 to 300 kg (Semaan in press). The concentration of some of these anchors puts forward the potentiality of commonly-used anchorages. These are located south of the promontory and parallel to it (Fig. 8).

Literary and archeological evidence just as ethnographic practices vouch for the inherent connections that the town had, and still has, with the Mediterranean.

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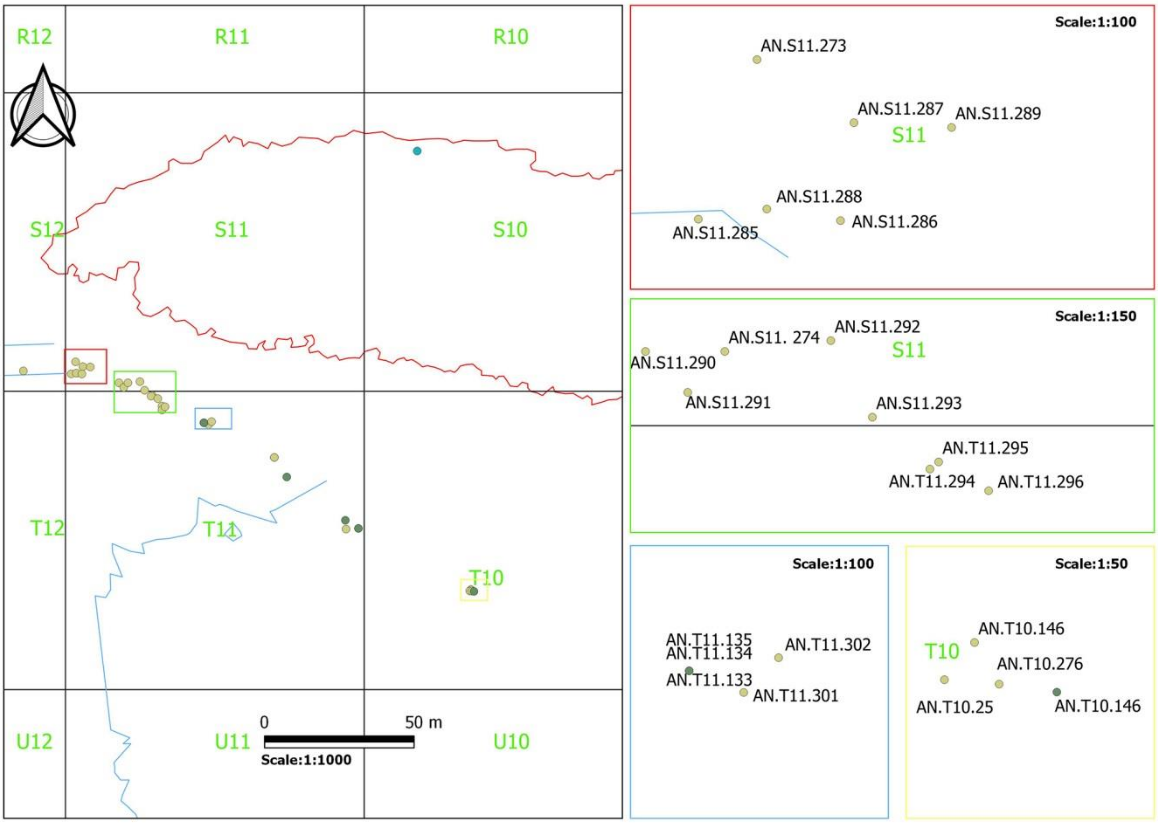

Fig. 8: Location of the concentration of the anchors south of the promontory (Map: Enzo Cocca)

3. STRATEGIZING THE CONSERVATION OF THE SITE

3.1. General approaches

Several approaches can be tackled when strategizing a mitigation or a conservation plan for a cultural heritage site. This is due to the fact that sources of threats for an archaeological site are multiple and diverse. Nevertheless, most of these threats are connected to the way current developments of social orders are taking place. Protection endeavors are still, much of the time, attempting to address just one of these dangers, the one that is generally and unmistakably the most relevant: Physical disintegration (Palumbo, 2002). Intangible heritage addresses a significant role in how individuals connect with their social situations and the significance of these qualities sway on the manners by which individuals react to protection needs (Clarke and Johnston, 2003). However important and necessary, conservation approaches have traditionally excluded the impalpable heritage and have focused mainly on the material culture, thus lacking acknowledgment of its relevance; Hence the importance of documenting traditional fishing and salt extraction practices through ethnographic field work.

Furthermore, the recognition of the financial potential of impalpable heritage as a significant asset can promote organized governance and subsequently can guarantee the protection and conservation of the different parameters of a site encompassing its instructive and monetary potential (De la Torre, 1995).

Although the following paragraph focuses on the management of the underwater cultural heritage, it will however show that evaluating the reasons for the disintegration of our archeological legacy and reacting to these dangers by assessing them early on in the conservation planning of the archeological legacy, is the best way to limit the impacts of the numerous elements of deterioration.

3.2. Anfeh as a case study

DAM forestalled a multidisciplinary and interdisciplinary project which is growing organically around the site of Anfeh. Several surveys campaigns were organized since 2010 followed closely and often simultaneously by excavation campaigns on land and underwater. A noteworthy focal point of this undertaking was to reconstruct the historical data of the site by joining archaeological information from excavation's literature reviews, of both ashore and submerged material culture, with an investigation of epigraphic sources, as well as ethnographic information gathered from oral accounts (Panayot Haroun, 2015). Indeed, oral history contributes different perspectives and viewpoints that fill in the holes in archived history, sometimes even revising or infirming the records. Questioners allow individuals whose accounts have been untold or overlooked to complete the data collected (Lang and Mercier, 1984).

As underlined above, Anfeh's identity lies not only in its cultural and historical assets but in its remarkable natural resources as well. Thus, its geological setting, as well as its flora and fauna were systematically documented and inventoried. This led to a successful holistic conservation approach that takes into consideration both natural and cultural heritage including their tangible and intangible parameters, with the objective of promoting sustainable development.

Nevertheless, this paper will focus on the underwater natural and cultural heritage and its preservation since it is an inherent part of the 17 Sustainable Development Goals (SDGs) set by the United Nations General Assembly in 2015, for the year 2030. Indeed, Goal 14 "Life below water" aims "to conserve and sustainably use the oceans, seas and marine resources for sustainable development". The goal emphasizes the need to incorporate good governance Instruments to consider "anthropogenic activities occurring outside of the ocean", thus developing the perception of the seamlessness of sea and land. Concerns with respect to sea well-being in dangerous angling practices and marine contamination are also considered as seas are an integral part of economies. The objectives incorporate averting and lessening marine contamination and acidification, securing marine and coastal biodiversity systems and managing angling. The dual objective of natural, cultural ecotourism promotion and sustainable local economic development requires an integrated planning approach that builds on the existing natural, cultural and human capital of local areas without adversely affecting this capital.

With these various concerns in mind and the large variety of data at hand, many initiatives were undertaken by DAM to build affinity and awareness with the nearby population since 2012. A series of activities were implemented such as giving ordinary discussions to present the archaeological finds to numerous gatherings within the town as well as taking part in international conferences; Allowing the locals to assist the archeologists in their field work through explicit projects, for example: "Be an archaeologist for a day" and children ceramics workshops. These initial steps were trailed by educational documentaries and academic exhibitions that represent the promising work conducted. Involving the native population in educational and scientific knowledge assortment was the key to acquire its trust. Engaging citizens is a process that creates a participatory culture, thus resulting in the unanimous signing of the Hima accord by the municipal council of Anfeh with the SPNL (Society for the Protection of Nature in Lebanon) on September 22, 2017.

Hima means "protected area" in Arabic; it is a community based approach used for the conservation of sites, species, habitats, and people in order to achieve the sustainable use of natural resources.

Signing the boundaries of the protected space enabled us to become a stakeholder in the governance of the town, planning efficiently and properly the preservation of both nature and culture by incorporating them into sustainable development schemes for a positive effect on a low-income community. The Hima Committee undertook several actions which are already bearing fruits in terms of conservation and economic development. These are:

- Commissioning the Institute of the Environment (IOE) of the University of Balamand to conduct a study for the assessment of the fisheries' sector in Anfeh;

- Commissioning a private diving club for the monitoring of the sea urchins. Indeed, the development of small scale barrens of sea urchins on the shores of Anfeh has been reported one year after the application of protective measures. These early actions contributed to the implementation of the rules and regulations of the Marine Hima of Anfeh, by controlling and properly managing the fishery sector and the angling practices turning them into respectful practices of the biodiversity.

- Since April 2019, DAM is in the process of developing an underwater cultural and natural heritage trail south of the promontory of Anfeh in partnership with the IOE of UOB and the municipality of Anfeh. This will highlight the series of anchors uncovered by the maritime archaeological team and left *in situ* in order to preserve their significance following their full documentation (Fig. 9). The objective of the UCH trail is to build a cooperative effort to coordinate education and preservation of UCH across the Lebanese territory. Maritime history and heritage can be explored in many ways; this trail gives a novel chance for the general public to experience various submerged material cultures, geological formations and endemic species. Divers will visit the sites in native Mediterranean environments, giving another dimension to the history of the town.

Many of the spots on the path had been used for maritime archeology coaching courses and archeological recording techniques offered by the Department of Archaeology and Museology and the Nautical Archaeology Society (NAS) which organized the first field school in underwater archaeology in Lebanon, with the support of the Honor Frost Foundation (HFF) as part of its initiatives to build local capacity in the country.

When the trail will be launched, divers will be able to enjoy a self-guided tour of the path using an interpretive booklet and interpretive signs for the trail to explore a wide wide variety of types of anchors spanning nearly 5,000 years as well as the different species of fauna and flora that are endemic to the region of Anfeh, or hire a local guide who would take the visitors on a tour.

The implementation of the UCH trail will surely accelerate the process of registering the waters of Anfeh as a Marine Protected Area through the Ministry of the Environment.

Fig. 9: Different types of anchors south of the promontory (© M. Salma)

4. CONCLUSION

The conservation strategy used by DAM contributed to a re-appropriation of the local inhabitants of their own heritage investing and turning a once static and dilapidated space into a dynamic one. They have subsequently facilitated the implementation of best governance.

Indeed, heritage includes a large scope of social scenes and landscapes, from current social center points to remote traditional milestones. Alongside a network of traditions, customs, and stories, these noteworthy archaeological and historical elements constitute the present landmarks of cultural landscapes. Securing the protection of heritage requires coordinated the effort, commitment, and inclusion between a wide range of NGO's, governmental bodies and institutions, and civil society. The "Hima" concept offers such bottoms' up approaches by empowering the members of the civil society and giving them the right to be involved, to communicate, to choose and to decide what should be protected and what should not be within the limits of their own direct environment (city, town, village). However, the decision making process is achieved in close collaboration with the municipal council which in turn answers to the different ministries involved, insuring a smooth transition towards sustainable practices and the development and economic growth.

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Community Cultural Infrastructure: Sustainability of the maritime and underwater Cultural Heritage of Bocachica, Cartagena

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***Abstract*:** The present investigation develops in the framework of the project of the grade of the Archaeology program in the Universidad Externado de Colombia, entitled "*Community Cultural Infrastructure: Sustainability of the maritime and underwater Cultural Heritage of Bocachica, Cartagena",* which wants to consolidate the underwater archaeology Laboratory, located in the Fuerte de San Fernando de Bocachica, Cartagena de Indias, as a Community Cultural Infrastructure (CCI) ; with a view to the sustainability and protection of the Maritime and Underwater Cultural Heritage of the Corregimiento de Bocachica; establishing in this way a node, that is, a point of meeting and building relationships, between the Maritime and Underwater Cultural Heritage and the various interest groups that are linked to the Laboratory (community of the place, academy institutions and state institutions) that allow to promote the social appropriation of the heritage, the active cultural participation, the strengthening of the identity bonds and contribute to the research, conservation, management and divulgation of the Maritime and Underwater Cultural Heritage of this place.

Keywords: Bocachica-Cartagena, development, sustainability, Maritime and Underwater Cultural Heritage, Community Cultural Infrastructure

1. INTRODUCTION

The Project is develop in Bocachica, Cartagena, located on the Isla de Tierrabomba, in the Caribbean Sea, en Cartagena de Indias, Colombia, and is part of a rural area of the city (Alcaldía de Cartagena, 2016). in this sense, their sociocultural constructions are framed by the dynamism of the different forms of life adapted in relation to the marine environment, said dynamism and diversity of ways of appropriating the sea from the economic, institutional or symbolic spheres, constitute their identity both individually and collectively (Rubio, 2014). Therefore, the community of Bocachica has a broad cultural potential, product of historical and territorial processes related to the sea, the foregoing is understood in terms of Maritime Cultural Heritage of a material and immaterial nature, which converges in the multiple expressions of the daily life of the inhabitants of the place, since they are part of the daily landscape of Bocachica (Rubio, 2014).

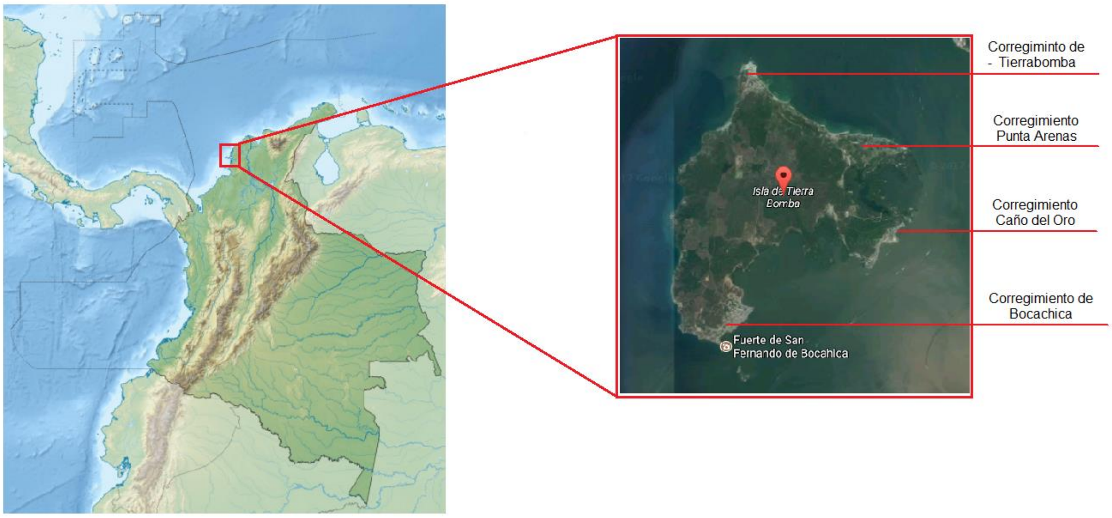

Fig. 1: Location of Bocachica

In 2015, during the dredging of the navigation channel, in the bay of Cartagena, in front of the Fort of San Fernando de Bocachica an archaeological site was found, where from the identified material evidences it was considered that the site could possibly be belong to a shipwreck, a ship of colonial Spanish line of the eighteenth century, which together with other 5 ships, was part of the military complex for the Spanish defense in the battle of the taking of Cartagena de Indias when the English Empire in 1741 tried to invade the port of the city (Fundación Terrafirme, 2017).

After the discovery, it was thought about a strategy of management of the underwater Cultural Heritage in Bocachica; and therefore, considering the potential of the Cultural Heritage, and especially the underwater archaeological potential, with which Bocachica has in. At 2016 the Universidad Externado de Colombia in agreement with the Instituto Colombiano de Antropología e Historia (ICANH) and the Escuela Taller de Cartagena de Indias, proposed a project for the reactivation of the Fuerte de San Fernando, and within this, with the intention of responding to the needs of the archaeological project of the possible shipwreck, for the conservation of inorganic material extracted from the deposit, it was thought in the opening of an infrastructure for the preservation and conservation of the Underwater Cultural Heritage. This proposal, established a diagnosis with the guidelines and basic parameters for the constitution of the laboratory and the consolidation of trained personnel for the conservation of the Underwater Cultural Heritage of this place.

This laboratory, is located inside the Fuerte de San Fernando, and when making use of its facilities, aims to help the revitalization of the fortification and become a space for community meeting, to integrate this form into the cultural dynamics of the Community and generation of spaces for community socialization. Which, makes relevant, the potential of the laboratory in terms of management, not only of the Underwater Archaeological Heritage, but also in the Maritime Cultural Heritage of Bocachica, represented in the various cultural manifestations and the associated materiality.

Thus, the project that is being carried out, aims to consolidate the Underwater Archeology Laboratory, as a Community Cultural Infrastructure (CCI) with a vocation to the Maritime Cultural Heritage and especially to the Underwater Cultural Heritage. It constitutes a proposal for the creation of a model of sustainability and viability of this heritage with a view to development, understanding that culture, nowadays, more than a means, is an end of development.

2. CONSOLIDATION OF THE LABORATORY AS SUSTAINABLE COMMUNITY CULTURAL INFRASTRUCTURE

Currently, we are working on a model for the sustainability and viability to medium and long term of the Laboratory, by means of its consolidation as a Community Cultural Infrastructure, which is thought of as the space from which the community and the groups of interest, besides taking advantage of the services that this offer, they have the capacity of agency and the power of decision in the constitutive aspects of it, means to open intelligent and positive spaces to build an integral change that is adjusted from and for the needs of the community and therefore, allow the community meeting for the creation, production, and promotion of artistic and cultural practices and manifestations, in this case, focused on the promotion of the Maritime and Underwater Cultural Heritage of the place.

Following Alcaraz's (2014) proposals on infrastructures and cultural equipment, it's about how those spaces can cause a strongest social impact, to the extent that it is the community itself that promotes a critical dialogue scenarios and reflection on their sociocultural reality and therefore, the approach is more profound and real. This leads to the infrastructure being dynamic, flexible and versatile against the multiplicity of perceptions and social and cultural representations of the environment in which it is immersed.

The importance of these cultural infrastructures lies in their appropriation by the community to obtain sustainability: infrastructure – society. Segura (2010) considered that a community space:

- It must be inclusive and invite to the active participation of the community
- It must be constituted as a space of coexistence with the environment
- It must allow the sociability of the community
- It must be stable and it must allow projection of the time
- It must have an optimal dimension for meetings and representations

Therefore, the existence of spaces or infrastructures that allow the community meeting for the creation, production, and promotion of artistic and cultural practices and manifestations are fundamental. Therefore, based on the fact that Cultural Heritage is a catalyst for regeneration and social change, community inclusion plays a fundamental role in the processes of patrimonial valuation, since it can have repercussions on the quality of life of individuals belonging to vulnerable populations, since communities, in addition to being recipients, are also generators of cultural processes and dynamics (Cerón, 2014). So, one of the keys to this community approach is the way in which information flows between institutions and users, the public or the community, so the content must be multidirectional and co-produced with the community.

In this sense, from the idea of the Infrastructure, cultural participation is key in the process of laboratory management, since it allows to address the Cultural Heritage and its conservation processes from the global needs of society, allowing a democratic participation on the decisions and actions that are taken for their protection, conservation and management, which contributes to invigorate the Cultural Heritage processes (García Canclini, 2004).

This proposal constitutes a cultural intervention from the heritage field through its dynamization with the Laboratory as well as its commitment to Cultural Heritage. By having a vocation to link various interest groups from a participatory approach, this proposal aims to contribute to strengthening the social fabric and the transformation of the social reality of Bocachica from culture towards a path of sustainable development.

In this regard, the sustainability and management of the laboratory and the Cultural Heritage of the site must act in an inclusive manner with local groups and other stakeholders to ensure their active participation in decision making and strategy development, because it is essential to consider the environment in which the Laboratory is developed.

The involvement of interest groups from a participatory approach, was defined from the approach taken by the International Center for the Study of the Preservation and Restoration of Cultural Property - ICCROM (2015) on people-centered approaches to the conservation of Cultural Heritage, where it is understood that heritage is not an isolated entity, since it plays an active role in communities and brings benefits to people, demonstrating that it is significant for societies.

Therefore, working with specific groups supports the development of their capacities to contribute to the sustainability of heritage, in this case working with the local community, academia and political institutions.

3. LINKING INTEREST GROUPS IN THE WORK OF THE LABORATORY

The project of the Laboratory intends to consolidate it as a Community Cultural Infrastructure, because from a participatory approach it seeks the constant linking of interest groups in the different aspects of its development and implementation in the short and long term.

For this reason, the basis of the conservation of the inorganic material extracted from the excavation of the sinking site located in front of the bay, three axes of execution of the Laboratory were proposed: as a center of operations, as a training center and as a center for sociocultural interactions.

The laboratory, as a center of operations, has served as a basis for the development of the excavation activities of the archaeological project of the shipwreck found in 2015. Additionally, the facilities have provided preventive conservation aids to inorganic material excavated as ballast stones, ceramics and metals and have been the place where activities of the different field seasons have been planned, serving in turn as a space of formation, while: (1) in the framework of this archaeological project have participated students who are being trained as professionals in Archaeology and Conservation and Restoration of the Furniture Cultural Heritage; (2) the laboratory facilities, have been used for the analysis and classification of archaeological material, excavated within the framework of various projects carried out on the island of Tierrabomba; (3) and the Instituto Colombiano de Antropologia e Historia (ICANH) in agreement with the Universidad Externado de Colombia and the Escuela Taller de Cartagena de Indias, developed, through the laboratory, a theoretical – archaeology assistance and preventive conservation workshop, in which a group of people between men and women of different ages was trained, the local community, in the different processes of excavation and conservation of archaeological material in terrestrial and underwater contexts, where special emphasis was placed on the importance of in situ conservation, and the recovery of material evidence is only relevant when carried out within the framework of scientific projects, that can ensure appropriate conservation processes for the various types of excavated materials.

At the end of the course, the participants have the capacity to act as assistants in various projects of terrestrial and underwater archaeology and to give the first aids of preventive conservation to the material remains extracted from the excavations and particularly of underwater contexts. Additionally, the course was consolidated as a space of interaction around the reflection and the evaluation of the material and immaterial cultural potentialities of the subdivisions, and has in turn contributed to the dynamization of the fortification, while in the district of Bocachica, it is being recognized as a space for formation.

Fig. 2: Briefing 4th Season Shipwreck excavation, March, 2019

Fig. 3: Assistance course in archaeology

Been developing, to link the interest groups in the processes of patrimonial activation, initiatives have emerged such as the opening of an underwater museum in the bay of Cartagena, this project, has been advanced with various entities of state order that are related to the management of the Underwater Cultural Heritage, like the Universidad Externado de Colombia, the ICANH, the Dirección Genera Marítima (DIMAR), etc and seeks to materialize in the remainder of 2019.

Also, within the framework of the specialization in Underwater Cultural Heritage, of the Universidad Externado de Colombia, which seeks to contribute to national and regional professional capacities to lead study activities, intervention, protection and management of the Underwater Cultural Heritage; aims that the Laboratory, together with the shipwreck, will serve as a training space on a practical level, where the knowledge acquired around the three emphasis of specialization is applied: Underwater archeology, Assessment and Management of the Underwater Cultural Heritage and Conservation and Restoration of the Underwater Cultural Heritage.

4. CONSIDERATIONS

The use of heritage as an entry point for the opening of opportunities for sustainable development allows the laboratory, through its consolidation as a Community Cultural Infrastructure, to aim to protect and safeguard the Maritime Cultural Heritage and immersed by means of the implementation of strategies that manage to link the interest groups, not only to contribute to the valuation and appropriation of the same, but to generate opportunities of development that allow to improve the quality of life of the Local community

Consequently, the preservation of the heritage and the existence of an infrastructure that supports it, constitutes and provides tools that can generate impact on the capacities of interest groups, as it enables the realization of ideas by helping to build knowledge and institutional support networks to work for the promotion, conservation, safeguarding and management of the Maritime and Underwater Cultural Heritage of Bocachica.

The today's journey has shown that the laboratory is a driving project that has allowed the development and design of new strategies such as the creation of the Underwater museum, and the integration of various institutions committed to the management and safeguard of underwater Cultural Heritage.

Clearly, it becomes a challenge, in as much as it has been shown that in the short term the laboratory model has worked, it is important to work on its viability and sustainability in the medium and long term, to allow the continuity of the processes that have been initiated through the linking of the different interest groups, so, in this point, the management of the heritage and its involvement with the sustainable development, are key to think about the institution and consolidate it in such a way that it is maintained over time and allows the implementation of various strategies that ensure the protection, safeguarding and management of the Maritime and Underwater Heritage of the place.

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The in situ preservation as a priority option. Experiments in the upper Adriatic Sea

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Abstract: Underwater archaeological heritage is exposed not only to natural environmental stresses, but is also threatened by human activity. As a matter of fact, both commercial fishing and recreational diving have caused considerable damage to several major wrecks in the northern Adriatic Sea. So a new project was started in order to develop that has as its primary objective the protection of underwater sites by both surface and underwater video surveillance. It was also decided to start an experimental trial on the shipwreck of Grado 2 (3rd century B.C.), where a metal structure designed ad hoc for the protection of the wreck and enhancement of in situ preservation was assembled. The construction is in fact composed of a system of load-bearing squares with attached protection grids, which, through a system of "keys", can be opened and removed selectively as necessary to allow maintenance and future excavations. A second trial has been carried out on the shipwreck of Caorle (2rd-1rd century B.C.), for which we have planned a video-surveillance project.

Keywords: Adriatic, preservation, shipwreck, video-surveillance, enhancement

1. INTRODUCTION

If cultural heritage is a public asset and if submerged heritage "must" remain underwater (in accordance with the UNESCO convention: article 2, paragraph 5), developing systems to ensure that it is not reserved solely for professionals becomes a moral obligation that we cannot avoid.

Therefore, the project was born first from the need to protect, but also to promote, the use of submerged archaeological sites by sport divers and also by those who cannot dive: all children, the elderly, and the disabled.

With these goals, the University of Udine gave life to an interdisciplinary project that involves the Department of Humanities and Cultural Heritage and the Polytechnic Department of Engineering and Architecture, in collaboration with the Superintendences of the Friuli Venezia Giulia and Veneto regions.

In accordance with these local offices of the Italian Ministry of Cultural Heritage, we have also decided to start an experimental work in the upper Adriatic on two sites (Fig. 1) that represent different conditions: the shipwreck of Grado 2 (3rd century B.C.) and the shipwreck of Caorle (2rd-1st century B.C.).

Fig.1: Experiments localization (created by Massimo Capulli; background Image © 2019 Google)

2. THE SHIPWRECK OF GRADO 2

The shipwreck was found in 1999, about 7 miles off the coast of Grado, not far from another shipwreck, so-called Iulia Felix that is Grado 1 (Capulli et al. 2016: 47-63). The underwater site of Grado 2 lies at a depth of 19 meters, embedded a few centimeters in the flat sandy sea-bottom. In the months immediately following the discovery, a team from the University of Catania verified the actual consistency of the find (Tortorici 2000: 91-98). They constructed a grid with stakes and ropes, and then, after an initial surface cleaning of the sandy sediments was carried out using a water-dredge, they produced graphic and photogrammetric documentation. In order to study the type of cargo, some fragments of amphorae not in situ were also recovered. The remarkable fragments visible and recovered so far seem to belong to a type of transport container belonging to the so-called Greco-Italic group (Fig. 2), in particular to the type MGS VI of the Van Der Mersch classification. It is a type of wine container whose production centers were located in Campania, Puglia, Calabria and eastern Sicily and attested by multiple discoveries (including from submerged sites). Despite the presence of a large number of findings, the entire production is not yet framed within a fully reliable type, especially with regard to advanced and chronological aspects. But the more interesting fact is the chronology of the cargo, as it has been advanced on the basis of archaeological data, because it defines the finding of Grado as the oldest evidence of underwater archaeology of the historical period of the entire Northern Adriatic. Of particular importance is the fact that the wreck was found well before the Roman foundation of Aquileia (181 B.C.) on which the entire territory is based. The presence of a boat loaded with Greco-Italic amphorae from the 3rd century B.C., probably of productive relevance to the Adriatic area, also highlights the need to address on a new basis the problem of trade routes, ports and landings of the Hellenistic period in this geographical area (Capulli, Tortorici 2018: 89-96).

Fig.2: Amphorae Greco-Italic of Grado 2 shipwreck (Massimo Capulli)

The need to take action to protect the site emerged in particular following an inspection carried out in 2010, when a series of damages were recorded. In the period from 2012 to 2015, under the scientific direction of Luigi Fozzati, the Superintendent for the Archaeological Heritage of Friuli Venezia Giulia, we conducted two campaigns, aimed at the realization and then implementation of a metal structure designed specifically for the protection and enhancement of the site.

2.1. A metal grid project to protecting and enhancing

The basic design idea was to create a modular load-bearing structure, such as to allow its extension in every direction, on which to place removable grids, therefore different from those used in Croatia (Jurisic 2006: 147-160). The system thus conceived allows each single square to be "opened and closed" simply by selectively removing the protective grid according to present needs, such as, for example, the maintenance/cleaning of the cargo on display or a deepening of the vertical archaeological excavation, without, however, affecting its value as a protection or enhancement garrison. The grids have in fact been designed to allow a not too oppressive view of the cargo while at the same time preventing the removal of the amphorae.

In particular, the system is comprised of squares consisting of four horizontal tubular bars (square in section, 50 mm sides and 4 mm thick), which are fitted with a bayonet coupling on special crosses, orthogonally equipped with an adjustable foot to rest on the bottom.

Three protruding metal plates are also welded on the lower face of each tube, so that when the square is assembled there are twelve points on which the protection grid can be placed internally. The grids are instead made of a single block made up as follows: perimeter plate, 2 meters per side and 40x5 mm thick, with an interior space divided in small squares of 20x20 cm.

Thanks to the presence of a through hole, in correspondence with each of the support plates of the bearing structure, it is possible to fix other metal plates on the upper faces of the tubes by means of vertical screws. Since these are not welded, it is sufficient to loosen and tighten the fixing screw to rotate them so that they are aligned with the tubes, thus allowing the movement of the grid, or so that they are orthogonal to the tubes, to block each individual grid with twelve plates. It was decided not to use common fixing screws, but to use prototypes that can only be unlocked with a dedicated Allen key. In other words, this system acts as a sort of ad hoc lock.

The second campaign in 2015, in addition to providing for an extension of the exhibition area by highlighting a new portion of the cargo, also saw the installation of a protective frame around the structure (Fig. 3). Already during the first campaign in 2012, it was recognized that by digging manually at the sides of the metal structure or by simply taking advantage of the natural collapse of the walls of the archaeological excavation, it would perhaps be possible to access the cargo brought to light. To avoid this possibility, a 50 cm wide metal frame was designed that surrounds the entire structure and that, just like the latter, can be removed using the "keys" and expanded to follow any future expansion.

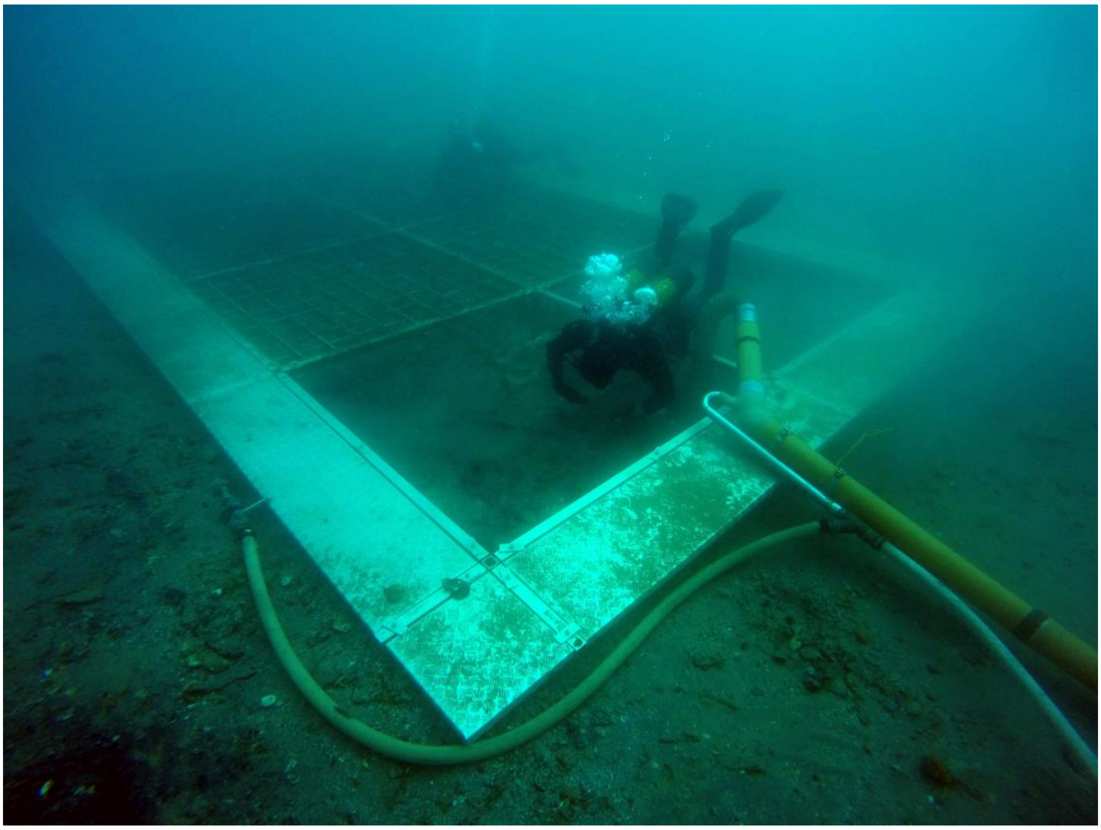

Fig.3: Grado 2 shipwreck: excavation operations inside the metal structure (Massimo Capulli)

At the end of the opeartion, the wreck of Grado 2 was potentially usable for 32 square meters to recreational divers through eight grids from which you can observe part of the cargo, accompanied by two explanatory panels.

3. THE SHIPWRECK OF CAORLE 1

The second test was done on this site because it represents a limited case. Indeed all of our other shipwrecks have easier conditions. It is located 12 nautical miles from Caorle, the harbor of the ancient Iulia Concordia, at 28 m under sea level. The cargo is contained inside a very hard calcareous concretion that is 23 m long, 7 m wide, and rises from the surrounding flat sea bottom to a height of 3 meters (Fig. 4), so it seems a kind of small hill in the Adriatic seabed (Capulli 2007: 124-131).

Fig.4: Caorle 1 shipwreck: amphorae inside the calcareous concretion (Massimo Capulli)

Despite no excavations being yet conducted, during our site inspections (more or less once per year), there have been recuperated some amphorae that could be dated to the end of second century or firstpart of first century BC. The type of these amphorae can be considered a transitional one, to collocate between the standard Greco-Italic type and the Lamboglia 2 type. Specifically, the amphorae recovered were located on the side of the wreck, the "hill", while in the thick limestone shell you could see evidence of lootingWe probably managed to save them before they were completely taken away.

In this case, the particular nature and conditions of the site have suggested the use of a video-surveillance project. This has meant the development of a feasibility study for the video recording, both on the surfaceand underwater.

An interdisciplinary team from the University of Udine, including the Department of Humanities and Cultural Heritage, the Department Polytechnic of Engineering, and the Department of Computer Science and Mathematical and Physical Sciences (Capulli et al. 2013: 1239-1251), carried out the research.

3.1. The video-surveillance project

The project involves the creation of a video surveillance system capable of continuously monitoring both the body of water above a submerged site and the actual site. The system involves sending video streams, collected by underwater cameras installed at various points of the archaeological site, to a management and sorting system located on a buoy, on which additional cameras are placed to also record the surface, combined with motion sensors. The acquired images are also transmitted in real time to a remote server and recorded.

An important role is entrusted to the software that must manage this flow of data. The real time stream is for the public, while the police and Soprintendenza have control of the server with the data of the last several days, where videos/pictures are stored, but for a limited period of time. As new data arrive, the system deletes older data. Part of the technological challenge was also the study of energy supply systems. Engineers decided on a mixed system with a natural energy and security battery as it did not have any "holes".

The aspect of protection remains in fact primary and thus, in addition to distribution for remote use on the web or in a special virtual station in the museum, the system monitors all situations of underwater intrusion or damage from professional fishing. The surface images are aimed solely at keeping the area monitored, thus constituting the main element of deterrence for any malicious acts. It would be possible to see in the records those responsible for the misdeed, including any intentional tampering with the same buoy (Capulli et al. 2013: 1239-1251).

Fig.5: Test phase at sea with sending of real-time video to the University of Udine (Massimo Capulli)

The study and development phase of the system was followed by a trial at sea. After an initial test with antennas for the radio-transmission was unsuccessful, due to the earth's curvature and lack of buildings high enough to always ensure transmission, we switched to a satellite system. Thanks to a collaboration with Eutelsat S.A. and the technical intervention of Open Sky Srl (which has provided the necessary satellite band for transmission) the test at sea was successfully concluded with the sending of real-time video (Fig. 5) from the underwater site to the headquarters of the Scientific Pole of the University of Udine (about 70 km).

4. CONCLUSION

The sea has always been the unintentional guardian of many pages of human history. Over the last seventy years, underwater archaeological research has brought some of these pages back to mind through material evidence that is often found in many museums. Nevertheless it is not always possible or correct to recover these remains of the past (Flatman 2009: 5-8). In situ conservation, in line with UNESCO guidelines, seems to be preferable in many ways (Richards, McKinnon 2009). However, the cultural heritage, although underwater, is a public good and is so in the broadest sense, given that at sea there are wrecks of unknown origins and destinations.

Fig.6: Diving on the underwater museum of Grado 2 shipwreck (Massimo Capulli)

The project elaborated by the University of Udine aims to increase the number of the possible users of UCH. On the one hand, the creation of an underwater display case for the shipwreck of Grado 2 illustrates the attempt to respond differently to the needs of protection, taking up the challenge of possible underwater tourism (Fig. 6). On the other hand, the development of a remote video control system, tested on the shipwreck of Caorle 1, contributes to a more effective protection action, giving at the same time the possibility for all to observe live images of a submerged site, or better, of a submerged archaeological landscape.

Of course it is possible to use the same system and with more ease on the Grado 2 site, which is not as deep nor as far from the coast. This shipwreck should not constitute an entity detached from the sea museum of Grado, if not from a physical point of view. Those who can dive will have the opportunity to do it on the submerged site, while those who cannot (first of all children, the elderly, and the disabled), could visit the Grado 2 room in the museum and there watch the site in real time by monitor.

Maybe in the future a child, during their museum visit, will be able to see their father or mother while they are diving, and the parents will be able to send them a greeting from the shipwreck.

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How the Greek pilot sites were selected and the creation of the Knowledge Awarness Centers (KACs) in Greece

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Since 2008 to 2018 as Director of the Ephorate of Underwater Antiquities, I set two targets – visions for the display and promotion of this so important Service of the Hellenic Ministry of Culture. After thirty five years of service at the Ephorate of Underwater Antiquities as a diving archaeologist with postgraduate studies and PhD thesis in Underwater Archaeology, I have envisioned the foundation of a Museum of Underwater Antiquities, as it is necessary for a naval country like Greece, with a maritime history since 3000B.C. We have also made a lot of headway at a satisfactory level both for its implementation and for the foundation and operation of visible Underwater Archaeological Sites (The Underwater Museums) that is something similar to overland sites.

The project "Blue Med", which would aim at the implementation of my second target, it really clicked to my targeting at the right time (2016). Since then 2016-2017, it has been as good as it gets for the dissemination of our country's Underwater Cultural Heritage through the project "BlueMed" and "visible Underwater Archaeological Sites" in Alonissos and Pagasitikos, and it would had also a really positive result in the sector of tourism. In this framework, I made speeches in many places in Greece and also abroad as far as the distant China, in excellent cooperation with the other partners of the Mediterranean (Cyprus, Croatia, Italy, Spain and the other authorities of Greece). The Ephorate under my direction and in cooperation with Dr Barbara Davidde of the Instituto Superiore per la Conzervaziöne ed il Restauro, applied a pioneering method of conservation of the sunken roman villa in Ancient Epidaurus.

EGNAZIA: Enhancement and use of submerged Structures along the coast guided diving and snorkeling tours

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Abstract: The archaeological site of Egnazia is located on Puglia's Adriatic coast, in the territory of Savelletri, a hamlet of the municipality of Fasano (Province of Brindisi). Due to its geographical position, the presence of the harbour and the Via Traiana, the place was of great importance and it played a prominent role in the ancient world, especially in Roman times, being an active centre of trade and communications. Since July 2016, guided diving tours have been offered in Egnazia, near the port structures dating back to Roman times. A guided tour can be arranged either by using the snorkel or by using the aqualung. The tour itinerary is divided into two parts. The first one embraces a visit to the coast, including the remains of the Messapian fortifications situated on the cliff edge where you can also see quarry remnants and tombs. The second part represents an easily accessible underwater itinerary 400 metres long, which starts from the coastline and reaches the submerged Roman structures at a maximum depth of 6 metres.

Keywords: Tourism, Use, Guide, Diving, Itinerary, Museum, Enhancement

1. GUIDED DIVING AND SNORKELING TOURS

In Egnazia is present and available from July 2016 a guided tour underwater at the port facilities of Roman times, wanted by the Museum of Puglia in collaboration with the Superintendence of Archaeology, Fine Arts and Landscape of Brindisi, Lecce and Taranto. The underwater route complements the offer of the National Museum and the Archaeological Park, unique in Puglia.

Creating and making available underwater routes and museums at the bottom of the sea can be considered a winning idea. More and more visitors are interested in learning about submerged sites where you can see finds and archaeological evidence on site. Archaeological underwater tourism is a constantly growing trend, underwater archaeological routes in Italy are increasingly in demand and the presence in some sites such as Baia and Gaiola in the Phlegraean area, Pantelleria, Levanzo, Ustica in Sicily, at the forefront for testing of innovative visiting technologies, are increasing sharply.

The sea is to be understood as a large museum where the testimonies of the past are read without altering the original context of location. Where the conditions for a safe stay of the finds at the bottom of the sea are created, they can be made available in a linear itinerary with guided routes through individual finds, or in an area itinerary with finds collected in a limited area, or in real submerged parks.

The enhancement and use of submerged archaeological assets, through an eco – sustainable discipline such as diving, represents both and increase in the attractiveness of the Museum and an opportunity for development of the economy of the territory. The visitor, accompanied in immersion by the underwater archaeologist, observes reality through the mask exactly as a visitor would do with the visrtual display apparatus of the archaeological sites, but in this case his relationship with the surrounding space and objects underwater is of a real type. While the traditional visitor gets used to intertwining nature and culture, art and technique, physicality of archaeological objects and abstractness of technical reworkings, archaeological emergencies and immaterial heritage, those who visit an underwater site implement a naturalistic practice, a real "immersion in nature"; that implies a total contact with the environment, but that requires a series of equipment and technical knowledge and implies a relationship with the environment always mediated by the technique (Melotti 2007 : 51) becoming a technophile practice. In short, it's a question of developing a relationship with nature that is not only the traditional and static relationship of the viewer. The museum thus becomes a provider of services for the varied range of visitors of all ages and educational backgrounds.

For the specific type of visitors, consisting of divers, who perform primarily a recreational dive, a submerged archaeological path becomes a model of edutainment (Melotti 2008 : 25) and allows to combine the educational function with entertainment.

Since 2018, the Egnazia site has been part of the MUSAS project, directed by the ISCR archaeologist Barbara Davidde (also director of the Underwater Restoration project, which has enabled strategies, models and best practices to be established for the safety and restoration of the underwater archaeological heritage). The aim of the MUSAS project is to experiment on a supra-regional scale with an integrated model for the monitoring and enhancement of submerged archaeological heritage, in museum collections and in situ, in order to create methods that can also be applied to other sites.

2. THE ARCHEOLOGICAL SITE OF EGNAZIA

The archaeological site of Egnazia is located on the Apulian Adriatic coast in the territory of Savelletri di Fasano (BR), in particularly favourable context from a naturalistic and environmental point of view. The Archaeological Park and its Museum are part of an area of considerable landscape and environmental value, characterized by beautiful examples of olive trees and a stretch of rocky coastline, strongly marked by the presence of man (Fig.1); it contains evidence of the different phases of life of this important center of the Apulian Adriatic coast, the ancient GNATHIA, mentioned by authors such as Pliny, Strabo, Horace, which evolves and develops over a very long period of time, from the XVI century BC to the XIII century AD (Cassano and Mastrocinque 2016 : 33 – 129). For its geographical position, the city had great importance and a prominent place in the ancient world especially in Roman times, thanks to the presence of its port and the Via Traiana, becoming an active center of trade and commerce (Mastrocinque 2016: 1 – 12).

Currently, the remains of the ancient city can be visited within an archaeological park equipped and guarded. The tour starts from the Museum, where finds and images tell the story of the city and its territory, with an exhibition that covers an area of about 1200 square meters, organized in 13 rooms. The rich exhibition layout is designed for time and theme sections, from the Bronze Age village to the Middle Ages, with illustrative and explanatory panels that describe the evolution of the settlement in relation to the surrounding territory (Guide to the Museum 2015).

Fig. 1 Egnazia port and coastline. Photos G. Colucci.

The visit then moves outside the Museum and continues in the Archaeological Park, among the remains of the Messapian, Roman and late-antique settlement (the ancient defensive walls, the Via Traiana, the public baths, the civil basilica, the area sacred to the Eastern deities, the large square-market arcade, the ceramics district, the cryptoporticus, the early Christian churches). The tour also includes the possibility of observing different areas of necropolis. Among these, the Messapian necropolis, with the pit tombs, semi-chamber rombs and some monumental underground chamber tombs from the Hellenistic period, frescoed and decorated.

The excavated and usable archaeological area covers an area of 12 hectares out of a total of about 40. With the new guided immersion route it's also possible to anjoy the coastal strip and the water mirror overlooking the ancient city, already subject to direct archaeological constraint, which until now weren't included in the itineraries of visit.

The archaeological emergencies present near the sea are heterogeneous: the necropolis and the Messapian walls, the extraction quarries, the road sections, the tanks, the cisterns and the other human signs cut directly into the rocky bank (Fig.2); in the sea, the pilae in opus caementicium referable to the piers of the Roman port (Colucci 2006-2007: 70).

Fig. 2 Visit and snorkeling along the coast. Photos G. Colucci.

Overall, the port basin is small in size, with an area of about 16.000 m2 and an opening to the east about 40 m wide. Two mighty parallelepiped structures in opus caementicium lie just under 100 m from the shore at the depth of -6 / 2 m. The dimensions, the shape and the technical characteristics lead us to refer to these plinth elements: we can speak of a work with pylons obtained, at least in the case of the outermost plinth, with the help of a "tinned"; formwork, considering the presence of a curtain in the face. It could therefore have been the real foundations off the pier on which the docks and mooring bollards had to rest. The two plinths are staggered with respect to an ideal path connecting them with the probable ground connection, housed in a cut of the bottom and are spaced 3 m apart. The outermost plinth has a negative traces of opus reticolatum and corner clamps in opus vittatum: both the cubilia of the first and the blocks of the second have been stripped of their seats by wave motion, so that only the voids of the modules of the remain Fig.3.

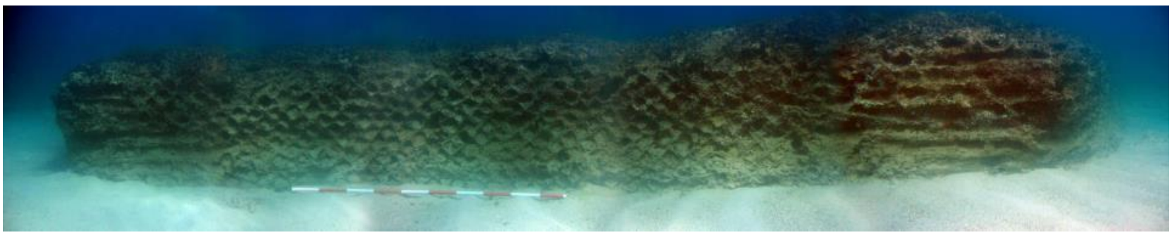

Fig. 3 Structures of the northern pier in a concrete structure covered with an onsite facing of which the trace remains. Photos G. Colucci.

The work identified as a surviving portion of the southern pier is of considerable size. Made of cement, with successive castings, it has a dense series of cracks. The southern pier is in fact located on the rocky bank at the edge of the submerged ridge that delimits the invaded port, and is divided into three blocks of different sizes altogether 23 m long (Auriemma 2004: 44). The guided tour of the submerged structures can be done by snorkeling or scuba diving (Fig.4-7).

Fig. 4 Underwater visits to the structures of the port. Photos G. Colucci.

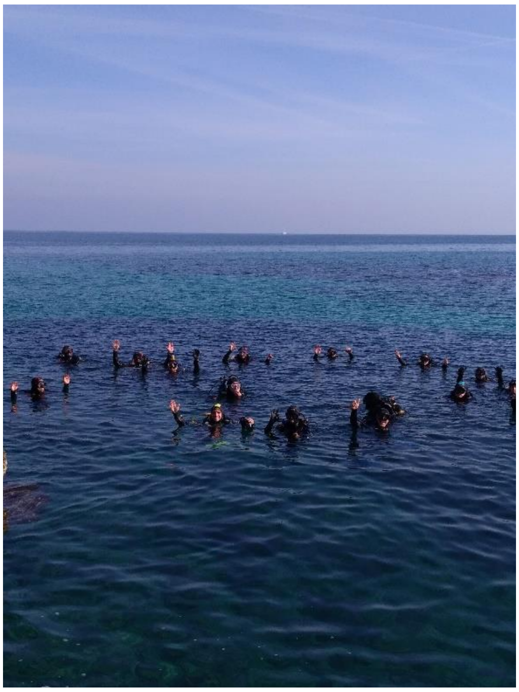

Fig. 5 Underwater visits to the structures of the port. Photos G. Colucci.

The route is divided into a route of visit on the coast, within the defensive system of the Messapian era in the rocky bank of the cliff where there are quarry cuts and tombs, and an underwater path about 400 m long of easy access that, starting from the coastline reaches the submerged structures of Roman times located at a maximum depth of 6 m (Colucci 2009-2010: 65).

Throughout the dive, the visitor can appreciate the conspicuous presence of ceramic fragments of various sizes, a recurring feature in ancient port areas, connected with the activity of loading and unloading goods and the activity of throwing into the sea of amphorae broken during transport, the amount of finds confirms the intense vitality of the port and the commercial dynamism in the entire area.

Underwater archaeological routes, such as museum services, present the basic service and the peripheral service. Specifically, for the underwater route of Egnatia, the basic service consists of the Roman structures that lie on the seabed and, as for a museum, represent in their uniqueness the permanent collection. There are many peripheral services that include strictly technical support activities related to the use of equipment and means needed (diving service) and those aimed at improving the use and meet specific needs of visitors such as guidance services, educational assistance and refreshments.

Fig. 6 Underwater visits to the structures of the port. Photos G. Colucci.

Fig. 7 Underwater visits to the structures of the port. Photos G. Colucci.

The project for the enhancement and use of the submerged structures of Egnazia is in line with the principles of the UNESCO Convention on the protection of the submerged cultural heritage. The access to the public of the archaeological evidence on the bottom is promoted and favoured with a guided itinerary that allows to see the objects in the original arrangement established by man. The establishment of a marine protected area is a desirable in order to fuly guarantee the preservation of the good.

The ancient city of Egnatia lived in close symbiosis with the sea, as now the entire territory of Egnatia and Fasano. The beauty of the sea and the peculiarity of its coasts are responsible for the development of tourist infrastructure and accommodation in the entire area. With the enhancement and use of the submerged evidence we want to propose a "return to the sea"; and its great underwater heritage that preserves. What still resists at the bottom of the sea can become an integral part of a vast and articulated museum, which brings together natural, landscape, anthropological and historical-archaeological values useful for understanding the history of the relationship between man and the sea, for a healthier and more sustainable tourism and cultural development.

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Change behaviour and raise awareness about the Adriatic's underwater treasures as common goods: the UnderwaterMuse Project

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Abstract: The project aims at applying on sample areas (maritime landscapes of Torre Santa Sabina, Grado, Resnik/Siculi, Caorle) a methodological and technological protocol based on research/ knowledge and development/communication of underwater archeological sites that are complex and multi-stratified, characterized by strong diversity. The project's objective is therefore to transform the site into an underwater archaeological park (or eco-museum) through innovative and/or experimental methodologies and techniques in order to try to reduce the loss of important cultural heritages as well as to guarantee an economic spin-off deriving directly from the creation of a sector linked to the tourist-cultural promotion of the context of reference.

UnderwaterMuse will target local communities as long-term keepers of vitality at tourist destinations, promote co-creative partnerships among tourism and cultural actors, public decision makers, creative companies, associations of citizens, facilitating exchange of information. An immersive virtual reality (VR) approach renders underwater sites accessible to a wider public, including people with different kinds of disabilities. Building capacity for professionals already working in this field will help them adapt to a "museum for all" concept, in spite of limited organizational or financial resources. Training diving guides will improve the immersive experience of underwater sites. Regional action plans will enhance environmental management and preservation of coastal areas harbouring those sites. Based on the experience gained, an innovative promotional GIS tool, the 'UnderwaterMuse MAP' for promoting underwater sites with accessibility standards, will be developed. The 'UnderwaterMuse MAP' will be promoted at transnational, national and local level, in the Adriatic and beyond, thus guaranteeing its sustainability and transferability during and after its implementation.

The interdisciplinary partnership from 4 different regions will carry on pilot actions focusing on transforming sites with a strong potential as experience-based tourist destinations testing a sustainable tourist offering in areas less interested by major tourist flows.

Keywords: underwater cultural heritage, in situ protection and valorization, underwater archaeological park, VR, GIS.

Through interpretation, understanding; through understanding, appreciation; through appreciation, protection (Freeman Tilden, Interpreting our Heritage, 1977)

1. A PREMISE: WHY UNDERWATERMUSE NOW?

For the underwater archaeology, the "waterscapes archaeology", the in *situ* preservation and enhancement represents the first option. We can recall two key passages[46]:

1. the Convention on the Protection of Underwater Cultural Heritage 2001;
2. the Faro Convention.

The key goals are clear:

1. building an archaeology community, building awareness;
2. cultural heritage as common good and economic resource;
3. archaeology for the territory, archeology for the environment;
4. research, conservation, protection, management and participation as parts of the same chain.

In the Unesco's Convention on the Protection of the Underwater Cultural Heritage we have the best and forward-looking premise. Actually, as we know, the Unesco's Convention on the Protection of the Underwater Cultural Heritage affirms, in rule 1, that in situ preservation is the first option because the site of a historic event is authentic and the context defines significance.

Moreover, in rule 7, the Convention underlines that *public access to in situ underwater cultural heritage shall be promoted, except where such access is incompatible with protection and management*: heritage is protected for its public interest and its unique value for humanity; it should be enjoyed by as many people as possible; access contributes to the appreciation and awareness, and to a better understanding and knowledge and also to a better protection (Maarleveld et al. 2013).

It's true that heritage is finite but, once adequate measures for protection have been taken, there is no further reason to restrict access permanently.

Experiencing the past under water is rapidly becoming an enormous asset in the leisure industry and the experience tourism. This development has risks and opportunities for the underwater cultural heritage, but providing diving operators with a measure of responsibility and custodianship is a good solution for the need of supervision and control. As an alternative to the direct access, traditional publications and media may be supplemented with more and more virtual techniques, simulating experience or allowing for visualisation at a distance, through internet or other means.

To ensure a worldwide respect for submerged heritage by individual divers and to set a common standard UNESCO has promoted a Code of Ethics for Diving on Submerged Archaeological Sites[47].

1.1 The new stage that strengthens the process: the Faro Convention

After the Unesco's Convention on the Protection of the Underwater Cultural Heritage the new stage of the current process of reappropriation of the cultural heritage as common good, "popular" good, is represented by the Faro Convention, "framework convention", adopted by the Committee of Ministers of the Council of Europe on 13 October 2005 and ratified by 17 member States. In Italy the implementation process inside our legislative system has been interrupted by the change in government and therefore we have only the draft bill.

[46] For the previous conventions and laws related to submarine archaeological sites, a good synthesis is in Negri 2000 and Prott 2000.

[47] UNESCO Code of Ethics for Diving on Submerged Archaeological Sites http://www.unesco.org/new/en/culture/themes/underwater-cultural-heritage/divers/code-of-ethics/

However, it emphasizes the important aspects of heritage as they relate to human rights and democracy. As we know, it promotes a wider understanding of heritage and its relationship to communities and society. The Convention encourages us to recognize that objects and places are not important in themselves, but because of the meanings and uses that people attach to them and the values they represent[48].

In line with the Faro Convention, we must address our effort to the development of "models for managing underwater cultural heritage in a way that brings benefits for the sustainable economic development of regions", in order to "increase the positive image of underwater archaeology and the involvement of the public in the awareness, the protection and enjoyment of the underwater cultural heritage" *It is necessary to engage, not only from a research perspective, but also as an ethical obligation to the local communities within the environments that archaeologists work. It is important to recognize the different values attached to the project by ourselves as heritage professionals, and the communities as «providers» of knowledge* (Roberts, Benjamin, McCarthy 2016).

The Faro Convention stresses the continuous dissemination of activities and initiatives, in a living dialogue with the communities and the individuals, to start participation processes and raise awareness of ever widening groups.

It is necessary to communicate the entirety and the complexity, to properly use the technologies, to do good storytelling and to stimulate the proactive participation (Volpe, De Felice 2014), in the framework of a "community archaeology".

The Scientific and Technical Advisory Body - STAB of the UNESCO Convention 2001, gathered in its following 5th session in Paris in June 2014, adopted the 3rd Recommendation 3/STAB 5 in which "*recommends* to consider as best practice all initiatives, taken in exemplary manner and in conformity with the Convention, permitting the public at large access to knowledge about the underwater cultural heritage, in particular: responsible **non-intrusive access to observe or document** *in situ* underwater cultural heritage, such as provided through dive trails, submarine visits or glass bottom boat visits; responsible **public access on land**, such as provided by museums, exhibitions and interpretative trails; and access**, such as provided by publications, virtual or digital applications**, websites or other means" (Rey da Silva 2016).

2. PUBLIC ACCESS CASE STUDIES

Some existing examples of responsible public access initiatives could possibly be counted in future under best practices.Around the Mediterranean[49] the best practices of caging experienced in Croatia are well known: Za Planiku, Island Lastovo (1), Saplun, Island Lastovo (2), Bay Koromašna, Island Žirje (3). Islet Supetar near Cavtat (4), Klačine, Island Mljet (5), Bay Vlaška Mala, Island Pag (6),

[48] See in particular art. 10 – Cultural heritage and economic activity, Section III – Shared responsibility for cultural heritage and public participation, 11 – The organisation of public responsibilities for cultural heritage, 12 – Access to cultural heritage and democratic participation, 13 – Cultural heritage and knowledge, 14 – Cultural heritage and the information society. See also Faro Action Plan Handbook.

[49] We can't quote all the exemples outside the Mediterranen, but we remember that currently the largest underwater museum in situ is the Baiheliang Museum in China, where some of the oldest hydrological inscriptions, recording 1 200 years of changes in the water level of the Yangtze River have been seen submerged after the construction of the Three Gorges Dam and now lye at a depth of 43 metres (Ge Xiurun, 2011).

Cape Sorinj, Island Rab (7), Shallows Buje near Umag (8) (Zmaić 2009; Pešić 2011; Mesić 2008, 2014).

We can point out the important experience in Greece: the cases of Methoni Bay – Sapienza Island and the National Marine Park of Alonnissos and Northern Sporades, with the submerged Neolithic site of Aghios Petros, the biggest shipwreck of the classical age, 'Peristera' wreck, and many other well preserved classical, Roman and Byzantine cargos (Georgopoulos, Fragkopoulou 2013, with references); surely another impressive cases are the Sebastos of Caesarea Maritima (Raban, Holum 1996, Raban et al. 2009; Hohlfelder et al. 2007, 2014; Brandon at al. 2014) and Alexandria, Egypt: the latter, aiming at presenting submerged Egyptian culture, including small finds and features, the remains of the Alexandrian harbour and the famed lighthouse on Pharos, is still under study and highly recommended by the personnel of Department of Underwater Antiquities (Morcos 2000; Hafiz 2011; Frigerio 2013; El-Kady 2017).

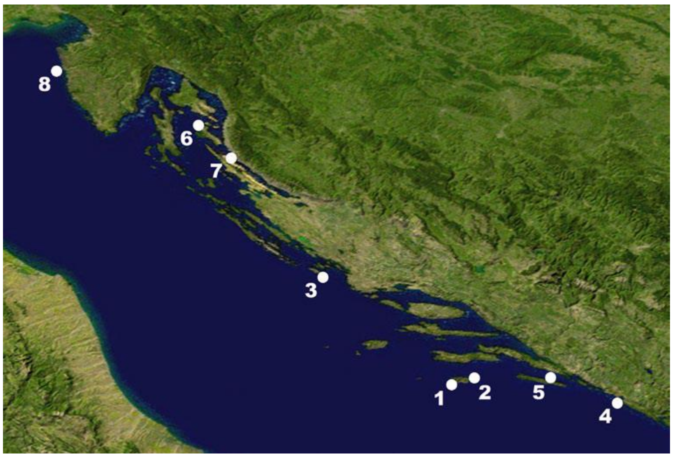

Fig. 1. Caging best experiences in Croatia (*Exploring Underwater Heritage in Croatia 2009*).

Moreover, a few open underwater archaeological excavations can be recalled: the Roman shipwrecks of Bou Ferrer (Juan Fuertes, Cibecchini, Miralles, 2013) or Cap del Vol, where engagement with diving clubs and federations show success (Aguilar 2013).

As far as the Italian experiences are concerned, some marine parks and underwater trails, such the positive experiences of Baia and the Sicilian trails, contrast with the tens of coastal and submerged sites literally abandoned, encircled by abusive urban speculations and wild moorings, whose access is totally uncontrolled with all the risks and possible damage that this situation brings with it (Stefanile, 2012; Stefanile 2016 with references; Secci, Stefanile 2016).

In Pozzuoli and Baiae, in the Gulf of Naples, villas, mosaics, baths, streets, houses and harbour structures of the Roman period were submerged by the sea, as a result of the volcanism. This unique environment, severely looted over the years, has been included in a Marine Protected Area since 2001**.** Since then, the Archaeological Superintendence has carried on some research and documentation works, while the Conservation and Restoration Central Institute – ISCR has experimented with new techniques for the conservation of the underwater structures. The public access has been made possible with the opening of underwater archaeological trails, and through the involvement of the diving instructors active in the area, appropriately trained.

The benefits in terms of local development were foreseen already in the Interminsterial Decree 304/2002 for the Institution of the Underwater Park. The finalities (article 3) include also the promotion of a socio-economical development compatible with the historical and landscape evidences of the area, also sustaining existing local traditional activities; (in this framework) the regulation of the activities related to the management of the touristic flows, guided visits and public transports would foresee that the above mentioned activities are delivered primarily by the local citizens and businesses.

Currently, five sites/trails are predisposed for diving (and others probably will be open) equipped with guidance ropes and didactic PVC panels, accompanied by official diving guides, trained thanks to professional courses held by the Superintendence. Due to the shallow depth, four of these spots are accessible by snorkeling or on glass bottom boats, suitable also for primary school groups. The area lends itself to underwater archaeology training courses and field schools as well as environmentalist interventions and it is also object of real archaeological research.

The diving centres, made responsible and aware, pay a fee for each diver, and at the same time take a proactive role in UCH protection: sending away the pleasure boaters and intruders, reporting to the Superintendence damages or problems, and even checking divers for eventual artefacts souveniring.

The involvement of diving centers by the Superintendence has been a good choice: the site is undoubtedly more protected and exploited than in the past, and the visits, both of foreigners and locals, are increasing. On the other side, also the diving centers benefit from this activity, increasing their revenues, creating job opportunities (also for archaeologists!), deseasonalising and expanding touristic flows, receiving recognition for the significant results (Stefanile 2016).

Fig. 2. The underwater archaeological Park and MPA of Baia and Gaiola (Naples).

Other case-studies can be the Protected Marine Areas of Gaiola, S. Maria di Castellabate - Punta Licosa (Stefanile, Agizza 2012), Ischia –Aenaria Regno di Nettuno

The Region of Sicily has devoted particular attention to this phenomenon, due to the fact that it is currently the only region that has a Superintendence of the Sea. This has fostered the creation of numerous archaeological trails and the publication of scientific and informative material, related to the underwater tourism (Melotti 2007; www.regione.sicilia.it/beniculturali/archeologiasottomarina/itinerari.)

Where the diving is difficult or there are risks for the UCH, monitoring and broadcasting systems have been employed, through the use of underwater telecameras.

3. THE UNDERWATER TOURISM

The underwater tourism combines in a single activity leisure, sport, culture and ecology, it is very profitable and highly sustainable, low or zero environmental impact, it is a "programmed alternative tourism", at high regulation and low intensity of flows but needs a local touristic system integrated, effective, diversified, as well as areas provided of a status of juridic protection of environmental type (MPA) and/or archaeological type (Parks), in according with a "culture of the territory", investment in protection policies and in making the territory more attractive with specific environmental brands (MPA). On the other side, the underwater archaeological tourism implies elevated costs for the users, limits the fruition and can generate a form of "gentrification". The question is: is it really a tourism for all?

In the UK a study into the economic impact of the historical wrecks diver trails was carried out to determine the number of visitors to the site, and how much each visitor had spent in the surrounding areas. The study aimed to understand the value of the protected wrecks in terms of the economy of the country and the well-being of the people, that is to say the principles of Faro Convention. In the period 2008-2012, considering 3 different sites, there was an increase up to 341%. In the case of *Coronation* Wreck Project, the study found that in 2012 alone over 700 visits were made to the wreck, generating £42000 worth of benefits to Plymouth: over £60 per visitor to the city. The study demonstrates that underwater historic wrecks can actually be a great benefit to local economies.

The success of any designated wreck diver trail can only be evaluated in the long term. Visiting, seeing and touching a real archaeological monument like a wreck site is without doubt a positive experience that can change people's perception of the UCH value. *Public access must remain a cornerstone of any underwater cultural heritage management strategy, a strategy that must receive long-term commitment from both the trail organizers and the heritage agencyes* (Beattie-Edwards 2016).

4. THE PROJECT UNDERWATERMUSE: THE CHALLENGES

Returning now to the initial question (*why UnderwaterMuse now?*), the project UnderwaterMuse could be, such as the Bluemed project and others, one of the responses, based on the principles of the Convention on the Protection of Underwater Cultural Heritage 2001 and the Faro Convention 2005. Furthermore, as far as the international cooperation is concerned, rule 8 of the Unesco Convention 2001 affirms that *International cooperation in the conduct of activities directed at underwater cultural heritage shall be encouraged in order to further the effective exchange or use of archaeologists and other relevant professionals*

The project UnderwaterMuse aims at applying on sample areas (maritime landscapes of Torre Santa Sabina, Grado, Resnik/Siculi, Caorle) a methodological and technological protocol based on research/ knowledge and development/communication of underwater archeological sites that are complex and multi-stratified, characterized by strong diversity. The project's objective is therefore to transform the site into an underwater archaeological park (or eco-museum) through innovative and/or experimental methodologies and techniques in order to try to reduce the loss of important cultural heritages as well as to guarantee an economic spin-off deriving directly from the creation of a sector linked to the tourist-cultural promotion of the context of reference.

UnderwaterMuse will target local communities as long-term keepers of vitality at tourist destinations, promote co-creative partnerships among tourism and cultural actors, public decision makers, creative companies, associations of citizens, facilitating exchange of information. An immersive Virtual Reality approach renders underwater sites accessible to a wider public, including people with different kinds of disabilities. Building capacity for professionals already working in this field will help them adapt to a "museum for all" concept, in spite of limited organizational or financial resources.

Two work packages particularly concern field activities.

The WP 3 foresees a recognition and analysis of the current state of underwater cultural heritage knowledge and valorization, and a subsequent summary comparative study (1 for each region). Furthermore, the WP 3 includes the involvement of local actors: diving guides, aspiring diving guides, tourist associations, museum curators, beach establishments owners, sailing clubs, local government representatives, MPA or CPA representatives, i.e. all the possible stakeholders.

It aims at adaping underwater cultural heritage tools for the whole partnership and stakeholders: first of all, are foreseen training activities on the use of Augmented Reality tools to recreate the experience of visiting underwater archaeological sites for people who are unable to access the site on their own (children, people with physical disabilities or those who cannot afford diving equipment/tours).

Secondarily, training on action planning and joint WEB GIS development will be delivered to the entire partnership and stakeholders

The process implies a primary selection of sites identified by partners jointly with their Regional Stakeholders Groups) based on joint methodology to be further developed on trans-national level to respond to regional gaps, followed by a study of interoperability with SIRPAC FVG and SIRPAC PUGLIA regional WebGIS. SIRPAC Puglia is the Geographic Information System of the Cultural Heritage of Apulia (Carta dei Beni Culturali – CBC), an instrument of the Regional Landscape Planning (PPTR); it has evolved since 2007 until now, reaching the third final phase.

It is an integrated information System that aims at representing and re-tracing through an interpretative attempt based on scientific data, the complexity and historical depth of the Apulian landscapes.

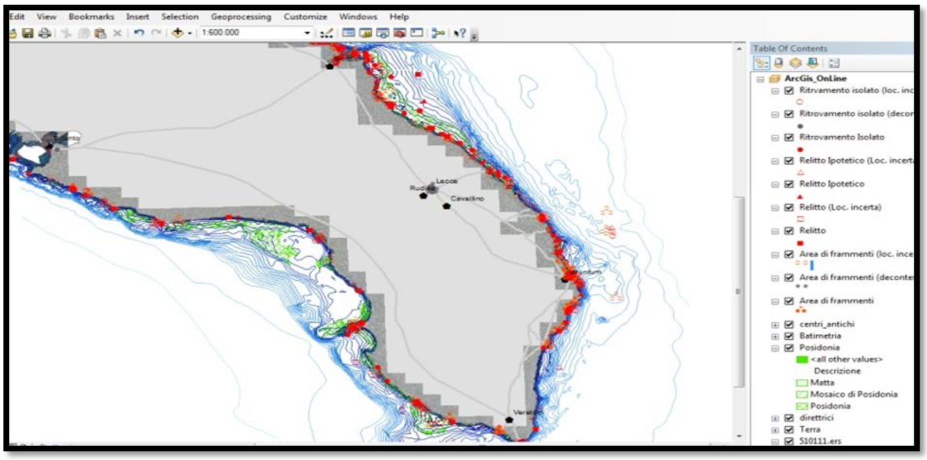

Fig. 3. Southern Puglia underwater archaeological map, integrated in SIRPAC Puglia.

Coherent with the spirit of the Regional Landscape Plan (Piano Paesaggistico Territoriale Regionale, since its inception the Map has been characterized by a holistic, stratigraphic and contextual approach to the cultural heritage, surpassing the traditional cataloguing models based on fragmentary and sectorial concepts.

SiRPaC FVG is the Geographic Information System of the Cultural Heritage of Friuli Venezia Giulia, constituted by a database of over 320.000 records and related webGIS, implemented in collaboration with Universities, Superintendence public and private institutions (www.ipac.regione.fvg.it/).

It is an instrument for sharing knowledge, of documentation for research and dissemination purposes, but also of efficient territorial *governance, protection and proactive valorization policies.*

The Informative system is a guarantee for the protection that must pass from defensive and proprietary to proactive and communitary, «from economically residual and supported to industrially affordable" (Montella 2009).

The WP 4 includes the preparation and implementation of two types of pilot actions:

- in the field of capacity building

Capacity building on AR-focused training material developed for museum experts to be held in Venice and Split; VR workstation will be realized in Grado, Caorle, Kaštela, Brindisi Museums.

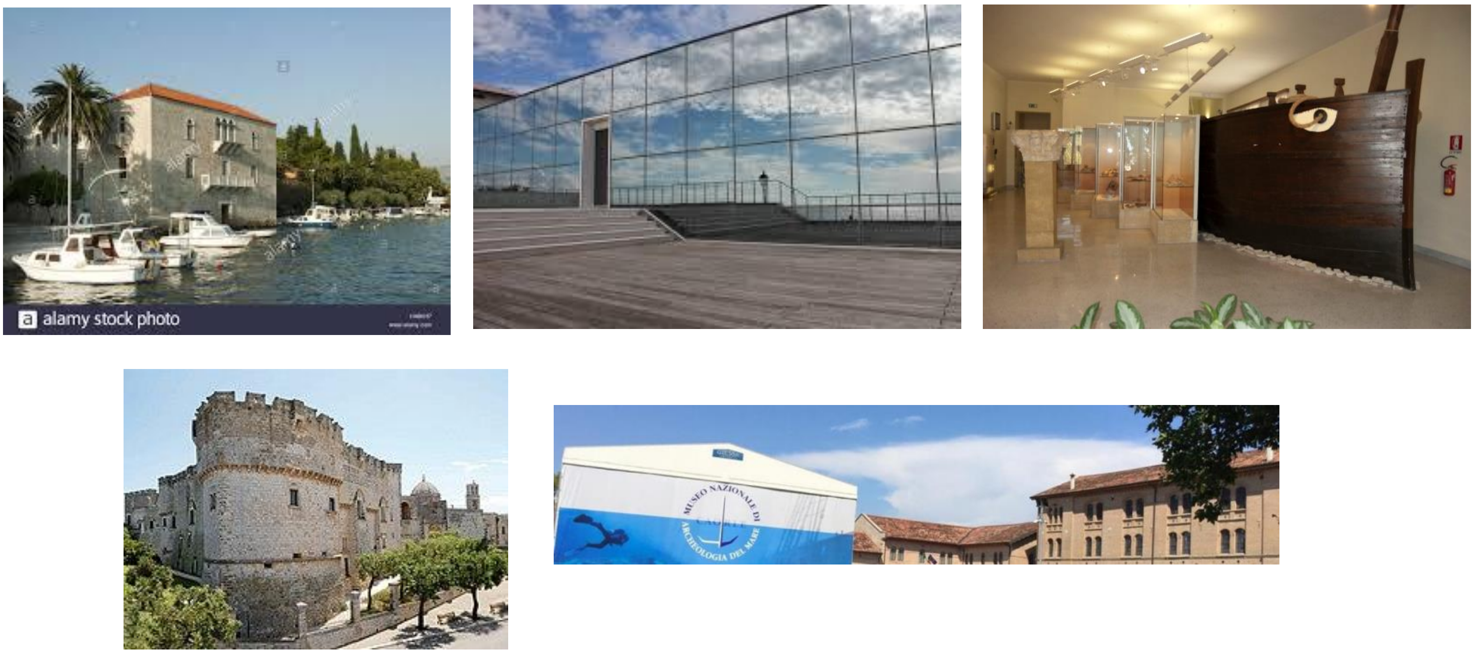

Fig. 4. Project UnderwaterMuse museums: Kaštela, Grado, Brindisi, Carovigno Caorle.

The technology is presented to museum experts at events, in Grado, Caorle, Kaštela and Bari. Stakeholders participate in the decisions regarding the organisation and location of the workstations in the museums where VR becomes available, bearing in mind their accessibility to tourists.

This peculiar pilot action will enjoy the benefits deriving from the established experience and competence in this field of Ca' Foscari University. Beltrame's staff at Università Ca' Foscari has recently produced a virtual dive on the shipwreck of the brig Mercurio (1812) from legacy data (Secci et alii, 2019) which has become a digital workstation in the virtual tour at the exhibition on the Mercurio excavation in the Museo Nazionale di Archeologia del Mare of Caorle, and has also produced various VR dives from 3D photogrammetrical models made on the cargos of marble of Roman age from Sicily (Balletti et alii, 2016) and Sardinia.

- *in the field of underwater cultural heritage valorization*

The project foresees diverse modalities of enhancement for the diversified cases/sites:

- the shipwreck Grado 2 (or another similar site, if the former is unavailable due to decisions of the new Superintendence): underwater steel cages for its exploration by divers and glass-bottomed vessels.
- the site of Torre Santa Sabina: "blue trails" that encompasses the landing site and exposed portions of shipwrecks, in agreement with Superintendence
  the site of Resnik/Siculi: photographed and mapped in 3D

Exhibition and educational activity programme will be developed for an interactive underwater museum. It is foreseen the dissemination and the collaboration with the schools, considering that children/teens require a different approach to Underwater Cultural Heritage from the rest of the public, but the needs vary considerably depending on age.(Claudino 2016).

Torre S. Sabina, 25 km to the north of Brindisi, is a real challenge for this project, because it's a pluristratified site, with very different evidences, some of them really fragile and vulnerable; first, some **wooden remains** of various shipwrecks, above all TSS 1 wreck, dated back to the late Imperial age (around 300 BC), that seems to be the most preserved hull of that period in the Mediterranean, with surviving stanchions, beams and significant remains of the deck; these wooden remains obviously can't be left without protection, exposed to the elements. Secondarily, the **stratigraphical sequence**, constituted by the overlapping of various cargos of the ships crushed against the reef and sank; these cargos were scattered at the foot of the reef, forming layers alternating with the natural sediments and with the materials dumped as part of the normal everyday activity of the landing place.

We can recognize 2 or 3 distinct sinking episodes, represented by the layers, from the deepest to the most superficial: 1. an archaic wreck, with Aegean amphoras and pottery, coming from Greece; 2. a Late Republican cargo, with local production (in particular oil and wine amphoras of Salento origin) and fine ware of eastern provenance, such as the batch of Megarian bowls. The identification of the deposit with the remains of a cargo is supported by three elements: 1) the position of the pottery finds, often upside down; 2) the high concentration of non-local pebbles in the upper layer ; and 3) the discovery of burnt wooden remains between the pebbles. 3. Finally, in some points, we have scant traces of a third cargo pertaining to the Late Antiquity (Auriemma 2014, Auriemma 2015, Bandiera et al. 2015, Antonazzo, Auriemma 2018).

Also Resnik/Siculi is a pluri-stratified and complex site that presents many affinities with Torre S. Sabina but it shows also an underwater structure of a stone jetty/pier presumably of the Hellenistic age (Babin 2011; Kamenjarin 2016).

Fig. 5. Torre S. Sabina. The underwater stratigraphy

4.1. The UnderwaterMuse pluri-stratified sites: which solutions?

How best to allow the visibility and fruition of such fragile, nebulous and difficult to read underwater evidences? How best to narrate the historical continuum and the waterscape evolution represented by those tenuous remains?

First of all, prior to carrying out the *in situ* protection practice, we should acquire a good knowledge of the different degradation processes and the environmental conditions. It is well known that stability, degradation and corrosion rates of the different materials depend on environmental marine conditions. Thus, shipwreck site formation and degradation are influenced by geomorphologic changes (shoreline erosion, regression, advancement, etc.), physical phenomena (currents, waves, etc.), chemical conditions (in water and sediment) and biological factors (see for example the project ARQUEOMONITOR: Izquierdo et al. 2016 with references).

The concept of managed visitor access via an underwater trail is not a recent acquisition. In the UK since the late 1990's, the trails have been experimented on various wrecks (the Needles protected wreck, HMS *Colossus*, in the Scilly Isles, Cornwall, the Norman's Bay Wreck, The HMS *m/A1* Submarine), with simple/plain but efficient means: an underwater information booklet guides divers around the site and some diver stations were established around the wreck to aid diver navigation (Beattie-Edwards 2016).

Also in Sicily a didactic booklet describing in detail all the underwater itineraries delivered by the Soprintendenza del mare (Sea Superintendence), with maps and sheets of the various sites, can be taken under water by the divers. The POIN Project Underwater cultural trails of the Sea Superintendence uses also more innovative tools, such as the UCH Fruition Interactive System (UG3K): the divers find, close to the evidences, a small buoy with an identification tag containing a chip; thanks to an underwater viewer with antenna, they can read a sheet with information and image (choosing the language, italian or english), like on a normal tablet. The viewers will be given free to the diving centers that will request them, by specific agreements with Port Authorities and MPAs. The project has also foreseen a web portal including all the itineraries, with sheets, video and news, as well as an app for smartphone and tablet.

An hypothesis for the pluri-stratified sites could be the replica of a schematic stratigraphic sequence in the museums of the partnership (Grado, Caorle, Kaštela, Brindisi Museums) and others, related to the same UCH (Carovigno Castle Museum)[50], but also under water, on the sea-bottom at the foot of the reef, with specific materials .

For the well-preserved Torre S. Sabina 1 wreck and the other wooden remains in the bay, that cannot be left exposed or uncovered, the best solution after the setting up of a passive protection system (barrows or strongboxes[51]; Negueruela 2000; Koncani Uhač et al. 2017), could be 3D models to enjoy with underwater viewers when the divers are on the site. In parallel, with other funds and institutional agreements, also the recovery and the restoration of the ship could be studied and planned, as well as the ship's physical replica construction.

The solutions are diverse and they can be tested on the diverse evidences: stratigraphy and archaeological materials in situ reproductions; signals, labels, tags and QR codes; 3D Viewers and tablets; ships replicas, etc.

We have to answer all these questions, but especially we have to think of the valorization of our UCH in a logic of economic, environmental and social sustainability.

4.2. At the end….

Joint methodologies and tools developed in WP3 are applied to the problems identified in WP3 and tested in the context of specific pilot examples in WP4. The information that derives from this process is elaborated in WP5 to generate draft action plans and a ToolKit to be used in future studies or projects of underwater cultural heritage valorization and improved accessibility. The transnational ToolKit synthesizes good practices on efficient underwater cultural heritage valorization and increased accessibility, responding to gaps revealed in the analysis phase, gained from the pilots and from other relevant experiences of partners and RSGs .

In other words, we would like to implement a replicable model of site management plan or programme capable to guarantee the sustainable use of the site and a vision for the future that implies the economic balancing of costs and benefits for society. This model should aim at promoting access and research, public education, efficient and continuous dissemination and experiential tourism. Moreover, it should identify risks for the site stability and conservation, proposing a policy framework of adequate measures.

An authentic site is a joy forever, as a monument for those associating themselves with its history, or its environment, as well as for the local economics of recreational and touristic visits.

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[50] In the Carovigno Castle Museum the permanent exhibition shows a replica of the stratigraphical section of the Torre S. Sabina sea-bottom with all the distinguished layers and the included archaeological original materials representing the overlapped dispersed cargos.
[51] Large metallic modular strong boxes, constituted by a framework to which independent plates are fitted, were used in the excavation of the Mazarron shipwrecks by the Spanish National Maritime Archaeological Museum and in those of the Zambratija wreck by the Archaeological Museum of Istria, Pula.

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MUSAS: an innovative project for the enhancement of the Underwater Cultural Heritage

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***Abstract*:** Substantial effort is required to effectively monitor Italy's underwater archaeological heritage, in order to protect and conserve submerged sites, and to enhance their importance and value. ISCR is therefore driving an innovative underwater heritage project. The MUSAS project started in 2017. Its aim is to develop an integrated supraregional model to monitor and enhance underwater archaeological heritage, in museums as well as *in situ*, in order to develop best practices that can be extended and deployed at other sites. It has three specific objectives:

1) The creation of a web-portal for the *Museo Virtuale dell'Archeologia Subacquea* where annotated images and 3D models will illustrate artefacts recovered from submerged sites and now housed in museums, and the underwater sites that are the focus of the project.

2) The implementation of an advanced exploration system at the submerged archaeological sites of Baia and Egnazia.

3) The development of a network of innovative sensors that can be deployed flexibly to monitor the environment, the condition of submerged sites and the location of divers.

A number of archaeologically significant locations in Southern Italy have been selected as test sites, in Campania, Puglia (Apulia) and Calabria. In this presentation we will give an update about the activities carried on in Egnazia (Puglia), Kaulonia (Calabria) and in the underwater park of Baiae, in the Gulf of Naples

Keywords: Underwater Cultural Heritage, *Baiae*, submerged sites, 3D reconstruction, virtual museum.

1. THE MUSAS PROJECT

The UNESCO 2001 Convention on the protection of the Underwater Cultural Heritage set new priorities in maritime archaeology, strongly emphasizing the importance of the *in situ* heritage protection and the need for new strategies for its enhancement; innovative projects are nowadays trying to develop shared guidelines and best practices to make easier and safer the enjoyment of cultural heritage in underwater environments, enlarging the public access and including, when it's possible, also people who cannot practice scuba-diving: a vast segment of public, hitherto excluded from the enjoyment of underwater heritage, or limited to a visit to the few dedicated museums or to the still very rare itineraries in coastal sites with transparent bottom boats.

The MUSAS Project (MUsei di Archeologia Subacquea. Tutela, valorizzazione e messa in rete del Patrimonio Archeologico Subacqueo [Campania, Calabria, Puglia]), with a funding of 3,250,000 euros within the PON "Culture and Development" programme, intends to promote the knowledge of the rich underwater archaeological heritage of Southern Italy through new technologies, favouring the fruition of underwater sites and finds, even remotely and in a virtual way, guaranteeing at the same time a constant monitoring.

For the ISCR – the Italian Institute for Conservation and Restoration, it is a new challenge in the field of marine archaeology, after the long experience of the NIAS, the Nucleus for Interventions in Underwater Archaeology established in Rome in 1997 and long directed by R. Petriaggi, that headed an exciting season of works on submerged sites, in Italy and, abroad, in Yemen, Oman, and Libya.

The MUSAS team, led by the current NIAS director, B. Davidde, creator of the project, has been carrying out since 2017 several underwater campaigns, in addition to the implementation of a big web portal (www.progettomusas.eu) and to the execution of a large 3D acquisition campaign, both in the selected sites and in the museums. One of the key-points of MUSAS, actually, is the creation of a Virtual Museum for the Underwater Archaeology, easily accessible by PC and mobile devices, in which the huge amount of data and images acquired in field missions will be shared; the users will be able, using their personal devices, or the *totems* installed in the Museums, to virtually dive in the sites, exploring the submerged ruins of *Baiae*, the port of *Egnatia*, the architectural remains on the seabed of *Kaulonia*; they will have access to accurate 3D models, but also to the reconstructions of spaces and environments in their original aspects; moreover, they will be able to explore a virtual gallery in which they will find the 3D models of a rich selection of underwater findings from the partner Museums: statues and altars, amphorae and anchors, freely scalable and rotatable in order to facilitate their analysis. The archaeologists will enrich the user experience, with detailed charts and explanations of the sites and artefacts, as well as with rich archives of materials for the needs of scholars and researchers. The biologists, on the other hand, will have the task of examining the colonization of ancient structures by marine organisms, in order to provide the tools for an updated assessment of the degradation and for a planning of conservation interventions. Lastly, the aspect of environmental monitoring will be considered with the deployment in the selected sites of a network of submarine sensors, functional to the verification of different parameters, but also to the location of divers: an innovative system that will make possible diving tours with the use of tablets perfectly operating and communicating, online, even underwater.

2. THE SELECTED SITES

2.1. Baiae

Baiae, the luxury thermal Roman resort condemned to submersion by the Phlegraean bradyseism, is a very evocative place for the Italian underwater archaeology: it was the theatre of the first underwater explorations in a submerged structure by N. Lamboglia, just after the pioneering campaigns of Albenga, and quickly became a site of excellence for the experimentation of new excavation strategies, documentation, protection and enhancement of the underwater cultural heritage.

The MUSAS project is operating in two different sites within the complex of the ancient *Baiae*. The first one is the magnificent *nymphaeum/triclinium* decorated with sculptures that was part of the palace of the Emperor Claudius (ZEVI 1983), and which today lies underwater not far from the tufaceous promontory of *Punta dell'Epitaffio* (fig. 1). The archaeologists are at work to document and register the state of conservation of the walls and of the sumptuous coverings, but also to better understand the architectural characteristics of the monument, that was repeatedly subject to works and rearrangements during its long history before the submersion; the detailed 3D survey of the entire site has already been completed during the first season of the project, and will soon be available on the dedicated portal together with the 3D interpretative reconstruction of its features at the time of Claudius.

Fig. 1: The *Nymphaeum* at Punta dell'Epitaffio, in *Baiae*

The second site in *Baiae* selected for the MUSAS Project is the gigantic *Villa dei Pisoni* (fig. 2) (DI FRAIA, LOMBARDO, SCOGNAMIGLIO 1988, DI FRAIA 1993, LOMBARDO 1993, SCOGNAMIGLIO 1997) and 2002, whose *viridarium* surrounded by a portico marked by niches and half-columns is today one of the favourite destinations for a large number of divers. The villa, which takes its name from the *Calpurnii Pisones*, who were responsible of a conspiracy against Nero and related to the owners of the magnificent *Villa dei Papiri* in Herculaneum, extends over a large area close to the *lacus Baianus*, the ancient port basin today entirely submerged but once surrounded by piers and arches, *villae maritimae* and palaces. In this case too, the archaeological study and the realization of 3D reliefs will allow to offer to the public the use of a complex and stratified site, and to the archaeologists the tools for a new understanding of the articulation of the villa and of its various construction phases.

During the underwater researches, the work of 3D acquisition of a rich selection of artefacts from the Archaeological Museum of the Phlegraean Fields has already been completed: over sixty models, mostly sculptures, discovered in the Gulf of Pozzuoli and rich of stories and connections with the intense life that was led *in amoenis Baiis*, between the villas of the most important figures of republican Rome and the sumptuous palaces of the emperors, from the Julio-Claudian dynasty onwards.

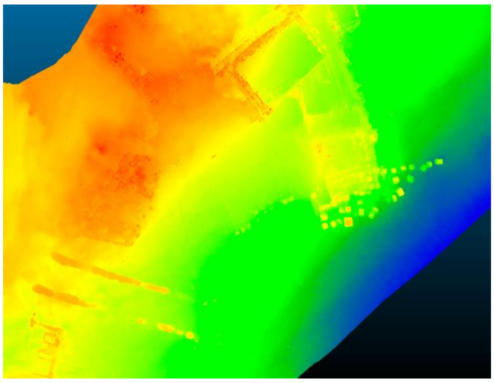

Fig. 2: MBES of the *Villa dei Pisoni*, in *Baiae*

2.2. Egnatia

Before the acropolis of Egnatia, towards the sea, there are important evidence, including rectangular carvings into the rock attributable to burials and underwater remains interpretable as a roman harbor.

The first scientific investigation of the Roman port, especially with aerial photos and echosounder, are due to S. Diceglie (1972, 1981, pl. II, 2002). An analysis is also present in Vlora (1975, pp. 56-61, figs. 35-39). Diving and surveys were carried out in 1979 and 1994 by A. Freschi, (FRESCHI, ALLOA 1979-80, pp. 60-65 and p. 134; FRESCHI 1980, pp. 450-455, and 1995, pp. 141-143). A picture of what it was known in the early 1980s is due to Andreassi, Sciarra-Bardaro (1982, pp. 107-118). More recently R. Auriemma (2003, pp. 77-97 and 2004, pp. 15-16) has definitively established the type and the construction techniques.

The northern part of the port has preserved optimally two huge *pilae* (a type of structure that was widespread in the Phlegraean area: GIANFROTTA 1996, p. 71) distant three meters from each other. This work in concrete piers, thrown into water within watertight formwork according to the Vitruvian canonical directions, possessed originally a wall facing in *opus reticulatum* and corners in *opus vittatum*, visible today in the exposed part only in negative.

Along the ideal line of this north side there are also some elements of collapsed *pilae*, always constructed in *opus caementicium* with traces of *cubilia* on the cement mortar.

Compared to these remains, the southern part, probably a pier, is more recognizable. It is a construction made of *opus caementicium* with several superimposed levels, the base of which rests directly on the rock (Auriemma 2003, pp. 81-85).

A series of comparisons suggests a building date for these structures between the end of the Republican and beginning of the Imperial ages. Some experts do not rule out that the construction of the port of Egnazia should be attributed to *M. Agrippa*, *patronus* of the *municipium*, as attested by an inscription, now lost, whose *terminus ante quem* is 38 BC (CIL IX, 262 = EDR026582). All this is framed, in fact, with the strategic position of *Salento* coast as part of the war between *Octavianus* and *Antonius* and the role of *Agrippa*, commander of Octavian's fleet.

Thanks to the MUSAS project a series of discussions could be carried on the Roman port, both at the level of archaeological and historical research. Firstly, following an analysis of the submerged structures with specific SAMAS card (analytical record card for submerged archaeological artifacts, see Petriaggi, Davidde 2005), has been chosen one of the northern side *pilae* to be able to carry out an investigation of the foundation which has allowed to reveal, concealed from the sand, a few rows of *opus reticulatum* perfectly preserved. The excavation yielded ceramic fragments relevant to types and different chronologies, documenting the intense life of the harbor (fig. 3).

Fig. 3: The underwater cleaning of a *pila* in *Egnatia*

Historical research on the port is also directed to the post-classical sources, often bearers of fundamental information. An examination of medieval nautical maps revealed that Egnazia, cited as *Annaso*, *Anazzo* or *Adanazzo*, often appears near Brindisi as a minor port place since at least the fourteenth century. In fact, in the middle age the ancient city was not completely abandoned: in the acropolis it was built a Byzantine fortress and, later, a fortified town with a tower (CAMPESE, CAGGESE, CUCCOVILLO 2012; CASSANO, CAMPESE, CUCCOVILLO 2015) and it's possible that the old port retained, in some circumstances, a certain functionality.

The archaeological activity was not, of course, just diving. The MUSAS project includes scientific cataloging of finds from the sea of the affected areas. They have been so identified, at the National Archaeological Museum of Egnazia, a number of objects, some of which are of the greatest interest, which have been subjected to 3D relief for exposure within the Virtual Museum.

2.3. Kaulonia

The ancient Achaean colony of *Kaulonìa* (Kaulon) was partly identified with modern town of Monasterace, on the Calabrian Ionian coast between the provinces of Reggio and Catanzaro (Orsi 1891 and 1916). The whole stretch of coast in front of it, from a geomorphological point of view, is changing a lot, due to heavy subsidence and eustatic phenomena that generate an unstable tectonic (GUERRICCHIO 1987, pp. 44-47; D'ARRIGO 1959, p. 60). These have led, over the centuries, to the disappearance of important underwater archaeological evidences related to the Greek colony, identified thanks to thirty years of underwater surveys by the team of Kodros, coordinated by S. Mariottini. Among the Doric temple and the Assi river were found more than 200 stone construction elements with various functions, some of which are clearly not finished (fig. 4). The discovery in the area of two limestone mooring bollards has permitted to hypothesize the presence of a workshop specialized in the processing of building material, presumably located near of a port channel now disappeared (IANNELLI et al. 1993[a]; IANNELLI 1993[b].). According to ancient sources in this area was located the famous *Cocinto* promontory, which *Plinius* the Elder defines as very pronounced (N. h. III, 95): *«Cocynthum, quod esse longissimum ltaliae promunturium aliqui existimant»*. This evidence is now less noticeable precisely because of geological phenomena above described.

Fig. 4: Underwater architectural remains in *Kaulonia*

Underwater it was also found important evidence of more recent times, such as four cast iron cannons dating from the seventeenth century. They may be related to the important phenomenon of Barbaresque ships privateering or to productions of the nearby Stilo furnaces.

The MUSAS project, in addition to detect in three dimensions the underwater artifacts, is handling the cataloging and 3D modeling of many objects recovered from the sea in front of the Greek city and now preserved in the nearby Archaeological Museum of Ancient Kaulon. Among them, many relevant elements of nautical archeology, as anchors of various ages and components of board equipment.

2.4. Kroton

The jagged coastline of Crotone is historically favorable to navigation. Especially Capo Colonna, the old *Lacinium promunturium* (*Strabo, VI, 1:11*), had a considerable importance for the ancient sailors and is quoted by different sources, especially for the presence of the sanctuary dedicated to Hera Lacinia (*Plut. Pomp., XXIV, 6,* describing it as one of the *asyla* of universal fame*; Liv. XXIV, 3. 3*: *sanctum omnibus circa populis*).

The city of Crotone, an Achaean foundation, was a busy port at different times (Severino, 1988).

Despite its fame as fundamental points for sailors, however, the sea in this area is not easy navigable: the coast is characterized by the widespread presence of rocky outcrops, which often have returned evidence of shipwrecks of different times, with a concentration hard to find in other traits of Italian sea (Medaglia 2008, 2010).

Because of these features, the MUSAS project focused primarily on the cataloging and on the 3D survey of the underwater archaeological finds preserved at the National Archaeological Museum of Crotone and those presented in the National Archaeological Museum of Capo Colonna. It was also decided to document, on a preliminary basis, a little-known wreck identified in 2007 in Capo Bianco and characterized by the presence of cast iron cannons (fig. 5).

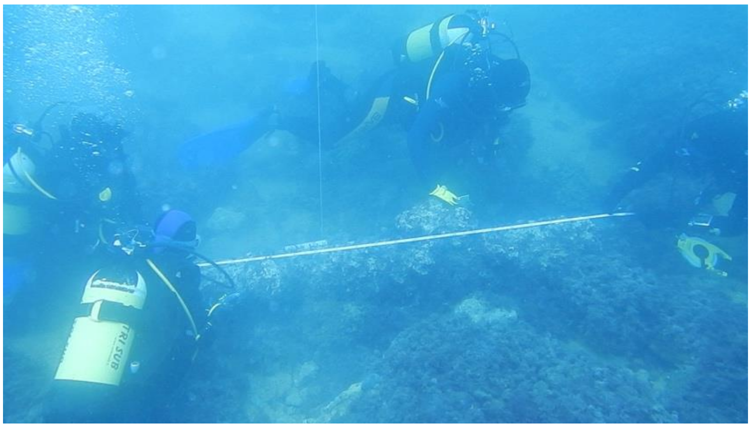

Fig. 5: Underwater documentation of a cannon in Capo Bianco

3. THE TECHNOLOGIES

The activities of the MUSAS project provide advanced operations for documentation and exploitation of submerged archaeological sites and will remain stored up in the various participating museums, with 3D underwater reliefs usable with VR visors and 3D digitization of artefacts. The ISCR has selected the company 3D Research srl, a spin-off of the Department of Engineering Mechanics, Energy and Management (DIMEG) of the University of Calabria, specialized in this type of activities. The 3D surveys use high-resolution data obtained from photogrammetric techniques and the latest acoustic technologies for generating micro-batimetric maps, in order to obtain a three-dimensional representation of the underwater scene that combines the resolution of the optical sensors with the accuracy of the acoustic type techniques for bathymetric surveys. The methodology allows to have a complete representation of the submerged archaeological site where the artifacts and structures of archaeological interest are accurately georeferenced (BRUNO et al. 2016[a]; BRUNO et al. 2016[b]; LAGUDI, BIANCO, MUZZUPAPPA, BRUNO 2016).

The Sonar Multibeam (MBES), usually used for the generation of bathymetric maps in archaeological contexts, allow to scan large amounts of data over long distances and with low visibility too, but the results are influenced by a low resolution and lack of color information. The optical systems, in contrast, are more suitable for short-range acquisitions and allow to obtain high-resolution 3D data, accurate and textured, but the final product is affected by the underwater visibility. Therefore, the integration of 3D data acquired from these two types of systems turns out to be an excellent technique in underwater applications, since it allows to reconstruct extended and complex scenes in a relatively short time. One of the techniques used for georeferencing provides the positioning, inside the archaeological site, of special optical-acoustic markers, specially made, through which it is possible to unambiguously assign precise spatial coordinates to certain points of interest (position of objects, perimeter of the archaeological site, etc.) according to a local or global reference system.

Downstream of the acquisition process, the optical-acoustic dataset is processed using the most modern techniques, both photogrammetric that computer vision, in order to generate the optical-acoustic georeferenced 3D model of the investigated archaeological site. Independently from the particular technical and technological solution adopted in each stage of the process described, the idea at the basis of the methodology developed for the generation of 3D models of multi-resolution underwater archaeological sites, consists in obtaining a low-resolution polygonal mesh (in the order of tens of centimeters) from the general acoustic bathymetry of the underwater site and surrounding areas, which will be superimposed HD models (at sub-centimeter resolution) of the areas of greatest interest of the underwater site, through a merger that makes imperceptible to user the junction between the two models. The generated 3D model will be finally texturized through HD textures obtained by processing images acquired during the optical survey and appropriately mapped on the model itself (fig. 6).

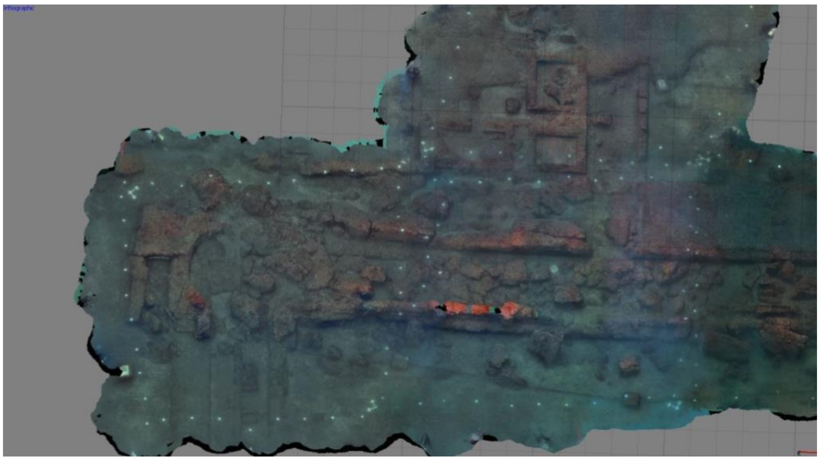

Fig. 6: 3D model, texturized, of a part of *Villa dei Pisoni* in *Baiae*

The 3D digitization of archaeological sites takes place through three-dimensional photogrammetry and laser scanner. The reconstruction method involves two basic steps: the optical acquisition, performed by photography, and the real reconstruction, realized through various software as Agisoft PhotoScan and Blender (Gallo, Muzzupappa, Bruno, 2014, pp. 173-182).

As part of the MUSAS project the enjoyment of these data can take place in two main ways:

- at involved museums, through the use of VR visors and PC. In this case the level of quality of the 3D rendering may be benefited at the top, allowing almost realistic visual experience.
- Remotely, via the website www.progettomusas.eu, to consider the MUSAS project portal a real Virtual Underwater Archeology Museum.

For its implementation it was first launched a worldwide cataloging of all websites developed by various underwater or nautical archeology museums, to understand how new technologies are implemented in this specific field (it was used the DB Symphytum, freeware and open source software, written in C ++ and Qt, for Windows, Linux and MacOS (https://github.com/giowck/symphytum#symphytum). At the same time we have set up a graphics project that could offer to end user a proposal integrated communication at all levels (fonts, logos, project colors, panels, etc.). The MUSAS website uses a CMS (Content Management System) very popular as WordPress, which make WebGL extensive use, a native web technology that doesn't require plugins, completely open source. WebGL takes advantage from graphics chip devices and therefore can offer scalable performance on various hardware typologies, from smartphones to better performing PC. It also allows high performance VR visors to offer virtual augmented reality experience without applications download.

In this mode it will be realized an interactive multimedia exhibition process, able to best describe cultural submerged heritage through surfing the immersive virtual reality sites and through stereoscopic viewing of individual artifacts captured and contextualized, where possible, in the site of origin.

But it will be possible also to enjoy a range of information directly immersed in three archaeological sites involved in the project. This will be through the implementation of an increased exploration system based on the use of special underwater tablets, integrated with inertial navigation systems and acoustic localization. These devices will provide information to enhance the visitor experience. The divers will know, in fact, its position within the site, will receive information about points of interest, depth and dive time. The underwater positioning system, which compensates the absence of the GPS signal underwater, integrates an acoustic communication system based on the installation of four beacons, an inertial platform, a magnetometer and a depth gauge. This is a completely innovative solution and opens up the use of these systems also to non-professional divers.

4. THE BIODETERIORATION OF UNDERWATER ARCHAEOLOGICAL ARTEFACTS

The fulfillment of the Virtual Museum of the Underwater Archeology allows the knowledge of the Underwater Cultural Heritage of the Southern Italy and includes a virtual tour of the marine sites in which the selected remains still lie to explore the underwater archaeological artefacts and to know the biological aspects involving the ancient materials during their underwater life.

The submerged structures can be a growth substrate for countless living forms from the first moment of their permanence on the sea bottom. The marine microorganisms and organisms interact with them temporarily or permanently and establish different relationships connected with their specific ecological needs. The epilithics – that grow on the surface - and the endolithics - are able to produce cavities and tunnels inside the substrata, both microflora and animals, settle on artefacts causing degradation processes, generally defined *bioerosion*.

The substrates with carbonate composition, often used for the construction of ancient statues, mosaic floors, columns and architectural structures, represent the stones most subjected to bioerosion processes in relation to the ability of the biodeteriogens to solubilize calcium carbonate by acidic metabolites produced by themselves (RICCI et al., 2013; 2015; 2016a; 2016b; SACCO PERASSO et al, 2015). This deterioration may occur with different levels of dangerousness depending on the degradative capacity of the biodeteriogen, the lithotype, the depth, the microenvironmental features of the site and above all the exposure time. The biological colonization is very heterogeneous, including striking forms that cannot be necessarily harmful for the artworks, and microscopical forms able to exert a considerable damage. The purpose of this biological study is to present to the big public the complexity of the ecosystem artefact/environment and to highlight the biological damage. The Virtual Museum shows the three underwater sites, Baiae, Kaulonia and Egnatia, offering an articulate and exhaustive view of the biological problems linked to the variety of substrates and artefacts and the different laying conditions.

Baiae, with mosaic floors and walls still in place (Figs. 7A-B), preserves a peculiar floristic and faunistic richness. The mosaics, mainly made of calcareous tesserae, sometimes polychrome, are a good example of the high damaging role played by endolithic micro and macroorganisms, such as sponges and bivalves (Fig. 7C).

Kaulonia is a site characterized by alternating phases of coverup and uncovering of the submerged column drums and the semi-finished blocks made of calcarenite (Fig. 7D). This environmental condition represents a limiting factor for the development of majority of biodeteriogens selecting only the organisms able to survive. The artefacts are therefore involved in the degradation processes, mostly due to the bioerosive action of endolithic bivalve molluscs.

Egnatia preserves two long and imposing cement-based piers (Fig. 7E) showing a dense biological colonization with epilithic algal felts and coloured encrustations, not particularly harmful for colonized substrates.

Species descriptions, their ecology and role in degradation processes will be reported in dedicated sections of the web site, guiding the visitor to the discovery of this "invisible" submerged world.

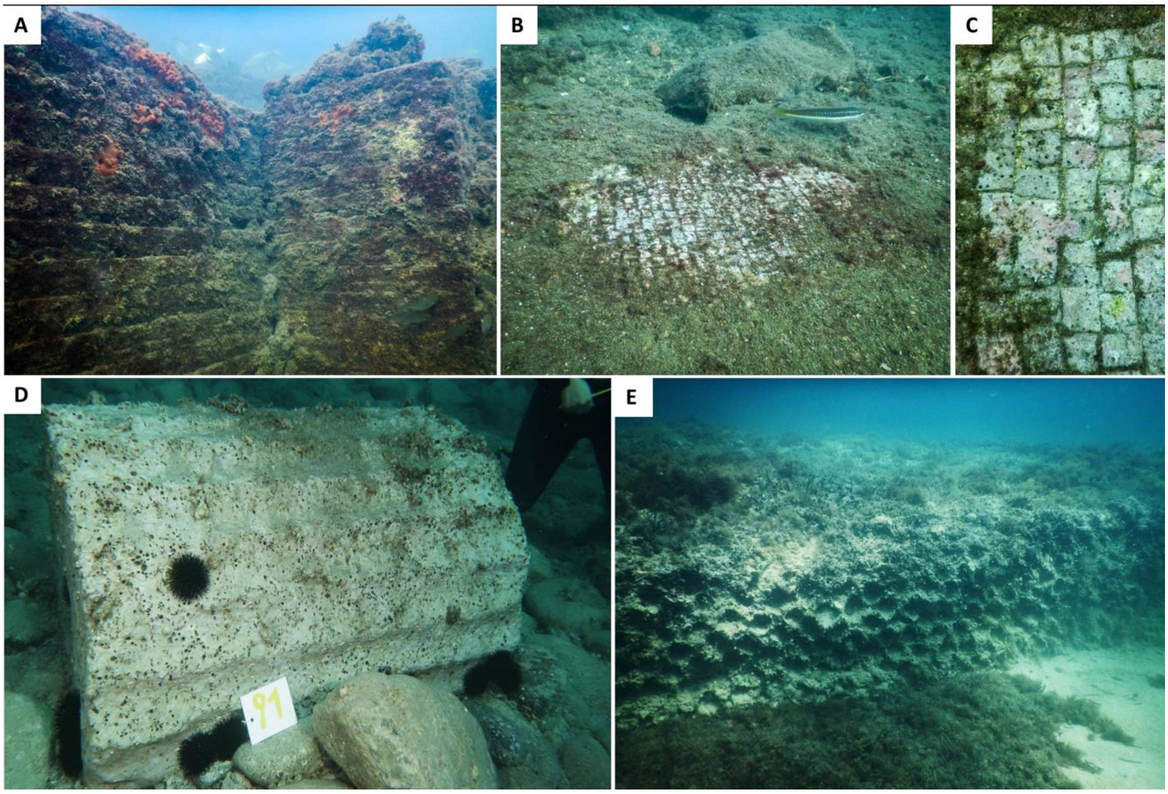

Fig. 7: Biodeterioration in the MUSAS sites

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Linking WWI and II Underwater Cultural Heritage to Sustainable Development in the Mediterranean: An Integrated Participatory Strategic Planning Approach

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Abstract**:** Of the millions of historic wrecks that scatter the ocean's floors across the world, those from the 20th century form a valuable part of our shared Cultural Heritage (CH). The Underwater Cultural Heritage (UCH) of WW I and II represents the dramatic events marking the history of the past century. The lessons learned from them are significant to our European identity, and its principles of peace, safety and freedom. Preserving and promoting these principles involves linking the UCH with their associated memories, both of which are threatened to loss.

Preservation of European WW I and II UCH has many diversified challenges in different coastal & maritime regions. The Mediterranean region, as a hot spot with respect to climate change, urbanization, pollution and tourism, creates specific challenges and threats to these types of UCH. Today WW I and II UCH in the Mediterranean area is: endangered and not well explored, researched and protected; fragmentarily exploited largely ignoring social, ethical, historical, cultural and environmental CH values of the respective regional settings; lacking an integrated management of tangible and intangible, land and maritime, CH to understand their full narrative; challenged by a lack of participatory governance, engaging a range of decision-making bodies and stakeholders for its preservation and sustainable management. Motivated by a WW II UCH case study in Greece (Leros island), the paper addresses these challenges and threats and the necessity these to be overcome in order to link this UCH to sustainable developmental future pathways that ensure its preservation.

Keywords: Underwater Cultural Heritage Preservation, Mediterranean Region, WWI and II, Scenario Planning, Strategic Planning, MSP, ICZM, Cultural Tourism

1. INTRODUCTION

Globally, there is a large number of World Heritage sites located in terrestrial and coastal areas, with established sustainable management plans that integrate concerns of both Sustainable Development and Climate Change into their approach so as to preserve and enhance these sites (UNESCO-WHC 2006)(UNESCO 2015). Most of these sites serve as major tourist attractions and, given their status, there has been extensive research with regards to their protection/preservation along with local development planning for their exploitation (Makuvaza 2018). Surprisingly, there are no Underwater Cultural Heritage (UCH) sites with this label in the Mediterranean region, despite the wealth of commercial and cultural interactions through its sea-roads, which go back at least 5,000 years and are witnessed by some of the most world famous ancient and modern-day wrecks (eg., for Greece: Antikythera and HMHS Britannic). Tangible wrecks and submerged artifacts/structures from inhabitations or use of Mediterranean coasts are strongly linked to both past or modern-day intangible maritime and island traditions (UNESCO 2001).

During the 20th century, the Mediterranean region played a major role in WW I and II as a scene of many war operations due to its strategic geographical position, economic importance and role in protecting national borders and sovereignty. As a result, thousands of wrecks related to this era are scattered along the Mediterranean sea crossroad of three continents (Europe, Africa, and Asia), and most of this UCH, along with their related stories, is largely unknown to the general public (Argyropoulos and Stratigea 2019). These wrecks have the potential to serve as an Open Museum of European identity and history, since their narrative marks all nations' struggles as well as a commemoration of the events leading up to the founding of its Union (Timmermans, Guerin, and Arturo Rey da Silva 2015).

The UCH in the Mediterranean has to deal with problems and risks emerging from the marine environment of this landlocked sea that act in unison over time. Additionally, Mediterranean WW I and II UCH are confronted with unique challenges as opposed to other types of UCH, so as to address its protection/preservation needs. The paper describes the complex issues specific to this type of UCH in terms of its protection/preservation, including exploitation under the current national, European, and international legal and policy frameworks. Furthermore, an interesting WW II UCH case study area in Leros, Greece, is highlighted, which could serve as a potential diver accessible underwater museum or marine park as an initiative for implementing the EU Blue Growth strategy.

2. WW I AND II UCH IN THE MEDITERRANEAN - PROTECTION, PRESERVATION, AND RELATED POLICY CONTEXTS

2.1. The Mediterranean Context

Along its coast, the Mediterranean region is marked by numerous environmental 'hot spot' areas due to major impacts of intense global challenges, such as Climate Change (CC), demersal fishing, ship traffic to name a few (Giannakopoulos et al. 2009)(Stratigea, Leka, and Nicolaides 2017). At the same time, it has some of the oldest underwater living organisms, the P. oceanica, which is the most widespread sea grass meadow in the Mediterranean and is considered protected natural heritage in most countries (Fourqurean et al. 2012). This natural heritage acts as a carbon sink, reducing greenhouse gases and carbon dioxide emissions from the atmosphere, but also helps to preserve submerged archaeological and historical remains (Krause-Jensen et al. 2019).

Within this setting, there are thousands of wrecks from the events surrounding WW I and II. During WW I, the famous naval battlefields, the Battles of Gallipoli and Otranto Barrage, are evidenced by its associated marine sites in Turkey and Croatia respectively, incorporating hundreds of wrecks related to this period, many of which are diver accessible (Timmermans, Guerin, and Arturo Rey da Silva 2015). There are also famous shipwrecks related to naval tragedies of this period in Greece, such as the HMHS Britannic and the SS Burdigala in the deep waters off the coast of Kea island (Thoctarides and Bilalis 2015).

In contrast to WWI, the WW II period (1939-1945) was marked by extensive naval warfare and military operations that took place in both the Pacific and Mediterranean Theaters, and thousands of war vessels of different flag nations can be found at the sea bottom, such as ships, aircraft, submarines, U-boats, as well as other war-related remains (Veronico 2015). The Mediterranean UCH of this period can be found in marine sites all over near the shores in Croatia, southern France, Greece, Italy, and

Malta, including North Africa, which are remnants of famous battle scenes, and memorials or graves commemorating maritime disasters. The narratives of many of these Mediterranean battlefields are unknown today, even though military historians have argued that the Mediterranean Theater of WW II played a significant role in the Allied victory in Europe (Porch 2004). These WW II marine sites are linked to famous battle scenes, such as 'Operation Dragoon'(Zaloga 2009) on the southern beaches of the French Riviera (August 1944), 'The Battle of Leros' (November 1943) (Mentogiannes 2004) on Leros island in Greece; and are serving as memorial or graves, commemorating huge casualties of prisoners during the war, e.g. SS Oria, and/or holding iconic status for a nation, e.g. RHNS Vasilissa Olga for Greece (Thoctarides and Bilalis 2015).

Today, many WW I and II locations in the Mediterranean are popular diving destinations due to the warm and clear waters, and often underwater WW I and II wrecks are visited, such as legendary WW II wrecks along the Corsican shores ("11 of the Best Wreck dives" n.d.), and the many diving sites in Greece (see Figure 1), but often the story behind the wrecks are unknown. Also, diving visits are rarely organized with guidance by national/local authorities – so that divers' access of such sites is at their own risk and/or may ignore obtaining the necessary permits to visit such sites.

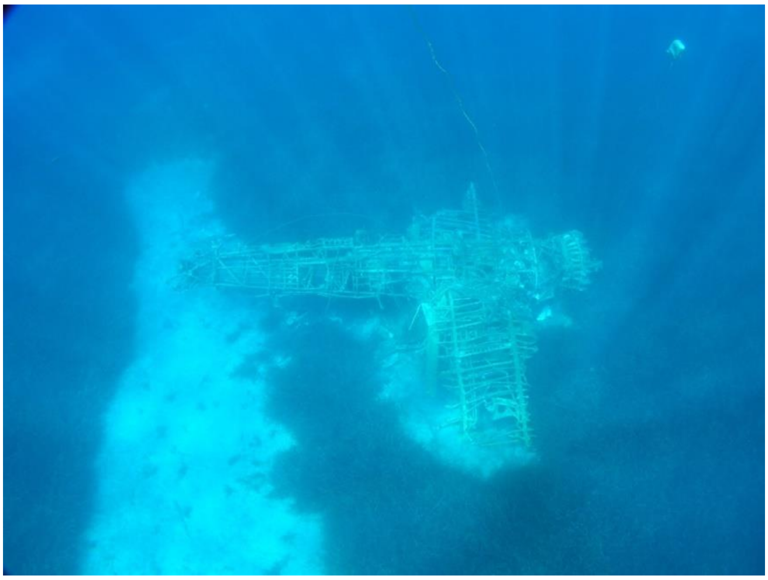

Figure 6: German WW II "Arado 196" crashed on September 17, 1943, location Iraklia island, Greece at 11 m in depth (photo credit: P. Nikolaidis).

2.2. Protection Framework

Very few countries have national laws protecting WW I and II UCH. The US and other maritime powers, such as Japan, Netherlands as well as others have made formal statements upholding the notion of sovereign immunity of their sunken warships, regardless of which maritime zone they are located in (Browne 2018). The 2001 UNESCO Convention on the Protection of UCH (UNESCO 2001) is an international framework instrumental in providing a definition for UCH and for linking such heritage to international laws related to the sea, such as the United Nations Convention on the Law of the Sea (UNCLOS) (United Nations Treaty Series 1982). More specifically, it outlines the cultural importance of 'State vessels' defined as warships, aircraft and other non-commercial vessels used by a state at war time. Furthermore, it goes beyond UNCLOS to set out the rights and duties of the coastal state and/or flag nation for the UCH according to their location, as defined by its maritime zone. Also, the Convention uses the rules of Charter on the Protection and Management of UCH (ICOMOS 1996) on the in-situ handling and management of UCH.

Still, there are some limits with the 2001 UNESCO Convention in that it only protects UCH older than 100 years old, which excludes WW II UCH. Furthermore, the issue of UCH ownership remains unclear in the Convention, since it was considered too complex from a technical and legal point of view to determine when a military vessel has abandoned its rights due to its sinking outside its waters (Strati 2006)(Browne 2018). Finally, issues on how to manage UCH that involve hazards from polluting or dangerous materials, which may be associated to these types of wrecks, are not detailed in UNESCO's provisions (Forrest 2012)(Browne 2018).

2.3. Preservation and Risk Assessment Issues

Apart from the issue of ownership/protection, preservation issues for WW I and II UCH are multi-dimensional and go beyond simply documenting the condition, site formation, and associated risks related to the wreck. Their marine surrounding environment is full of challenges for all types of UCH, with a range of both natural and anthropogenic risks, such as Climate Change impacts, storms, salvaging for metal and looting, demersal fishing, to name a few (Perez-Alvaro 2019).

WW I and II UCH are mostly made from either low-carbon steel (ships) or aluminum alloys (aircraft), which corrodes rapidly in saline water depending on the burial environment (Argyropoulos, Giannoulaki, and Charalambous 2015)(MacLeod 2019). The corrosion of metal wrecks from this era can, depending on their construction materials and containments, act as either a cause for marine pollution, i.e., a threat to the environment due to their containment of fuel (Russell and Murphy 2003); or as a beneficial factor, facilitating the formation of artificial reefs that colonize marine organisms and sea-life. In the US, researchers are using the WW II wrecks to examine how the marine communities change as ocean temperatures rise as a result of CC ("WWII Shipwrecks Swimming in Marine Life" 2011).

There are additional unique preservation issues for this type of UCH. First, they have varying interests/values associated to them including their remains, eg., for locals, coastal state, and/or flag nation, and as such can be regarded as 'dissonant heritage' (Kisić 2013). Second, this type of UCH is also associated with multi-source historical documentation, with narratives concerning its construction (design details), career (operational history), and sinking/crash. Thus, the varying values and narratives for this type of heritage is often associated with 'fragmented group histories', related to local, national, and even international groups (Papuccular 2015). The UCH and its remains can represent different stories for different groups, for nations about a victory or defeat, for ethnic minorities about deportation or execution, and for soldiers about escape, surrender or death. Third, there are often ethical issues concerning the access to or even handling of UCH with human remains. Finally, another unique challenge related to this type of UCH preservation is safety with regards to munitions and unexploded ordnance and their risks to diver safety (Delgado and Varmer 2015)(Browne 2018).

Thus, preservation plans for this type of UCH must be set up using a value- and risk-based prioritization framework, which considers a range of specific and unique assessment criteria, such as exposure to risks/vulnerability, environmental including CC impacts, values attached, ethical concerns, spatial attributes, just to name a few. It must use tools and technologies to support and promote the UCH preservation, such as mapping, documenting condition, monitoring changes, visualization, presentation etc. in a challenging environment – the marine one. Finally, it must also consider related policy contexts for marine/coastal activities that will also impact its sustainable management.

2.4. Other Policy Contexts and Related Issues for Sustainable Management of WW I and II UCH

Preservation plans for WW I and II UCH need to be in alignment with a variety of terrestrial and marine legal frameworks and related policies, since coastal land developments and/or sea use will impact them. Thus, policy making for UCH in a marine environment is more complicated than the one of Cultural Heritage sites in terrestrial areas. Specifically in Europe, spatial planning in the marine environment is outlined by the Blue Growth Strategy (European Commission 2012), along with relevant planning tools, i.e. Marine Spatial Planning (MSP) and Integrated Coastal Zone Management (ICZM) (Ehler and Douvere 2009). This has resulted in new perspectives for the sustainable exploitation of marine resources, which are capable of tackling developmental perspectives and related environmental impacts in oceans and seas. They can also prepare the ground for dealing with emerging conflicts or threats (e.g., fishing) and promoting synergies' creation among various stakes in the marine environment; while setting up an effective spatial delineation of maritime uses to the benefit of UCH protection.

Any sustainable management planning for WW I and II UCH will need to cope with threats and opportunities in this newly evolving marine environment, resulting in additional challenges. It is expected in the future that under the blue growth strategy, coastal and maritime tourism activities will become more intense with the use of the sea and coast for various recreational purposes. Here WW I and II UCH could serve such sustainable exploitation fulfilling 'glocal' (global and local) developmental objectives. Thus, a more integrated UCH management approach is required for conceiving UCH as a pillar for reaping economic and societal benefits.

To fulfill these local sustainable development objectives, UCH protection/preservation will have to move away from the 'silo' approach in the handling of such assets, traditionally represented by archaeological/historical and conservation norms to a more multi- and interdisciplinary cooperation in the UCH management field, involving experts, such as spatial planners, marine scientists, economists and other related professions (Nutley 2007)(Firth 2013). This multi- and inter-disciplinary research field also attracts the interest of a variety of stakeholders e.g., institutions, administrative entities, societal and user groups, bringing additional layers of complexity in management of this UCH. UCH governance implies horizontal but also vertical interactions among those involved in decision-making processes (Argyropoulos and Stratigea 2019). Horizontal interactions address linkages of UCH exploitation to coastal and land developments. Vertical interactions reflect the necessity for coordination among UCH policies articulated at different spatial decision-making levels (national, European, global). Design and enforcement of UCH preservation decisions is actually dispersed to a range of jurisdictions, with different and sometimes conflicting interests and perspectives; and at a variety of spatial scales, from local to global. This, coupled with the recently evolving paradigm towards an enhanced collaboration between public authorities as well as private actors and the civil society, renders UCH management a principally "cultural governance" topic.

3. INTEGRATED SUSTAINABLE MANAGEMENT APPROACH FOR WW I AND II UCH IN THE MEDITERRANEAN

Cultural governance is key for integrating the preservation of underwater historic environment to the pillars of (local) sustainable development for its management. Today, there is a heightened recognition of the importance of WW I and II UCH at various spatial scales (UNESCO, flag nations and coastal states, Europe) along with varying viewpoints (political, social, economic, cultural, environmental, technical and technological). This relates to the value attached to this heritage and the high risk of its loss, if preservation is not undertaken soon. This risk is due to its construction materials and the high salinity of the Mediterranean Sea. Protection, preservation, and sustainable management of UCH in the Mediterranean calls for addressing some critical issues, such as:

- The comprehensive registration and risk assessment of UCH for the specific conditions of the Mediterranean environment, taking into account CC impacts and incorporating them into UCH preservation plans for serving long-term historical memory and identity transmission.

- The development of a value/significance typology in support of policy making with respect to UCH protection/preservation in alignment with rational use of resources in this debt-ridden region.

- The integration of WW I and II UCH into coastal cultural settings as part of the Blue Growth Strategy, since they constitute remarkable cultural assets of local and EU/global importance and can add value to economic growth and social cohesion of such regions.

- The exploitation of UCH in alignment with the current trends and related policies in promoting the culture–tourism complex (e.g., Regional Innovation Strategy for Smart Specialization – RIS3), in order for sustainable pathways through experience-based and of low ecological footprint tourism products to be established, while supporting the exchange of new, meaningful and authentic tourism experiences.

- The current developments in the legislative context, which relate to the management of marine space that are in progress in the Mediterranean countries, coupled with relevant planning tools (Marine Spatial Planning – MSP and Integrated Coastal Zone Management – ICZM). These prepare the ground for dealing with emerging conflicts and promoting synergies' creation among various stakes in the marine environment; while setting up an effective spatial delineation of maritime uses to the benefit of UCH protection.

- The participatory governance towards UCH preservation and sustainable management, with a multiplicity of policy and decision-making bodies in charge in a variety of spatial scales.

There are examples of such Good Practice Guidance and sustainable management plans for WW II UCH in the Pacific theater (Van Tilberg 2017)(Jeffery 2017)(Viduka 2017). This region and its islands had the largest actions of naval warfare in WW II, impacting the indigenous populations. Based on these plans, this region is today one of the most popular tourist destinations for diving on the hundreds of WW II wrecks ("World's Best Wreck Dives: The Top 10" 2019). In 2010, the Bikini Atoll in the Marshall Islands was placed on the UNESCO World Heritage list, with its own sustainable management plan (UNESCO-WHC 2010). This site is a Pacific archipelago, where nuclear testing took place directly after WW II, resulting in many sunken wrecks as well as displacing its inhabitants in exile due to resulting radiation levels. Today, it is a popular tourist destination, but threatened by dramatic sea level rises from the impacts of CC. There are also efforts to nominate other WW II related sites and their UCH in the Pacific, e.g. Truk Lagoon, for the World Heritage label (Jeffery 2004).

Figure 7: Scientific examination by Ian MacLeod and team on the WW II US military aircraft 'the Emily' in the Pacific (photo credit: B. Jeffery, Earthwatch).

Despite the work in the Pacific including its UNESCO World Heritage site, there is still a lack of a commonly accepted and applied legislative framework, governing decisions as to UCH preservation and sustainable exploitation at the global or the EU/national level. Finally, policy making as to UCH preservation and sustainable exploitation lacks a coherent, value and risk-based preservation framework for setting priorities and effectively accommodating UCH preservation resources. Preservation and sustainable exploitation of this type of UCH has to cope with challenges that cut across a variety of spatial scales as well as diverse actors / stakes and power of these actors to influence the UCH status at various policy making levels (local, national, EU/global). Challenges at each specific level have as follows:

- Local level: communities are not engaged in understanding / valuing UCH, resulting in their damage from manmade actions (e.g. looting, salvaging for scrap metal and fishing trawlers); along with further challenges emerging from e.g. CC impacts on the marine environment.

- National level: there is a lack of a common and integrated policy framework incorporating all dimensions of UCH. Efforts up to now are usually fragmentary, dispersed to a number of formal policy making bodies, confined to legislative actions, mostly ineffectively implemented, and not fully integrating the MSP and ICZM dimension.

- EU level: there is lack of a common ground for coastal states on the protection and recognition of WW I and II UCH.

- Global level: WW II, as opposed to WW I UCH, is not covered under the UNESCO 2001 Convention.

However, there are international and some flag nation laws that protect the military sunken vessels and their remains, but many times there is no consistent practice in determining when a nation has abandoned a vessel, while the governing international laws can be problematic in their interpretation.

Thus, the sustainable management approach for this type of UCH needs to be driven by regional development and strategic planning structured by setting at its core a spatially defined, community-driven, value/people-centered, culture-based and locally adjusted management approach of WW I and II maritime (and land if relevant) CH (Koutsi and Stratigea 2019). Such plans must integrate in a sustainable way, tangible and intangible aspects of maritime and land WW I and II (U)CH into each cultural, social, economic, environmental, value dimensions.

4. CASE STUDY AREA IN GREECE: THE WAY FORWARD

There are thousands of WW I and II wrecks in the Greek seas, the majority of which carried a Greek flag, but they are also represented by other nations during the wars, such as Germany, Italy, and Great Britain to name a few (Dounis 2000)("WWII Shipwrecks in the Greek Seas" 2019). For these wrecks, there are databases of information with regards to the type of vessel, capacity, type of fuel engine, cause and year of wreckage, but only some have been located and mapped in the Greek seas ("WWII Shipwrecks in the Greek Seas" 2019). Unfortunately, immediately after WW II many of these vessels were sold and salvaged for scrap metal (Thoctarides and Bilalis 2015), such as the famous S/S Oria, which sunk off the island of Patroklos near Attica Region. There is even a case, where the WW I wreck HMHS Britannic was sold to a private owner in 1996 for 15.000 sterling pounds (Ioannidis 2016). Those that usually remain untouched till today are sunken vessels in deep waters (not reachable after the War) or submerged aircraft. Fortunately, since 2002 WW II UCH or UCH less than 50 years old are legally protected in Greece (Law 3028/2002: For the Protection of Antiquities and Cultural Heritage in General 2002).

Accessing these protected UCH sites implies the need for permission by either the Ministry of Culture or, if considered sovereign immunity, from the flag nation or Greek Ministry of Defense. Nonetheless, many diving centers take tourists to visit such sites in Greece, without any formal good practice guidance by national/local authorities concerning risks to and from these sites.

Figure 8: Inside the observation post/battery of the Farinata Battery on Mount Markelos in Leros island, Greece (photo credit: Mentogiannis 2004).

A good case study area is the small island of Leros situated in the Dodecanese islands, Greece, which served as a military naval base during WW I and II. Leros is strategically located in the Eastern Mediterranean, with large natural harbors and very deep waters, with the ability to host submarines. During the 20th century, Leros was occupied by the Ottomans, Italians, Germans and British, before becoming a part of the Greek state after WW II. The Italians had possession of Leros after WW I, which resulted in them spending 24 years fortifying it as a naval base with a range of important land remains in creating its base as well as a new model town using Italian rationalist architecture. There are also other cultural land assets related to this period, such as the famous gun emplacements/batteries (see Figure 3), tunnels/shelters, and the uniquely designed Patella telecommunications' center. During WW II, Italy fought with Germany, and Leros suffered bombing raids by the British Royal Air Force. Due to its excellent anchorage for war ships in its natural coves, it was the second most bombed island during WW II after Crete. On September 8, 1943, Italy came over to the Allied camp, resulting in British reinforcements arriving to Leros and other Dodecanese's islands. Leros suffered continuous German aerial bombardment, with one of the largest attacks on the Greek Naval flagship 'The Queen Olga'. The island was finally captured by the German troops during Operation Leopard, November, 1943 (Chant 2013), and remained under German occupation till the end of the war.

Leros is a volcanic island, with high visibility of sea waters to a depth of 30- 45 meters. In the bays around the island there are many WW II wrecks, depicting its role in this war. There are also numerous underwater caves. Based on the tangible WW II UCH and the natural underwater beauty, Leros is considered as a great diving destination, with good diving sites being the Queen Olga Destroyer at the port of Lakki; the Anti-Submarine ship in the bay of Partheni; and the wreck of German bomber Henkel-111 in the bay of Blefouti. WW II wrecks in the bays around the island lay in a depth ranging from 16 to 50m. Some UCH are in areas covered by prairies of Posidonia oceanic (5.5km) and coralligene (1.5km) (Geraga et al. 2013). The most famous is the Greek Navy Destroyer "Queen Olga" that served with the Greek Hellenic Navy. This was bombed by 25 Junkers Ju 88 bombers and sank in September 1943, killing 80 crew members, including officers (Mentogiannes 2004). Today, there is a monument in Lakki port in honor of this ship. There are also several museums, such as the War museum housed in a WW II tunnel, as well as military works from that time, such as buildings of coastal fortifications on the heights of the coastline and other military infrastructures (workshops, warehouses, magazines barracks etc.).

Research has begun in mapping these UCH sites (Geraga et al. 2013) as well as unburying the hidden land and maritime cultural potential of this island for heritage led local developmental paths (Koutsi and Stratigea 2019). More research is needed in devising a preservation framework for these wrecks and linking them to local development specific for this insular community. This paper describes some of the complicated issues that will need to be addressed when developing a sustainable management plan involving WW I and II UCH. Today there are new opportunities, e.g. in the tourism sector in coastal and insular areas in the Mediterranean, where sustainable and resilient exploitation of WW I and II UCH in this region can strongly be linked to alternative development pathways, e.g., dark/battlefield, cultural or diving tourism.

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Tourism experience in the Underwater Archaeological heritage site: managing emotional state to increase archaeological diving tourism in the Sunken City of Baiae

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***Abstract*:** Tourism experience focuses on tourist travel experiences that involve personal needs, from pleasure to a search for meaning (Rodrigues et al. 2016). Literature highlights the importance of experiential paradigm to manage effectively tourism destinations (Ritchie and Hudson, 2009; Morgan et al., 2010; Wang, Pizam, 2011; Neuhofer et al., 2012). According to this approach the tourist' decision-making process is not perceived as a purely cognitive process aimed at maximizing utility but as a more complex process, affected by sensations, feelings involving fun, fantasy and desire (Lagiewski, Zekan, 2006; Pike 2008; Ryan, 2010). As a result, there is an increasing attention to examine the psychology behind tourist experiences and on delivering unique and memorable tourism experiences (Ritchie, Hudson, 2009; Kim et al., 2012)

However, scholars have recently called for more research on the topic, while large empirical studies are still few (Kim et al., 2012; Chandralal, Valenzuela, 2015; Tsai, 2016). To contribute to fill this lack the paper presents an explorative analysis in the field of tourism experience in the underwater archaeological heritage site as the Sunken City of Baiae, where the archaeological diving tourism has been growing during last years. The aim of this study is to explore how visitors create their touristic experience, by acknowledging the role of feelings and emotions in the consumption process. In particular, we try to understand which are the key elements of an extraordinary, unique and memorable touristic experience. Results provide interesting insights on how divers create a memorable tourism experience, by identifying also different consumption profiles related to the diverse role of feeling and memories involved in the consumption process. This study also provides some suggestions for managers and policy makers to manage an underwater archaeological heritage site such as the Sunken City of Baiae, increasing its competitiveness as a touristic destination area.

Keywords: memorable tourism experience – underwater archaeological heritage – archaeological diving tourism.

1. INTRODUCTION

Emotions affect customers' purchasing and consumption process. They are indeed the ones that make us take a decision rather than another one, leading us during the whole purchasing process and to get us in action.

Consumers are not considered anymore simply "rational animals" but rather like "rational animals, emotional above all" (Schmitt, 2001). The irrational part has the tendency to prevail the rational one.

Today's consumer is looking for experiences, meanings and emotions rather than products. For this type of consuming, so called experiential, in opposition to the functional one, there is only one rule: give space to emotions.

Literature highlights the importance of experiential paradigm to manage effectively tourism destinations (Ritchie and Hudson, 2009; Morgan et al., 2010; Wang, Pizam, 2011; Neuhofer et al., 2012). According to this approach the tourist' decision-making process is not perceived as a purely cognitive process aimed at maximizing utility but as a more complex process, affected by sensations, feelings involving fun, fantasy and desire (Lagiewski, Zekan, 2006; Pike 2008; Ryan, 2010).

As a result, there is an increasing attention to examine the concept of experience in the tourism field and on delivering unique and memorable tourism experiences (Ritchie, Hudson, 2009; Kim et al., 2012).
The role of experience has always had a relevant role in tourism research and practice. Nowadays the consumers are ever more sophisticated: social, knowledgeable, demanding, and emotions seeker; we could say he is a traveller 3.0.

Travellers are searching real and unique experiences that are always different in each travelling. They don't want anymore to be simple spectators, but they want to be protagonists. That's a completely new approach to the travel, completely different from the past; the aim is not anymore the relax, but rather we travel to know, learn, have fun, experience emotions, to feel oneself as part of a group, to share, tighten new relationships, take part of any kind of activity, not necessarily sport, and last but not least, people travel to discover oneself, to come to know aspects never known before, cause we never challenged ourselves before, we travel to go beyond our limits.

Studies on the field are based on two main different backgrounds: the social science and the marketing/management approach (Mossberg, 2007). The first describes the touristic experience as a relatively meagre concept. The tourist is looking for new experiences that can help him escape from daily stress. Only this moment, when the tourist is able to escape, can be defined as "the peak experience" (Mossberg, 2007). All the rest, like accommodations, the visited places, restaurants and the setting offering the service influences their travelling, is not considered in the definition of touristic experience.

The second approach has a broader insight. The experience is considered as the whole of all the experienced moments, the emotions felt, all services and activities involved with the consumer during the travel. This concept is not focused only on the peak experience, furthermore this research topic states that the peak experience has only to be understood as out of ordinary dimension (Mossberg, 2007), namely is that cannot be forecast, that surprised us unexpected and in a positive way. In this study we focus on the marketing/management approach that better manages to explain the concept of touristic experience: a wide and complex concept that cannot be reduced only to a single moment. If the accommodation and other missing support services have been considered low in quality standard, nevertheless the visited places are much better than expected, the visitor could experience huge dissatisfaction that will affect the overall final evaluation of the travel experience.

According to Mossberg (2007) there are three factors that influence the mood and, therefore, the tourist satisfaction during the experience:

1. Physical Environment
2. Personnel
3. Other tourists, the other tourists who share some moments of the experience

However, the focus is not on "consuming" but rather on "consuming experience". This is the experiential marketing, which is based on the prerequisite that the consumer is not always rational, but the emotions play a key role during the purchasing process. In this perspective the experiential marketing does not focus on the physical and functional characteristics to attribute to a product, but rather on the customers, on their desires and their emotions. It is all about the consumer. It is not only the quality of a product that affects their behaviours but also the emotional, sensorial and relational experiences connected to the action of purchasing and consuming. But we don't have neither universal methods or tools that we can apply in any case, nor diagrams and equations that are able to interpret, explain and forecast the consumer behaviour. It is necessary to experiment, and sometimes even fail, because it's not easy to go in tune with the customer, and every experience is unique on its own. This new marketing concept has involved especially the tourism sector. In this field, the focus become marketing based on liability and simplicity, able to build experiences that can tell the stories of a territory and to point to the authenticity of a place, so that it can be well visible by the tourists. It is all about building memorable experiences so that the tourist can be a different person after his travelling.

2. CASE STUDY

2.1. Background

Different studies have analysed the tourism experience concept and measurement, nevertheless scholars have recently called for more research on the topic, while large empirical studies are still few (Kim et al., 2012; Kim, 2013; Chandralal, Valenzuela, 2015; Tsai, 2016). To contribute to fill this lack the paper presents an explorative analysis in the field of tourism experience in the underwater archaeological heritage site as the Sunken City of Baiae. The aim of this study is to explore how visitors create their touristic experience, by acknowledging the role of feelings and emotions in the consumption process. In particular, we try to understand which are the key elements of an extraordinary, unique and memorable touristic experience. For this purpose the exploratory analysis focuses on testing memorable tourism experience (MTE) scale among the Campi Flegrei Diving Center clients visiting the Underwater Archaeological Park of Baiae, known as the Sunken City. In this study, diving, snorkelling and Discover Scuba Diving Program (a trial dive for people without scuba certification) are the tourism experiences investigated and the underwater cultural heritage site, like the Sunken City of Baiae represents the tourism destination context, where the archaeological diving tourism has been growing during last years.

2.2. The set of the research: The Underwater Archaeological Park of Baiae, the Sunken City

The Underwater Archaeological Park of Baiae is a marine protected area (MPA) located in the Campi Flegrei, to the west of Naples. Campi Flegrei area (taken from the Greek, burning earth) lies in a harmonious landscape of rolling hills, a volcanic land characterized by the volcanic phenomenon of bradyseism, a gradual uplift or descent of part of the earth's surface caused by the filling or emptying of an underground magma chamber. Due to this phenomenon the ancient coastal belt experienced a collapse and the result was the total submersion of all the buildings which were constructed upon it. The once most reclaimed, commercial city of Pozzuoli, the famous residential area of Baiae, with maritime villa of Roman aristocracy, and Miseno, the seat of the western imperial fleet, were all of great significance during the Roman era and are today protected all below the sea level at a shallow depth of 3-5 m. MPA was established in 2002 and is managed by Superintendence "Archaeological Park of Campi Flegrei". It is considered one of the most famous archaeological sites for the relevance of the underwater cultural heritage represented by a Roman sunken city named "Underwater Pompeii" with mosaics, statues and ruins of maritime villa. The MPA is divided into three zones. In the zone A, at Epitaffio Point are located Protiro Villa Pisoni's Villa and Sunken Nymphaeum with beautiful mosaics, marble flooring and statues. In the zone B is located Portus Julius, the Roman port commissioned by Marcus Vipsanius Agrippa during the civil war between Octavian and Sextus Pompey (37 BC). In the zone C is located Smokey Reef, with numerous active fumaroles which attest the volcanic origin of this area. The fumaroles are columns of gaseous bubbles which escape from the sea bed depositing sulphur which covers the surrounding sea floor.

Nowadays, about twenty years after the establishment of the park it seems that the area enjoys the benefits of the protection, conservation and valorisation, also thanks to the choice of the Superintendence to entrust diving centres the visits that are increasing, both with foreigners and local divers (Stefanile, 2012). Figures shows that archaeological underwater itineraries are attracting even more people (Davidde, 2002), during the last years the Sunken City has seen an increase in visitors number, becoming even more visible as it is considered one of the coolest underwater attractions (Ocean, 2013) and, as Lonely Planet 2014 suggests, one of thousands most adventure experience to do around the world. Moreover a previous study (Canoro, Izzo, 2014) underlines the growing trend of the Archaeological Diving Tourism (ADT) in the site. The data revealed that it represents a driver for the local development in an area of incredible beauty and richness of natural, historical, archaeological and cultural resources, which should be valorized managing the efforts of local actors organizing synergies and networks among them. In the recent years the Sunken City of Baiae has been a set of different research projects, some of which co-funded by the Cosme program of the European Union to

build international networks of Mediterranean Underwater Cultural Heritage sites.

Fig. 1: Archaeological Underwater itineraries in MPA of Baiae.

Recent figures show that the MPA of Baiae attracts about 200,000 tourists each year. About 60% of tourists are managed by CFDC. MPA of Baiae can be visited only by authorized divings and boats and the visit must be conducted by authorized guides. Nowadays visits are managed by about 10 diving and one boat with a glass bottom.

2.3. Campi Flegrei Diving Center tourism strategy

Campi Flegrei Diving Center (CFDC) was founded in 1992 and it is one of the oldest divings in Italy. It is an established diving training centre, notably being a 5 Star Instructor Development Centre (IDC) with the Professional Association of Diving Instructors (PADI) and has been distinguished numerous times for its on going activities. Since 2007, when the agreement between Superintendence and the association Assodiving Flegreum was signed, CFDC has been active in promoting diving tourism in the area and in particular it has focused its activities on the Underwater Archaeology Park of Baiae. It provides different services: training (diving courses, underwater archaeology courses) equipment rental, diving with professional guides, inbound and outbound services, diving services in support of filming activities using new technologies (3D, audioguides, communication diver-diver and diver-surface). In collaboration with local and national entities, universities, training organizations in the field of diving, environmental protection, tourism and underwater archaeology CFDC organizes events, conferences, informative demonstration to encourage a sustainable development of our area driven by the underwater archaeology. Moreover, it participates at several projects, at national and European level about the development of the underwater archaeological tourism in the area of Campi Flegrei, the spread of the sport culture, the respect for the environment, in particular the marine environment and cultural heritage underwater sites. In particular, in the last years CFDC has taken part in different European projects supporting researches on underwater sites providing diving and technology support services. In the 2015 the diving centre submitted the Grant application form by EASME for the program concerning the Implementation of the European Maritime and Fisheries Fund Work Programme about thematic touristic routes on underwater cultural heritage, as coordinator of an international partnership. The project aimed to build a network among underwater itineraries in Italy, France and Spain. Besides, the project proposed the implementation of innovative technologies during the visits to allow the development of competitive routes. One of the main objectives of the project was to encourage the promotion and knowledge of transnational archaeological diving tourism routes to the public using innovative technologies. The proposal failed and it was not financed, but the experience allows to continue working on building international network to promote archaeological underwater itineraries. Finally in 2019 the project proposal "MeDryDive", presented in partnership with SMEs from Greece, Italy, Croatia, Montenegro and the municipality of Kavaje in Albania, was approved, receiving a funding by the European Union's Cosme Programme. The project, coordinated by Mazi Travel from Greece, aims creating personalized dry drive experiences for the promotion of Mediterranean Underwater Cultural Heritage sites. The mission is to create and offer personalized CCI (Cultural and Creative Industry) apps (dry apps, AR apps, serious games, videos) that enrich the experience of tourists (both divers and non-divers) and stimulate their interest on Med/EU Underwater Heritage sites. The project integrates ICT/CCI applications into the development of new transnational thematic tourism product in the Med. A new transnational thematic tourism product "Dive in the Past" with a combination of packages will be created and promoted by tourist operators. The product will target divers and non-divers globally in order to develop a transnational thematic tourism products focusing on innovative solutions, such as but not limited to AR apps, used as interface to explore tourism attractions/destinations and develop new modes of visitor servicing, storytelling and gamification. In the future CFDC aims to build an international network of Universities, research organizations and institutions in the field of underwater archaeological tourism to propose new tourism experiences. In particular these networks, focusing on new technologies, will allow to de-seasonalize tourist flows and to increase visitors targets, offering new tourists' experiences of various kind.

2.4 The survey

The explorative analysis was carried out in 2018 (June/July) at Campi Flegrei Diving Center on a sample of 300 visitors of the Sunken City of Baiae guided by CFD**C**. In order to have a representative sample, the questionnaire was submitted to women and men, Italians and strangers, tourist and excursionist, expert and novice divers, non-divers (snorkelling). The study has allowed us to gather relevant information about visitors' feelings and emotions during the visit and to evaluate the customer satisfaction, analysing the point of view of each visitor in order to make the experience memorable and more competitive on the market. Data was collected using a questionnaire to test MTE scale developed by Kim et al. (2012) to analyse tourism experience provided by Campi Flegrei Diving Center. The questionnaire is made up of 56 questions, some discretionary, divided in 4 sections: the first about general information regarding the visit of the Sunken City of Baiae; the second about the experience, emotions and feelings perceived during the visit; the third about personal data; the fourth, discretionary, about further information on the stay. The first section allows us to understand how visitors come to know the underwater site and CFDC, if it was their first time visiting it and if visiting the Underwater Archaeological Park was the main motivation of their travel. From the first analysis we obtain the information that 79% of tourists was visiting the site for the first time. The data is relevant to confirm the developing opportunities of the site to attract thousands of tourists each year. The remaining 21,4% instead is representative of a market share composed of faithful excursionists who having previously experienced pleasant and memorable experiences, as soon as they can, they return to enjoy the wonderful visit. Regarding the way they came to know the Sunken City, the most used communication tool is the word of mouth (38%), then follows internet (22%), belonging diving (21%), social network (15%) and finally tour operators and newspapers/television (4%). Moreover it is interesting to underline that 84 % of the sample states that the visit to the Park was the main motivation for the trip in the Campi Flegrei area.

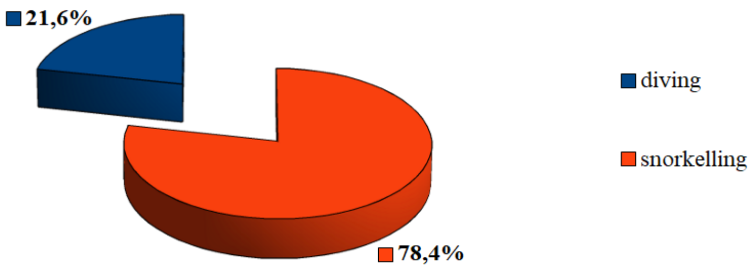

Fig. 2: Type of visit: diving versus snorkelling

2.5 The visitors of the Sunken City of Baiae

The exploratory analysis allows us to define the visitor's profile. The total respondents are 300, 51% of these are women and 49% men, of whom slightly more than half (56%) are Italians and the main part comes from different countries, like as U.S.A. (13%), U.K. (9%), Germany (7%), France (3%), Belgium (2,5%) and some minorities from Spain, Australia, Turkey, China, Netherlands and Russia.

Data shows that the wider group of tourists are young (32%), between the age of 26 and 35, followed by the Millennials (27%), between the age of 18-25, then the adults between the age of 36-45 are 18% and finally the mature between the age of 45 and 60 are 14% of the total. Tourists had the opportunity to choose different types of visit: diving or snorkelling.The large majority of the interviewed (78%) decided to visit the Sunken City by scuba diving. This is a relevant data, revealing the great opportunity to develop the snorkelling market and to promote different experiences using new technologies to de-seasonalize tourist flows and to increase visitors target. The great part of divers are certificated, the remaining part scuba diving for the first time, the so called "discover scuba diving" experience.

2.6 Results

The main focus of the questionnaire is the section dedicated to the emotions felt during the visit. The study explores tourists' emotions and feelings through 7 domains based on the MTE scale developed by Kim (2010, 2012) and adapted to the context.

1. hedonism
2. novelty
3. refreshment
4. meaningfulness
5. knowledge and local culture
6. Organizational quality
7. involvement

The first dimension is hedonism and it encompasses all the emotions related to the travel, and therefore excitement, entertainment, satisfaction and pleasure related to the whole experience and to the single activities. It is defined as the seeking of sensual pleasure and it represents the emotional value of the experience.

Novelty dimension: this study refers to unique, rare experience, different from previous. Hence it is strictly related to the traveller satisfaction. Refreshment is defined as the ability to help people escapes from daily stresses, so they do not realize time is passing and they forget everything. Meaningfulness is a relevant concept related to the memorable experience, indeed the more the experience gives the tourist a sense of value, the more it will remain in memory. This dimension can enable personal changes and affect the way of living, their beliefs and habits. In this study it refers to the statements about doing something important on the day of the visit, hence something meaningfulness that allows learning something about themselves to remember forever.

Knowledge and culture are two relevant concepts in the tourism field. The desire to learn it has always affected the tourists' purchase intention. In our research this dimension refers to the statement about learning new things, acquiring new skills, being in touch with a new culture and learning more about Roman history and culture after visiting the Sunken City of Baiae. Organizational quality is a broader concept. In this study it refers to the statement regarding not only the setting, services, equipment of the diving centre but also professional skills of the staff, key element to make their visit a memorable experience. Moreover it was considered the relationship with the diver buddy. Involvement is defined as the interest of the tourist for a particular activity and the enthusiasm that results from them. In the research it refers to statements about the interest in the activities they experienced, if they enjoyed the visit and if they had visited a site that really they wanted to know. Besides we asked if they were so involved to make photos to show to friends and /or to share on the social and if they would suggest to others to visit the Sunken City of Baiae by CFDC services. The study is designed to measure the above mentioned 7 dimensions felt during the visit at the underwater site. Each construct has different questions based on Kim studies (2010, 2012) measured with 5-point Likert scales. The graph highlights the resulting values of average of the all respondents, from which we can claim the completely fulfilling customers' satisfaction of the visit at the site through Campi Flegrei services provided. The experience was then up to their expectations. Moreover the high value of novelty cluster points out the tourist perception about the lived experience unlike any before it.

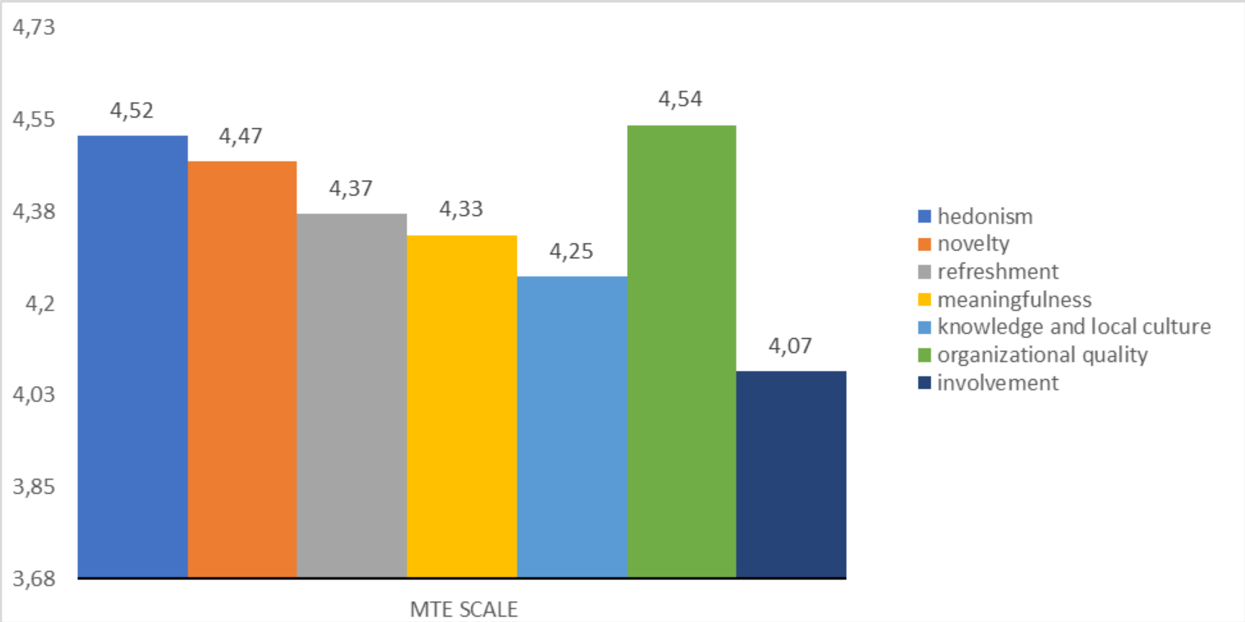

Fig. 3: MTE scale tested on Sunken City of Baiae tourism experience provided by Campi Flegrei Diving Center

The visit has been so rare and extraordinary for them to leave a strong impression in their minds and heart.

Data analysis on the "organizational quality" dimension shows how the tourists feel comfortable and safe, thanks to the welcome and the hospitality of the staff. Moreover sharing experience with fellow travellers was considered enjoyable, all the visitors were encouraged to socialize and experienced pleasant relationships with their fellow traveller. However, sharing experience is definitely part of the fun, instead the dimension "involvement" represents the lower value, although the value indicates high satisfaction. Interviews explain that the relative low involvement is not affected by the activities proposed, considered interesting and enjoyable, but by the inability to take pictures underwater. Indeed some tourists regret to not have pictures as souvenirs for their friends. The motivation is the lack of personal equipment to take pictures underwater or lack of time cause the itinerary is so special that needs a high concentration.

2.7 CONCLUSIONS

Results provide interesting insights on how visitors create a memorable tourism experience, by identifying the different role of feelings and memories involved in the consumption process. This study also provides some suggestions for managers and policy makers to manage an underwater archaeological heritage site, increasing its competitiveness as a touristic destination area. The exploratory analysis was carried out in 2018 (June/July) at Campi Flegrei Diving Center on a sample of 300 visitors of the Sunken City of Baiae guided by the diving center, and it allow us to test the MTE scale on the tourism experience for the purpose to evaluate emotions and feeling of every single traveller to deepen their point of view. The research suggests that the beauty and value of the Underwater Archaeological Park of Baiae have been understood from all the interviewed, and CFDC with his staff has been able to make the experience memorable. However, the valuable insights are useful not only to evaluate the quality of past experience but above all to improve the quality of the services provided and to make the future visit experience at the underwater archaeological site unique, enjoyable and unforgettable. Moreover, the MTE scale is a very useful tool to analyse strengthen and weakness to improve competitiveness and increase the number of satisfied visitors from year to year. It is therefore essential that CFDC continues to innovate and to diversify its offer, in particular focusing on new technologies to offer unique and memorable tourists' experiences providing value added services. In fact, future developments are in new technologies investments, thanks to European funds with the aim to de-seasonalize tourist flows and to increase visitors target, offering underwater dry and wet experiences of various kind. Finally further research will be carried out to analyse traveller perception on the new visit experience by new technologies such as serious game and 3D models.

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Diving and Underwater Cultural Heritage: a reasonable or a forced marriage? The Greek case.

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Until recently, protection of underwater archaeological sites was synonymous to prohibition of any activity within their limits, especially diving. However, in most cases these sites are remote and difficulty accessed and more often than not protecting the sites tends to be words on a paper rather than a continuous active patrolling of the area by the coast guard.

During the last couple of decades, developments in diving have made it possible for many to dive more easily and in greater depths giving a big boost to the diving industry. Consequently, diving tourism became a major sector of touristic activity and making underwater archaeological sites accessible to the diving community has become a pressing matter to the governments of coastal states. Thus, finding the right equilibrium between protection and exploitation of underwater cultural sites has been an ongoing debate on many levels and with various approaches (scientific, cultural, social, financial etc.)

The major question posed is how can accessibility be achieved, without damaging the site in the long run. In other words, if physical presence of a group of divers/snorkelers is the key to an essential educative/entertaining experience and interaction with Underwater Cultural Heritage, in which ways should this be made possible without posing any threats to the archaeological record and its context? More importantly, when does this reasonable marriage between UCH and diving becomes a forced one? In order to provide answers to the above this paper focuses on examples from Greece and the way this matter has been handled so far by the Greek stakeholders.

Protection and development of the Lake Bolsena underwater heritage (Lake Bolsena - Italy)

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***Abstract*:** The bottom of Lake Bolsena is an extraordinary 'container' of different archaeological finds: the protohistoric settlement of Gran Carro (discovered in 1959), the two Bronze Age logboats; the wrecks of Punta Zingara and the most recent one of Martana Island; the submerged roman *villae* remains and the ancient harbours and docks. In a context so extensive and various, the local Superintendence chose to preserve and to make available *in situ* the underwater heritage.

The Underwater Archaeological-Naturalistic Route, created in 2009, is the first for the inland waters. It represents the beginning of an extended Underwater Archaeological-Naturalistic Park. The itinerary is situated approximately 250 m from the Bisentina Island, out from Punta Zingara. It is 280 m long at a depth of 9 to 19 m. Along the way it is possible to admire Roman pottery and stone anchors, as well as a small sarcophagus from the Etruscan era and Medieval household pottery. The naturalistic itinerary begins exactly halfway along the route and it is dedicated to the study of the local fish species. The final segment is dedicated to the so-called Punta Zingara wreck, where it's possible to see the remains of its load of bricks and roof tiles, some of them still arranged as in the stowage.

Keywords: inland navigation – conservation of waterlogged wood - underwater itinerary – widespread museum

1. THE LAKE BOLSENA

The Lake Bolsena – the greatest volcanic lake in Europe and the first in the Latio region – is an inner sea between the Tiber River and the Tyrrenian Coast of Central Italy. The lake has a surface of 114 Km², a perimeter of 43 Km² and the maximum depth of 151 m, in the center of the basin. The only emissary is the Marta River that begins its course to the South of the lake near the same town; it flows into the Tyrrhenian Sea near *Tarquinia*. In proximity of the southern coast of the lake, there are the *Martana* and *Bisentina* Islands, the remains of ancient volcanic cones. The temperature of the Lake Bolsena water surface varies from 25°C (during summer) to 8°C (during winter), while below 130 metres the temperature is constantly around 7°C.

Starting from 304 m on the sea level, this lake has a catchment-basin with a surface of 273 Km² of which less than the half of this is occupied by the same lake. The water source comes from different streams.

The Lake Bolsena basin is constituted of numerous volcanic complexes with different geo-chronological characteristics. Today the volcanic area of the *Vulsini* Mountains is characterized by three principal zones: Bolsena, Latera and Montefiascone. Each one of these three areas includes different craters or eruptive centers. In the area of Bolsena many craters were already in eruption over 600.000 years ago and they have been active at least for 350.000 years. The activity in the areas of Montefiascone and Latera marks the final volcanic phase in the territory.

The final eruptive phase of Latera's volcano, probably is the last of the whole *Vulsino* District and it goes back to about 150.000 years ago. The coast of Lake Bolsena has been occupied since the beginning of the Middle Paleolithic. Sites are generally distributed between the backdrops and the perimeter of the lake, with an increasing from the Paleolithic to the Etruscan phase (fig. 1).

Fig. 1: The archaeological sites at Lake Bolsena

The bottom of Lake Bolsena is an archaeological complex of great importance, which deserves protection and promotion. For several years all materials were systematically removed, where possible, in order to protect this relevant underwater cultural heritage. Over time, however, another conviction started to spread: archaeological remains should not have been taken out of their context but rather protected and left on the lakebed, favouring future studies and researches.

Below Lake Bolsena two dugout canoes have been found till now: Isola Bisentina logboat, discovered in 1989, dated to the Late Bronze Age (2970+70 BP) and Monte Bisenzo logboat, found in 1991. By the second monoxyl, the first in situ conservation experiment has begun at the bottom of the lake between Monte Bisenzo and Punta San Bernardino. The Monte Bisenzo logboat, situated at a depth of approximately 11 m, was made from the trunk of a deciduous oak and the relative radiometric analysis dated to the Middle Bronze Age (3185+70 BP) (Rome 563, Calderoni et al. 1996). The monoxyl is 9.67 m long. The prow, where it is intact, is 57 cm wide. From here the width increases reaching a maximum of 74 cm in the section near the stern, where both sides are intact. Beyond this section there is a slight reduction in width towards the extremity (Petitti et al. 2009).

The particular shape of the wreck leading to the design of a "shield" that would preserve the logboat, at the same time keeping the container away from its contents. It was not possible to build the cover in a single piece, too difficult to transport, because of its size: therefore a modular structure was planned. Each module was welded with reinforcements on the joints and made of 0.50 cm thick iron sheets, with a total of eleven elements in two different shapes, the end two made to close the protection. The central modules were trapezoidal, with a larger one, the lowest side open (larger side 2.50 m, smaller side 2 m, height 0.50 m and width 1 m). All modules were provided with grooves, clamps and wings for positioning on the lakebed. There are five perforations (1.6 cm diameter) on the upper part of every module to allow water circulation. The work undertaken to protect the Monte Bisenzo logboat was the first project of this type to preserve an underwater archaeological wreck. Many years have passed and despite the complete change in techniques used for underwater interventions, the logboat cover has been a success. Still today it shows no signs of yielding or aging, maintaining the logboat in the same condition as it was on the day it was found. The next step would consist in replacing the present shield with a transparent one, so as to include the logboat in a visitors' itinerary, for better "fruition" of this submerged monoxyl (fig. 2).

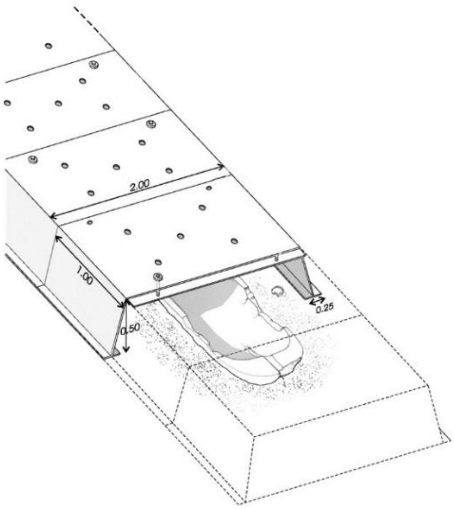

Fig. 2: The 'shield' of Monte Bisenzo logboat (from D. Silenzi project 1992, reviewed by A. Sciancalepore)

Since 2006 to 2009 a positive experience has been made near the Bisentina Island, thanks to the studies and researches developed by the Research Centre "Lake Bolsena Scuba School" (Centro Ricerche S.S.B.) in collaboration with the Superintendence of Archaeology, Fine Arts and Landscape for the Metropolitan Area of Rome, the province of Viterbo and Southern Etruria. The result of these researches led to the realization of an archaeological-nature itinerary. This is the first eco-archaeological route for the inland waters and the first in Central Italy. The area was chosen for its archaeological remains and underwater landscape, and for the vicinity of other sites which could ensure a promising future (fig. 3).

Fig. 3: Underwater Archaeological-Naturalistic Route - Bisentina Island (E. Severi)

This route was created in 2009 and the itinerary is situated approximately 250 m from the Bisentina Island, out from Punta Zingara. It is composed of six stopping points, including archaeological finds from different periods and of differing historic-archaeological importance, left in situ. At the beginning of the visit a large information board shows the itinerary and gives general and geographical information (fig. 3). The itinerary is approximately 280 m long at a depth of 10 to 19 m. It is delineated by stakes connected by a rope with arrows, which can also help manually in poor visibility or for serious disorientation. Two exits have also been planned for shorter visits. The archaeological finds along the itinerary are illustrated by information panels, showing how to continue the itinerary. Starting from the mooring point, it is possible to see lithic anchors and net fishing weights (8-9). Soon after, we find a Medieval household pottery (11-12). A little beyond a small sarcophagus represents the Etruscan phase. Then, a millstone with a central hole (fig. 4), related to a medieval fishing system (16) and a fragment of a large globular-shaped container, a dolium (20). The natural itinerary – focused on the study of local fish species – begins exactly halfway along the route (fig. 5).

Fig. 4: Millstones of a medieval fishing system (E. Severi)

Fig. 5: Lake Bolsena fish species (E. Severi)

The final segment is dedicated to the so-called Punta Zingara wreck (or Tile Wreck). Discovered in 1990 this wreck still shows its load of roof tiles – some still in the piles – exactly as they were when they loaded. It occupies an area of about 60 m², at a depth of 13 m (Dettori et al. 2009). The boat first leaned at 12-13 m: because the deterioration of the hull caused over time a load slip towards the deepest part of the slope (14-15 m), in a backdrop without a rock bank (fig. 6). The boat was probably sailing to the island, and the artefacts suggested that its dates back to the late Etruscan era.

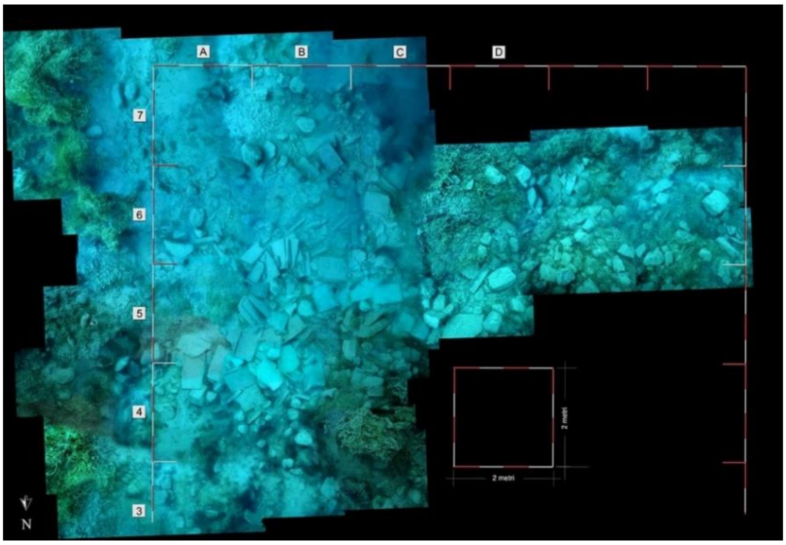

Fig. 6: Photogrammetry of Punta Zingara Wreck - Bisentina Island (E. Severi)

Another route is available at Martana Island, about 250 m from the West coast of the island. The itinerary is approximately 275 m long at a depth of 10 to 18 m. The bottom of this area is constituted of clay soil and a few rock formations. Along the way it is possible to admire Roman and Medieval household pottery. The main attraction of the route is the Martana Island wreck, found in 2009, 150 m West off the island, at a depth of 17 m and lying on a plane muddy backdrop, with the bow facing North-East. The wreck is 612 cm long and 174 cm wide (Sciancalepore *et al.* 2014). The cargo consisted entirely of fired bricks and some of them are still arranged as in the stowage. The discovery of this boat has offered more information about the construction of the traditional fishing boats used on Lake Bolsena. According to all the information gathered and to the details found on the shipwreck during the researches we could conclude that this boat dates back to the last quarter of the XIX century A.D. (fig. 7).

Fig. 7: Photogrammetry of Martana Island Wreck (E. Severi)

The two routes of Tile Wreck and Brick Wreck were tested during the "ArcheoSub" events conceived and organized by the Research Centre "Lake Bolsena Scuba School". Six editions were organized with the aim of protecting and making the legacy of the territory more accessible. The events offered, since the beginning, various multimedia opportunities, including archaeological experiences, conferences, guided tours, diving and water testing with equipment. During these events it was possible to develop educational activities with the schools to promote the knowledge of the lake cultural heritage.

The two routes were used in short periods from 2009 to 2015 and during events more related to underwater tourism (fig. 8).

Fig. 8: Poster of an "ArcheoSub" edition (E. Severi)

They can represent a precious "resource", with the realization of an extensive Underwater Archaeological-Naturalistic Park, sensitizing to the concept of heritage as an interrelated system of works, monuments, museums, houses, landscapes, cities, customs and traditions, composing the territory: the cornerstone of civil society, the wealth of a country.

Lake Bolsena represents an example of a "widespread museum", with its strength in water, where wooden remains – generally not documented in 'terrestrial' archaeological researches – can be preserved for the future.

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Cartographic Documentation and Proposed Criteria towards the Protection and Preservation of Wrecks from the Great War in the Greek Seas.

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***Abstract*:** Even though the importance of war underwater heritage is obvious for humanity, land monuments are treated differently than underwater. In fact war wrecks tend to be forgotten.

This study aims at the protection of sunken ships from the Great War or their remainings in the Greek seas as material assets, but also at the preservation of the intangible cultural heritage, associated with the related wreck sites. This is achieved by the cartographic documentation of those wreck sites and the definition of a preliminary set of criteria, for the evaluation of their vulnerability. In our study we have used the example of the shipwrecks from the first World War (WW I) in the Greek territory as this era was characterized by major changes in shipbuilding and has affected the modern history of Balkan region.

Through this research: a list of wrecks was created, in order to present what is found underwater, a map was designed to identify where those wreck sites are located and a prioritization list was derived towards the protection of wrecks (as material) and the preservation of their history and significance for the society (as intangible cultural assets).

The results of this study are expected to be used as a basic reference for further multidisciplinary research on the documentation, the protection and the promotion of underwater cultural heritage.

***Keywords*:** Underwater Cultural Heritage (UCH), wreck sites, First World War, Balkan Wars, risk assessment, vulnerability index, classification, public awareness

1. INTRODUCTION

Unfortunately, as in many other Mediterranean countries, the majority of the Greek population **is** not aware of the archaeological and historical evidence hidden under water (https://bluemed.interreg-med.eu/). By neglecting their existence, these monuments cannot be integrated in the historical timeframe of our common maritime history and culture.

The effects of armed conflict—a destructive, unfortunate, but nonetheless universal cultural process—on the archaeological record are most commonly recognized in, and associated with, terrestrial sites where people live and maintain the symbols of their cultural identity (De Ruyter M., 2014). WWI is not called "Great War" by chance. It is the war that has affected everyone's life and its impacts are still prevalent today.

The Great War left testimonies of significant value on ground as well as in the water. Uncountable lost ships, aircrafts and submarines "decorate" until today the Greek basin, reminding us the mistakes once committed, those that must not be repeated. The "war at sea" – including naval battles and U-boat activities – was an important and integral part of WWI. The Underwater Cultural Heritage (UCH) associated to this war enables humanity to understand the devastating human consequences of conflicts, and to encourage everyone to endeavor to preserve lasting peace (UNESCO, 2015).

Despite the great interest and admiration of the general public for these historical submerged monuments, Greece is still way back on the subject of accessibility and promotion. These monuments haven't been studied and are not even included in the nautical maps and charts.

The Greek UCH is a valuable asset for the touristic development of the country. The underwater sites are part of our cultural identity, unveiling actions, techniques, customs of the past, thus describing our cultural evolution.

The aim of this study is to protect the material assets and to preserve the associated intangible cultural heritage, which are related to the wrecks from the Great War in the Greek seas. Specific objectives of this work include a list of wrecks from the Balkan Wars and WWI, a map of their wreck sites; and the calculation of a vulnerability index.

Through the example from an era of major changes in shipbuilding and of great importance for the Balkan region, it is given a preliminary approach for supporting decision making on matters related with the documentation, the protection and the promotion of underwater cultural heritage.

2. IMPORTANCE OF WAR WRECKS

The world's cultural heritage is the traces of not only the most beautiful, but also the most tragic events of human history, understanding and sharing this heritage can serve as a strong uniting force (Timmermans, et.al., 2015). The respectful treatment of war wrecks as gravesites is perhaps the most difficult challenge all nations face (UNESCO,2014).

Concerning the purpose of this paper, the selection of Greek territory as a study area and the specific time frame was based on the fact that after the Second World War a mandatory legislation (Mandatory Ley 464/1945) set the framework for the massive salvation of wrecks, while there was no evidence for similar activity after the Balkan Wars or WWI. For this reason, it is perceived that most of the wrecks from this era (1912-1918) remain in place.

Another important feature of this era is the transition from traditional to industrial shipbuilding and navigation. Steel as a construction material was introduced, replacing iron and wooden structures. Moreover, steam powered vessels are used more than sail ships. In technical terms this fact imposes a diverse field for handling the remaining tangible assets.

2.1 Balkan Wars and The Great War

The sum of wrecks that was the result of the Balkan Wars and the First World War has an additional value for the local communities when concerns human casualties and they are therefore characterized as memorials and/or underwater graves.

In the site "Greek Shipping Miracle" it is written that "By the end of the War, the Greek merchant fleet had comparatively recorded more losses than most other nations" (http://www.greekshippingmiracle.org). Among others the famous steam ship "Miltiadis Embiricos" built in 1897 and lost in 1917, the steam ship "Nefeli" built in 1912 and the steel steam ship "Vasilefs Constantinos" built in 1913.

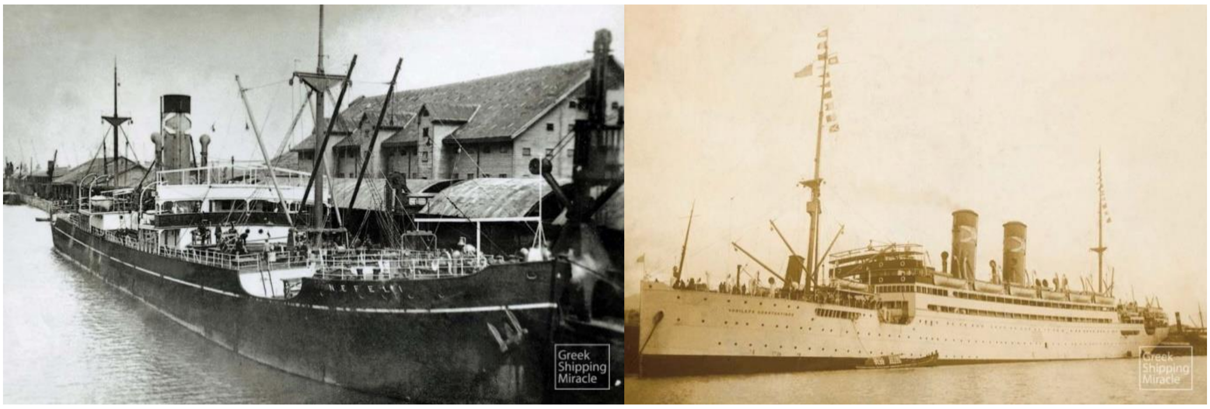

Fig. 1: The steam ship "Nefeli" on the left and the steel steam ship "Vasilefs Constantinos" on the right (photos: http://www.greekshippingmiracle.org/)

2.2 Current framework

Whilst historic wrecks are often thought to be mainly those of past centuries, wrecks of the 20th century are increasingly regarded as embodying historic or cultural values worthy of protection. This is particularly so for many World War I and II wrecks, whose significance is recognised by their designation and protection by domestic heritage legislation in a number of States (Forrest, 2012).

According to the 2001 Convention of UNESCO "Underwater Cultural Heritage" means all traces of human existence having a cultural, historical or archaeological character which have been partially or totally under water, periodically or continuously, for at least 100 years (UNESCO, 2014).

In Greece since 2003 after a Ministerial Decision, shipwrecks over 50-years-old have been designated as "cultural assets", thus including the wrecks from both World Wars (Tripontikas, 2016, p. 16). Over the course of the Balkan Wars and WWI, battleships were mainly active in the seas, but also ships of other types played their role in this strategic game.

In this context, the ownership of each wreck varies in regard to its use. In Greece sunken warships, war material, and merchant ships within the area of naval fortresses are under the property of the Stakeholding Navy's Fund (M.T.N). The ownership of all wrecks of merchant ships that sunk between 1830 and 1951, has the Mariners' Pension Fund (N.A.T) (Tripontikas, 2016, p. 28).

2.3 Preservation state

Archaeological material from marine sites presents some of the most difficult problems confronted by the conservator (Hamilton, 1998). In- situ conservation surveys are vital to understanding the construction of these sites from an archaeological or cultural perspective, but also contribute to understanding the longevity of sites with relation to the material composition of metals and organics, how they react to and survive within the environment, and their overall structural integrity (Mckinnon, et.al., 2014).

The mostly known metal found in contemporary shipwrecks is steel. Steel as construction material started replacing iron after the invention of the Bessemer[52] converter in 1856. The use of steel in the shipbuilding begun after the 1870 decade and during the 1890 decade its price was only 10% more expensive than iron (Argyropoulos, et. al., 2015, p. 12).

[52] The Bessemer process was the first inexpensive industrial process for the mass production of steel from molten pig iron before the development of the open hearth furnace.

In many cases alloys of iron and copper were also used in the construction techniques of this period and wood was also present in parts of the structures or in objects of the cargo (Argyropoulos, et. al., 2015, p. 23).

Some basic factors that determine their corrosion rate are: the depth, the water composition (salinity, dissolved oxygen, pH, conductivity), the underwater currents, the wind waves, the light, the temperature and the presence of marine organisms (MacLeod, 1987, p. 68).

3. METHODOLOGY AND RESULTS

The main sources of this desk based research have been two online databases and a hard copy book.

Wrecksite.eu (http://www.wrecksite.eu) is an online database of wreck sites with a great variety of information, open to the public. This database offers also paid services (additional data, maps and positions) for subscribed members. In this study only the free accessed search engine has been used giving results for 193 wrecks.

Uboat.net (http://uboat.net) is an online site that lists the German U-boats of both World Wars, their commanding officers and operations including all Allied ships attacked, technological information etc. Through this source, data for 91 wrecks has been collected.

In the first volume of the book "Shipwrecks in the Greek seas" (Ntounis, 2000), the names of ships that sunk between 1900 and 1950 are presented in alphabetical order and accompanied by a brief description. For some ships apart from the date of wreckage, the location of the wreck today, is also noted. After reading the book, an amount of 134 ships in the Greek region were recognised.

3.1 List of Wrecks

The initial step of this research was to create a list of known vessels lost in the Greek seas during 1912 - 1918). A sum of 195 wrecks resulted from all sources, in the Greek waters. Based on this primary investigation, the list provides information for the flag, the type of vessel, the type of propulsion, the cause of loss, the dates (built and wrecked) and the construction material. This list of wrecks is available online (https://users.auth.gr/paki/WGS/WW1/List.html).

The names of the ships are displayed in accordance to the Wrecksite.eu names (in order to facilitate their search). Additionally, a numeric field presents the relative page number at the book of Christos Ntounis and another one the link to the uboat.net site. For some records, other references on the web have also been included.

3.2 Overview Map of Wreck Sites

In the same context a separate list was extracted in order to identify the information about the geographical position of each wreck.

In the used sources position is mentioned either as a geographical description (e.g. island, sea, country, etc.), or by the exact coordinates (latitude, longitude). At several cases location was not mentioned at all.

Georeferencing the above information allowed the composition of an overview map, on which those wrecks having a defined geographical position are displayed. An interactive version of this map was published on the web (https://users.auth.gr/paki/WGS/WW1).

Sequentially, the estimated depth of each wreck was calculated through map overlaying of the Digital Elevation Model (DEM) of the seabed, with the defined positions of wreck sites (http://www.emodnet.eu/).

3.3 Vulnerability Index

Generally, the preservation state of each wreck, differs and depends on the prevailing environmental conditions. In this study a risk assessment was implemented in order to quantify the vulnerability of wrecks.

The parameters selected for the risk assessment were: construction material, the age (years sailed), the time being underwater, the construction material and the depth of each wreck.

Wood is an organic material more fragile than iron, while steel is an alloy of iron characterized by high durability. The following rough assignment of values has been proposed in relation to the resistance of each material: wood has been rated with a high vulnerability value (3), iron with medium (2) and steel with low (1). That is, wood is considered more vulnerable than iron and steel more durable in underwater conditions. Wrecks with unknown construction material assigned with a negative value (-1).

The age of ship describes how many years it was sailing. It is the time between construction and wreckage. Older ships are carrying an intangible load (related to the people, the places and the operations of their lifecycle), while younger ones are more representative for the studied era (in terms of material, technology and design as constructions).

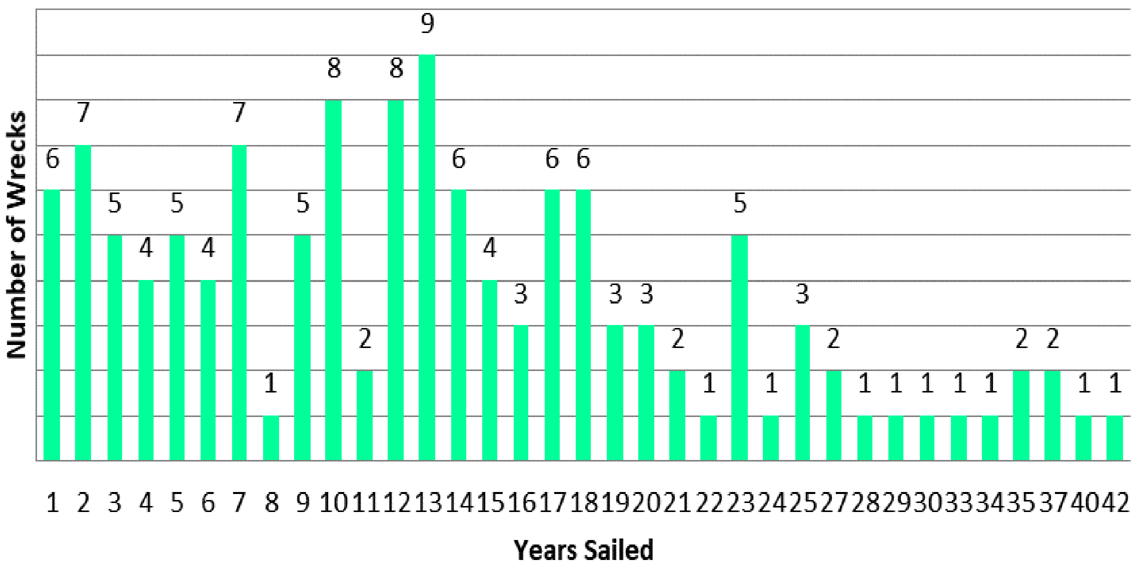

Fig. 2: The graph displays the number of wrecks per age by the time of their wreckage.

The time being underwater is the factor based on which a wreck may characterized either as a cultural heritage asset (100 years according to the UN convention) or as a monument (50 years according to the national legislation). It is derived from the difference from the current date and the date of wreckage.

The depth range at the Greek territory (0 to 4000 m) was divided into nine categories. Each category was defined according to the depth limits for dive training levels or maximum operational depths of known underwater surveying methods (divers, surface operated or autonomous vehicles).

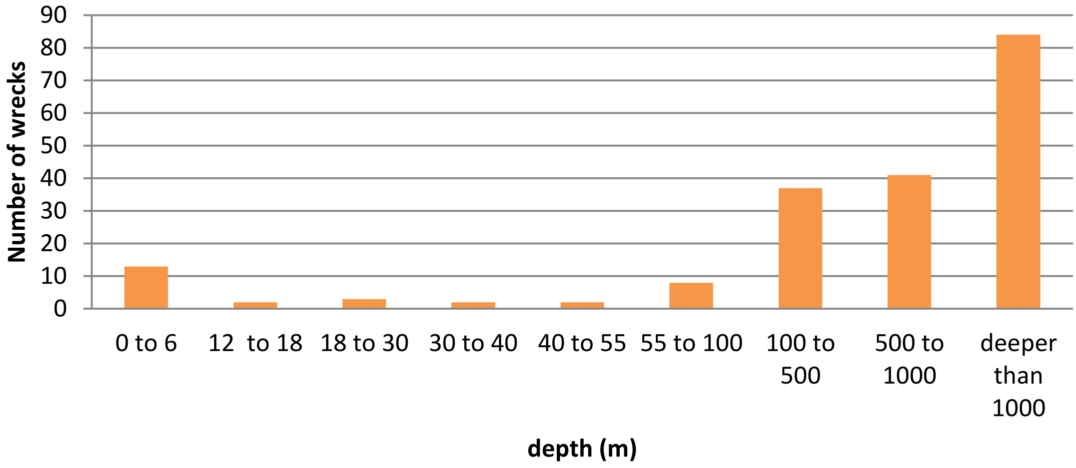

Fig. 3: The graph displays the number of wrecks per categories of maximum operational depth.

A mathematical formula has been proposed for quantifying the Vulnerability (V) of a wreck:

$$\textbf{1.}\quad V = CM \times (A + W) / \ln$$

The Construction Material (CM), the Age (A), the time being underwater (W) and the Map Depth (MD) have been taken into account.

The effect of the MD parameter has been expressed by a logarithmic function, as the underwater conditions present higher alteration in the first few meters, while at they tend to be stabilized as depth increases. The calculation of V, allows ranking the wrecks based on their vulnerability.

Table 1: The following table displays the ranking of wrecks that are within the limits of diving (6m for snorkeling, 12m for Scuba, 18m for Open Water, 30m for Advanced, 40m for Deep, 55m for Tec Rec and 100m for Technical divers).

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#	Name	A	W	CM	MD	V
1	Moghrab SS (+1918)	35	101	2	6	151.806
2	Kiki Issaias SS (+1916)	22	103	1	6	69.764
3	Leitrim SS [+1913]	17	106	1	6	68.648
4	Norseman SS [+1916]	19	103	1	6	68.089
5	Carroccio SS (+1917)	16	102	1	6	65.857
6	Clacton SS (+1916)	11	103	1	6	63.625
7	Burdigala SS (+1916)	19	103	2	55	60.888
8	Maria SS (+1918)	37	101	2	100	59.933
9	Polcevera SS (+1916)	33	103	2	100	59.064
10	Lord Salisbury HMT (FY1212) (+1917)	6	102	1	18	37.365
11	Nerissa II HMT (FY1793) (+1918)	12	101	1	30	33.224
12	Minnewaska SS (III) [+1916]	7	103	1	40	29.819
13	Parana SS (+1917)	9	102	1	55	27.699
14	Reventazon SS (+1918)	12	101	1	100	24.538
15	Floréal (Q-54) (+1918)	10	101	1	100	24.103
16	Ginette (+1916)	3	103	1	100	23.018
17	By George HMT (FY 253) (+1917)	3	102	-1	100	-22.8

18	Princess Alberta SS (+1917)	12	102	-1	100	-24.755
19	Marquette SS [+1915]	17	104	-1	100	-26.275
20	Dragonos (+1918)	0	101	-1	40	-27.38
21	Biolleta (+1918)	0	101	-1	30	-29.695
22	Evangelistrios (UC-23) (+1918)	0	101	-1	30	-29.695
23	Jane Radcliffe SS (+1917)	20	102	-1	18	-42.209
24	AS19 (+1918)	0	101	-1	6	-56.369
25	S275 (+1918)	0	101	-1	6	-56.369
26	V135 (+1918)	0	101	-1	6	-56.369
27	SS165 (+1918)	0	101	-1	6	-56.369
28	V108A (+1918)	0	101	-1	6	-56.369
29	Aghios Nicolaos (UC-37) (+1918)	0	101	-1	6	-56.369
30	Ermine HMS (+1917)	5	102	-1	6	-59.718

4. CONCLUSION

Unfortunately, the state of preservation for the majority of the wrecks identified in this study, remains unknown. According to this desk based assessment, it can be seen that only thirty wrecks lie at depths shallower than 100 meters. Twenty wrecks lie in accessible positions by recreational divers (up to 40m) and should be protected against both environmental conditions and human activities. The remaining (ten), though at deeper positions (more than 40m) which could be approached by technical divers, might be preserved by regulating measures.

Wreck sites beyond their cultural value, they also have a great value for the local economy. Heritage tourism has an important role in sustaining coastal and island communities (Firth, 2015). Through responsible accessibility of the wreck sites and by raising public awareness for the associated intangible cultural heritage, those assets are becoming known and are being protected.

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The National Marine Park of Alonnisos Northern Sporades: an area of rich natural and cultural heritage facing human and climatic pressures

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***Abstract*:** The National Marine Park of Alonnisos Northern Sporades (NMPANS) was founded by a Presidential Decree in 1992 for the long-term protection and conservation of biodiversity with special focus on the unique population of the Mediterranean monk seal Monachus monachus. However, the first management plan for the NMPANS was drafted in 2009, but it was never officially ratified by the competent authority in the country. Aiming to contribute towards the development of an effective management plan for the NMPANS, in the frame of the Interreg MED "AMAre", special effort was exerted to shed light on possible conflicts between human activities and specific ecosystem components having high conservation priority, namely Posidonia oceanica, a seagrass species that is endemic to the Mediterranean Sea, and biogenic constructions forming coralligenous assemblages. Indeed, the NMPANS hosts extended sea grass meadows, while there are also rocky reefs covered by biogenic constructions; both habitats are very important for ecosystem functioning, providing also numerous services (e.g. linked with food provisioning, leisure/diving) that underpin human well-being. During three field surveys to investigate the status of these two conservation priority habitats conducted in September 2018, June 2019 and September 2019, alarming outcomes have been reported; sea grass meadows particularly in specific locations and down to 15 m depth exhibited a deteriorated status, with anchoring being one of the main pressures, while fishing activities seemed to be one of the major pressures exerted on coralligenous formations. Furthermore, in the latter field survey a new potential threat to the benthic ecosystem status emerged in the form of ephemeral mucilage blooms covering extended areas of the sea bottom including also the site of the Peristera wreck. As habitat loss is one of the greatest threats to biodiversity and conservation, addressing key challenges posed by this threat is crucial to provide relevant material for the preservation of the NMPANS' natural heritage and authenticity, closely linked with cultural capital aspects, towards contributing to the provision of welfare benefits to the present and future generations.

Keywords: seascape, priority habitats scientific monitoring, human pressures

1. INTRODUCTION

Oceans cover more than 70% of our planet. They store more than 90% of the world's carbon dioxide while they remove 30% of the carbon dioxide released in the atmosphere. Oceans include some of the most fragile ecosystems and species on earth but are continuously threatened by human activity. More than 60% of the population now lives on or near a coastline, and 80% of tourism is concentrated in coastal areas. Close to 25% of fishing in the coastal zone is carried out near coastal ecosystems such as reefs and seagrass meadows and more than 70% of the world's fisheries are in danger. One of the most effective means of protecting marine and coastal biodiversity is through the establishment and effective management of marine protected areas (MPAs). According to IUCN's definition, a protected area "*is a clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long term conservation of nature with associated ecosystem services and cultural values*", while WWF define them as "*an area designated and effectively managed to protect marine ecosystems, processes, habitats, and species, which can contribute to the restoration and replenishment of resources for social, economic, and cultural enrichment*". In Greece, two protected areas have been declared as MPAs, the Zakynthos Marine Park putting conservation emphasis on the loggerhead turtle *Caretta caretta*, and the National Marine Park of Alonnisos Northern Sporades (N.M.P.A.N.S.) mainly established for the preservation of the monk seal *Monachus monachus*. The latter is the largest coastal marine park in the Mediterranean and has been declared as a marine park under a Presidential Degree in 1992 while the final declaration was endorsed in 2003 (official paper of the government 621/19.6.203). The NMPANS (Figure 1) has been selected as the Greek case study of the INTERREG MED project AMAre with the aim to provide concrete scientific results, useful towards drafting an effective management plan for the MPA, which is currently streamlined by the competent authority.

Figure 1. The boundaries of the Marine Protected Area.

The project, that will be completed in 2020, has as objectives to develop shared methodologies and geospatial tools for multiple stressors assessment, coordinated environmental monitoring, multi-criteria analyses and stakeholder's engagement and to develop concrete pilot actions and coordinated strategies in selected MPAs to solve conflicts affecting marine biodiversity and the services it provides. The final aim is to scale up strategies and recommendations at transnational level adopting an ecosystem-based approach considering the goals of the Marine Strategy Framework Directive (MSFD) across MPAs. The project focuses on two conservation priority habitats the Neptune's grass (*Posidonia oceanica*) and the biogenic/coralligenous formations, and studies pressures exerted by anthropogenic activities. The first results from the analysis of the data gathered so far are presented herein.

2. METHODOLOGY

2.1. Seagrass meadows

It has been recognized that seagrass meadows constitute a significant component of coastal marine ecosystems (UNEP/MAP 2012). They are among the most productive habitats in the coastal zone, providing essential ecosystem functions and deriving essential ecosystem services (Duarte et al., 2011). Some of the most critical ecosystem services and functions are water oxygenation and nutrients provision, seafloor and beaches stabilization (as sediment is controlled and trapped within the rhizomes ofthe meadows), carbon burial, areas for nursery, and refuge of several commercial and endemic species (Boudouresque et al. 2012; Cullen-Unsworth and Unsworth 2013;Vassallo et al. 2013; Campagne et al. 2015). However, seagrass meadows are presently experiencing a decline globally due to intensive human activities and the emerging climate change (Boudouresque et al. 2009). Threats from climate change include increase of sea surface temperature and sea level rise as well as frequent and intensive sea storms (Pergent 2014). These threats represent a pressing challenge for coastal management and are predicted to have deleterious effects on seagrasses in both deep and shallow limits (upper–lower limits). The Mediterranean Sea contains lush seagrass meadows made by the endemic plant *P.oceanica*. The meadows are extended from the sea surface down to a maximum depth of 50 m depth in extreme cases and form the basis for a key marine habitat/ecosystem in the region (Boudouresque et al. 2012). The European Environmental Agency has recognized it as a priority habitat for the European Union (EU) (*P. oceanica*, code: 1120) among the nine marine habitats that have been identified within the Natura 2000 areas. Seagrass meadows exist in almost all the coastal zone of the NMPANS. There, and based on the common protocol of AMAre, data related to the ecological status of the seagrass meadows have been collected by means of SCUBA diving. At each location, three replicated sites have been selected; these have been approximately 70-100 meters apart. At each site, data from five plots, where the shot density has been measured using a frame of 40x40 cm^2, have been recorded. For comparative purposes the reference depth for all locations and sites was fixed at 10m at all AMAre sites. The response variable was the shoot density. A shoot is a rhizome tip with a bundle of living leaves. Shoot density is correlated with annual leaf primary production at local scale (patch). Primary production is a basic response variable for the functioning of the *Posidonia oceanica* ecosystem. It was estimated by the number of shoots per square meter, measured within the abovementioned small square frame. In addition to shoot density, records related to the abundance and typology of marine litter, presence of discarded fishing gears, as well as sedimentation issues were kept.

2.2. Coralligenous formations

The coralligenous habitats are among the richest and most characteristic marine habitats of the Mediterranean Sea, ranging from about 10 to 120 m of depth (UNEP-MAP-RAC/SPA 2003; Ballesteros 2006; Cánovas Molina et al. 2016). They are the most important biogenic structures in the Mediterranean (Boudouresque 2004; Ballesteros 2006; Bertolino et al. 2013), usually characterised by a well-defined community. However, due to their peculiarities and great structural, biological and geographical heterogeneity, it seems more appropriate to consider them as a puzzle of communities rather than a single community (Ballesteros 2006; Cánovas Molina et al. 2016). Light plays a fundamental role in the structure of this mosaic affecting the distribution of benthic organisms along a bathymetric gradient on rocky bottoms and the development of different coralligenous communities (Laubier 1966; Martí et al. 2004, 2005). In addition, the temperature range influences most coralligenous benthic species. Some organisms living in coralligenous assemblages in deep waters seem to be highly stenothermal since they have never been found in shallow waters (Ballesteros 2006). The above parameters along with the topography affect the nature of the outcrops, leading to coralligenous banks on the horizontal seafloor and rims of vertical cliffs, the latter usually being shallower (Pérès and Picard 1964; Laborel 1987).The main bioconstructors of the coralligenous substrate are coralline algae growing at low light levels; the shallower coralligenous habitats are dominated by erect and foliaceous forms, which, as the water deepens, are progressively replaced by encrusting species (Ballesteros 2006). Regarding the associated fauna, the abundance of suspension feeders depends on the average current intensity and availability of food and is rich in mobile species (Poursanidis et al., 2015). Gorgonians dominate the community in areas rich in suspended organic matter, while sponges, bryozoans and scleractinian corals are the dominant suspension feeders in more oligotrophic waters (Gili and Ballesteros 1991; Ballesteros 2006). With respect to their position, role and ecological functioning, Hong (1982) distinguishes four different categories of invertebrates in the coralligenous habitats, all of them contributing to the turnover of the calcareous concretion: fauna contributing to build up, cryptofauna, epifauna and endofauna, and eroding species. Coralligenous formations occur at several locations in the NMPANS, mostly on vertical cliffs, from the depth of 30m and below. The protocol for the collection of data requires the use of underwater photography and a frame of 50 x 50 cm, in order to photograph each frame and perform a post analysis on the computer. An important issue of the specific site is that, in comparison with the AMAre sites in the West Mediterranean, the depths of SCUBA diving for scientific work are at the limits of technical diving, requiring extended times for the collection of the data, thus the use of frames has been skipped and a qualitative visit for the identification of the impacts from marine litter and fishing activities has been performed. Special effort has been also exerted to collect data close to sites of cultural heritage in order to explore the possibilities of linking the natural and cultural heritage within the NMPANS through the development of targeted SCUBA diving routes in ancient wrecks and nearby meadows and reef ecosystems.

3. RESULTS & DISCUSSION

Most of the sites in Zone A have been found to be in a good ecological status, while the situation in Zone B is mixed (Gambi et al., 2004), with few to be in medium and quite fewer in bad status (Figure 2). The shoot density ranges from 113.75 shoots per m^2 to 643.75 shoots per m^2 for the same depth of 10m. The main pressures that have been identified for the seagrass meadows are the uncontrolled anchoring by boats of all sizes, the invasive species that intrude in the meadows at the sites where the meadows are at bad ecological status, and then marine mucilage (marine snow) which was present at 27 sampling sites out of the total 82 sites during the June 2019 survey (Figure 3). It is worth noting that the latter is considered as a response of the marine ecosystem to direct and indirect anthropogenic impacts, and a potentially expanding carrier of viruses and bacteria, including pathogenic forms that are harmful for the health of humans and marine organisms (Danovaro et al., 2009).

As for the coralligenous formations, the main pressures that have been identified are discarded fishing gears (ghost fishing), the necrosis of parts of the gorgonians due to epibenthic growing, and then the occurrence of mucilaginous algae on gorgonian forests, possibly also linked with necrosis phenomena on these priority species (Figure 4).

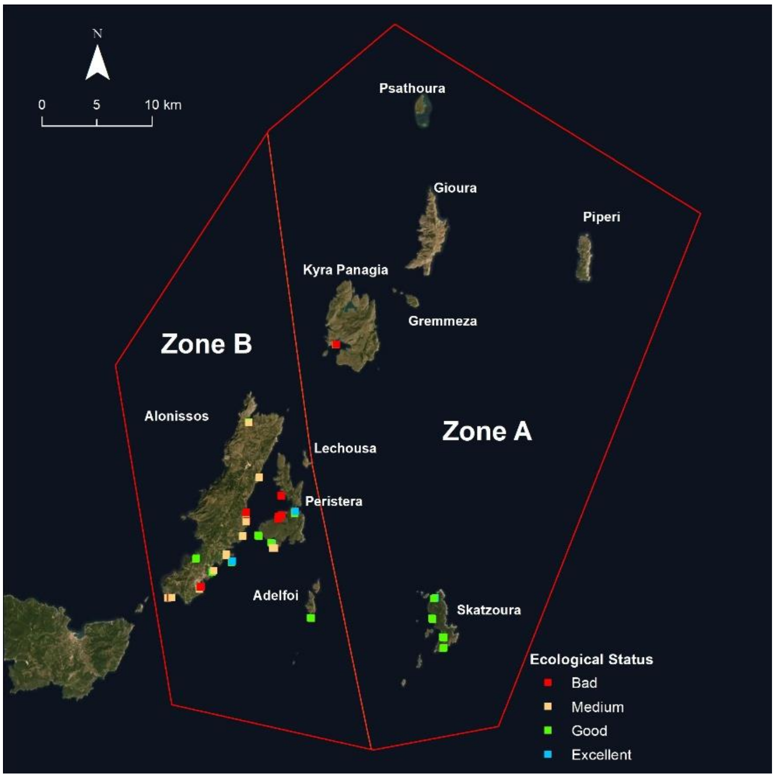

Figure 2. The ecological status of the seagrass meadows based on the AMAre criteria.

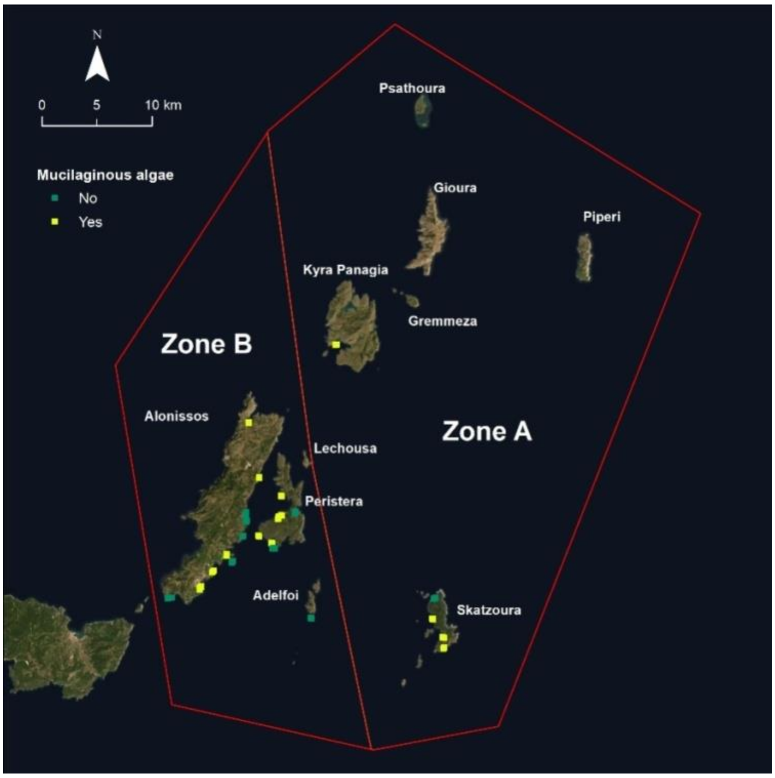

Figure 3. The presence of mucilaginous algae at the seagrass meadows.

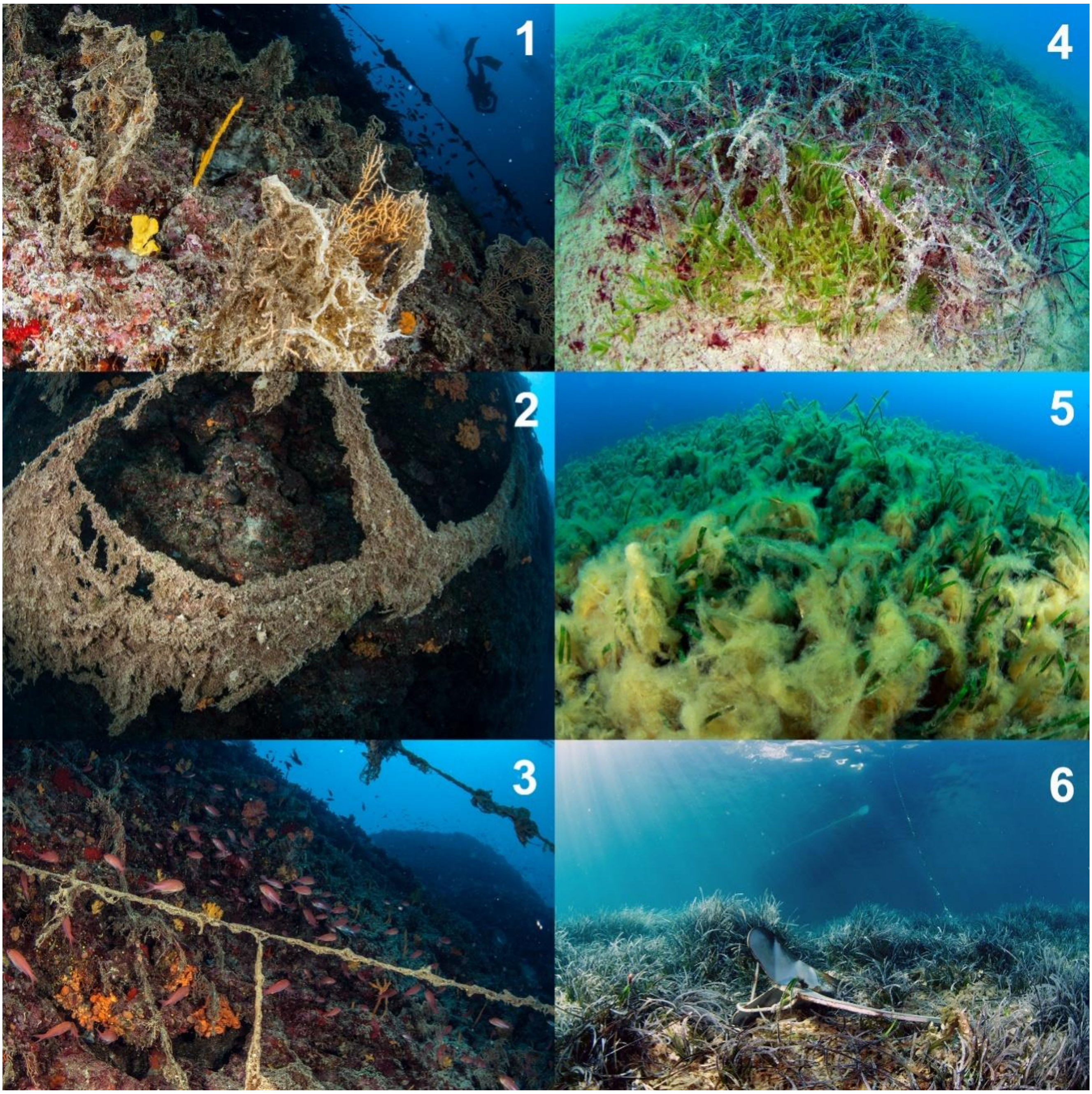

Figure 4. Snapshots of seagrass and coralligenous habitats at NMPANS locations as recorded during the AMAre project. Plots 1, 2, 3: Abandoned fishing gears at the coralligenous outcrops. Plots 1 & 5: Filamentous mucilaginous algae at gorgonian forests and seagrass meadows. Plot 4: Invasive species (*Halophila stipulacea*) at impacted meadows. Plot 6: Uncontrolled anchoring of a leisure boat, directly impacting part of the sea grass meadow.

The fact that the two diving surveys were conducted in two different seasons (autumn and summer) enabled a more thorough observation of temporal pressures exerted on the habitats under study; indeed, during the early summer survey of this year the occurrence of huge loads of filamentous mucilaginous algae on the seagrass meadows and the nearby reef systems in many different locations of the NMPANs, including Peristera and covering also the wreck and the amphoras, has been documented (Figure 5). Following discussions with local stakeholders (fishermen, business owners related to the aquatic environment) and utilizing the local ecological knowledge, it seems that the phenomenon appears at the end of spring with a peak at mid-summer and disappears around mid-autumn. Locals link the event with heavy rainfall during the winter but also with increased temperatures in late spring and summer. The occurrence of benthic mucilaginous aggregates has become an increasing problem in many areas of the western Mediterranean Sea (Sartoni et al., 2008) and follows a seasonal pattern from small, yellowish tufts in early spring to extensive patches covering the bottom at the end of the summer. Depending on the topographical features of the rocky bottom and local hydrodynamic conditions, the benthic mucilaginous aggregates may develop in a wide depth range while these aggregates can damage benthic organisms as gorgonians, coralligenous formations (Piazi et al., 2018) and seagrass meadows (Lorentzi et al., 2005). In Greece, such phenomena have been also documented along the coasts of the northern mainland and were linked with necrosis of gorgonian forests as well with impacts to benthic fisheries (Skoufas & Poulicek, 2001, Skoufas et al., 2015).

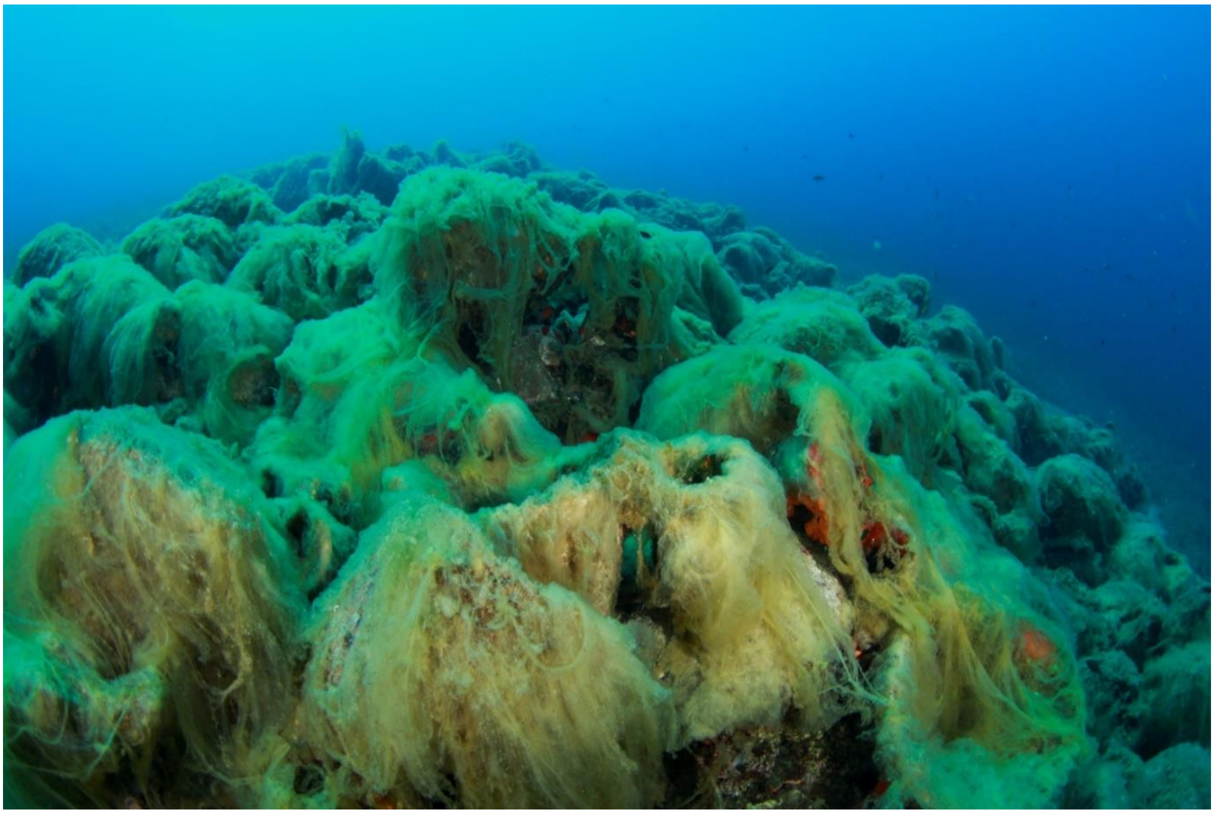

Figure 5. Mucilaginous algae covering the Peristera wreck in June 2019.

The considerable effect marine mucilage has on fishing activities in Alonnissos has been also documented by local fishers who underlined that they practically stop fishing for a period of about two months. In the same vein, as this phenomenon occurs mainly in summer it can potentially restrict the potential of the local tourism product aiming to expand further the sector of SCUBA diving by including unique routes of natural and cultural significance during this period. Existing studies indicate a clear link between climate anomalies and the occurrence of mucilage and, in the light of the warming trend of the Mediterranean Sea, the mucilage phenomenon could increase in the future (Danovaro et al., 2009). Following the above, it evident that further studies are needed to shed light on the spatio-temporal impacts of the identified stressors on the conservation priority habitats accounting also for their role in the potential hampering of the delivery of provisioning and cultural ecosystem services. Such information is crucial for the development of effective maritime spatial plans that will adequately address conservation and socio-economic objectives aiming towards the sustainable development of the region, and in accordance with the provisions of the Marine Strategy Framework Directive and the Maritime Spatial Planning Directive that enable the achievement of a sustainable Blue Economy under the Blue Growth Strategy.

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A fresh (water) case study: the time travel under water project in Lake Attersee

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***Abstract*:** Although many component parts of the transnational UNESCO-World Heritage Prehistoric Pile Dwellings around the Alps are submerged archaeological sites in lakes, they are usually not accessible to recreational divers. Due to the sensible character of the sites, most areas - at least in the Austrian lakes - are no-diving zones. But also, in a more figurative sense, the sites are not easy to access: usually the archaeological remains are covered by lake sediments and are barely visible. In contrast to the distinct fascination of a shipwreck, the prehistoric pile dwellings are rather unspectacular on first sight. Therefore, it is difficult to convey the outstanding universal value and provide a first-hand experience of this extraordinary cultural heritage.

To a certain extend impelled by local diving businesses and the regional tourism agency but also to fill the obvious gap of information and lack of offers for interested sport divers we created in the Lake Attersee / Upper Austria three Underwater Cultural Heritage (UCH) diving spots off site. The places are linked to already established diving entry points and shall also raise the awareness of so far indifferent divers to cultural heritage.

The concept of the „time travel under water project" includes a first on-land introduction, underwater installations with further information, and accompanying mediation offers. Additional offers for non-divers have been conceptualized but could not be implemented due to budget restraints. The inauguration of the three micro UCH diving parks happened in spring 2019. First experiences after the main diving and holiday's season already show that the concept was more than welcome and is well running.

Keywords: Freshwater, Prehistory, Off-Site Attractions, Visitor Guidance, Awareness Raising

1. AN UNKNOWN WORLD HERITAGE

The largest museum on earth is located under water. Somewhat less than ¾ of the earth's surface (approx. 70 %) is covered with water. It contains countless traces of global environmental history and human civilization. However, only about 3% of global water resources are fresh water, most of which is bound to the poles as ice or part of the groundwater. A minimal part of these are open freshwater areas such as lakes, moors and rivers (Shiklomanov,1993).

Understandably, freshwater archaeology also takes a proportionally much smaller share of underwater archaeology. However, due to the excellent conservation conditions under water, some archaeological sites in this area are among the best that archaeology can offer. Particularly in the field of prehistoric settlements, pile-dwelling research, which has existed for over 150 years, has strongly influenced our picture of prehistory in Europe. More than 1000 pile dwelling sites around the Alps document numerous prehistoric cultural groups around the Alps since the 5th millennium BC. Numerous facets of the everyday life, but also the large scale changing climatic conditions and developments of land- and waterscapes and lifestyles in prehistoric times have remained in this context.

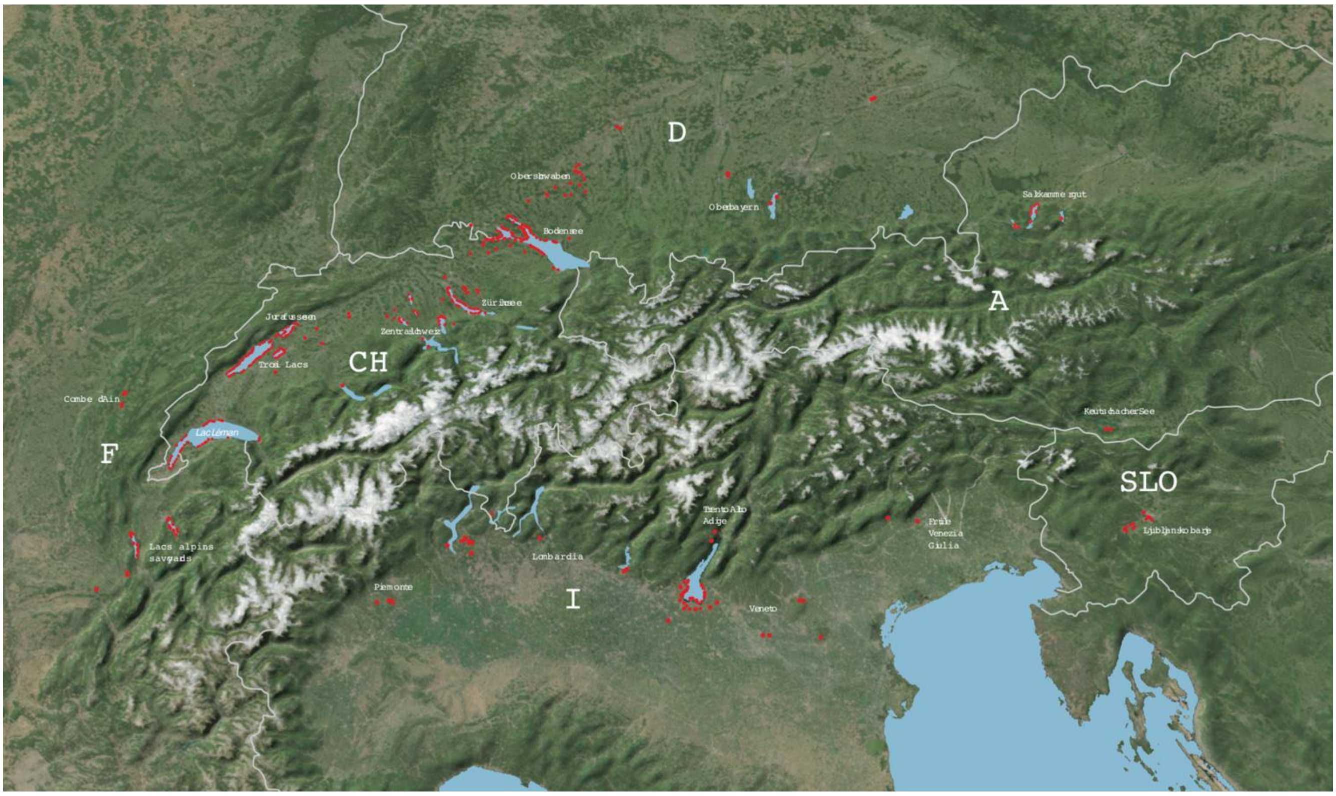

Fig. 1: Map of the known pile dwelling sites around the Alps.

The exceptional qualities of these sites were recognised by UNESCO in 2011 with the inscription of a selection of 111 sites as a serial, transnational World Heritage. Five of those sites are located in lakes in Austria, the rest in Switzerland, Italy, France, Germany and Slovenia. In Austria, an independent organisation was founded for the management of this World Heritage site, the Kuratorium Pfahlbauten. The management staff has expertise in archaeology, cultural heritage management and mediation, as well as communication and conflict management. The Austrian management structure for this UNESCO World Heritage is an international unique one and often used as a successful example for Heritage managements (Dworsky and Novak, 2012).

2. CHALLENGES OF THE PILE DWELLINGS WORLD HERITAGE IN A LANDLOCKED COUNTRY

What the UNESCO World Heritage of Prehistoric Pile Dwellings around the Alps has in common with other underwater archaeological sites is a generally limited access to the archaeological sites. In principle, direct access is only possible for a relatively small group of people with a diving training. In the case of pile dwellings - at least this is the case for the sites in Austria - diving prohibition zones have also been decreed. This is to protect the fragile remains of these prehistoric village sites, which lie close to the surface, from deliberate and unintentional destruction.

These protection zones were introduced at the instigation of the Austrian Federal Monument Office because it was not possible to control and intensively supervise the sites. Extensive plundering of the archaeological material by recreational divers was numerous before and was never completely prevented even after the introduction of the no-diving zones. The lack of awareness in the diving community of the need to protect cultural heritage under water is still noticeable today in discussions online and offline. It is regularly fuelled by the treasure diving mentality of well-known diving pioneers and swashbucklers.

Effective protection of archaeological sites in situ must always be accompanied by awareness-raising measures that go beyond the legal framework. There are already some successful programmes for the popularisation of monument protection and cultural heritage, such as the European Heritage Days. However, these usually refer to "classical" topics and hardly touch the cultural heritage under water in Austria. Therefore, a new awareness-raising programme for recreational divers had to be set up from the scratch. In this context it should be mentioned that the 2001 Paris UNESCO Convention for the Protection of the Underwater Cultural Heritage has not been signed by the Republic of Austria. Nevertheless, as an organisation that deals professionally with underwater archaeological heritage issues, we feel committed to the principles of the Paris-Convention. We see our task in a holistic approach to the general protection of archaeological sites in Austria and beyond. For this reason, target-group-specific offers and information for recreational divers have long been on the to-do list of the Kuratorium Pfahlbauten. The inquiry of the tourism association at the Attersee – the lake with the most pile dwelling sites currently known in Austria - for the support with an underwater pile dwelling museum offered finally the impulse to develop a concept for three new micro dive parks. The developed programme is not only about a deeper understanding for the protection of the UNESCO - World Heritage Prehistoric Lake Dwellings. It is furthermore about a general positive attitude and an awareness that some of our global cultural heritage lies hidden under water.

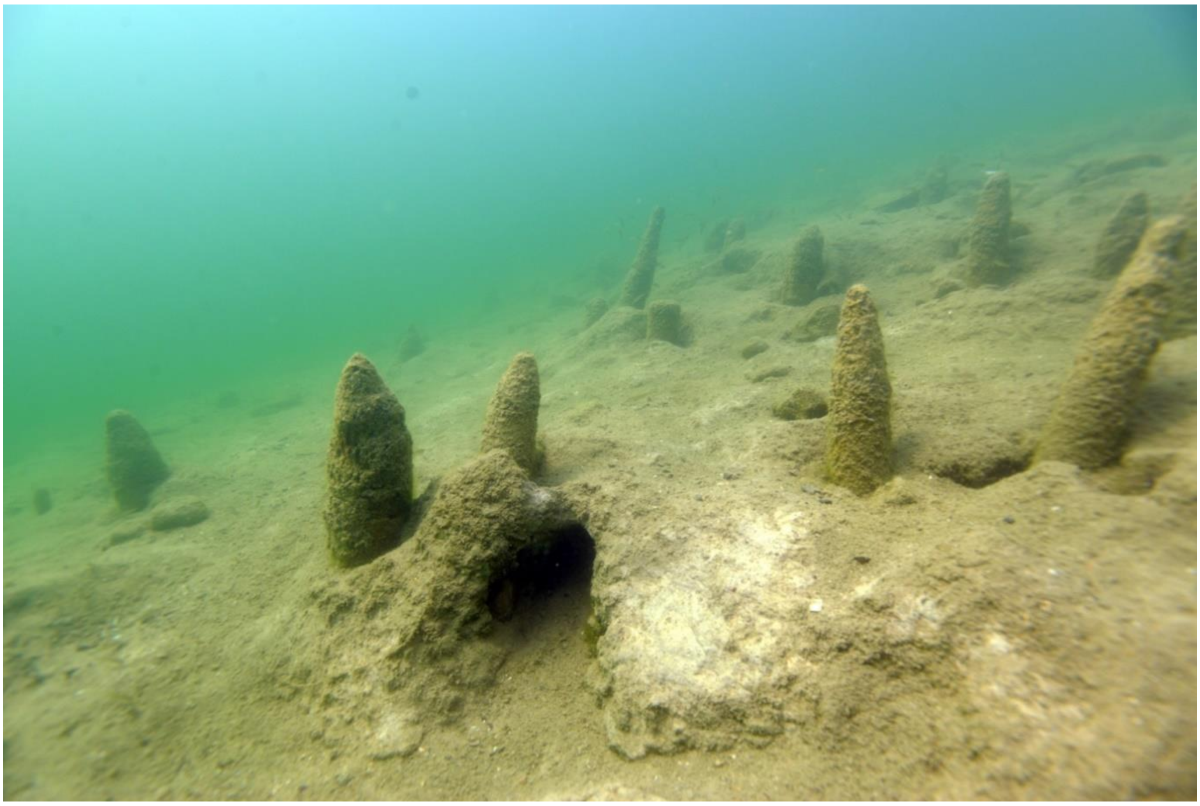

Fig. 2: The eroded pile field of the UNESCO-World Heritage Site of Keutschach am See (Carinthia)

2.1 Setting up the stage

For the tourism managers the primary importance is to create new offers and products. Therefore, the valorisation of the UNESCO World Heritage Sites in the region was welcomed. For the Kuratorium Pfahlbauten, on the other hand, the project focused on creating a communication platform with recreational divers.

The original wish or idea of the tourism managers and diving sport providers was to sink in three places in the Attersee 1:1 models of a Neolithic pile dwelling house, as authentic as possible. Thus, an open-air museum as it is known for example from the Lago di Ledro in Italy or the Pile Dwellings Museum in Unteruhldingen/Germany, only under water.

Fig. 3: Placing the "pile dwellers house" (© Tauchkompetenzzentrum Attersee)

Alas, this would have exceeded the available budget (the project was co-financed within the framework of the European EFRE funding scheme) as well as the conceptual claim of a more open presentation of underwater cultural heritage. Our aim was to achieve a higher degree of abstraction in the presentation. This was necessary to be more flexible in the depicturing of prehistoric pile dwellings. Research on the underwater sites and how the houses were constructed is just at the beginning in Austria. In any case, the impression that the stagings could be real archaeological sites or even still existing houses from prehistory should be avoided. Clearing up such misunderstandings is a common challenge for open-air museums. The limited picture of an interpretation, frozen at a certain point in time, is a compelling representation and offers a static set for imagination of the Prehistory.

The aim was also to incorporate the needs of recreational divers into the design. After consultations with local diving organizations, how to build up an exciting and safe dive experience for them, the concept was designed accordingly. Their most important wish was to plan the dive sites more spatially as a flow of information, because most recreational divers are used to stay in motion and do not like to remain longer in one place. For this reason, care was taken to ensure that the three locations to be designed offer the possibility of a "circular route" and that the information is distributed as continuously as possible in small, easy to digest portions over a longer distance.

Since many of the divers at the lake Attersee are tourists, and many of those are day tourists, it was assumed that they only come into contact with the topic of pile dwellings at one or at most two of the new underwater attraction sites. Therefore, even though the detailed contents of each of the three planned station are different, the same basic information on pile dwellings, the UNESCO-World Heritage and cultural heritage under water was designed for each location.

All of the dive sites are suitable for beginners, only one site was considered more difficult due to the greater diving depths at the beginning. For this specific diving spot, we initially designed a concept of a mini-statues-park, which aimed particularly at atmosphere and not so much on knowledge transfer. At the end this diving spot was ruled out to provide better access and also out of local political reasons. Still the mini-statues-park was kept as part of the general concept but translocated to a different diving spot.

Taking into account the existing infrastructure for divers and the requirements of the nature conservation authorities and fishing associations, three different mini diving parks on the topic of pile dwellings and underwater cultural heritage were finally opened on Lake Attersee in May 2019.

3. THREE WAYS TO DIVE INTO HISTORY

Three main topics were selected for the content and formal design of the three diving spots:

- the pile dwellers house as an icon of prehistory and as a starting point for a further examination of cultural heritage under water
- the people of pile dwellings as representatives of prehistoric epochs and changes in civilization
- the pile field as a symbol of the archaeological sciences and as a link to the other countries of the pile dwelling World Heritage

3.1 The house as nucleus

The first station was designed as a modern "underwater info pavilion" in the form of a stylized building with information areas (texts and pictures) about the construction of pile-dwelling villages, the architecture of prehistoric houses in general and wood working technologies. Similar examples of information pavilions on land already exist in Austria and Germany, where simple house structures are used as carriers for text boards as well. At each of the three entry points on land, introductory panels on the UNESCO World Heritage Lake Dwellings and on the respective topics were also erected. (See Fig. 7) On these panels more information text could be provided, because here - on dry land - the divers prepare themselves for the forthcoming dive, or rest after the dive. In contrast, the underwater information boards were designed with concise and short texts in mind.

In future, step by step, the information panels of the "pile dwelling house" will be extended with new information or changing subjects. Over the years new topics regarding the cultural heritage under water will be introduced at this station.

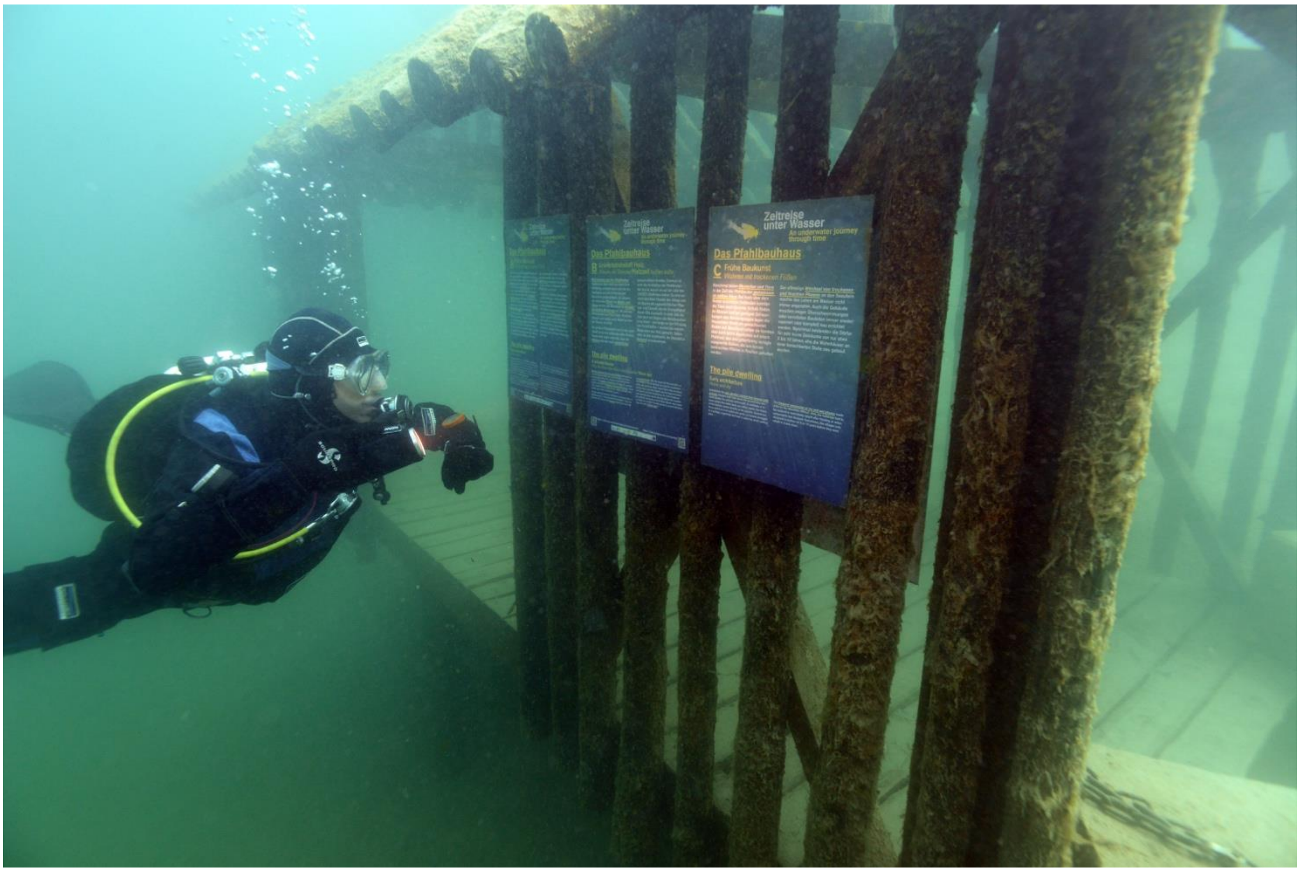

Fig. 4: A first visitor at the "pile dwellers house"

3.2 Humans in prehistory

The "people of the pile dwellings" station was created together with a local wood sculptor. Three groups with three statues each were created on the basis of real live models from "prehistoric fashion shows". In these archaeological outreach projects, lay models wear clothes reconstructed from archaeological sources. In this way, vivid examples of the appearance of people in prehistory and in the respective contexts of archaeology and natural sciences are presented.

On the related description panels under water these models can be seen in real photos with a short explanation of the relevant epoch and the innovations in appearance, in order to be able to give more detail and provide more connections to the wooden statues. As the statues will soon be occupied by algae, mussels and other microorganisms, an exaggerated attention to details was not intended.

Since lake dwellings on the shores of the pre-alpine lakes manifested themselves over a long period from the 5th millennium to the 1st millennium B.C., three figures for every group of statues were created as representatives of the three epochs: Stone Age (Neolithics), Bronze Age and Iron Age.

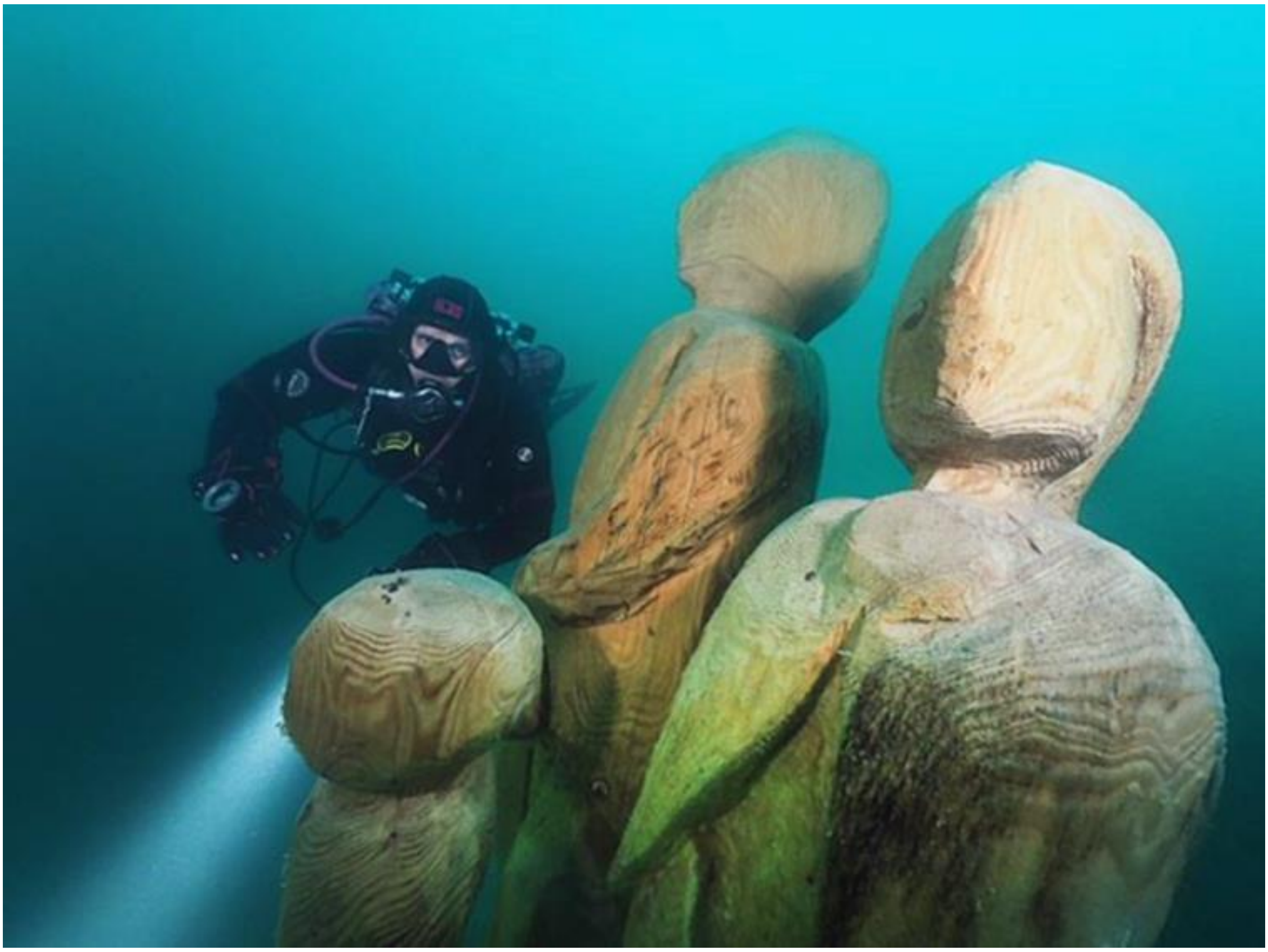

Fig. 5: The wooden statues are still quite sterile and need more patina for a good diving experience. (© Under Pressure)

3.3 A forest of piles

The third station illustrates on one hand the serial world heritage, and on the other hand it refers to the remnants of the pile-dwelling sites under water and the finds hidden therein. In a labyrinth of 111 piles, the divers move as in a distorted representation of an underwater excavation site. This super-elevated pile field symbolizes the eroded structure of a prehistoric village and its decay. The poles are arranged in such a way that the imaginary remains of a footbridge, as access to the settlement, a round palisade to protect the village and the foundation poles form a single, ruinous house can be imagined.

Of course, the number of piles has to be seen as a reference to a World Heritage site in six different countries. In this way, visitors again are informed that these are not just individual important sites for the study of our human history, but it is the joint statement of this phenomenon that constitutes the World Heritage.

As an extension of the dive in this "forest of piles", models and explanations of finds from the pile dwellings sites will be successively attached to the heads of the piles. The aim of this element is to satisfy the divers' "hunger" for finding objects. But also, to offer small insights into the variety of archaeological topics, which are represented by these findings. The models are produced in a 3D printer according to models from local and national collections, whereby not only Austrian objects, but also finds from other countries are going to be exhibited. Explanation panels for each object are also provided.

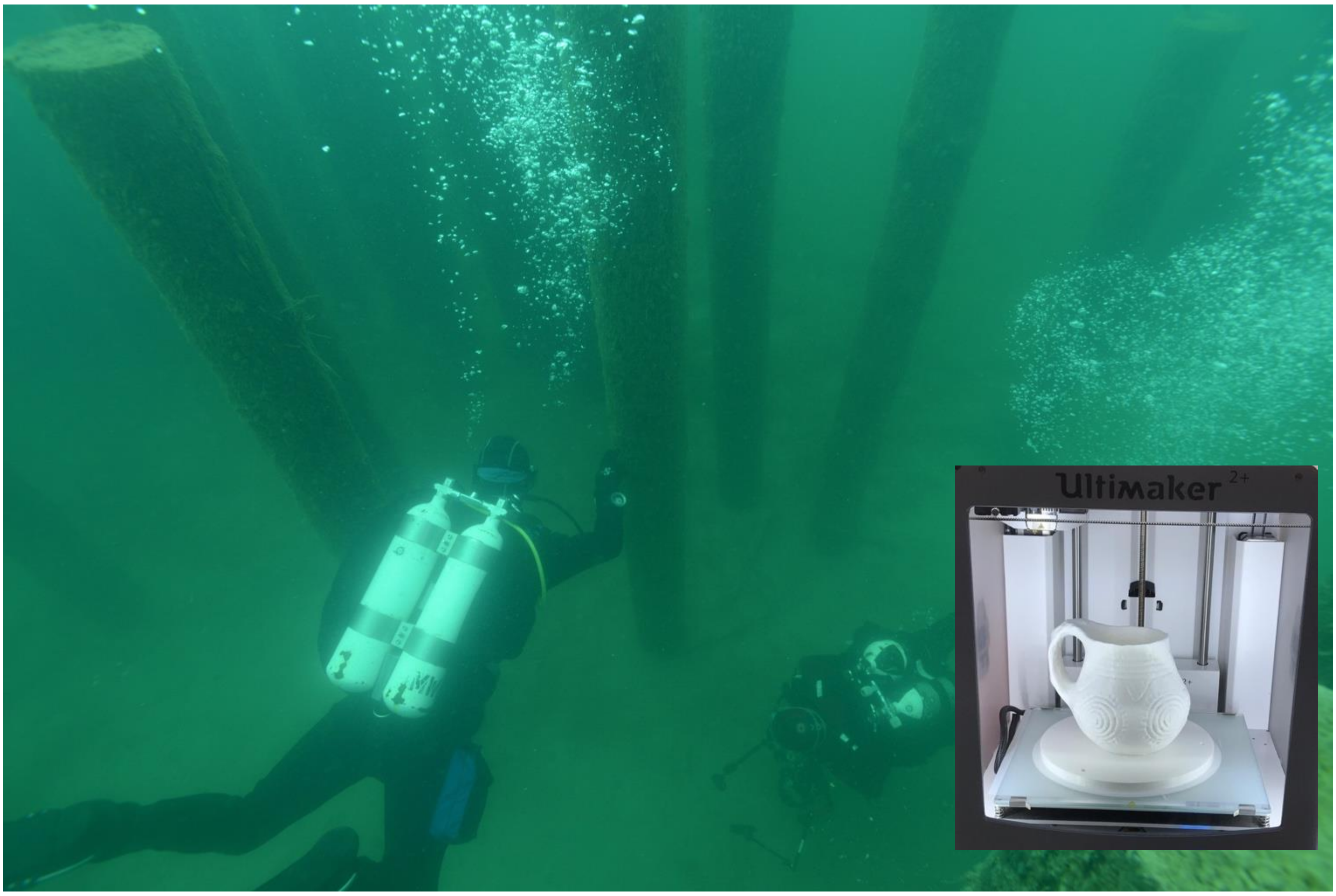

Fig. 6: The "pile field" and a 3D-printed ceramic of the Neolithic Mondsee culture

4. EXPERIENCES AND FUTURE THINKING – EXPLORING NEW ENGAGEMENTS WITH HERITAGE

After about half a year one can say that the three mini dive parks were very well received by the diving community and the local tourism companies. Several German diving magazines have already reported about the facility. The personal feedback and the comments in social media are mostly very positive - criticism predominantly refers to a basic discussion about the exuberant tourism in the region. In this respect the underwater attractions offer a good supplement to the touristic offers at the lake, since diving tourism is all-season. It will only be possible to say at the end of the year 2019 season whether positive impact of the facility on tourism indicators as overnight stays will also be reflected in tourism figures. Overall, there is still a need for optimisation in various areas. For example, the texts in some areas have to be revised, because despite the self-limitation to short texts, there is still feedback that too demanding information is given. Although the main target group comes from the German-speaking area, all information and printed materials are provided bilingually in German and English. Of course, this also increases the space requirement and the general impression of overloading with text.

In cooperation with the local diving providers and clubs, accompanying offers will also be created in future. For example, guided dives will be developed, which include preparation and debriefing to provide more fist hand information from trained facilitators. Additional information material will also be produced to prepare the topic on land and to expand the knowledge to the internet and social media channels. Preferably most of the information should be channelled to owned media as personal reports on our "Pfahlbauten-Blog" or shared links on our Facebook or Instagram accounts, whereby we bind the community to those media that convey our core messages.

Generally, the mediation of cultural heritage should be more interactive and aimed at discoveries. It is planned to explore more playful methods to interact with the heritage. One example could be to include small searching games, e.g. to place objects of modern daily life or modern trash as part of the collection of 3-D printed objects and create something like a quiz out of this. This would also trigger interesting discussions on the confines of archaeology in general. Such "Ironic approaches", as promoted by Cornelius Holtorf, could help to facilitate the dialogue between conservationists and the diving community, which is often marked by mistrust and misunderstandings. (Holtorf 2010)

Also, the dimensions of authenticity can be explored nicely in a further evaluation of the project, which should support our future planning of the mediation and valorisation of the World Heritage. Although it was deliberately planned to avoid a sensation of "being at a real archaeological site" and no experience of the "genius loci" was intended, still many divers experience a sensation of authenticity and notion of "pastness" and wonder on the authenticity of the dive parks. (Holtorf 2011) More experiences with the 3D-objects have to be collected, as this element of the project was installed later, but first feedback underlines that lack of authenticity has to be seen in the context of presentation and must not be contradictory to the intended outcomes. Especially if complementary offers – e.g. the local museums with original finds – are available and part of the communication strategy. (See the study of Hampp and Schwan on the role and various dimensions of authenticity: Hampp and Schwan 2014, p.10)

This project has to be seen as a pilot program to provide access to cultural heritage under water that is currently inaccessible. The facility was planned to raise the awareness on cultural heritage but could also act as a training ground for divers to get acquainted with the proper behaviour in sensitive protected areas or even to learn more in depth skills necessary to participate in underwater archaeological endeavours.

However, it is only necessary in exceptional cases to go "deep". The new diving attractions at the Attersee should rather open offers for a new target group, sport divers, which is of enormous importance for the preservation of the lake dwellings and the future of cultural heritage under water. Similar to "archaeological windows" in public spaces, ideas and stories shall be transported in an easy and compelling way at this first interpretation centres for cultural heritage under water. With this micro dive parks, we would like to provide a spark for the consideration of the past and the future, or even the foundation for a better recognition and acceptance of archaeological contexts.

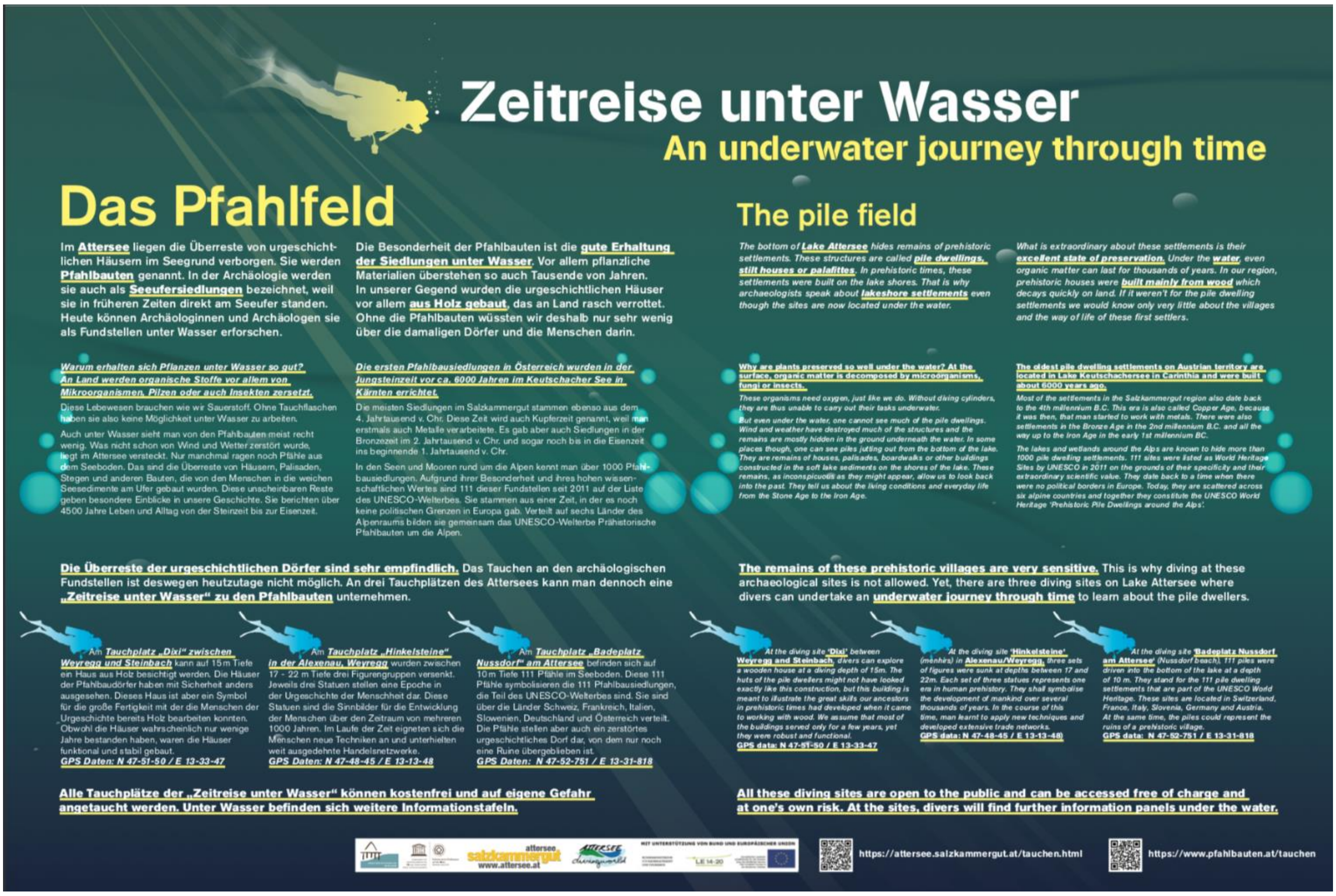

Fig. 7: Big bilingual information panel at the entry spots on land.

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A framework for the evaluation of Cultural Ecosystem Services in Underwater Cultural Heritage spaces

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***Abstract*:** The Underwater Cultural Heritage spaces have a value per se which necessitates their preservation and management. The establishment of accessible underwater cultural sites and diving parks creates financial benefits at regional and local level which have already under study. What is less investigated is frameworks able to take into account the Total Economic Value of the environmental and socio-cultural benefits.

In this work an attempt is performed to develop a conceptual model of evaluating the above benefits that the public enjoys in Underwater Cultural Heritage (UCH) settings. From a socio-economics perspective, it aims to review methods already applied in the context of environmental economics in order to capture the perceptions of the public towards qualitative and quantitative evaluation of the cultural ecosystem services that these spaces offer. It includes new methods based on story-telling and GIS.

The blue tourism as a development of the ecotourism concept is planned to take into account the 3 pillars of sustainable tourism (development), namely economic, social-cultural and environmental. It focuses on the maritime and coastal natural resources as tourism objects to develop attractions (such as marine biology, marine recreation) and still offers aspects of learning, of environmental as well as cultural conservation. The greater these attractions and its products the higher is the value of interest in it as a blue tourism destination. The conceptual model of this work can be applied in case studies of UCH spaces that need to assess that value. The natural and cultural preservation aspects, which are important for the establishment of UCH spaces, if translated in Cultural Ecosystem Services and valued will be able to capture better the benefits from tourism development interventions.

***Keywords*:** cultural ecosystem services, underwater cultural heritage sites, blue tourism, evaluation methods

1. INTRODUCTION

The concept of sustainable development originates officially back to 1969 in the US National Environmental Policy Act, and its growth as practice was a result of the 1972 United National Conference of the Human Environment in Sweden. However, it is known that the term derives from an old forestry term "sustainable yield" or "nachhaltiger Ertrag" in German forestry dating from 1713. Nowadays, the achievement of sustainable development needs a balance between the exploitation of natural or cultural resources for socio-economic (including touristic) development and conservation of the ecosystems that are critical for human well-being and communities' livelihoods. There is no recipe for obtaining that balance and within the sustainable tourism context many concepts have been proposed attempting to understand how resources and ecosystems or heritage contribute to livelihoods, who benefits and who loses from tourist development interventions.

Resources such as the cultural and natural ones are usually considered as public goods that do not fall in the monetary system. This is true on the one hand in the sense that they encompass all the characteristics of public goods, meaning non-rivalry and non-excludability 53. And for that reason appear "market failures" for those collective consumption goods, or common pool resources. The fact that for those goods are missing the markets where these will be provided efficiently and fairly, means that no proper budget is allocated for their preservation and the system fails to sustain them for future generation. Of course the cultural heritage has a value per se and for that value should be preserved and managed. On the other side, the practice shows that the cultural resources as common-pool resources are not subject to evaluation and for that reason are unrecognized and under-valued in planning and policy making.

In this work is adopted an environmental economics perspective, that considers crucial the process of attaching a value to resources, especially important for the non-renewable resources such as heritage. That value reveals to policy makers the benefits from their preservation, stops or reduces the cost of their degradation and helps raising awareness of the general public. The adoption of monetary equivalents within the context of natural and cultural capital does not aim at assigning a market value to these resources but at making them visible and comprehensible to policy makers, users and the general public. The purpose of the valuation is not to pave the commodification of nature and culture but to link economic value with elements of natural and cultural environment. Incorporating these values in management decisions can sustain the flow of their goods and services in the interest of current and future generations.

The last years, the policy works towards the direction of expanding the networks of marine protected areas, diving parks, UCH sites offering many opportunities for diving and blue tourism. This necessitates a research towards stakeholders perceptions in order to understand the societal perspectives and potential conflicts, trade offs and synergies among groups before taking relative policy measures. A research that reveals who and which resources benefit and who loses from blue tourism development interventions accounting for the total socio-cultural and economic values is of urgent need.

The conceptual framework adopted in this work towards the evaluation of UCH sites is the Ecosystem Services (ES) framework. This is an approach research and applied in depth since years in the sector of environmental conservation and has been introduced in the European policies towards environmental management. It is used for the classification and evaluation of the services that the ecosystem provides to humans and has affected up to now the conservation strategy. It is considered one of their subcategories, the Cultural Ecosystem Services (CES) can have direct application to UCH sites, as it is related to the provision of benefits such as seascape aesthetics, the recreation and tourism, the sense of belonging, the cultural identity, the educational and spiritual services to the public, which accrue from marine and underwater cultural resources, which will be analyzed in the next chapters. The CES are closely associated with the societal perspectives that need to be evaluated before taking policy decisions related to marine, underwater and cultural management. They reflect the value that the diverse stakeholders enjoy from different tourism interventions. A research focusing on CES valuation can widen the range of information regarding the benefits from the marine and UCH preservation especially for decisions involving trade-offs between cultural underwater protection and opportunity costs of the blue economy.

[53] The non-rivalry characteristic means that when a good is consumed, it does not reduce the amount available for others. The non-excludability characteristic means that it is not possible to provide the public good to someone without it being possible for a whole community to enjoy it.

The CES are important in different way in each society. In industrialized societies f.e. their importance is shown with an increasing budget share towards cultural activities, while in traditional communities are essential for survival or common identity. In all cases due to their close link with human attitudes towards natural and cultural environment they have the potential to motivate and sustain the public support towards cultural heritage preservation and ecosystem protection.

Yet CES are understudied due to their particular inter-disciplinary nature, confusing meanings and intangible, qualitative character. Social Cost-Benefit Analyses and impact assessments usually lack cultural benefits of these natural and cultural resources as there are not standard assessment indicators and as their evaluation raises methodological challenges. There is the need to clarify the diverse evaluation methods and analyses useful for decision making in order to interpret social perspectives of well-being and CES aspects by including more perception studies and combining deliberative with qualitative methods.

2. ECOSYSTEM SERVICES POLICY FRAMEWORK AND THE MAIN CLASSIFICATION SYSTEMS

2.1. Policy framework

The concept of Ecosystem Services (ES) dates back in the late 1970s when beneficial ecosystem functions were attempted to be defined and promoted from a utilitarian approach in order to increase public support for conservation. In the mid 1990s it emerges in literature and researchers such as R. Costanza (Costanza et al. 1997) and Daily G.H. (Daily et al. 1997) introduce the idea of estimating their economic value. In early 2000s the ES receive increased attention and with the publication of the Millennium Ecosystem Assessment synthesis reports (MAE, 2005), are introduced in the policy agenda, and are classified. In that publication ES as well as their subcategory CES are officially defined as a framework for assisting the understanding of ecosystem functions and processes and the relationship with human well-being.

At the policy level, there is no European policy to govern the ES, however since 1992 the approach of ES management has affected the policies on natural resources conservation. The UN Convention on Biological Diversity (CBD) brings in 1992 as primary framework for action the equilibrium between: the integrated management of land, living and water resources with clear references to ES approach. The European Marine Strategy Directive (2008/56/EC) links the ES approach to the human pressures and impacts on the marine environment with 11 descriptors and does so towards the target of reaching a Good Environmental Status for marine waters by 2020.

In 2014, the EU Maritime Spatial Planning Directive 2014/89/EU necessitates the evaluation of conflicting uses and makes clear that marine strategies *"shall apply an ecosystem-based approach to the management of human activities, ensuring that the collective pressure of such activities is kept within levels compatible with the achievement of good environmental status and that the capacity of marine ecosystems to respond to human-induced changes is not compromised, while enabling the sustainable use of marine goods and services by present and future generations"*. It introduces the idea of zoning where each use can be assigned to a zone where it is performed, which is crucial for the case of UCH sites. The relationship between each cultural ecosystem service with an UCH site can be allocated geographically and mapped, the impacts on the services from different uses can be assessed and zones be attributes according to the uses of high dependence and minimal impacts to the UCH site.

As can be seen the policy framework is quite developed and the ES applied and researched in depth, however the subcategory of CES is the least developed one. The CES are still not fully operationalized in the valuation methodologies, while their definitions, conceptual models and assessment indicators are not standardized. Even in cases where CES are considered and evaluated, are nearly always studied the cultural services accruing from the natural resources solely, for example the aesthetic benefit from fish biodiversity, the underwater seascape, the recreational value from whale watching, or the educational value of a Marine Protected Area and the affects on mental health. Cultural services accruing from to history, identity and cultural heritage are quite understudied.

2.2. International frameworks for Ecosystem Services classification and valuation

In this work two of the most respective conceptual frameworks have been reviewed for the definition and classification of CES towards making them more operational not only in policy agenda but also in projects application/decision making.

A) The Millennium Ecosystem Assessment defined ES as the *"benefits that people obtain from ecosystems"* (MEA, 2005) and categorized them in provisioning, regulating, supporting and cultural services. The CES relate to the *"nonmaterial benefits that people obtain from the ecosystem"* and influence the quality of life, are intangible and invisible, while the rest of the ES are considered as material services. In that particular conceptual framework, the classification is based on the practices and experiences that arise in the environmental spaces under consideration, while the last years there is a critique from diverse researchers that this method results in double-counting.

B) The UK National Ecosystem Assessment and its follow-on phase (UK NEAFO) categorizes values according to the environmental settings or spaces themselves were CES can be identified. Specifically mentions that CES *"encompass the environmental spaces and cultural practices that give rise to a range of material and non-material benefits to human well-being. These spaces and practices interact with contemporary cultural values to shape people's identities, provide experiences that contribute benefits in terms of well-being, mental and physical health, and equip people with a range of skills and capabilities"* (Church et al. 2014). This framework allows consideration of well-being benefits that can be captured with qualitative methods such as story-telling as well as consideration of settings which include natural and cultural features associated with existence and bequest values that can be captured with stated preference methods.

Different definitions accompanied by different frameworks for categorization among CES subcategories allows for different valuation approaches. In this work the UK National Ecosystem Assessment and its follow-on phase (UK NEAFO) is considered the most suitable for case studies of UCH sites. These so-called "settings" can be studied in that context not as a sum of individual resources or units but as an interconnected system that contributes to human well-being, that allows including both cultural and natural aspects/characteristics and benefits.

3. BREAKING DOWN CULTURAL ECOSYSTEM SERVICES

3.1. Subcategory of Ecosystem Services

The ES arise when an ecological structure (e.g. wood fiber) or function (e.g., filtering function of vegetation and soils) directly or indirectly contributes toward meeting a human need or want. These services are divided into four categories, namely: provisioning, regulating, cultural and supporting ones and contribute to human well-being. In the marine environment the provisioning services are the food provision, raw materials, fisheries etc. Regulating services are the gas and climate regulation, flood and storm protection etc. Cultural is the recreation and ecotourism, aesthetic values, spiritual and religious values, educational, cultural heritage values etc. While supporting are the basis for all ecosystems and their services and include resilience and resistance, nutrient cycling, maintenance of plants and animals diversity and provision of living spaces (Remoundou, Koundouri et al. 2009). As one can see the cultural ones are mainly related to the non-material benefits the people obtain from ecosystems.

The UCH sites are environmental settings where CES accrue from both cultural and natural environment and this is why they offer unique tourist experiences. In most of the cases the natural resources just co-exist with cultural ones offering a synergistic service, but there are also cases where the natural resources might act as seal for the preservation of the archaeological remains. Such as the case of seagrass meadows which have the potential to stabilize sediments, protect underlying archaeological layers and serve as historical archives. A review of 25 examples across the Baltic Sea, the Mediterranean Sea, the Indian Ocean, the Black Sea and the Gulf of Mexico present evidence of that relationship based on the collaboration of seagrass ecology with marine archaeology (D. Krause-Jensen et al. 2018). This relationship was clear since 1969, when Frost used the seagrass debris to determine the period when a ship sunk in Malta (Frost 1969). The seagrass "seal" around the shipwreck was 4 m thick and the ship was estimated to have been buried 1100 BP.

3.2. Cultural Ecosystem Services in UCH settings

Usually the valuation of marine or underwater ES, in the context of ecotourism or diving tourism projects, takes into account only market related values for tourism and recreation f.e. tourists' expenditures on access, entrance fees, diving equipment cost, fuel, accommodation in order to create a proxy of divers willingness to pay for that kind of activities. However, these valuations fail to capture all the use values (including non-consumptive recreation such as whale watching) and to investigate frameworks that will reveal all the hidden benefits from underwater or marine CES. There is the need to reveal both use and non-use values for that reason is followed the Total Economic Value framework which is essential in socio-economics and includes both value classes.

Use value, to potential divers in UCH sites, is the value of recreating, diving or snorkelling in an area, option value is the value of preserving the UCH site's availability for potential future use and non-use values are altruistic values of maintaining the site for others (the case of non-divers), bequest are the values of maintaining the site for the future generations and existence which is the value that we put on the merely existence of the marine species along with the ancient remains.

Considering the UCH sites as underwater settings allows for valuation of different types of activities/practices, with different types of well being benefits arising from practices through cultural identities, or different knowledge and (diving) skills as well as experiences (spiritual and aesthetic). The valuation of CES in these settings includes the satisfaction/benefit the public places on the sea associated with history, heritage and identity in combination with the diversity of underwater seascapes and a diversity of species more attractive for some users and less for others. What makes attractive an UCH site for snorkeling or diving tourists is the combination of the archaeological remains with the marine biodiversity, the wild sea life and the diversity of the underwater seascape. That is why the protection of biodiversity is crucial for the existence values of UCH sites.

4. VALUATION METHODS FOR CULTURAL ECOSYSTEM SERVICES IN UCH SETTINGS

4.1. Monetary valuation

Regarding the ES in general, there is a variety of the methods used by environmental economists to estimate their value, which are mainly monetary. Following the categorization given previously on the types of values, is necessary to be explained that there is a wide range of methods developed throughout the years to capture the Total Economic Value (TEV) of environmental resources. The values linked with the CES (including non consumptive tourism and ecotourism, heritage, aesthetic etc.) are approached by non-market valuation techniques as they are related to un-priced benefits from marine ecosystems and are not traded in the market (Koundouri et al. 2014). These methods are divided in 2 categories, the revealed preference and the stated preference approaches. The revealed preference methds are based on market information as proxies for uncovering public's preferences, while the stated ones are based on the construction of hypothetical markets and are conducted through direct questionnaires where the public/stakeholders are asked to put value to the services described in the survey or to choose between hypothetical scenarios that include bundles of services that the policy/tourism intervention will affect.

The second category is receiving increasing attention since years by the research community and in this work is believed that perception surveys via stated preference techniques can capture the Total Economic Value provided by marine and heritage resources in UCH sites. Respondents are asked to choose among bundles of services that correspond to existing or hypothetical (policy) scenarios. The services are described by unique characteristics of each ecosystem, which are called "attributes" and in the case of UCH spaces/settings can be the site "attributes" /features, that affect either divers trip choices or the value divers put on protecting the UCH sites against future degradation/harm.

Examples of these key attributes are: underwater seascape, diversity of substrate type, archaeological objects abundance/presence, sea life (wild life), difficulty to dive, water clarity/visibility, access to the UCH site/ distance from home, vulnerable species protected at site, important marine habitats, entrance fee (if applicable), restrictions (to fishing, mooring, trawling etc) (modified by N. Jobstvogt et al 2014).

Results from these evaluations can answer to questions raised before decisions on blue tourism interventions, such as: what are the benefits from the preservation of the underwater cultural heritage along with marine biodiversity conservation? What is the public's willingness-to-pay for the services (whether potential entrance fee is investigated or public financing for a UCH site is examined)? What attribute(s) affect(s) most the respondents perception? Finally, examining the statistical significance among the different groups of stakeholders can explain each group's Willingness-To-Pay and answer to questions such as: Which will be the potential trade-offs among stakeholders categories from the different policy scenarios? Will there be mutual benefits from policy combinations?

4.2. Non-monetary valuation

Depending on the type of information needed for policy-making as well as due to some types of CES that cannot be expressed in monetary terms, the last years non-monetary methods are receiving highly increasing attention. Thirteen different methods were identified by X.Cheng et al. (2019) divided again in revealed and stated preference ones. The three revealed methods use observation, or texts, images photos taken by the public, advertisements or social media data (such as photos with cultural heritage or wildlife) as proxies to obtain the values the public places on types of ecotourism.

Non-monetary stated preference methods use questionnaires with questions on qualitative information, narratives asking respondents to engage in story-telling or describe their perception on well-being from CES. Special interest appears in techniques such as participatory mapping, participatory GIS or public participatory GIS. These incorporate participatory methods (for example questionnaires) where respondents are asked to indicate on maps the hotspots of their perceived CES. The 'participatory mapping method' links the CES perceived by respondents to specific locations, while the participatory GIS incorporates GIS, GPS and remote sensing image analysis software together with questionnaires or interviews human spatial knowledge. While the public participatory GIS brings out the perceptions of the public with the use of geographic technology education. These methods can be valuable if combined with citizen science in order to obtain volunteered geographic information and their results can inform spatial planning decisions.

5. CONCLUSION

There is already rich research and application background on environmental and natural resource economic techniques that have evaluated natural resources towards ecotourism and are ready to be adopted and researched further in UCH settings. In parallel, the Greek Ministry of Culture and Sports is already in collaboration with regional authorities in order to render the UCH sites accessible. Considering the potential of these steps to attract blue tourism as Greece posses the richest underwater shipwrecks in the Mediterranean as well as the importance of Blue Growth in the European policy context and, it is important that the research towards that direction be linked with environmental economics research. The natural and cultural preservation aspects important for the establishment of UCH sites if translated in CES benefits and valued will be able to capture better the CES from tourism development interventions. This progress can also produce new inter-disciplinary data and results, offer opportunities for innovative research, for bridging the gap among intellectual heritages, for education and awareness raising towards preservation.

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The S/S Burdigala former Schnelldampfer Kaiser Friedrich (1897-1916)

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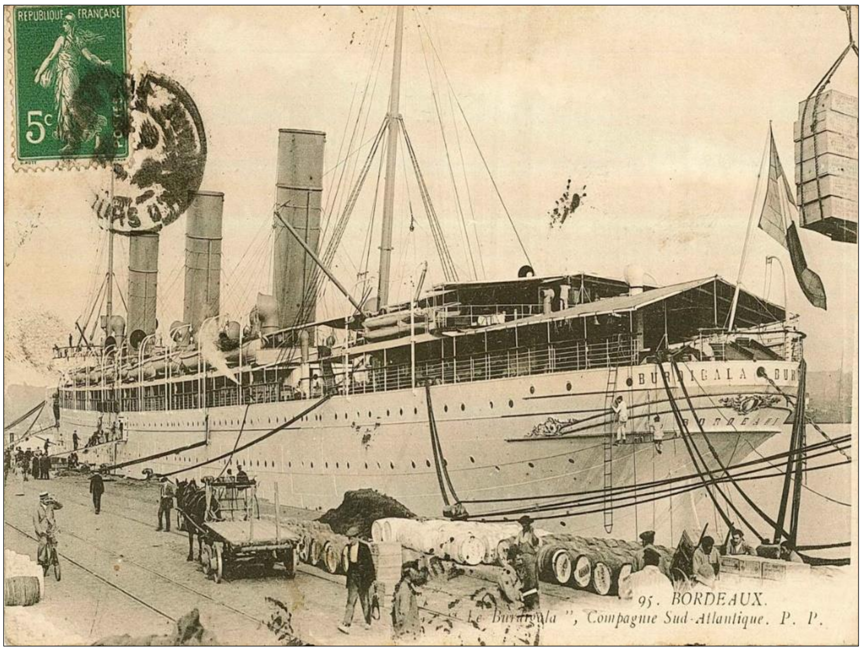
Abstract**:** The luxury ocean liner S/S *Burdigala*, formerly known as Schnelldampfer *Kaiser Friedrich*, which struck a mine and sank at the northwest off the island of Kea on the 14th of November 1916, is one of the most important shipwrecks of the Greek Seas due to her historical role in the transatlantic immigration story of the North and South American continents. Her direct connection to the social and political crisis of the beginning of the 20th century and her intertwined destiny with the hospital steam ship HMHS *Britannic* makes her one of the last witnesses of the World War I. The S/S *Burdigala* is the second largest preserved shipwreck in modern history that has been discovered in the Greek Archipelago and she officiates as one of the protagonists of the historical ocean liners that were lost during World War I in the eastern Mediterranean. Therefore, she deserves not only to be considered as an *Accessible Underwater Cultural Heritage Site* but also to be a part of the planned *"Underwater Cultural Diving Park of the Island of Kea"*.

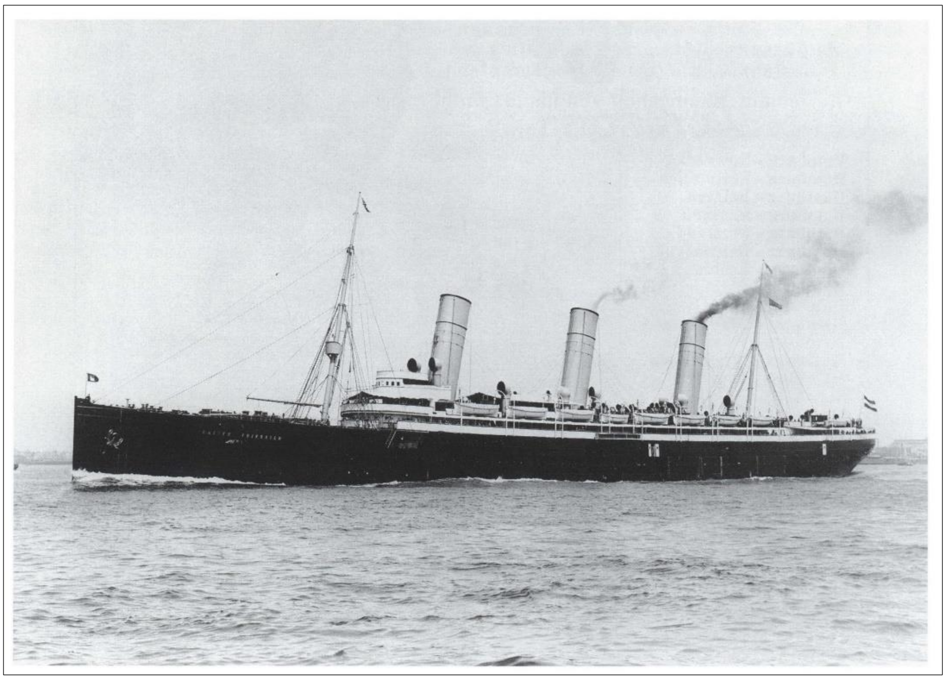
Keywords: Burdigala, Britannic, World War I, Historical Wrecks, Diving, History, Underwater Cultural Heritage, Diving Park, Island of Kea



1. INTRODUCTION

Just as human history is dominated by powerful figures, so is the history of maritime shipping marked by large and powerful ships, some of which became central in the development and prosperity of shipping industry itself. The history of these vessels is intertwined not only with the companies that showcased them, but also with significant events that make up human history. The French ocean liner S/S Burdigala, or S/S Kaiser Friedrich as she was first christened, claims a position in the history of

North Atlantic steam navigation unlike any other ship associated with the development of shipping. Unlike other ships, S/S Burdigala was well-known for her failures, rather than her successes. This vessel was constructed for one of the most important shipping companies of Imperial Germany, the Norddeutscher Lloyd, or better known as NDL, with the intent to compete for the prize of speed and luxury in the most highly demanding shipping route of the time, the North Atlantic route. She failed to fulfill the expectations of her owner, who had contractually specified that the ship's minimum speed be 22 knots, a number that the vessel never achieved. This failure tainted her, throughout her 17 years of existence; she served for less than five years and was condemned to remain mothballed in storage, dry dock, and port for the remainder of her time.



2. BORN THE GERMAN SCHNELLDAMPFER KAISER FRIEDRICH (1897 – 1912)

At the end of 1895, the Norddeutscher Lloyd, under the administration of manager Dr. Heinrich Wiegand, set up the ambitious goal of taking over the Europe to North America shipping route then dominated by the British. To accomplish this, the company needed ships capable not only of crossing the Atlantic faster than the ships of companies like HAPAG of Hamburg or the French Line, but also faster than the renowned ships of the British Cunard Line. For this purpose, Dr. Wiegand ordered two ocean liners from two shipyards; the A.G. Vulcan shipyard of Stettin constructed the ocean liner Kaiser Wilhelm der Grosse while the Ferdinand Schichau of Danzig built the ocean liner Kaiser Friedrich. In accordance with the Norddeutscher Lloyd policy, vessels' names honored the Kaisers of the Hohenzollern family from which Kaiser Wilhelm II and his ancestors descended. The contract between the Schichau shipyard and NDL stipulated that the test speed of the Kaiser Friedrich be 22,5 knots for a period of six hours and that the guaranteed speed be at least 21 knots, so that the total duration of a transatlantic voyage was exactly six days.

Predicated on these requirements, she was designed with the following characteristics:

Length: 183 m

Width: 19,4 m

Tonnage: 12.480 GRT54

Displacement: 20.100 tons

The two five-cylinder reciprocating engines of quadruple expansion drove two three-wing brass propellers of 6,19 m in diameter. The engines were supposed to have a maximum indicative power of 28.000 hp and, in combination with the 15,5 bar pressure of the ten boilers of the ship, they could offer an important savings on coal according to the estimations of the Schichau engineers. Unlike the common construction practices of that period, F. Schichau placed the ship engines a little more forward, between the second and the third boilers. The ship had nine main boilers, each fitted with two coal-loading trap doors, plus a tenth auxiliary boiler. These were positioned in three watertight compartments, each with a funnel.

After construction concluded in May 1898, the vessel undertook her first voyage on the 12th of May from Danzig to Bremerhaven, the mother port of NDL. During that voyage, the engineers of NDL observed with great disappointment that Kaiser Friedrich was only able of reaching 20 knots with huge effort and could not surpass that speed. On her arrival in Bremerhaven, NDL refused to accept delivery based on the explicit conditions of the contract and her poor performance. The F. Schichau shipyard promised it would improve her speed, and so NDL tentatively accepted Kaiser Friedrich into its fleet.

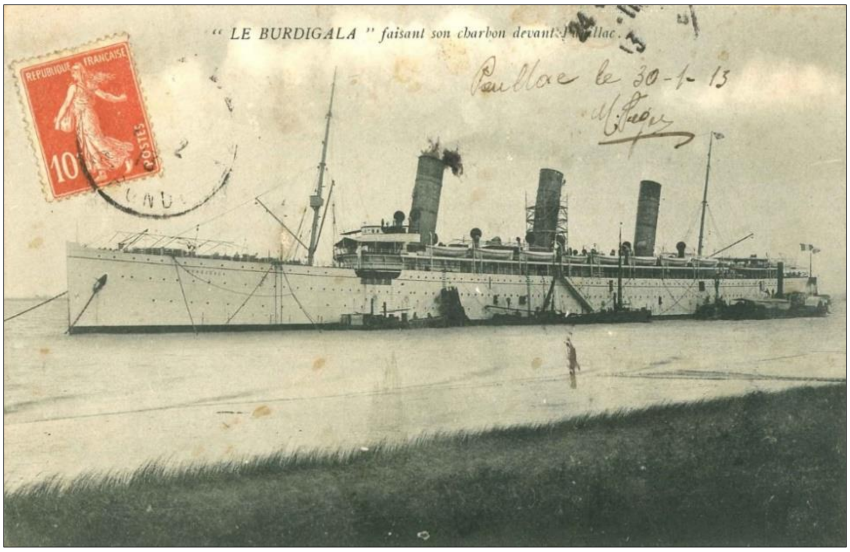
Her first transatlantic voyage was to be from Bremerhaven to Southampton and then to New York. On the 7th of June 1898, Kaiser Friedrich sailed under the command of NDL Captain Ludwig Störmer from Bremen to Southampton. On 8th of June she began her first transatlantic voyage towards New York. The voyage started well, but quickly, bad weather and engineering problems decreased the speed of the ship. Later, the operation of the left engine halted for 20 hours and 26 minutes, and then the same happened with the right engine for 11 hours and 42 minutes. The Marine Engineer magazine stated that the cause of these problems was the "failure of the slide valves to work smoothly and to the breakage of studs on the air pump brackets, so that a proper vacuum could not be maintained." The result was disastrous, as the voyage of Kaiser Friedrich from Southampton to Sandy Hook, New York lasted 7 days, 10 hours, and 15 minutes, finally ending on the 16th of June 1898.

On the 25th of June 1898, S/S Kaiser Friedrich began her return voyage to Southampton without passengers; this lasted 9 days, 2 hours, and 30 minutes. Due to her low average speed of 15 knots and

[54] *GRT* stands for *Gross Register Tonnage*

the mechanical problems that again plagued the voyage, NDL cancelled the next two scheduled voyages. The ship was sent to the F. Schichau shipyard in Danzig to be fixed, with the intent to reach the promised 22 knots. Over the coming months, S/S Kaiser Friedrich fulfilled nine more voyages, of which the fastest was six days, 22 hours, and 30 minutes, placing the ship firmly in the class of 19 knots. On the 27th of June 1899, NDL returned Kaiser Friedrich to her construction company with the official reason that the ship did not fulfill the speed requirement of the contract.

In 1898, the shipping company Hamburg Amerikanische Packetfahrt Actien Gesellschaft, better known as HAPAG, sold one of its oceangoing ships to the Spanish government. They then decided to charter Kaiser Friedrich from F. Schichau and added her to its express line from Hamburg to Southampton, and New York. On 2nd October 1899, Kaiser Friedrich departed from Southampton to New York for her first transatlantic voyage with HAPAG. Over the next few months, the ship completed nine transatlantic voyages. According to the press of that period, Kaiser Friedrich looked like she had finally found a home in the HAPAG fleet; her speed was comparable to that of other oceangoing vessels while offering a more luxurious and sophisticated accommodations than the others. In July 1900, HAPAG received the newly constructed ocean liner, the S/S Deutschland, and within only a few months, she conquered the speed trophy, the so-called "Blue Riband." This accomplishment signaled the entry of HAPAG into the superior class of transatlantic shipping and the end of chartering the Kaiser Friedrich. In October of 1900, Kaiser Friedrich began her last transatlantic voyage from New York. Upon her arrival in Hamburg, she was returned to F. Schichau, who laid her



up in Hamburg where she stayed for almost 12 years.

3. AS FRENCH PAQUEBOT POSTAL À GRANDE VITESSE BURDIGALA (1912 – 1916)

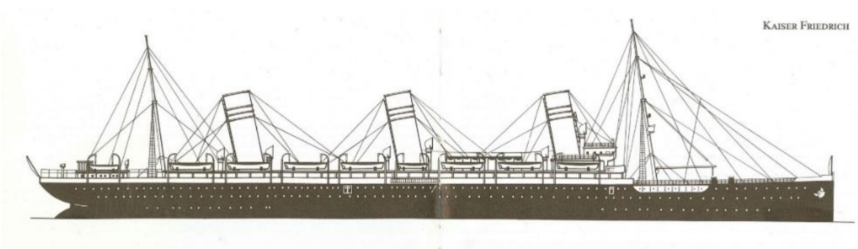
The Kaiser Friedrich remained inactive in Hamburg until the 1st of May 1912, when she was bought for 4.000.000 French francs by the Compagnie de Navigation Sud-Atlantique, based in Bordeaux, France. The ship was renamed Burdigala, in accordance with Sud-Atlantique's policy to award ancient Latin names to its ships, such as Lutetia for Paris, Gallia for France and Burdigala for Bordeaux. According to shipping historian Arnold Kludas, Burdigala was renovated at the Blohm & Voss shipyard in Hamburg. In addition to modifying its food halls, changes were also made to the ship's main systems, including the boilers. Finally, the ship was painted white, and displayed the coat of arms of Sud-Atlantique on its funnels: a red rooster, the symbol of the ancient Gauls. Following the completion of the renovations, Burdigala sailed from Hamburg to Bordeaux, where she was enthusiastically welcomed as the biggest and fastest ship of the South Atlantic.

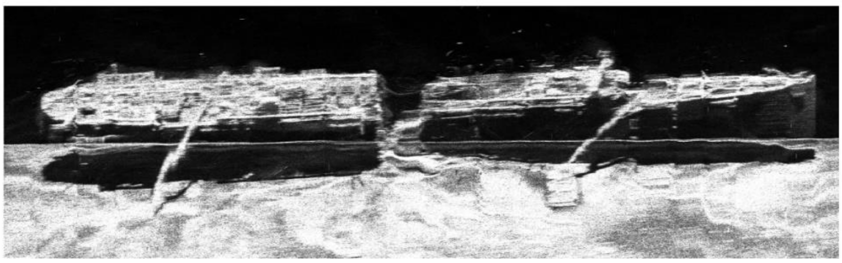
On the 5th October 1912, the Burdigala undertook her first voyage to Buenos Aires, Argentina. The voyage was uneventful, but on her return the ship experienced engineering problems that led her to the shipyard for repairs immediately upon her arrival at Bordeaux. During her time of inactivity, Cie Sud-Atlantique replaced her with a chartered vessel. This fact, along with Burdigala's huge consumption of coal, made Sud-Atlantique re-examine the ship's value. They determined that she was ultimately not profitable and retired her on 1st November 1913, when Sud-Atlantique's new liner, the S/S Lutetia, began her first voyage to South America. On the 29th of November 1913, Burdigala was condemned, and she stayed at the port of Bordeaux until the beginning of World War I and her requisitioning by the French government.

4. THE BURDUGALA'S REQUISITIONING BY THE FRENCH GOVERNMENT

The requisitioning of the Burdigala marks the beginning of the last chapter in the ship's existence. The French government used the Burdigala both as a troopship and supply carrier from the Mediterranean French city of Toulon to other theaters of war. In 1915 and 1916 and until her sinking, the Burdigala carried troops to the Dardanelles and to Thessaloniki in Greece, which served as the base of the Entente forces in the Balkans. On 13th November 1916, the Burdigala sailed empty from Thessaloniki to Toulon to load troops and supplies. Her captain was the reservist Lieutenant Francois Rolland and August Richard served as chief engineer. The next day at 10:45 a.m., almost two nautical miles southwest of the cape of Agios-Nikolaos in Kea Island, an explosion at amidship on the starboard side caused the engine room to flood. At first, given that the ship had only a list of four degrees, her captain thought the vessel would not sink. Twenty minutes later, however, water began to pour into the vessel's second engine room. As a result, the list of the Burdigala increased, and her captain commanded the crew to abandon ship. A second explosion then ripped the ship in half, and fifteen minutes later, she sank to a depth of 76 m off the northwest coast of Kea.

The ship had struck a mine laid by the Imperial German submarine U-73 on the 28th of October 1916. Commander of the German submarine was the highly decorated Kapitänleutnant Gustav Siess from Hamburg. Just one week later, on the 21st of November, only two nautical miles from Burdigala, the British hospital ship HMHS Britannic was also sunk after striking a mine in the same minefield.





5. DISCOVERY AND EXPLORATION

In 2007, Assistant Professor George Papatheodorou of the Department of Geology at the University of Patras, Greece, led his team in the mapping of the bottom of a region north of Kea Island using sidescan sonar. During the survey, a large, unidentified shipwreck was spotted. The Kea Dive Project was thus organized to examine and document the wreck from the 21st to the 30th of September 2008. The Kea Dive Project was the first dive expedition having as aim to examine and document the then unknown wreck. During this mission, which was accompanied by a supervisor from the Hellenic Ephorate of Underwater Antiquities, the wreck was measured, examined, and finally identified to be the ocean liner Burdigala, formerly the Kaiser Friedrich. Since then, five more expeditions have been carried out to collect more information being capable to answer questions and to highlight the wreck and its history.

The Burdigala sits upright on her keel, cut in two sections, at a depth of 76 m with the bow and aft masts broken and fallen to the starboard side. The longitudinal axis of the vessel (stern to bow) points southeast. The two sections tilt to the right; the fore lists by about 10 degrees and the aft by approximately 25 degrees. The overall length of the wreck, including the hull gap, is approximately 200 m. The depth ranges from 76 to 54 m, where one finds the upper sections of the ship's superstructure. Along the fore deck, which is also part of the upper forecastle, thick anchor chains extend from their bow holes to the large twin winches, which still hold the two massive anchors in the raised position. On either side of the fore deck along the vertical axis, two large-caliber cannons face the sea. At the end of the bow deck there is a deepening which interrupts the smooth form of the main deck, structurally separating the bow section from the main superstructure. In this area at about 10 m long is the foremast, broken at its base but with the internal wiring intact.

In this area, there are also two internal staircases leading to the upper deck (second row of the superstructure) and steerage. The upper deck area included the most luxurious cabins and passenger lounges, such as the music room, smokers' and reading lounges, of which some have collapsed. From the second row of the superstructure, most of the accommodation areas are also partially collapsed, except for the wheelhouse (bridge) and the saloon directly beneath it. The port and starboard side navigation lights are in good condition after a century underwater, and this greatly assisted during the identification process as the team compared the wreck with old photographs.

Near where the three funnels should be are the remains of large airways, arranged in groups of four. The hull breakage separating the wreck into two distinct pieces is almost amidships, right after the ninth lifeboat davit (counted from bow to stern). At the two vertical sides of the hull breakage, cabins with their various accessories for everyday use, such as sinks and bathtubs, as well as pieces of machinery like rollers and shafts, are visible.

The aft hull section consists of holds number three and four, the engine room, the rest of the superstructure, the aft deck area, the rudder room, and the quarterdeck. After the third funnel opening, two staircases leading to the deck of the aft-peak region are the first things encountered, followed by the broken and fallen aft mast and the mouths of the hull. Just aft of the poop deck are two cannons of the same caliber as those at the bow, also facing towards the sea. The aft deck is covered by the debris of the completely collapsed poop deck. Behind the two large aft winch capstans at the end of the stern is a single hole at the middle of the upper part of the transom where the ship's name was inscribed in duplicate, now heavily coated by multiple layers of benthic marine growth. The entire area of the stern deck is scattered with cannon shells and ammunition boxes.

Lying at a depth of 76 m, the two large three-bladed propellers are clearly visible at the underside of the ship. One blade is missing from the port side prop, while the starboard side prop is immersed in the sand and fully covered by the listing hull. A distinctive long, U-shaped structural hull ending at the stern is visible, as can be clearly seen in all the old photos of Burdigala.

6. LAST WORDS

The Burdigala may have failed to fulfill the primary goal of steaming at a speed of 22 knots, but she remained an important marker in shipping history precisely because of this failure. On one hand, the ship's history tells of the activities of the merchant shipping business of the day, including the know-how, the merchants, the profits, the social structures, and the politics tied to the rise of an industrialized economy. On the other hand, through her voyages and long lists of passenger names, the ship represents a chapter in the transatlantic immigration story of the North and South American continents. Her tragic end is directly connected to the social and political crisis of the beginning of the 20th century, directly connected to the social and political crisis of the beginning of the 20th century expressed through the armed attack that led to the World War I. Furthermore, the Burdigala's common historical destiny with the hospital steam ship HMHS Britannic makes her one of the last witnesses to the end of the historical ocean liners lost in the eastern Mediterranean Sea during World War I.

Therefore, the shipwreck of the Burdigala may be considered as an Accessible Underwater Cultural Heritage Site and an object that deserves to be part of an Underwater Cultural Diving Park, namely the "Underwater Cultural Diving Park of the Island of Kea".

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Performance management in Underwater Cultural Heritage (UCH) site, UCH diving parks and Knowledge Awareness Centers (KACs)

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***Abstract*:** To achieve strategic management, UCH sites, UCH diving parks and KACs have to develop integrated and holistic management methodologies and indicators that support: a) the delivery and evidencing of public value; b) the need for accountability; c) organizational resilience through resource management; and d) exhibition sustainability. For establishing sustainable UCH sites, UCH diving parks and KACs, an assessment methodology that includes the development of appropriate KPIs must be used. Managing authorities have to use the proposed impact and value indicators for activities such as learning and outreach; and quantitative indicators for other activities, such as web stats. In addition, the performance frameworks need to be appropriate to the scale and complexity of the organization, while emphasis should be placed on public value and social return on investment.

In this research a methodology is developed for tracking the performance of established UCH sites, UCH diving parks and KACs in order to: create a culture of continuous improvement, develop strategic resource planning/management solutions, identify and mitigate risk on current activity, inform future development, evidence return on investment and demonstrate value and supporting costs/benefits.

The new methodology allows selecting effective KPIs and identifying their characteristics. Sustainability KPIs checklists are developed on business performance, operation and environmental sustainability of Marine Protected Areas (MPAs), UCH sites, UCH diving parks and KACs. The new method can support and facilitate the improved management and promotion of natural and cultural heritage sites for implementing the existing legal frameworks, and tracking the performance of these sites.

Keywords: Performance Monitoring and Management, Key Performance Indicator, Sustainability, UCH site, UCH diving park, KAC

1. INTRODUCTION

BLUEMED project (Interreg MED programme) aims to support competent government authorities develop strategies, plans and policies for local coastal and island economies of the Mediterranean region in adopting a sustainable and responsible model for tourism development. This will be achieved by planning, testing and coordinating Underwater Cultural Heritage (UCH) sites, UCH diving parks and Knowledge Awareness Centers (KACs). Main objectives are the valorization and the protection of underwater natural and cultural heritage in accordance with UNESCO 2001, the raising of public awareness and the tourism attractiveness.

One of main BLUEMED objectives is to "contribute to Programme result indicators and policies with KPIs results that measure sustainability in tourism development, environmental and social impact". Due to the provided sustainability measures with KPIs measurements and the design of common BLUEMED project contributes to integrate principles of the EU Protocol on the Integrated Coastal Zone Management (ICZM), the Maritime Spatial Planning (MSP) Directive, the Green infrastructure (GI), and Plan Bleu strategies for all planning activities. Moreover, sustainability KPI's checklists, that are developed in the current research, can provide a useful guide to stakeholders in order to preserve and protect underwater cultural resources in situ and as a result to assist the Biodiversity and the Adaptation of EU strategies in minimizing the impact to marine ecosystem and in adapting to climate change phenomenon.

A Key Performance Indicator (KPI) is simply a set of quantifiable measures that a company or industry uses to gauge or compare performance in terms of meeting their strategic and operational goals. The process of identifying and measuring KPIs forces business managers to look at what specific actions and behaviors will drive the company towards their set goals. BLUEMED UCH sites, UCH diving parks and KACs are businesses. Their employees represent both an organization's biggest expense and its most valuable asset. This means the company's productivity, and ultimately, its profitability depend on making sure all of its workers perform up to, if not exceed, their full potential. KPIs can be used to assess how successful UCH sites, UCH diving parks and KACs have been in accomplishing their set smart sustainable goals. It is evident that businesses cannot manage what they cannot measure and KPIs help them understand if UCH sites, UCH diving parks and KACs, installed during BLUEMED project, are on the right track for success.

2. PERFORMANCE MANAGEMENT IN UCH SITES, DPS AND KACS

BLUEMED aims to build on the existing experience of partners and work done in mapping successful UCH sites, UCH diving parks and KACs. Through improving the management and the promotion of natural and cultural heritage sites and implementing the existing legal frameworks, tracking the performance of established UCH sites, UCH diving parks and KACs is of high priority. UCH sites, UCH diving parks and KACs have to track their performance to:

- create a culture of continuous improvement.
- develop strategic resource planning/management solutions.
- identify and mitigate risk on current activity.
- inform future development.
- evidence return on investment.
- demonstrate value and supporting costs/benefits.

To achieve strategic management, UCH sites, UCH diving parks and KACs have to develop integrated and holistic management methodologies and indicators which support:

- the delivery and evidencing of public value;
- the need for accountability;
- organisational resilience (resource management);
- exhibits sustainability;

2.1. Conceptual model of an organisation

The conceptual model of an organization can be described as in the simple diagram of Figure 1. Based on this, people use systems to implement processes which generate information. A holistic view exists as each of these elements acts on the other. Efficiency comes when they exist in balance, while value comes when they are motivated towards an external purpose. Finally, sustainability comes when they can adapt in response to emergent needs.

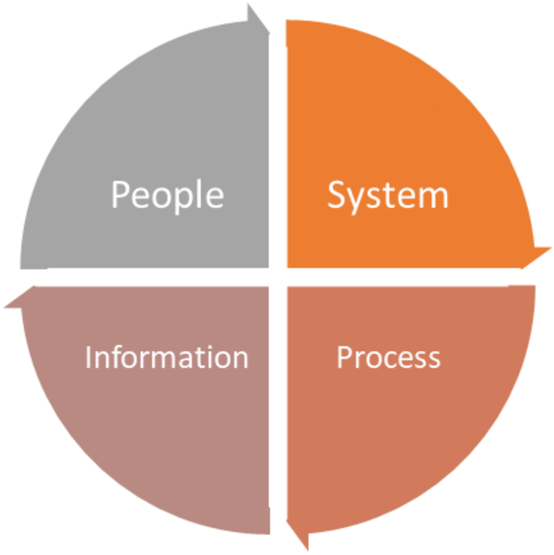

Fig. 1: The conceptual model of an organisation

2.2. Conceptual model of UCH sites, UCH diving parks and KACs functions

For the functions of UCH sites, UCH diving parks and KACs, the conceptual model can be described as in figure 2. In this case, the balance must be set in terms of access and preservation at the same time. Cultural value emerges from the interaction of caring for material, acquiring and "developing" accessible sites and supporting their visit in order to learn and to develop new knowledge from them.

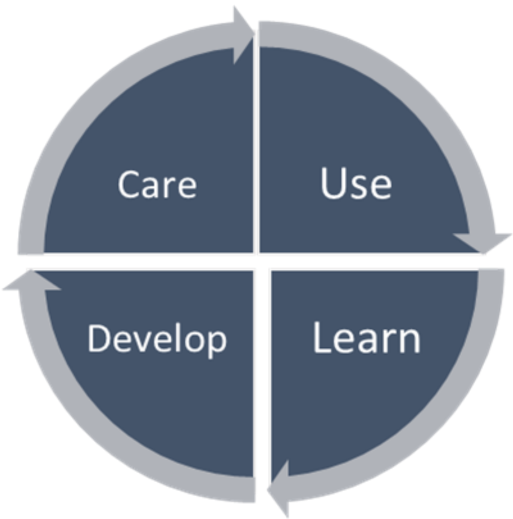

Fig. 2: The conceptual model of UCH sites, UCH diving parks and KACs functions

All the above and their connections are presented to the following structural diagram below (fig. 3).

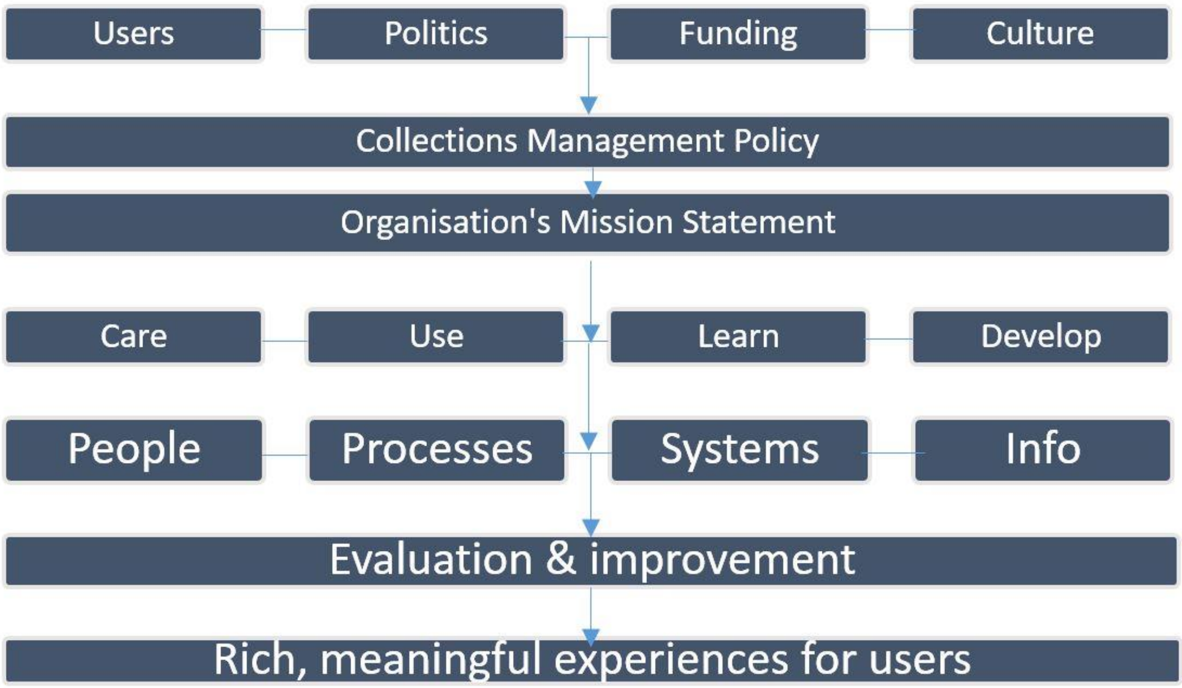

Fig. 3: Management framework

To conclude, for establishing sustainable UCH sites, UCH diving parks and KACs balanced scorecards and KPIs must be used. Managing authorities have to use the proposed impact and value indicators for specific activities (learning, outreach etc.) and quantitative indicators for specific activities, such as web stats. In addition, the performance frameworks need to be proportionate to the scale and complexity of the organization, while emphasis should be put on public value and social return on investment.

3. METHODOLOGY TO CHOOSE THE RIGHT KPIS

A KPI is a measurable value that demonstrates how effectively a company is achieving key business objectives. Organizations use KPIs to evaluate their success at reaching targets. Defining the criteria upon the right KPIs will be selected is the first step to be taken.

Specifically, selecting the right KPIs will depend on the industry and which part of that is about to be tracked. Different KPI types should be selected to measure success based on specific business goals and targets. Find out what types of KPIs are relevant to UCH sites, UCH diving parks and KACs is the first goal to be achieved.

1. Choose KPIs that are really key
Choose KPIs that will generate the biggest impact. Since it is unlikely to be able to focus on all KPIs, it is proposed to choose only two to three to focus on in each phase that are appropriate for the organizations sustainability maturity level.
2. Choose KPIs that are measurable
KPIs must be measurable, but, choosing factors just because they are easy to measure might lead to negative results.

3. Choose KPIs that regularly change
Some KPIs are important and measurable, but may not change much in the short to medium term. It is more effective to choose KPIs that regularly change to reflect short term progress and provide more timely feedback.
4. Consider industry specific KPIs
Generally, KPIs that are more industry specific are likely to be more useful. Developing a good understanding of what is important to the sustainability of the UM and its audience is of high priority before selecting the KPIs.
5. Choose only a few KPIs
Sustainability projects often have limited budgets, thus the choice of KPIs is restricted and the focus should be on the few most important.
6. Choose KPIs that are meaningful to your stakeholders
Different KPIs speak differently to various groups of stakeholders. Choosing KPIs that are related with the key stakeholders could help gain support for the process of measuring.
7. Choose KPIs that connect to the core business strategies
Sustainability KPIs that connect with core business strategies have more synergy and could require less effort to implement.

3.1. Characteristics of good KPIs

A good KPI should act as a compass, helping on understanding whether taking the right path toward business' strategic goals. To be effective, a KPI must:

- Be well-defined and quantifiable.
- Be thoroughly communicated throughout organization and its variable departments.
- Actually be crucial to achieving organisation's goals.

There are a number of general characteristics of indicators that can help to ensure that proposed indicators will be useful and effective. The most important are presented below:

1. **Relevant**

Indicators should be relevant to the organization. One way of ensuring the relevance is to relate the performance indicators to the strategic goals and objectives of the organization or of a specific service area. Indicators should ideally also be relevant to the people providing the data and to the users of the PI, but it may not be possible for a single indicator to be relevant to all users due to differences in perspectives and interests.

2. **Clear definition**

A performance indicator should have a clear and intelligible definition in order to ensure consistent collection and fair comparison. Vague descriptions can lead to misinterpretation and confusion. Additionally, to tight or to broad definitions could also create problems.

3. **Easy to understand and use**

It is important that indicators are described in terms that the users of the information will understand, even if the definition itself have to use technical terminology. Indicators focused on the public should avoid management jargon or abstract concepts.

4. **Comparable**

Indicators should ideally be comparable on a consistent basis both between organizations and over time. An essential aspect of the comparability of performance indicators is the inclusion of the context within which the comparison takes place. External and internal circumstances can differ to such a degree that comparison is invalid.

5. Verifiable

The indicator also needs to be collected and calculated in a way that enables the information and data to be verified. The indicator should be based on robust data collection systems, and it should be possible for managers to verify the accuracy of information and the consistency of the used methods.

6. Cost effective

Another important criterion is to balance the cost of collecting information with its usefulness. Where possible, an indicator should be based on information already available and linked to existing data collection activity.

7. Attributable

Service managers should be able to influence the performance measured by the indicator. If this is not the case, the incentives for making an effort to improve performance will diminish and the performance indicators may be regarded as unfair discouraging staff and managers.

8. Responsive

A performance indicator should be responsive to change.

9. Allow innovation

The definition of an indicator ought not to deter organizations from developing innovative processes or coming up with alternative methods, systems or procedures to improve service delivery. PIs should ideally be constructed to allow such innovations take place.

10. Statistically valid

Indicators should be statistically valid.

11. Timely

The PI should be based on data that are available within a reasonable time scale. This time scale will depend on the use of the data. Some data are collected on a weekly or even a daily basis, as they are needed in the operation management of the services, whereas others are available once a year for more strategic and long term purposes.

4. KPIS CHECKLISTS

UCH sites, UCH diving parks and KACs have to monitor different types of KPIs. Each department will measure its success based on specific goals and targets. The following indicators could be measured for every UCH sites, UCH diving parks and KACs.

1. **Number of visitors during low season months in general:** The number of visitors during low-season is indicative for the successful correspondence of tourist to a new and alternative touristic destination. If the number is increased, the extension of the touristic period in the pilot site will be succeeded.

2. **Number of visitors during high season months in general:** Measuring the number of visitors in high season is useful to get a clear picture of the operation of UCH sites, UCH diving parks and KACs.

3. **Increase in the high season period:** Comparing the above KPIs gives the opportunity to see if an extension of high season in the site has been succeeded.

4. **Increase in arrivals:** Comparing the number of arrivals in different period of a year or in the same month of different years gives the ability to monitor if there is an increase in the number of arrivals in the pilot sites.

5. **Increase in the number of visitors in diving centers:** To measure if there is an increase in the number of visitors in diving centers after the operation of UCH sites, UCH diving parks and KACs, shows that their operation has a positive impact in the regional economic sector.

6. **Number of tickets issued by the KAC:** This measure is indicative of the activities and visits that tourist select during their stay.

7. **Number of dives:** Tracking the number of dives shows if the site attracts more and more visitors, if there are the conditions to import beginners in the diving activities and if the site offers a pleasant experience.

8. **Number of diving centers:** If the number of diving centers is increased, there will be more job opportunities in the region and the touristic sector will be enhanced.

9. **Number of employees in the diving centers, UCH sites, UCH diving parks and KACs**: This measurement reveals the positive economic impact of the operation of UCH sites, UCH diving parks and KACs, as an extended employment sector will be strengthened.

10. **Number of educational visits to the sites by schools, universities and research centers:** Through tracking and analyzing by which organization or educational institution are the majority of visitors, it is provided a better feedback for organizations that are underperforming and that aren't familiar with UMs, DPs and KACs, is provided.

11. **Visits in the websites/social media pages of the diving sites:** Analytics given through websites and social media show if the diving sites are popular and what type of visitors are attracted.

12. **Percentage of response to open positions:** A high percentage of qualified applicants apply for the open job positions shows that maximizing exposure to the right job seekers is achievable. This will also lead to an increase in interviewees.

13. **Employee Satisfaction:** Measuring the level of employee satisfaction through surveys and other metrics is vital to the departmental and organizational health of UCH sites, UCH diving parks and KACs.

To measure enhanced innovation capacity and competitiveness of SMEs operating in underwater heritage sites:

1. **The number of service providers in underwater heritage sites offering underwater cultural heritage tourism products must be measured.**

To measure sustainable growth of pilot sites as cultural tourism destinations:

1. **Tracking the difference in the number of visitors in underwater heritage sites is indicative.**

2. **Measuring the difference in the number of visitors during lowseason months in underwater heritage sites would be helpful.**

Regarding the environmental sustainability of UCH sites, UCH diving parks and KACs, the following indicators are proposed.

1. **Utility consumption:** Tracking electricity, water, and gas consumption of UCH sites, UCH diving parks and KACs, focusing on water and electric use. It would be great to know how much UCH sites, UCH diving parks and KACs are consuming in order to minimize waste.

2. **Waste:** Measuring how much waste in UCH sites, UCH diving parks and KACs is produced is mandatory to guarantee their sustainability. Where the waste goes can really change the "green-ness" of UCH sites, UCH diving parks and KACs. After understanding how much and where it is wasted, managers of UCH sites, UCH diving parks and KACs can make calculated efforts to address these issues.

3. **Efficiency**: Track the efficiency of UCH sites, UCH diving parks and KACs equipment through monitoring their consumption and then comparing this to other available technologies.

4. **Renewable energy sources:** Although renewable energy has been around for a while, it has recently become an individually available target. Investing in zero net energy initiatives for the operation of UCH sites, UCH diving parks and KACs will be useful to reduce their environmental impact. Tracking if renewable electric sources (e.g. solar) or sustainable water tools are used seems mandatory. This measure can be shown as the share of electricity from renewable energy sources as a percentage of total energy consumed.

5. **Recycling**: During the operation of UCH sites, UCH diving parks and KACs, if recycling methods are adopted and if they are used in a daily basis is crucial to be measured.

5.1. KPI's checklist for UCH sites, UCH diving parks and KACs

In order to give a more detailed recording of the performance of the UCH sites, UCH diving parks and KACs is needed, an analytic table of more specific indicators follows.

Table 1: KPI's checklist for UCH sites, UCH diving parks and KACs

	ENGAGEMENTS	
MEMBERSHIP	**Membership Revenue Indicators**	
	Number of Non-corporate Memberships, Revenue and Member Admissions Attendance	Data
	Non-corporate Memberships Percentage of Earned Revenue	KPI
	Average Revenue per Membership for Non-Corporate Memberships	KPI
ATTENDANCE	**Total Visits**	KPI
	Website Visits	KPI
	Child Visits	KPI
	Number of Volunteers	KPI
	Educational Visits and Onsite Activities	KPI

	Overseas Visits	KPI
	Visitor Satisfaction	KPI
	Proportion of Visitors Who Would Recommend a Visit	KPI
	Attendance to Facility Size	
	Gate Admission Attendance and On-site Attendance	Data
	Ratio of Attendance to Facility Sq. Footage and to Exhibit Sq. Footage	KPI
	Ratio of On-site Visits to Building Square Footage	KPI
	Ratio of Gate Admission Visits to Exhibit Square Footage	KPI
	Gate Admission Visits by Category	
	School Group and General Public Admissions as a Percentage of Total Gate Admissions	KPI
	Percentage of Gate Admission Visits by Category: member and free	KPI
	Gate Admission Visits by Category: school, member, free and general public	KPI
EXPENSES	Percentage of Total Expenses by Selected Expense Categories	KPI
	Personnel Expenses	
	Personnel Expenses	KPI
	Personnel Expenses as a Percentage of Total Expenses	KPI
STAFFING	**Staffing Indicators**	
	Number of On-site Visits per Full-time Equivalent Staff Person	KPI
	Operating Expenses per FTE	KPI

5. CONCLUSIONS

The subjects of the current research is the development of sustainability KPI's checklists for the operational, management and business models to support the establishment and consolidation of UCH sites, UCH diving parks and KACs. The proposed KPIs focus on the following priorities: economical benefit, economic sustainability, environmental impact and staff issues.

These kind of indicators are transferable to Mediterranean areas with similar characteristics and needs and can be implemented in other UCH sites, UCH diving parks and KACs, operating in other areas except from BLUEMED pilot sites. The collected data, through the proposed KPIs checklists, can be used as justification tools in the selection process of Business and Operational Models to be applied on the establishment and consolidation of new UCH sites, UCH diving parks and KACs.

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THE WRECKS in THE GREEK SEAS, 1830-1951. The Underwater Heritage of Navy's Shareholding Fund and Mariners' Retirement Fund.

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Abstract: Following the period 1945-1951 after the WWII, shipwrecks found in the Greek Sea territory were salvaged and sold as scrap until 2003 when, their protection, preservation, and accentuate were put into effect in order to be kept internally in mind the historical fortune handed to us by our ancestors. The institutions Navy's Shareholding Fund and Mariners' Retirement Fund have been called to undertake the management of this underwater heritage, comprising hundreds of sea wrecks (ships, airplanes etc.), the ownership of which was granted to them in 1953.This document is a study that emerged as a result of many months of in-depth research on the current wreck regime. This study respectively attempts to answer key questions such as:

- • Who is the owner of the wrecks of navy vessels, warships, military aircrafts (warplanes), sea mines, etc, existing or can be found in the sea and are relics of the 2nd World War?
- • Does this owner have any specific duties and responsibilities concerning the wrecks?
- • Which is the jurisdiction over them? What does this signify?
- • Which are the Greek authorities and public institutions to be involved?

In this way we hope to start a fruitful dialogue on one of the most critical issues of our underwater heritage.

Keywords: shipwrecks, Navy's Shareholding Fund, Mariners' Retirement Fund, Hellenic Navy.

"The cultural resources contribute decisively to the creation and establishment of a general climate that is favorable to growth"

Lina Mendoni 2017

From the post-War period (1945-1951), when shipwrecks salvaged from all over the Greek seas were broken up and sold as scrap, up to 2003, when their preservation, protection and enhancement were put into effect.

The institutions SHAREHOLDING NAVYS' FUND (el M.T.N) and MARINERS' RETIREMENT FUND (el N.A.T) have been called to undertake the management of this underwater heritage, comprising hundreds of sea wrecks (ships, airplanes etc.), the ownership of which was granted to them in 1953.

1. INTRODUCTION

This document is the result of a many months' detailed research undertaken within the framework of a study dealing with the existing regime of the old underwater wrecks.

Its aim is to present to all those who are interested in the matter the framework that governs sea wrecks lying in the Greek seas, and especially those dated between 1830 to 1951. We hope that this will be the incentive for the opening of a productive dialogue regarding one of the most crucial issues of our culture. This document, will attempt to answer timely questions such as:

a. Who owns the wrecks of the ships and combat aircrafts of the 2nd World War; and who owns the wrecks of the commercial ships that were sunk during the same period?
b. Who is vested with the necessary authority for granting to one permission to study contemporary shipwrecks (dated before 50 years ago) and, on the other hand, being able to design their enhancement and development?
c. The Ephorate of Underwater Antiquities' jurisdiction applies specifically to what? And how it involves itself in the matter of the contemporary ship-wrecks/monuments?

2. THE LEGAL FRAMEWORK

Until 2003 the Ministry of Culture had no jurisdiction over shipwrecks, unless they dated before 1830, in which case they came under the Ephorate of Underwater Antiquities. Since 2003, however, and after the issuing of a Ministerial Decision, designating shipwrecks over 50-years-old as "cultural assets", certain responsibilities were deputed to the Ministry of Culture and Sports. (Law #3028/2002 "About Antiquities and the Cultural Heritage in General")

2.1. Compulsory Law #464/1945

By this law the Organization for the Raising of Shipwrecks (O.A.N) was established, – its aim being to remove shipwrecks lying within the Greek territorial waters (6 nautical miles) for whatever development or sale. During the years of its validity – until August 1951 – many tenders were opened for the sale of salvaged shipwrecks, whether Greek merchant vessels or warships, or vessels that had flown other countries' flags, such as German landing craft.

2.2. Legislative Decree #2648/ 1953

This decree was issued in 1953, and its Article 4 defines that all shipwrecks and wreckage in the Greek seas, which after the expiration of Law 464/1945 had become the property of the Organization for the Raising of Wrecks (O.A.N.), revert to the ownership of the Mariners' Retirement Fund. With the exception, however, of warships and war material, wherever they may be found, but also of all ship-wrecks lying within restricted areas (naval fortresses), the ownership of which is given to the Shareholding Navy's Fund.

This decree leaves no doubts as to ownership issues of sunken warships, war material, and merchant ships within the area of naval fortresses, since, by explicit pro-vision they are the property of the Shareholding Navy's Fund (M.T.N). However, it is necessary to find out to whom the ownership of warships that had flown a foreign flag is granted. Warships such as HMHS Britannic and S/S Burdigala, since these ships had been requisitioned, they were sunk following a pre-1945 war action and, therefore, they fell under the previous law.

2.3 Ministerial Decision to designate shipwrecks as Cultural Assets, Official Government Gazette 1701/Β΄/19-11-2003

Following the Minister of Culture's decision in 2003, the wrecks of ships and air-crafts, the date of sinking of which antedates the decision by 50 years, were designated as Cultural Assets. Further, by the same Ministerial Decision a protection zone of 300m, according to Article 15.4 of Law #3028/2002 was established. It should be noted that by these stipulations neither the legal status of the ships, when they sink, nor the legal definition of the warship, according to Article 29 of UNCLOS 1982, are affected. **In general the Hellenic Navy's ship and aircraft wrecks represent a fragile collection of non-renewable resources that, in addition to their historical value, are often considered war graves, may contain unexploded ordnance, classified information or materials, or environmental hazards.**

However, in the aforementioned decision there is no specific reference according the designation of "monument" to each shipwreck separately, as it happens in all the other cases of monuments. Typical examples of moveable and immovable monuments that have received the designation "monuments" are the following:

• (M.D) OGG B-1539/ 2015 Designated as monuments: the rowing tartan Evaggelistria and the ferry-boat Hagios Georghios.

• (M.D) 268//OGG 2012 B-1976 Designated as movable monument: the photographic archives of the Boissonnas' family, that are kept at the Photography Museum in Thessaloniki.

• (M.D) //2016 Designated as monuments: 350 objects (garments and ac-cessories) from Historic Wardrobe of the National Theater of Greece.

• (M.D) OGG B-351 //2006 Designated as monument: the main building of the former "Eastern Athens Airport ".

OWNED BY HELLENIC NAVY

• (M.D) ΥΑ ΥΠΠ//2006 B-1203: Designated as monument: the lighthouse at Cape Maleas, Lakonia.

2.4 Law #3028/2002 "About Antiquities and the Cultural Heritage in General"

With this comprehensive and methodical law legislation on archaeological matters has now been completed and systematized.

In Article 2, the following definitions, among others, are put forward:

a. The tangible evidence of the existence of man and of his individual and collective activities comes under the definition of "cultural assets".

b. The cultural assets that constitute material evidence and which belong to the cultural heritage of the country are considered monuments, to which a very special type of protection should be afforded, based on the following specifics:

(1) The term "ancient monuments" or "antiquities" is applied to all cultural assets belonging to the Prehistoric, Ancient, Byzantine and Post-Byzantine eras and which are dated before 1830.

(2) The term **"Modern Monuments"** is applied to the cultural assets that are posterior to 1830 and their protection is considered indispensable because of their historic, artistic or scientific significance.

(3) The term **"immovable monuments"** is applied to those monuments that were attached to the ground and which remain on it or they are found at the bottom of the sea or on a lake- or river-bed; also the same term is applied to those monuments that are standing on the ground or are found at the bottom of the

sea, or on a lake- or river-bed and it is not possible to move them without damaging their evidential value, while, on the other hand, the term "movable" is applied to those objects that are not stationary.

It is worth noting that, up to 2016, the Ministry of Culture and Sports considered shipwrecks as "movable monuments". However, there was an argument as to whether this classification is the correct one or it would be more appropriate to classify the shipwrecks as **"immovable monuments"**. In December 2016, the decision of the **State Legal Council** No 311 was issued, which states: **The wreckage of ships and aircraft designated as monuments under decision of the Minister of Culture are "immovable monuments"**.

3. CIVIL SERVICES and AGENCIES OF THE PUBLIC SECTOR INVOLVED

A brief presentation of the relationships between the civil services and the agencies of the public sector involved in the handling of various cases of shipwrecks follows:

3.1 Ministry of Culture & Sports

3.1.1 Directorate of modern cultural stock and intangible cultural heritage

The Directorate of Modern Cultural Stock and Intangible Cultural Heritage, and the Department of Substantiation and Protection of Modern Movable Monuments in particular, had the power until the end of the fiscal year 2017, to grant permits for studying shipwrecks over 50 years old, as well as keeping the relative archive and undertaking the project of the wrecks' enhancement and development.

This directorate the previous years operated closely with the **Ephorate of Underwater Antiquities** taking advantage of the latter's experience in underwater activities and also of the fact that the latter has the supervision and control of underwater research and activities conducted by either local or foreign organizations or private individuals.

3.1.2 Ephorate of Underwater Antiquities

The Ephorate of Underwater Antiquities (E.E.A) is responsible for the supervision and control of underwater research and activities.

The Department of Underwater Archaeological Sites, Monuments, and Research of the E.E.A is responsible, among others things, for the supervision and control of underwater research and activity conducted by either local or foreign organizations or private individuals.

The main framework within which E.E.A is active concerns shipwrecks that were sank prior to 1830, which are considered antiquities, and also those are-as that harbour underwater antiquities. However, after the very recently Minister of Culture and Sports decision (OGG B /2049 2019), Delegation of responsibilities of the Minister and the Deputy Minister of Culture and Sports, the following responsibilities (jurisdiction) are also delegated to the Director of the Ephorate of Underwater Antiquities:

- Grant permits to photograph, film and videotape individual monuments, archaeological sites, historical sites and museums or collections that fall under their public jurisdiction (Article 46 of Law 3028/2002).
- Grant permits for fishing, anchoring and underwater activity with breathing apparatus in the archaeological sites and historical sites (article 15, paragraph 1 of Law 3028/2002).

- Grant permits for the use of any observation equipment (ROVs etc.) while conducting research on the seabed (article 15, par. 3 of Law 3028/2002).
- Grant permits for port development. (article 15 par. 5 of Law 3028/2002).
- Grant permits to clean seabed or conduct wreck removal.

3.1.3 Archaeological resourses & expropriations fund (law no. 736/1977)

The Archaeological Resources & Expropriation Fund is responsible among other things for:

- the promotion of monuments and archaeological sites in Greece
- the management of archaeological resources from fixed sources of income

In accordance with Law 736/1977, article 8, **resources** of the Archaeological Resources and Expropriation Fund are: Proceeds from the imposition of a fee for filming or taking photographs within museums, monuments, archaeological sites and **underwater sea or lake antiquities**.

Our research on the shipwrecks has shown that in order to acquire a permit to carry out exploratory diving onto the wrecks *HMHS BRITANNIC*, *S/S BURDIGALA* and *S/S PATRIS* off the island of Kea and *S/S MONROZA* off the coast of Anavyssos, the applicant (who in this case was Mr. Mikhail Afendikov) had to prepay the amount of 800 euros per day and per place of diving, as administrative fee to the A.R.E.F (el Τ.Α.Π.Α) However, this amount has to be paid only in case someone shoots photographs or films of a monument which is under the **OWNERSHIP** of the Ministry of Culture and Sports and not of those being under any other authority. Had it been otherwise, then administrative fees would have had to be asked from all those who wish to photograph or film monuments using professional equipment – e.g. the two evzone uniforms (officer and soldier) of the Presidential Guard which are kept in a display case in the office of the Commanding Officer of the Presidential Guard; the lighthouse at Kavomalia; *HS VASILISSA OLGA*, *HS HYDRA* etc.

3.2 Ministry of National Defense

3.2.1 Shareholding Navy's fund (el mtn)

It is a legal entity subject to public law, and under the supervison of the Ministry of National Defence, via the Hellenic Navy General Staff and its aim is the development and increment of the Fund's property (movable and immovable).

According to Decree #2643/1953 analyzed above, all the wrecks of warships and war material in the Greek seas (namely, war aircrafts, firearms, military equipment, etc.) as well as merchant ships within the areas of naval fortresses – and relics included – have passed to the ownership of this Fund.

Some specific examples of such wrecks are presented below:

- Warships and Submarines Y/B KATSONIS , S/S VASILISSA OLGA off Lakki, Leros, H.S HYDRA;
- Aircrafts 2nd World War that have met their end in the Greek seas: Heinkel-He.111, Junkers – Ju87 "STUKA", Junkers – Ju52, Junkers – Ju88, Messerschmitt – Bf109, Arado – Ar196, and many others strewn all over the Greek seas.
- HMHS BRITANNIC, S/S BURDIGALA because of their unique status further inquiry into their cases is necessary, since they remain under the sovereignty of their mother country.

3.2.2 Hellenic Navy – Naval History department (n.h.d, el υιν)

The Naval History Department deals with all aspects of the Greek naval history, and cooperates with civil services, organizations, and any legal entity which has undertaken to preserve the Greek navy traditions, as well as to study and promote the Hellenic Naval history. As mentioned in the previous paragraphs the Hellenic Navy's ship and aircraft wrecks represent a fragile collection of non-renewable resources that, in addition to their historical value, are often considered war graves, may contain unexploded ordnance, classified information or materials, or environmental hazards. **The Naval History Department is now working on being responsible for the management, research, preservation, and interpretation of the Hellenic Navy's sunken military craft. Furthermore the Underwater History and Heritage Branch is now to be established due to an emerging need for Hellenic Navy to study and preserve its submerged cultural resources.**

Very recently for the very first time, on Tuesday, July 16, 2019, a Memorandum of Understanding (MoU) was signed between the Hellenic Navy and Planet Blue, owned by Mr. Konstantinos Thaktaridis, on Underwater research activities in three historic warships that are now listed as Immovable Monuments (Historic Wrecks):

"HS ARIS"

Destroyer "HS Hydra" UAV (D-97)

Destroyer "HS Queen Olga" (D-15)

3.2.3 Hellenic Navy Hydrographic service (hnhs)

The Hellenic Navy Hydrographic Service (HNHS) is the official hydrographic organization of Greece. It is an independent agency of the Hellenic Navy (HN). The purpose of HNHS is to study the Greek and the adjacent seas, coasts and ocean, the navigation conditions, to contribute to the development and the promotion of the sciences and arts related to navigation, hydrography, oceanography, shipping and maritime meteorology.

The mission of the HNHS includes, among other things, the composition and production of nautical charts and publications, as well as the creation of products that result from studying the parameters of the marine environment, the development of geosciences (hydrography, topography, oceanography, geography) and the science of navigation. The Hellenic Navy Hydrographic Service is a government agency that **has exclusive competence and certification to draw up, publish, supplement and correct the official navigational charts of Greece** and their updates, as well as to publish, supplement and correct official nautical publications.

HNHS is the National Coordinator for the management and operation of NAVTEX Service, in accordance with national and international law and practice. The Hellenic Navy Hydrographic Service, the official hydrographic agency in Greece, **performs hydrographic works** with the primary purpose of creating and updating official Greek navigational charts and publications. **Hydrographic surveys** include field collection and processing of data, preparation and/or updates of navigational charts and publications. These data include:

- Seabed depth and morphology
- Topographic mapping, and coastline and coastal area morphology;

- Details and positions of navigational hazards and obstacles (e.g. shipwrecks, dirty seabeds, submarine cables and wires, etc);
- Details and positions of navigational aids (e.g. lamps, beacons, buoys, known marks)

A recent discovery during those surveys was the historical shipwreck of HS 'Katsonis' submarine. The exact location has been confirmed by optical means 6 nm. northwest of the island of Skiathos at 253 meters depth.The historical wreck was found by HNHS hydrographic-oceanographic vessel NAFTILOS on January 29, 2018 using multibeam and sidescan sonars.Her identification was made by the same research vessel from 4 to 6/5/2018 using submarine robotic cameras (ROVs) with the assistance of K. THOKTARIDIS diving team.

Fig. 9 HS Katsonis Historical Wreck
https://www.hnhs.gr

3.3 Ministry of Maritime Affairs and Island Policy

3.3.1 Mariners' retirement fund

It is the sole owner of all wrecks of merchant ships that were lost at sea between 1830 and 1951, as per decree #2648/1953. Also, it owns all the contents the ship or aircraft, was carrying when it sank. Characteristic examples of such wrecks are the following:

- s/s PATRIS –1868
- s/s KLEIO –1904
- s/s CHEIMARA – 1947

3.4 Ministry of Foreign Affairs

3.4.1 Directorate d1 | Committee of licence granting for marine research (clgmr)

This committee is an informal advisory body which examines all the parameters (national sovereignty, security, archaeological treasure protection, underwater monuments, etc.) prior to giving to an organization or agency per-mission to conduct underwater research. This permission covers the sea-board zone, that is to say, six nautical miles from the shore. CLGMR is a committee which should have the support of all government agencies, since it can help coordinate the various ministries to work within the modern framework of research and development. The data collected from the underwater searches, especially when these are undertaken through the medium of research projects run by scientific agencies of the wider Public

Sector, and which also contain finds from shipwrecks, it is advisable to have them forwarded to the committee, so that HNHS, Hellenic Navy History Department and Ephorate of Underwater Antiquities will also be apprised of them.

- MEMBERS OF THE COMMITTEE OF LICENCE GRANTING FOR MARINE RESEARCH
- MINISTRY OF CULTURE & SPORTS, EPHORATE OF UNDERWATER ANTIQUITIES
- MINISTRY OF NATIONAL DEFENCE, HELLENIC NAVY BRANCH A2, HNHS
- MINISTRY OF MARITIME AFFAIRS AND ISLAND POLICY, DIRECTORATE OF HARBOR POLICE
- MINISTRY OF FINANCE DIRECTORATE OF PUBLIC PROPERTY, DEPARTMENT OF SEA-SHORE AND BEACH
- MINISTRY OF ENVIRONMENT AND ENERGY
- INVITATION ACCORDING TO JUDGEMENT
- MINISTRY OF FOREIGN AFFAIRS, DIRECTORATE D1 IS THE COORDINATOR

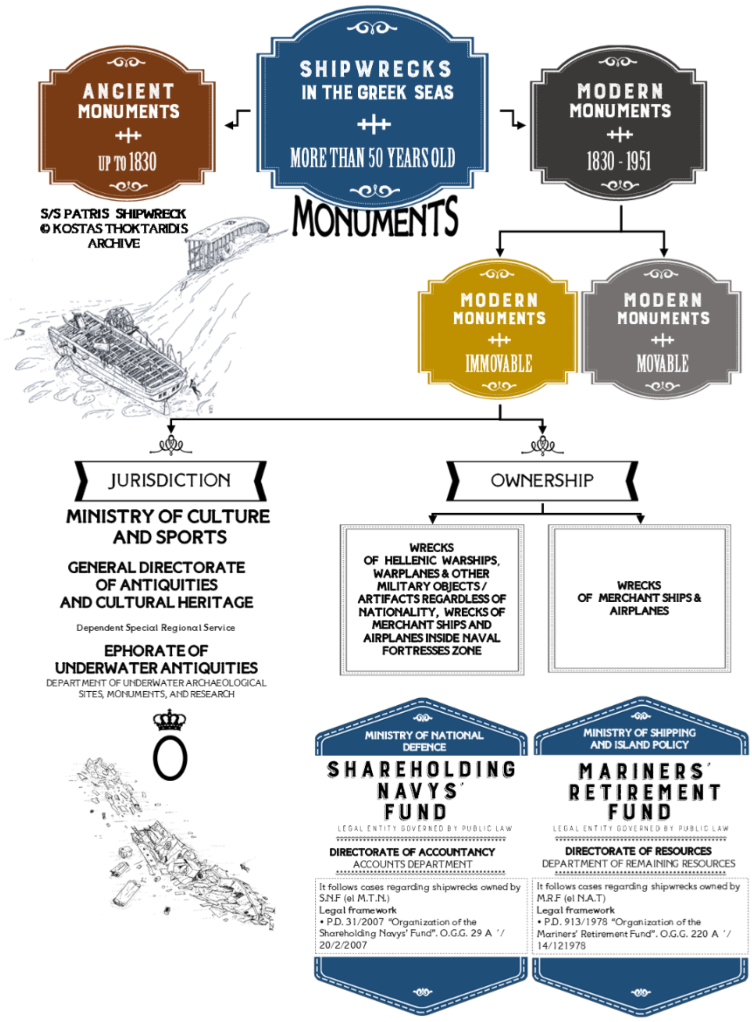

Fig 10 The Framework at a glance – the complete framework will be available at www.seathewrecks.com

4. OTHER COUNTRIES EXAMPLES

4.1 USA-US NAVY

The Navy of the United States of America gives us an admirable example on how both the cultural and maritime heritage should be protected and developed. In charge of this is the Naval History and Heritage Command, which has, among others, a department of Underwater Archaeology responsible for the management, research, preservation and interpretation of sunken war-ships and aircrafts of the US Navy. The US Navy is in charge of one of the largest collections of sunken cultural resources, which include more than 2,500 wrecks from both World Wars and 14,000 wrecks of aircrafts dispersed throughout the world. The Department of Underwater Archaeology was established in order to take care of the wrecks, counsel the US Navy on issues regarding the science of underwater archaeology and historical preservation, since it has to do with warships and aircrafts.

In order to achieve this, the department undertakes the:

- Archaeological Research
- Policy Development and Management of Cultural Stocks
- Preservation, Conservation and Care of Works of Art
- Cultural Awareness of the Public and Dissemination of Information

The general policy of the US Navy about the wrecks is the following: The wrecks of warships and aircraft remain undisturbed in their watery graves. It is possible to disrupt their peace for educational, historical, or archaeological reasons. Among other things, the unauthorized "recovery" of works of art is forbidden.

By being so well protected, these wrecks are able to illuminate the greatest moments of the naval history of the USA. Therefore, this service, the organization of which disseminates the glorious naval history of the US Navy to the public, enhances the patriotism and national consciousness of the people, becoming an example worth following.

4.2 UK - UK NAVY

Protection of Military Remains Act 1986. In 1986 the UK Parliament voted the protection of military relics. This Law defines the protection levels which are the following two:

a. Protected Areas

The wrecks, which are defined by name, can be designated as preserved lo-cations, even though their location is unknown. Thus, the wreckage of a UK aircraft is, ipso facto, a preserved place, even if it has not been found. It is considered as a crime for someone to disrupts the area or to remove some-thing from it. Divers may visit the place, but the rule says "Just look, don't touch, don't penetrate". The Law about protected areas applies everywhere in the world but, de facto, outside the United Kingdom, the penalties can be imposed only to the UK citizens.

b. Controlled Areas

As controlled ares are designated all the places where the relics of a crashed aircraft or ship lie for the last 200 years. The Law renders illegal any under-taking (including diving or excavations) within the controlled area, unless pro-vided with a permit from the Ministry of Defense. The controlled areas are noted on the maps of the Admiralty and their physical position is marked by a buoy. It is worth noting that HMHS Britannic does not belong to any of the above categories.

5. CONCLUSIONS

Shipwrecks are divided into three categories:

a. The ancient wrecks, the responsibility and ownership of which comes under the Ephorate of Underwater Antiquities. An important example is the shipwreck at Antikythira.

b. The modern wrecks of Warships, War Material and Merchant ships of whichever nationality that lie within the area of a Naval Fortress, the ownership of which comes under under the Ministry of National Defense and the Hellenic Navy Shareholding Navy's Fund (el M.T.N). Characteristic examples are the wrecks of HS KATSONIS, A/T VASILISSA OLGA, aircrafts from 2nd World War.

c. The modern wrecks of merchant ships (50 years or older before 1951) the ownership of which comes under the Mariners' Retirement Fund (N.A.T) Characteristic example is the wreck of S/S Patris.

The time needed for acquiring an ordinary permit for the underwater observation of a wreck e.g. HMHS Britannic, S/S Patris is considerable and it may extend up to eight months. However, it is strongly believed that now with the delegation of responsibilities to the Ephorate of Underwater Antiquities the time shall be less than 4 months.

The Hellenic Navy Naval History Department is now working on being responsible for the management, research, preservation, and interpretation of the Hellenic Navy's sunken military craft. Furthermore, the Underwater History and Heritage Branch is now to be established due to an emerging need for Hellenic Navy to study and preserve its submerged cultural resources. Cooperation with the Ephorate of Underwater Antiquities is a fact.

Also the Hellenic Navy Hydrographic Service, performs hydrographic works that can help the mapping of the Hellenic Navy's Culture Assets. Recently, navigational charts and publications updates with Historical Wrecks and Underwater Archaeological Sites.

6. SUGGESTIONS

The Underwater Cultural heritage, our "Modern Monuments" is an identity factor that can contribute to social cohesion by encouraging people's participation in events and decisions. **There is a common goal and that is the protection of underwater cultural assets.** Hellenic Navy providing the means of implementation of the relevant Ministerial Decisions, preventing legal activities (e.g. illegal recovery of artefacts from historical wrecks), while facilitating the work of the Hellenic Coast Guard.

THERE IS NO SPACE NOR TIME FOR COMPETITION

There are thousands of shipwrecks at the bottom of the Greek seas, of which several hundreds have been designated as "Modern monuments" or "Cultural Assets". There is a work that has to be done by the Ministry of Culture and Sports and also by Hellenic Navy and Naval History Department. It's very important and also very complicated. **Until now this heritage has not been officially recorded by the state**. There is a common goal and that is the preservation and enhancement of our Naval Underwater Heritage.

JOINT EFFORT, CO-PERCEPTION, COOPERATION, COMMUNICATION AND PUBLIC OUTREACH

One of the main concerns that all the actors (public sectors) must have is how to allocate the resources to get the job done. Both **public sectors** have to work together with **research centers**, **Universities** and **Private Sectors** to achieve maximum effectiveness. Also the diving community has to be engaged. It's necessary to accept that the diving community already has been diving at several of these "Modern Monuments" even if this is exceeding established restrictions. By engaging them, divers are becoming active part of the solution and not a problem that we all have to deal. <u>They can alert us from threats that may result from natural disasters, climate conditions and change.</u>

In these times, when the Greeks' resilience is still tested, the Hellenic Navy does not lack vision. In these shifting and unstable times, we should be the ones to lead the circumstances and developments, and not to lag behind, watching them taking place with bated breath.

Hellenic Navy has a clear and understandable vision on documenting the underwater culture assets.

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Management and protection of a little known underwater archaeological site: the case of the "Roman Villa of the dolia" in Ancient Epidaurus. Past experiences and future perspectives

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***Abstract*:** This paper presents the preliminary results of the studies conducted on the ancient city of Epidaurus, developed next to the unique natural harbor of the eastern coast of the Argolid peninsula to the Saronic Gulf. The research is inserted in the frame of the BLUEMED Project: 'Plan/test/coordinate Underwater Museums, Diving Parks and Knowledge Awareness Centres in order to support sustainable and responsible tourism development and promote Blue growth in coastal areas and islands of the Mediterranean', developed with a Collaboration Agreement signed between the Ephorate of Underwater Antiquities and the Istituto Superiore per la Conservazione ed il Restauro in Rome.

Keywords: Epidaurus; Conservation *in* situ; Underwater Archaeology;

1. THE STUDY AREA: TOPOGRAPHY, GEOMORPHOLOGY AND HISTORY

Fig. 1 View of the contemporary city of Ancient Epidaurus and "Nisi" peninsula (Aerial footage of Tom Drones aerial cinematography for Xinhua News Agency).

The archaeological site of Epidaurus, in the Peloponnese, is mainly known for the Asclepius Sanctuary and the Theatre. The ancient city of Epidaurus developed next to the unique natural harbor of the eastern coast of the Argolid peninsula to the Saronic Gulf (Lambrinoudakis – Katakis, 2012) (Fig. 1). The location of the city had as a result its turning to the sea and the creation of overseas relations. Architectural remains of the ancient city have been preserved in Agios Vlassios bay, in the area which is referred to as the "Sunken City" by the locals, on the South of "Nisi" peninsula. The city started sinking around 400 AD, after a period of relative stability that lasted 2.200 years.

The most important buildings that have been preserved in the "Sunken City" date to the Roman years, during which Argolis, after the destruction of Corinth in 146 B.C., was included in *Provincia Achaia*. At those times, great building programs were completed in the Argolis as the community of "craftsmen around Dionysus from Isthmus and Nemea" became quite popular, elevating the Roman Empire (Mpanaka, 2012: 144). Owing to the glory of Asclepius' sanctuary as well as Hadrian's visit in 124/5 A.D., Epidaurus expanded from its classical core and bloomed once again in the Roman times.

Fig. 2 The complex of the Roman villa in the Sunken City of Ancient Epidaurus (Aerial footage of Tom Drones aerial cinematography for Xinhua News Agency).

The ancient buildings today lie at a depth of approximately two meters due to changes in the sea level in this region (Kolaiti – Mourtzas, 2016). The buildings are visible from the air (Fig. 2) owing to the low depth and visitors can see them while snorkelling without the need of scuba diving. Along the Peloponnesian coast, in the Saronic Gulf and the coasts of Aegina and Poros, the geomorphologic features of underwater coastlines are closely related to the presence of sunken settlements.

The initial change of the sea level took place certainly after 400 (±100) A.D. (Kolaiti – Mourtzas, 2016).So far, no underwater excavationhas been conducted in the area and the monuments had been photographed from an air-balloon in the beginning of the 1970s under the supervision of archaeologist Ch. Kritzas, who published a relevant article (Kritzas, 1972; Papachatzis, 2004: 217-218, 220).

2. THE ANCIENT HARBOR

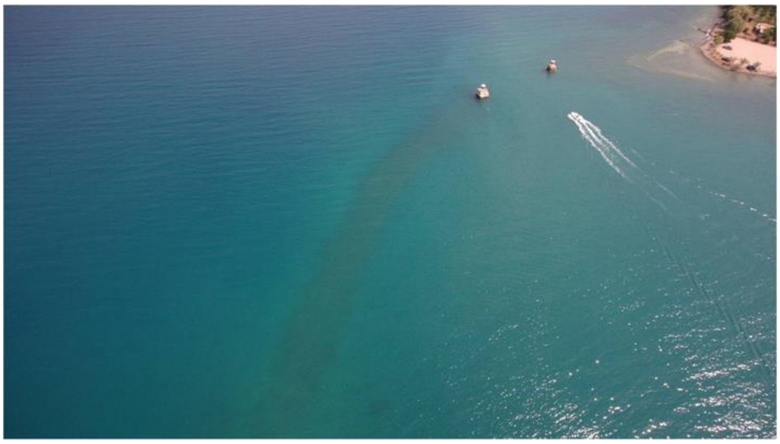

Fig. 3. Marine area of the ancient and contemporary harbor of Ancient Epidaurus. The ancient piers are visible (northern and southern) along with ancient buildings on top right (Aerial footage of Tom Drones aerial cinematography for Xinhua News Agency)

In the marine and coastal area of the contemporary harbor have been preserved the ancient piers (Fig. 3), northern and southern, between which there was a 40-metre-wide opening for the traversal of ships in antiquity. In a preliminary underwater survey that took place in the summer of 2017 by a team of scientists from the Ephorate of Underwater Antiquities of the Greek Ministry of Culture and Sports and the *Istituto Superiore per la Conservazione ed il Restauro* of Rome, to the SE of the harbor, the impressive number of sunken buildings was testified, along with the compact nature of the southern pier. The buildings possibly date to the Roman years, judging from their building features.

3. THE ROMAN VILLA

The sunken architectural remains of a villa (Fig. 2, 4) that are visible today, lie at a depth ranging between 1,00 - 4,00 m. (Lambeck, 1995; Mourtzas and Kolaiti, 2013) and stretch to an area of around 1000 square meters, at a distance of ca. 50 m. from the coast; its axis runs along N-S, its greatest length being 40 m. and width 15 m. The building complex it belongs to consists of different parts which have been constructed with the building technique of *opus latericium* and carved stone. The main building of the villa is divided in two oblong parts: the southern, which consists of seven small rooms and ends in an apse at the South and the eastern, which contained a large number of jars (*pithoi*) which still remain *in situ* and were probably used for the storage of food (liquid or solid).

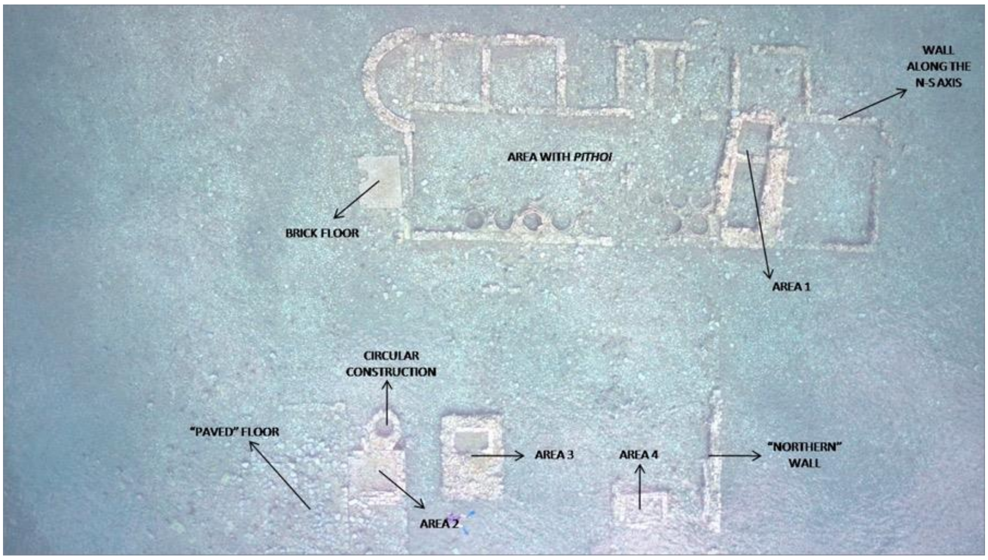

Fig. 4. Plan of the Roman villa with noted areas
(Aerial footage of Tom Drones aerial cinematography for Xinhua News Agency).

The presence of *pithoi* reveals the rural character of the villa. There are three rows of *pithoi* in total: in the eastern row nine *pithoi* are now visible, which have been fastened on the floor with mortar on their exterior; in the middle row some *pithoi* are of smaller scale; in the western row *pithoi* have not been well preserved. We estimate that the *pithoi* must have been 27-28 in total. On several *pithoi,* it is obvious that in antiquity interventions for their repairing took place using lead staples. Finally, there is a small rectangular area on the South of the room that probably did not contain any *pithoi*.

Moreover, it is notable that the wall which runs along the N-S axis in the interior of the villa should be considered of a different date from the apse on the South, as they do not share the same axis, the apse's southern ending lying a little to the south of the wall. Generally, it is inferred that at least two different building phases exist on the building. An apse at the end of the oblong part of a building, with a row of rooms in front of it, is common in Roman architecture (such as e.g. in a building that has been considered a bath in Budapest, with pottery dating to the 2nd – 4th century A.D.: Mulvin, 2002: 77, fig. 7). In general, apses were common in Late Roman houses, both in wealthy and humble ones, in cities and provinces (Guidobaldi, 1986; Bowes 2010: 54-55). The apses have been correlated with dining rooms and the Late Roman *stipadium,* a semicircular bench for diners (Ellis 1997, 51).

Closely observing a floor on the SE of the villa (Fig. 4, Brick floor, Fig. 5), it seems that a part on its SW had been lost in ancient times. Similar floors, constructed with bricks laid in a mortar layer (*opus figlinum*) are commonplace in country houses of Roman times in the Helladic area and they are quite widespread in buildings which have been identified as *lenoi* (wine presses), due to their nonslip nature; (cf. a wine press in Ancient Akraiphia of Boiotia, which had a long period of use, from the 1st century B.C. to the 4th century A.D.: Vlachogianni, 2013: 491-492, fig. 6, 8, note 14, where further bibliography on similar floors of Boiotia. In the 3rd century A.D., a tank on its NE corner was constructed: Vlachogianni, 2013: 505. A similar floor also exists in a wine press of a farm house in Elaiostasi of Nafpaktos, whose movable finds date to the 2nd – 3rd century A.D.: Saranti and Staikou, 2013:724-725, fig. 1).

Fig. 5. Brick floor on the NE of the Roman villa

In an area of the smaller complex and specifically in the small room (Fig. 4, Area 2) on the East of a circular construction the following layers are discerned: at the bottom there are raw stones as substructure; then there is hydraulic mortar mixed with a great number of broken tiles; above it there is a brick floor, which bears two decorative bands, the one with rhomboid and the other with rectangular bricks, in the *opus mixtum*. Therefore, this area, whose greatest part has been destroyed, could be, at first glance, identified as a bath, even more as two pipes lie on the SW. The brick floor on the South of Area 2 lies approximately 0.5 m. deeper than the rest floors and this could support the identification with a bath. The existence of a bath in an area separated from the main corpus of the villa is consistent with other examples of Roman villas, which are in their majority dated to the 2nd century A.D. (Zarmakoupi 2014: 379).

In general, it seems that the owners of Roman country villas that were located around the cities had particularly close bonds with the owners of luxurious mansions in the cities themselves, as both belonged to the same urban elite, whose identity is known only in few cases (Rizakis, 2013: 47; *SEG* 45, 1995: 418 [Patrai]). On the contrary, the precise relation between wealthy land owners and the rural population is a bit obscure, and so is the way in which the exploitation of land was organized.

The term *Roman villa* corresponds to the basic features of this Roman type of building, which can be summarized as follows: it is a rural house which is located in the countryside, frequently belonging to a wider complex in the center of a farm (Richmond, 1970: 51; McKay, 1975: 1-25; Percival, 1975: 5-13; Johnston, 1994: 6-8; Mulvin, 2002: 1; Marzano, 2013: 8-19; Zarmakoupi, 2013: 752-761). These complexes were found in the most fertile pieces of land, which were connected to the road network and extended in an area of ten to more than 1000 hectares. In Latin literature the term *villa* was often used for the place of residence or resort of the owner, who was usually a resident of the city, and his family, or a noble farmer, who invested their wealth in the land. In this case, their main residence must have had distinctive architectural elements in design or decoration (Smith, 1978b: no. 1, 117-147; Wilson, 1983: 72, 80; Clark, 1984: 98-99; Smith, 1997: no. 1, 5-12). In other words, a purely agricultural nature could not be attributed to a villa, as it seems that it housed a series of economical and social activities. Its basic elements should have been, apart from the main area of residence, baths and storing areas which spread around it. The products of the land supplied the army and the city, while the surplus was a tradable commodity or was kept in the granaries of the villa or the city (Wightman, 1975: 584-657).

In the whole area of the Roman Empire, grain and barley were the basic agricultural products, whereas in the Mediterranean basic products were olive trees and vineyards. The cattle, goats, sheep and pigs were bred everywhere and both stock-farming and rural works were related to the villas all over the Empire (Mulvin, 2002: 5, fn. 2; for practices of agricultural production, see Purcell, 1995: 151-179).

More specifically, the villa of Ancient Epidaurus should be included in the category of buildings that the Romans called *villa rustica* (Marzano, 2013: 8-19; Rizakis, 2013: 35-40) to describe a villa that was built in the countryside in an open space, often as part of a big farm of agricultural character, while the term *rusticum* served to distinguish those villas from the urban ones or those which were used as resorts. These villas may have served as both the owner's, his family's and workers' place of residence and as a centre of managing the agricultural produce. More often than not, there were further buildings to accommodate farmers who worked at the farm, to stable animals and store rural products. Other features of the farm-house estates were the existence of a second floor and the presence of a great number of vases, such as *amphorae* etc. for storing as well as transporting products to several markets (Petropoulos, 1994: 413-414; Petropoulos, 2013: 158).

It seems that in the Helladic area farm houses do not consist of only one house but of several buildings, each of which had a different function (Vlachogianni, 2013: 508). The design of the *villa rustica* differentiated according to the architect but basically consisted of three parts: the *urbana* or main residence, the agricultural center and the farming area (Rizakis, 2013: 35). The view that big estates (*laitifundia*) were quite common in almost all rural areas of the Helladic region has not been confirmed by recent excavation data, as the majority of Roman farms that have come to light are villas of a medium scale (200 – 600 m^2: Cato, *De agricultura*: I,7, 12-13; Martin, 1971: 89-90; Duncan-Jones, 1974: 325-326; Marzano, 2007: 107, fn. 21; Rizakis, 2013: 36). The main target of these Roman type villas was not autarky in production but the production of surplus which would become a tradable commodity and would be profitable (Brockmeyer, 1975: 213-228.; Kephoe, 2007: 553-557; Rizakis, 2013: 37). This parameter explains the fact that most of these villas were located in accessible sites, near cities, street networks, rivers, lakes and the sea, as is the case of Ancient Epidaurus. In regions such as the Peloponnese, Attica and central Greece, there was the potential of intensive farming, the most important products being grain, olive oil and wine. The excavation data from the area of the SE Peloponnese, where Ancient Epidaurus belongs, indicate that in this area there was probably intensified and specialized agricultural production (Stewart, 2010: 225).

Regarding to the features of the main building of the complex, which in our case could be the oblong building with the *pithoi* and the rows of rooms, these can be summarized as follows: a design of the complex in harmony with the landscape, a clear central axis, symmetry in the design of the main building of the villa and a pre-selected arrangement of the relation between the villa and the surrounding buildings (Smith, 1978a: 149-173). It is characteristic that different complexes developed through time and differed from one province to another. It was, thus, usual, in a pre-existing local settlement for a Roman plan to be applied, incorporating Roman architectural elements to the local features (for further definition of villas, see Percival, 1988: no. 1, 13).

The concentration of *pithoi* in the big oblong room that lies closer to the coast can be considered as an indication that this was the agricultural center of the villa, for the collection of rural production, which justifies the too great a number of *pithoi* for the needs of an average house.

The aforementioned comment on the different chronological phases that are observed on the building, could be regarded as an explanation not only for the fact that an exact parallel to the plan of the villa has not so far been found in the international bibliography, but also for the fact that the design of farming houses presents variations according to the architect.

In 2017, through a pilot collaboration program organized by the Ephorate of Underwater Antiquities (MCS-EUA) and the Italian Ministry of Cultural Heritage, Activities and Tourism – Istituto Superiore per la Conservazione ed il Restauro (MiBACT-ISCR), the conservation at the Roman Villa in Ancient Epidaurus began.

Some preliminary interventions were carried out at that time: the clay floors of the villa were cleaned and the hydraulic mortar damaged by the sea was restored.

Today, MiBACT-ISCR and the Ephorate of Underwater Antiquities (MCS-EUA), together with the Italian Archaeological School of Athens, promoted the insertion of the Epidaurus underwater site in the BLUEMED Project framework, in order to involve this important heritage site in the conservation and valorization activities scheduled for the Project Pilot Sites.

4. THE COLLABORATION BETWEEN THE EPHORATE OF UNDERWATER ANTIQUITIES AND THE ISCR OF ROME IN 2017 AND 2018: PAST EXCAVATION AND NEW PERSPECTIVES

In July 2017 a Collaboration Agreement for an educational program entitled *In situ conservation of underwater archaeological sites: methods and case studies* was signed between the Ephorate of Underwater Antiquities and the Istituto Superiore per la Conservazione ed il Restauro in Rome. The director of the pilot educational program was on the Greek part the Ephorate of Underwater Antiquities through its former Director Dr. A. Simosi, the supervisor on the site being Dr. P. Galiatsatou, while on the Italian part the activities were coordinated by Diving Archaeologist Dr. Barbara Davidde, Director of *Nucleo per gli Interventi di Archeologia Subacquea* of *ISCR*.

Fig. 6. Conservation works on wall façade of the Roman villa by the Ephorate of Underwater Antiquities in collaboration with ISCR. Summer 2017.

After the theoretical lessons, on 5-7 July 2017 practical works took place in the underwater archaeological site of the "Sunken City" in Ancient Epidaurus, which involved cleaning and fixation with the use of typical restoring tools, such as scalpels, chisels and electric tools that have been applied and approved by the *ISCR*. More specifically, the tools were used on facades of stone and brick walls (Fig. 6), in the cleaning of a floor paved with clay tiles (Fig. 6, 7, 8) at the NE of the villa, which might have been a patio, as it is not surrounded by walls in contrast to the other areas of the villa.

Fig. 7. Conservation works on a paved tile floor of the Roman villa by the Ephorate of Underwater Antiquities in collaboration with ISCR. Summer 2017.

Finally, adequate quantity of mortar was prepared for the filling of hinges on a brick wall, and the team worked to this direction (Fig. 9, 10) under the supervision of Diving Conservators of Antiquities A. Tsompanidis and R. Mancinelli on the Greek and Italian part, respectively.

Fig. 8. Brick floor on the NE of the Roman villa

Fig. 9. Filling of hinges on a brick wall of the Roman villa by the Ephorate of Underwater Antiquities in collaboration with ISCR. Summer 2017. (Photo by Gabriele Gomez De Ayala, copyright ISCR).

Fig. 10. Façade of brick wall of the Roman villa after the filling of hinges.
(Photo by Gabriele Gomez De Ayala, copyright ISCR)

In the summer of 2018 a systematic study of the Marine Area of Ancient Epidaurus was performed by both Institutions together with the underwater excavation and restoration of two selected sectors of the Villa. This study was funded in the frame of the activities conducted by ISCR in the BLUEMED project (WP4 and WP 5). The Bluemed project "Plan/test/Coordinate Underwater Museums, diving parks and knowledge awareness centers in order to support sustainable and responsible tourism development and promote blue growth in coastal areas and island of the Mediterranean", Project (Ref.703), promoted by the European Union under the transnational cooperation programme INTERREG MED Programme 2014-2020, aims to support competent government authorities develop strategies, plans and policies for local coastal and island economies of the Mediterranean region in adopting a sustainable and responsible model for tourism development. (https://www.facebook.com/BluemedMed/).

This will be achieved by planning, testing and coordinating Underwater Museums, Diving Parks and Knowledge Awareness Centers (KACs). Main objective is the valorization and protection of underwater natural and cultural heritage in accordance with UNESCO 2001, the raising of public awareness and tourism attractiveness

The scheduled operations included:

- *documentation* (photographic documentation and photogrammetric 3D recording), fig. 11

- *biological study (*data collection of significative samples to study biological degradation of the structures)
- *excavation* (removal of debris and sand deposits covering the underwater architectural remains);
- *analysis of the building techniques*
- *restoration* (cleaning of the surfaces from the encrusting biological layers; in-depth consolidation of the walls and pavements; repair of wall joints and cracks), fig. 12

Fig. 11. Archaeological documentation of the brick floor during the 2018 campaign.

All the methodologies, tools and materials adopted for the Conservation of underwater archaeological structures were developed in the frame of the ISCR Restoring Underwater Project (Petriaggi and Davidde Petriaggi, 2015).

In the summer of 2018, a new area of the smaller complex of the villa was excavated. A small room lies on the East of a circular construction, in the interior of which there was a lining of bricks, of which only two are preserved. The co-existence of the rectangular Area with this circular construction, the presence of pipes and the agricultural character of the complex, could be an indication for the use of this area as a *lenos* winepress. Moreover, on the South of Area 2 there is a floor paved with rectangular clay tiles, which supports the identification with a *lenos,* as such floors were used for the waterproofing of *lenoi* in country houses of the Helladic region.

The excavation in the interior of a circular construction brought to light a large amount of pottery sherds, mainly of vases with thin walls and plain or simply decorated with black and red lines or yellowish slip. Many of the sherds bore traces of firing. These finds indicate that at some point this construction had been used as a deposit area for throwing away useless objects, as not one of the vases was found intact. In the 2019 campaign the excavation of this construction will be accomplished.

Finally, a great number of grinding stones that were found in the recent project, further support the rural character of the villa in the Roman times. As Ploutarchos mentions, most inhabitants of Epidaurus lived and worked in the fields. The city was characterized as *αμπελόεντος (vineyard)* by both Homer and Strabo, while there was also the adjective *λειμηρῆς*, which is mentioned be Herodianus and Stephanus Byzantius, as there were many fields in the area.

Fig. 12. Archaeological documentation of the brick floor during the 2018 campaign.

The biological study, coordinated by the biologist Sandra Ricci (ISCR Biology laboratory) was carried out by the Diving Conservation Scientist C. Sacco Perasso during the project. She studied marine organisms that cause damage to underwater structures of the Roman Villa. The buildings have been subjected to bioerosion and biological colonization phenomena. The bivalve mollusk *Lithophaga lithophaga*, which thrives in the interior of buildings and the sedimentary rocks, has developed inside almost all walls and mortars of the complex, leaving the typical ovoid hole. The gravest destruction of the buildings has to do with the decomposition and loss of mortar joints, which had as a result the loss of numerous bricks and stones that consisted the foundations or the core of the walls

During the survey near the "Nisi" peninsula and the ancient (so-called small) theatre of Palaia Epidaurus, conservators Angelos Tsompanidis and Eleni Barda discovered an inscription, of which only the letters «Σ» and «O» were at first visible as the rest of the inscription was fully covered by seaweed. It was then found that the stone of the inscription was 2.08 m. long and 0.39 m. wide. Two ancient names were now legible, I Σ V Λ Λ Ο Σ and Δ Α Μ Ο Κ Ρ Ι Τ Ο Σ.

The following days we understood that the inscription actually belongs to a large square construction, 30 m. long on each side, and porticoes extending on each of the four sides. The latter are further divided into smaller rooms, a plan which resembles ancient public buildings, as e.g. outdoor sanctuaries or markets. The building material consists of rectangular stone blocks at the bottom, indicating a classical or Hellenistic way of architecture, whereas on the top there were walls made of brick and stone following the Roman way.

Considering the possibility of identifying this complex with the Ancient Market of the city, it seems difficult as boundary stones - όροι of the Agora have come to light on the land to the north and closer to the theatre. However, the ancient traveler Pausanias mentions a sanctuary of Asclepius, in which the statues of the god and his wife Hepione were standing outdoors. Although the building's construction bears some resemblance to an ancient sanctuary or temenos, it is too premature at this stage to proceed to any identification.

Further studying the names of the inscription, we realized that the name ISYLLOS probably is that of the lyric poet Isyllos from Epidaurus, who composed poems to honor Asclepius as this is the only name that has so far been located in relation with the area of Epidaurus and the Argolis.

Regarding Damokritus, he could be identified as a priest who is mentioned in inscriptions from the great Sanctuary of Asclepius in Epidaurus, from the 4th century BC. The priests were the most important officials in the god's sanctuary and also handled financial matters relating to the sanctuary. A second identification could be with Damocritus of Damochartus from Argos, who the Epidaurians had awarded with the office of thearodokos of Asclepius and proxenos. The dating of the inscription, in this case, would be between the last quarter of the 3rd and the first half of the 2nd century BC. Considering the wider historical frame of the area, we know that friendly relationships between Epidaurus and neighbouring Argos had been reestablished by the middle of the 4th century BC, especially when the building program of the sanctuary of Asclepius started. The Argives then often gave offerings to the sanctuary, along with benefactor services to the city, which, in its turn, rewarded them with the office of thearodokos and proxenos, as was the case of Damokritus. Either way, both names seem to have a connection with the worshipping of Asclepius.

5. PERSPECTIVES

The second campaign of excavation and restoration conducted by ISCR with the Eforia will be planned in the summer 2019 with the aim to continue to preserve and study this very important underwater archaeological site. On 2019 the students of the ISCR High School and selected students from Roma Tre University will participate at the works and they will learn methods and techniques to excavation, conservation in situ of archaeological structures. This underwater site is a ideal site to train underwater restores and archaeologists. Furthermore, the Ephoria has planned a pioneering project including Autonomous guided and narrated tour over the sunken city of Epidaurus has already been approved for European funding. The object of this project is the identification, conservation, documentation and elevation of the sunken city with the use of advanced technological practices. The ultimate goal is the operation, in the specific area, of a highly added value service, accessible to the wide public. It takes place on board a vessel with a transparent bottom which allows the safe implementation of automated guiding scenaria from a distance. These are carried out in real time taking into account information from sensors, such as the geographical detection of the vessel, the direction of the wind, and the location of obstacles with the use of ultra sounds, so that that can be immobilized in certain spots, on particular times. The visitor sees the sunken city through the transparent bottom of the vessel and hears the guiding in his/her mother tongue. At the same time, they watch, on the monitor of a computer, the three-dimensional representation of the sunken city, as it was centuries ago, according to what has been registered in the international bibliography. The project is materialized by the collaboration of 1) the Ephorate of Underwater Antiquities, the Scientific Centre "Athena" and 3) Marinco Ltd. The total duration of the project is estimated to 24 months. Finally, the Ephorate of Underwater Antiquities has applied for funding for a study on the protection and elevation of coastline sunken settlements on the coasts of the Peloponnese. The aim of which, in Epidaurus, will be easier access to the site through the coast or the sea area, information on the uses that are permitted in the area, coastal and underwater signs etc. This shall be part of the European Funding for the period 2021-2027.

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L'Anfora ASD, the sustainable tourism and use of submerged archaeological sites in Apulia.

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Abstract: Apulia holds a submerged archaeological heritage of great importance, a lush ground for a type of eco-sustainable tourism, suitable for any group, able to reconnect the tourist, but also the natives, to nature and to make him a part of thr achaeological history of the land he decided to visit, giving them a great experience.

***Keywords*:** Underwater archaeology, sustainable tourism, usability of submerged sites, local, seasonal adjustment of tourism.

1. L'ANFORA A.S.D.Culturale

The Anfora is an amateur sports association (fig.1), operating in Puglia (Italy), which aims among its objectives to promote underwater activities and in any case related to the approach of the public to nature, in total respect of the environment, whether water or land. It carries out numerous activities to enhance the territory and tourism in Puglia, through the use and enhancement of cultural heritage, archaeological heritage, nature and the environment, in the most appropriate forms and ways, encouraging contacts and collaborations with other cultural institutions. Among the submerged sites in Puglia we can certainly mention those of greatest visual and emotional impact, on which our association operates by organizing guided tours in diving and snorkeling, but also days of archaeo – trekking.

Fig. 1: The Anfora logo

2. THE ROMAN COLUMNS OF PORTO CESARIO

Near the inlet of Torre Chianca, in the municipality of Porto Cesareo (fig.2), near Taranto, there are Roman Columns dating back to the II century AD, partially unfinished, with just sketched grooves, about 9 mt. Long and with a thickness between 70 and 100 cm, located 80 mt from the coast; they were found in August 1960, at a depth about 5 mt underwater. The artifacts fall in the Marine Protected Area of Porto Cesareo: it is likely that the columns come from a boat leaving from the island of Eubea, in the Aegean Sea, whose cargo was made up of artifacts of various kinds (amphorae and bricks are now preserved in the Aragonese Castle of

Taranto), as well as including these five columns, in chives marble, all from the quarries of Karystos. Today they are mostly covered with algae, the site can be reached by sea by boat, but also by land, starting from the inlet adjacent to the tower and covering the short distance by swimming. To observe them it's possible to organize diving or snorkeling tours.

Fig.2: Torre Chianca

3. THE SARCOPHAGI OF SAN PIETRO IN BEVAGNA

Remaining on the Ionian coast we come across another site of great archaeological value, discovered in 1964 by Peter Throckmorton, an american journalist, pioneer of underwater archaeology which took its first steps in that decade, following reports from the locals. We are talking about large rough marble sarcophagi, located on the seabed in front of the small town of San Pietro in Bevagna, an important commercial junction on the route that connected Otranto, Leuca and Taranto. In total there are 23 marble blocks, whose weight varies from 1 to 6 tons: the works would have sunk during transport (fig.3). Despite their large size, the sarcophagi aren't always visible, because of the continuous storms that insist on a type of sandy bottom. It's possible to visit the site both in immersion and in snorkeling, being at an average depth of 2,5 mt, and being reachable both by sea and by land.

Fig.3: Sarcophagi of San Pietro in Bevagna

4. EGNAZIA

Moving on to the Adriatic side of Puglia, it's necessary to mention one of the largest submerged sites in this region, for its uniqueness and its beauty: the ancient coastal city of Egnatia, a city mentioned by Strabo, Pliny and Horace, inhabited since the Bronze Age (XVI – XII century BC), passing through the Messapian reality (VI – V century BC) until you reach the Roman emperor from the III century BC, which gave it a more functional port, under the patronage of Marco Vipsanio Agrippa. In the stretch of water in front of the acropolis of the ancient city of Egnatia, located along the coast south of Bari, we find the remains of the Roman submerged port, the lowering of the coastline and adverse natural events have contributed to the sinking into the sea not only the remains of the docks, but also a part of coastal Messapian necropolis that is presented with rectangular pit tombs, dating from the V century BC, which undergoes periodic flooding, due to the close proximity to the sea.

The sunken port structures (fig.4), strongly explanatory of the construction techniques of the time, are located at an average depth of 6 mt., and we can easily visit them both in diving and snorkeling, giving us the feeling of being able to walk on the ancient docks, which still retain the negative trace of the characteristic Roman "opus reticolatum".

Fig.4: The ancient coastal city of Egnati

5. CALA CORVINO MONOPOLI

Remaining on the Adriatic coast we come across another site of great archaeological value, in the locality of Cala Corvino, the inlet situated to the north-west of the town of Monopoli (province of Bari), At a depth of 12 to 13 meters, a few tens of meters off the coast was identified a considerable scattering of circular and semi-square stone artefacts with central holes in them and numerous stones in less definite shapes and of various dimensions also with holes in them (Fig. 5). Other artefacts were discovered on the coast. Some of them are already known while others are a recent acquisition. On the cliff, very close to the water were found short columns with the mushroom-shaped top that had been conveniently moulded from calcarenite and positioned over the length of about 200 meters, undoubtedly by human beings. They were identified as bollards arranged, in some cases, to form the real berth. In the sea, inside the through holes of some stone artefacts there is something that is thought to be the remains of ropes made from plants like hemp, covered by sediments. The artefacts, in particular those that are trapezoid in shape, are considered to be stone anchors. It cannot be excluded that other artefacts are also anchors. This series of elements, the land and the water together, suggests that the entire area was an ancient berth provided with well-organized mooring.

Fig. 5: Circular and semi-square stone artefacts

Cultural tourism linked to the archaeology of coastal landscapes is one of the most sophisticated and interesting new segments of italian tourism. The characteristics of tourism make it a phenomenon present especially in the regions of southern Italy, which benefit from an important wealth of archaeological assets both submerged and along the coasts. It's therefore a type of tourism that affects areas that already have a historical experience in mass tourism and cultural tourism, which are great opportunities for development. Underwater archaeological tourism is connoted as a practice to be enhanced because it can positvely affect to the territorial realities, but above all is sought after type of tourism of mixed character, with a very low environmental impact and with a high economic return and quality for the territory.

In this regard, among the activities promoted by the association in 2018 and in 2019 stands out the winning of the call promoted by Puglia region, "in Puglia 365 Autumn", which had as its main objective to make accessible, with a totally free formula, the sites of archaeological interest, submerged and not, in a period of the year not typically touristic, organizing scuba diving in sites affected by archaeological evidence along the southern coast of Bari, archaeological trekking and excursions available to a very diverse audience, having as a priority to raise awareness to a sustainable and conscious tourism.

The importance of the quality tourist offer, with unconventional means and experience is the central point of the work that L'Anfora Asd carries out with decision, with solid foundations in the centrality of the scientific value of the organized visits, with the aim of making it easily accessible to sports divers, professionals and not, but also to people who don't practice diving, but simply driven by passion for history and for the sea.

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Japanese Shipwreck and Diving Tourism in Sangihe Islands Indonesia

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***Abstract*:** This initial study is aimed to determine the management of diving tourism on Japanese shipwrecks in the Sangihe Islands. The data collection techniques which used were literature reviews, interview, focus group discussion and observation in 2017 and early 2019. The results of the study were known that diving tourism on Japanese shipwreck had been started since 2007 by the local government and then continued by several local people. Some of the strengths in this diving tourism are the condition of the shipwreck is still intact and the availability of facilities such as hotels, restaurants, parking area. While some of the weaknesses are lack of promotion and the locations far from large islands in Indonesia.

Keywords: Japanese Shipwreck, Diving Tourism, Sangihe Islands

1. INTRODUCTION

1.1. Background

This is a preliminary study of the management of diving tourism on Japanese shipwrecks in the Sangihe Islands. Most of the data were collected in 2017, then completed in early 2019 with an in-depth interview. This study is a continuation of the research which was conducted in 2017 with the theme of UGM Maritime Culture Expedition. The study on diving tourism on this shipwreck will be continued in August-September 2019 with more in-depth discussions such as the possibility of integrated marine tourism development strategy in the Sangihe Islands and Underwater Archaeological Park. In the last few decades, diving is one of the fastest growing tourism sports (Luck, 2008: 414; Ong and Musa, 2011 in Dimmock and Musa, 2012: 1) and one of the popular marine tourism activities (Treeck and Schuhmacher, 1998: 499; Edney, 2012: 1; Dimmock and Musa, 2012: 1; 2015: 1). It can be seen from the increasing number of certified divers in the world. According to the Professional Association of Dive Instructor (PADI), certified divers in 1988 were 2.5 million, and in 2008, it was 17.8 million (PADI, 2011 in Dimmock and Musa, 2012: 2). The latest data the number is rapidly increasing, with more than 25 million active scuba divers in the worldwide (PADI, 2019).

Basically, diving tourism is an underwater diving activity to see the landscape, coral reefs, fish, and other underwater floras and faunas (Edney 2012: 8; Dimmock & Musa, 2015: 6; Ardiwidjaja, 2017: 134). But now, diving tourism is also popular at the underwater cultural heritage (UCH), known as wreck diving, such as shipwrecks, planes, and ancient settlements (Delgado, 1998a, 1998b; Edney, 2006 in Edney 2012: 9). Some popular wreck diving locations are Chuuk Lagoon in the Federated States of Micronesia, the Great Lakes in Canada, Kronpis Gustav Adolf Shipwreck in Finland, the Graveyard of the Atlantic in the USA, and Scapa Flow in the UK (Ridwan et al., 2013, Tikkanen, 2008: 44; PADI, 1993, 2007 in Edney, 2012: 9).

In Indonesia, the shipwreck site that is famous as a diving attraction is USAT Liberty in Tulamben, Bali. The number of divers at this site ranged from 50-70 per day (Noerwidi, 2007: 119), in 2013 around 100-150 divers per day (Ridwan, 2013: 18), and in 2016 when the author visited the site, around 300-400 divers per day. Recognizing the enormous economic impact of wreck diving in the community economy as well as a media campaign site itself, various local government and researchers in Indonesia are discouraging other shipwreck sites such as Indonoor in Karimunjawa, MV Boelongan Nederland in West Sumatra and Japanese shipwreck in Gorontalo (Bagagarsyah, 2016; Ridwan, et al., 2014)

Another case of using shipwreck for diving tourism in Indonesia is the Japanese shipwreck in the Sangihe Islands Regency, North Sulawesi Province. The Sangihe Islands is a remote area in the northern part of Indonesia which is bordering the southern Philippines and the Pacific Ocean. Actually, the existence of Japanese shipwreck on the islands has been known for a long time by local people, but archaeologists and the Indonesian central government in particular only learned of the existence of this ship after research conducted by Gadjah Mada University students in 2017 with the theme UGM Maritime Culture Expedition. According to that study, it is known that this shipwreck is one of the shipwrecks in Indonesia with a condition that is still intact and has been used by local people as diving attractions since 2007. Although without the attention of archaeological experts or researchers, local communities have developed diving tourism on this shipwreck simply.

FIG. 1: SANGIHE ISLANDS REGENCY
Source: Google Map

This Japanese shipwreck is in Tahuna Bay which is also the center of the Sangihe Islands Regency government. According to Herjunes, one of the dive guides in the Sangihe Islands, the management of diving tourism on the Japanese Shipwreck has been started since 2007. Diving tourism is enough to provide economic benefits to some local communities at least to dive guides, but lately, the number of divers (tourist) has diminished. The development of diving tours in Japanese wrecks is interesting to discuss. It can be seen from the Underwater Cultural Heritage Management study. As known that diving tourism is considered to be one of the right steps to preserve the cultural heritage of the past, as well as to provide economic benefits to the local community.

Research on Japanese shipwreck in the Sangihe Islands has been carried out by Anshori et al in 2017 and has written an article (Sandy et al., 2019) and a book (Bagagarsyah, 2018) which has been published. The article and book discuss the Japanese shipwreck as one of the archaeological remains in the Sangihe Islands. In addition, another recent study which is carried out by the Directorate of Preservation of Cultural Heritage and Museums under the Ministry of Education and Culture of Indonesia in 2019. The study produced a book **(Sonjaya et al. 2019)** which discussed the maritime and agrarian life of the Sangihe Islands based on evidence archeology, one of which is a shipwreck. So far, research on diving tourism in Japanese shipwreck has never been done even though this issue is quite important in the context of managing Japanese shipwreck as a cultural-historical heritage and improving economy of the local community.

1.2. Research questions

The research questions are; a) how is the management of diving tourism on Japanese shipwreck by local people from the beginning to the present. What are the strengths and weaknesses of the management?

1.3. Purpose

The purpose of this study is to know and explain the management of diving tours in Japanese shipwreck. To know and explain the strengths and weaknesses of managing diving tourism in Japanese shipwreck.

1.4. Method

Data collection techniques of this study include literature review, focus group discussion (FGD), interviews, and observation. The FGD and Interview were conducted with representatives of local government and local communities to find out the condition of shipwreck and management of diving tourism. The observations were carried out by diving directly on Japanese shipwreck and diving activities for approximately 4 days. This study is an analytical description, which gives more descriptions of research results and does not carry out in-depth analysis.

1.5. Literatur Reviews

Diving tourism emerged in the 1930s but began to develop significantly in 1967 (Orams, 1999: 14-15). Diving tourism emerged because of the impact of technological developments on marine tourism (Orams, 1999: 14-15). Through Self Contained Underwater Breathing Apparatus (SCUBA), humans are able to dive under the sea for a long time. In order that it becomes one of attractive tourism object activities with multi-billion dollars industry (Orams, 1999: 14-15; Dimmock and Musa, 2012: 1). Moreover, SCUBA also affects the changing of human perspective toward the sea, which was a mystery and unexplored, unfamiliar, inhospitable to a fascinating, enjoyable, and accessible place (Orams, 1999: 14-15).

According to UNESCO (2001), a study states that dive tourists spend a lot of time and money on their destinations more than other tourists. It makes that the diving tourism industry's impact on economic growth is quite large. In the case of the USA, diving tourism contributes about $11 Billion to the USA gross domestic product (DEMA, 2018: 8). In Thailand, it has been estimated that divers contribute in excess of $150 million annually to the local economy (Dearden, Bennett, & Rollins, 2006 in Edney 2012: 7). Furthermore, in Vanuatu, diving tourism contributes to 10% of GDP (Edney, 2012: 7). In Indonesia, although there are no specific numbers, in general, marine tourism contributes to 10% of GDP, one of them come from diving tourism.

Wreck diving offers different challenges and sensations for divers than in ordinary locations (Edney, 2006: 201 in Rajardjo, 2011: 7; and Cater, 2008; Tabata, 1992 in Edney 2012, 9). Not only seeing fish and coral reefs in general but also experiencing diving between the space of a ship or plane and along with ancient buildings which are along with war stories or history. Wreck diving tests adrenaline and triggers curiosity of divers. Wreck Diving can be seen from two main issues, tourism and management of UCH (UNESCO, 2001; Edney, 2012: 8-9; Frigerio, 2013: 55-56). They are like currencies that are always related, both are mutually beneficial but also sometimes detrimental (Hasanah et al., 2013: 16). In the tourism industry, Cultural Heritage is often used as a tourism attraction and visited by many tourists. It is called cultural heritage tourism (WTO, 2001).

Seeing the opportunities and challenges in managing Underwater Cultural Heritage as diving attractions, there are several solutions and strategies provided by UNESCO and researchers:

- Collaborative Stakeholders started from the central government, local government, local communities, and related institutions such as tourism, environment, and Cultural Heritage (Firth, 2015);
- Increasing the establishment of underwater heritage museums also in regard to urban needs (in situ or land-based);
- Increasing media cooperation to publish archaeological work;
- More massive community involvement started with planning, management, and evaluation (Noerwidi, 2007: 133-134; Bagagarsyah, 2016: 7-9 Azevedo, 2014).
- Making diving grooves that are safe for both divers and underwater cultural heritage based on diver's expertise/certificate (Adhityatama, 2015: 8-10; Bagagarsyah, 2016: 7-8).

2. RESULTS AND DISCUSSION

2.1. Geography of the Sangihe Islands

Sangihe Islands Regency is one of the outermost areas of Indonesia which is directly adjacent to the Philippines. From Manado City, the capital city of North Sulawesi province to the Sangihe islands can be reached by airplane (45 minutes) and ships (5-8 hours). Sangihe Islands Regency consists of around 90 small islands with an area of 1,012.94 km² and is divided into 15 sub-districts. In 2015, the Sangihe Islands Regency had a population of 130,493 people (Statistic of The Sangihe Islands Regency, 2018). Among the dozens of the islands in Sangihe Islands Regency, there is the largest island by the local community called Sangir Besar. Sangir Besar Island is the seat of government for the Sangihe Islands Regency with its capital city Tahuna, which is located around Tahuna Bay. More than half of the Sangihe people live in Sangir Besar, the majority are Protestants and Catholics, mixed with Islam and Confucianism. The wide area of Sangir Besar Island is about 736.98 km2, which consists of 8 sub-districts (Statistic of The Sangihe Islands Regency, 2018).

2.1.1. Tahuna Bay

Japanese shipwreck is in Tahuna Bay, precisely in the old port which is about 20 m from the beach. Tahuna Bay has a length of around 2.5 Kilometers and a width of approximately 1 Kilometer. In addition, Tahuna Bay topography is a type of slope with black sand material and has a maximum depth of 40 meters. Tahuna Bay is also the location of the government capital of the Sangihe Islands Regency. As the location of the government capital, in Tahuna Bay, there are many public facilities such as ports, markets, hospitals, university, government offices, and hotels. Tahuna Bay also has adequate modes of transportation with good road conditions. The proximity of the location of the Japanese shipwreck to the city, which is equipped with a variety of public facilities, makes access to dive tourism on shipwreck quite easy.

Fig. 2: Tahuna Bay
Source: Travel.kompas.com

2.2. Diving Sites in Sangihe Islands

There are several dive tourism sites in the Sangihe Islands which were published by the Sangihe Regional Government through a book entitled Tourism Attractions in the Sangihe Islands Regency (2014). Some of these locations include the Banuawuhu Submarine Volcano, Mandaku Dakupang, Mahumu Island, Bukide Island, The Lost City in Kendahe, Kahakitang Island, and the Japanese Shipwreck in Tahuna Bay. However, popular locations include the Banuawuhu Submarine Volcano and Japanese Shipwreck.

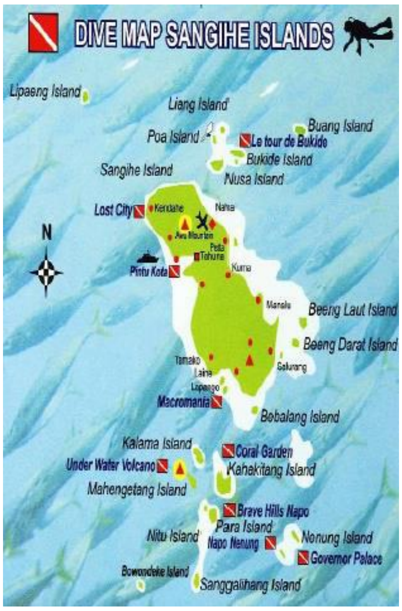

Fig. 3: Dive Map Sangihe Islands
Source: Sangihe Islands Government (2014)

2.2.1.Banuawuhu Submarine Volcano

The development of diving tourism on Japanese wrecks is inseparable from diving tourism on Banuawuhu submarine Volcano in Mahengetang Island, which is the main destination for local and International divers. Initially, Japanese shipwreck became the second diving choice after Banuawuhu Submarine Volcano. Tourists who have finished diving in the Banuawuhu Submarine Volcano will do dives on Japanese Shipwreck. But lately, the Japanese shipwreck is the first choice for divers who have only a short time in the Sangihe Islands and do not want to go to Banuawuhu Volcano which is quite far away and requires huge costs.

According to Center for Marine Resource Development and Technology of Gadjah Mada University (2011), the Banuawuhu submarine volcano is one of the few volcanoes in Indonesia that can be easily observed. The Banuawuhu submarine volcano is in Totoareng District, Mahengetang Island, Sangihe Islands Regency. At high tide, the peak of the volcano is at a depth of 5 meters, while when receding only at a depth of 1 meter. Until now this volcano is still active, so it emits bubbles from inside. Temperatures at a depth of around 26 degrees, while the temperature around bubbles is usually around 30 degrees Celsius.

Transportation from the Tahuna City to Mahengetang Island uses a boat with during 3.5 hours to 1.5 hours, depending on the type of boat. Nusa Utara Polytechnic in Tahuna City rents a boat from Tahuna City to Mahengetang Island (Speed of 8 knots) with a fee of Rp. 3,500,000 and 500,000 for ship crew. Based on Local Government regulations, each ship entering the Mahengetang Island area is obliged to pay Rp.500,000, the money goes to the cash of the Totoareng District.

2.2.2. Shipwreck

The location of the shipwreck is in Tahuna Bay which is about 20 meters from the coastline, precisely in the Old Port of Kota Tahuna. Around the location of the wreck, there is a floating dock. According to Sandy, et al., (2019), Shipwreck is at a depth of about 18-25 m. Underwater visibility is quite good ranging from 10-15 meters with calm ocean currents in the normal season. The ship is 40 meters long, 5 meters high and 7 meters wide. The components still look complete, such as rudder, engine steering, mast and propeller (Sonjaya, etc., 2019).

The history of this shipwreck is not yet known, but based on recent research the ship is suspected of being a type of Japanese fishing vessel (Sonjaya, 2019). During the Pacific War, this ship was allegedly used by Japanese soldiers to help transport the logistics of war in the Sangihe Islands region. This ship is also allegedly intentionally sunk by allies after Japan lost the war (Sonjaya etc., 2019). At present, almost all of the ship's bodies have been overgrown with coral and are home to thousands of fish. This is the main attraction of this ship as a diving attraction besides because of its importance as an underwater cultural heritage.

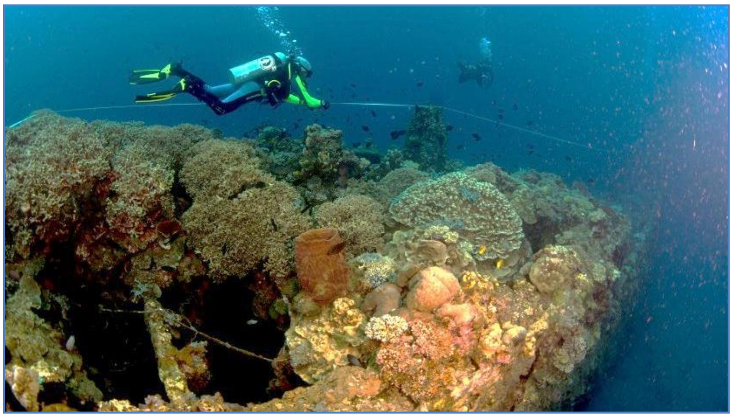

Fig. 4: Japanese Shipwreck
Source: Stefanus (2019) in Sonjaya, et al., (2019)

2.3. Management of Diving Tourism in Japanese Shipwreck

Management of diving tourism on Japanese shipwreck was initially initiated by the local government of the Sangihe Islands Regency. That made into a package with diving tourism in other locations such as Banuawuhu Submarine Volcano, Dakupang Mandaku, Bukide Island, and Mamuhu. But lately, promotion and management of diving tourism, especially in Japanese shipwreck is only done by a few local people.
In this section, it will be explained about the management of diving tourism which has been carried out by the local government and local people such as rules, facilities, dive center, dive guides, and visitor management.

2.3.1.Facilities

In order to support diving tourism in the Sangihe Islands, especially on Japanese wrecks, the Sangihe regional government has provided various facilities such as a dive center, parking area, and bathrooms. In addition, hotels, restaurants, and markets have long been available such as facilities for local people and other tourists. In Tahuna City, there are two dive centers, which were owned by the local government and managed by third parties with a revenue sharing system. But this dive center is no longer operating and it is considered to have various problems such as the lack of transparency in the financial report. Second is a dive center owned by a local university, namely the North Nusa Polytechnic. This dive center is still operating until now and is managed directly by the North Nusa Polytechnic staffs.

At the Nusa Tenggara Polytechnic Dive center, the cost of renting diving equipment (fin, mask, snorkel, BCD, 1 tank and belt) is Rp. 350,000 per day each person, if we want to add more tanks then pay Rp. 50,000 /tank. The diving equipment rental procedure is quite easy, just by leaving a personal identity card. The North Nusa Polytechnic also provides dive guides who have certified rescue. For tourists who at the same time rent diving equipment, it is enough to pay Rp. 250,000 dive guide per day. As for tourists who use their own equipment, pay Rp.350,000 dive guide per day.

Regarding the rules of diving guides, divers in Sangihe agreed that those who can guide tourists are divers who have at least a rescue certificate. Currently, in Sangihe, there are around 50 divers, around 32 are open water, 15 are advanced and 3 rescue certificate. During this time, local residents of Sangihe have their own initiative to get the certificate by using their personal money.

2.3.2. Tourist

According to the statistic of the Sangihe Islands Regency (2018), in general, the number of tourists in Sangihe in 2017 was 33.875, 31765 are domestic and 2110 are foreigners. While according to Herjunes, one of the dive guides in Sangihe, so far, there is no clear record of the number of divers in Japanese shipwreck. He and other dive guides only estimate it. According to him, lately, the number of divers on shipwreck tends to decline. From January to May 2019, he said that there were only around 40 domestic divers and 15 foreign divers. Usually, they choose 3 or 5-day dive trips using tour packages provided by tourism agencies in the Manado City, the capital of North Sulawesi Province. This tour package provides all tourist needs such as lodging, transportation and does not involve local residents. Local tourism usually comes in one group with around 8-12 people, while foreign tourists usually come alone/individually, if a group is a maximum of 5 people.

2.3.3. Local People Participation

The intact condition of the Japanese shipwreck is inseparable from the awareness of the local community not to look at the historical site while keeping it from being stolen by other parties. This is the main capital in the preservation of cultural heritage sites, namely the active role of local communities. But unfortunately, in managing dive tourism on this ship, basically there are not many local people who feel the benefits economically. Only a few people are directly involved in diving tours, such as diving companions, diving equipment rental providers, boat rental providers, and the captain and crew members. From the explanation above, we can find out that there are several strengths and weaknesses in the management of Japanese shipwreck diving tourism. They are;

2.3.4. Strengths

The strengths of management of Japanese Shipwreck diving tourism are; a) within the scope of local tourism areas, shipwreck location is in the center of the city making it easily accessible to tourists in the Sangihe Islands; b) availability of facilities and infrastructure such as Dive centers, hotels, restaurants, parking area and bathrooms around the location; c) the condition of the ship is relatively intact; d)public awareness to maintain the shipwreck; e) local divers who have been certified as diving guides; and f) support of local universities in providing human resources and diving equipment.

2.3.5. Weaknesses

Furthermore, this management of Japanese Shipwreck diving tourism has some weaknesses; a) within the scope of national tourism, the location of the Sangihe Islands is far from the major islands in Indonesia, especially from Jakarta, the Capital City of Indonesia. It causes the access to Sangihe Island is quite difficult and far away so it requires a large cost to visit; b) there are no detailed rules regarding safe diving lines and protection of shipwreck; c) plastic waste and bottles that are thrown into the sea, some settle on the shipwreck's body; d) in the south wind season, around September-October, sea wave condition around Tahuna Bay is high and to be dangerous for diving tourism; e) potential earthquakes and tsunami; and f) eruption Potential from Awu Mount.

3. CONCLUSION

Diving tourism in Japanese wrecks has not yet developed like in other sites, even the number of tourists who dive tends to decrease. Nonetheless, at least this diving tour on Japanese wrecks has helped to preserve shipwreck as a cultural-historical site. The preservation meant is to introduce the existence and importance of Japanese shipwreck to domestic divers and foreign. In addition, the on-going diving tourism will prevent the stealing of ships because their presence is always monitored by local people, especially local divers in Sangihe.

In the future, the research needs to be done to find out a number of things such as the causes of the number of divers declining, the perception of local residents and tourists on a shipwreck. Furthermore, it is also necessary to conduct research on better promotion and management of diving tourism strategies so that besides being able to preserve shipwrecks, it will also improve economy of both the local community and local government.

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The Faro Convention and the sustainable valorization of the underwater heritage. Case studies and projects in the Adriatic and Ionian seas

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Abstract: During the last years, some marine or coastal protected areas subject to the landscape planning restrictions, along the Adriatic and Ionian coasts have been the backdrop of the coastal landscape archaeological researches carried out by the Salento and Trieste Universities, in collaboration with national and international partners, both public and private. They are excellent sites for geo-archaeological research, where the protection activity allows us to individuate the signs – poorly recognizable or unequivocal – of the changes and to re-trace through the trans-disciplinary analysis the ancient landscape features.

The presentation aims to describe some projects, some of which are in progress, that have as common denominator a valorization model of the environmental and historical-archaeological heritage and a methodological protocol of the geo-archaeological investigation in a particular context such as a protected marine area and/or natural park.

These valorization proposals comprise a series of actions: a preliminary paleo-geographic, paleo-environmental and archaeological investigation program, that includes also topographical and bathymetric surveys, cores, targeted excavations, mapping and development of integrated information systems; furthermore the design of technical, exhibition and reception spaces, with interactive multimedia displays, life-size and scale replicas, landscape reconstructions and simulation of its changes, through semi-immersive fruition using holographic systems presented in sequence; design and installation of "blue paths" accessible by snorkeling, scuba diving with trained guides (also for people with a disability) and/or boat, glass bottom boat or video-boat; the blue paths' stops are represented by environmental, geomorphological, archaeological and geoarchaeological points of interest.

Keywords: marine or coastal protected areas, waterscapes archaeology, in situ preservation, enhancement, blue paths, Museum-acquarium.

1. ARCHAEOLOGY AND ENVIRONMENT, "WATERSCAPES" ARCHAEOLOGY

The best practice of the in situ preservation and enhancement is the natural target of the global landscapes archaeology, in our case "waterscapes archeology", "a coherent sub-discipline of human ecology, neither a form of natural science nor a form of archaeology, but an integrated way of understanding humans in dynamic landscapes" (Barker G., Bintcliff J. 1999: 207). As we know, the landscape/waterscape is a system generated by mutual relations between physical, anthropic and cultural features. Our primary task – as historians, geoarchaeologists, etc. – is to tell the story of social groups in changing landscapes, recording the discontinuities, the development processes, the identity-making features; this operation enables us to write the longue durée history, complementary to the Braudelian"histoire événementielle" (Braudel H. 1949; Barker G. 1991; Hodges 1993; Cambi, Terrenato 1995: 282-289)

The global landscape archeology, due to its holistic approach, has a very evident political connotation: it is public archaeology, "archaeology of the territory, carried out in the territory for the territory", an effective tool "*for the protection of the landscapes and for the measures of territorial planning, more careful to the* *safeguard and enhancement of the archaeological heritage, capable to reconcile the needs of the current society with the knowledge and the preservation of the traces of the past".*

The waterscape, because of its complexity and dynamism, is the most challenging and organic o ofthe territorial and cultural "archives", able to facilitate the entirety of approach and sources and to reassemble the various archaeological competences in a holistic perspective.

The submerged archaeological site is a perfect mix between nature and culture. We would define it as "eco-museum" or "widespread museum", where landscape, in our case waterscape, becomes museum, as a system where goods and objects are in connection and, because of this, understandable; a widespread museum, where the cultural heritage is preserved in the environment of which it is an integral part.

On this statement the Italian legislation is perfectly consistent with the European as testified:

- Codice Urbani: *the archaeological park is a territory characterized by important archaeological evidences and by the joined presence of historical, landscape and environmental values, equipped as an open-air museum*";
- also the framework law 394/1991 on the protected areas aims at safeguarding *anthropological, archaeological, historical, architectonical values*
- Faro Convention:

  Art. 2 - definition of cultural heritage: *a group of resources inherited from the past which people identify, independently of ownership, as a reflection and expression of their constantly evolving values, beliefs, knowledge and traditions. It includes all aspects of the environment resulting from the interaction between people and places through time;*

  See also Art. 8 – Environment, heritage and quality of life.

The marriage of nature and culture is particularly efficient in the touristic aspect of the *in situ* preservation. In the underwater tourism historical and biological/naturalistic concerns merge. Piero Pruneti, promoter of this kind of cultural tourism in Italy, speaks of an "history ecosystem". The underwater tourism combines in a single activity leisure, sport, culture and ecology. For exploiting its potential, it needs a local touristic system integrated and effective, quite diversified, in which different actors accept to interact. Futhermore, it's a kind of tourism that needs areas provided of a status of juridic protection of environmental type (MPA) and/or archaeological type (Parks).

These forms of protection imply and at the same time foster a "culture of the territory", that is increasingly important for our country.

If we want to attract cultural tourism or the more profitable underwater cultural tourism, it occurs to invest in protection policies and to make the territory more attractive with specific environmental brands (MPA), as evidenced/demonstrated by the brand "Unesco World Heritage", obsessively sought-after by the local authorities.

On the other side, the underwater archaeological tourism has a limit that conflicts with the principles of the UNESCO Convention and Faro Convention: it implies elevated costs for the users and limits the fruition to the middle and upper class, in a form of "gentrification". This public during holidays likes to or must spend a significant budget for diving services and equipment, the transport and the boat rental, the touristic services, such as hotels and restaurants.

It is very profitable/lucrative, of low or zero environmental impact, that is to say sustainable, "programmed alternative tourism", at high regulation and low intensity of flows. But it still doesn't seem a tourism for all that is that not all the community will be able to access, know and share its own heritage.

2. STUDY CASES: MARINE OR COASTAL PROTECTED AREA

During the last years, some marine or coastal protected areas subject to the landscape planning restrictions, along the Adriatic and Ionian coasts (Miramare Marine Protected Area and the Marano Lagoon (Ud) in Friuli Venezia Giulia, Torre Guaceto Marine Protected Area, Porto Selvaggio-Palude del Capitano Natural Park and the contiguous Marine Protected Area of Porto Cesareo) have been the backdrop of the coastal landscape archaeological researches carried out by the Salento and Trieste Universities, in collaboration with national and international partners, both public and private. They are excellent sites for geo-archaeological research, where the protection activity allows us to individuate the signs – poorly recognizable or unequivocal – of the changes and to re-trace through the trans-disciplinary analysis the ancient landscape features. They are excellent sites in which to experiment widely accessible forms of underwater tourism, affordable tourism for all, in line with the principles of Faro Convention.

The first example is offered by the **Miramare Marine Protected Area** and its immediate surroundings, located at the foot of the Miramare promontory.

Fig. 1: Grignano, Trieste. The promontory. Aerial photo: 1. submerged breakwater; 2. findings behind the Miramare Stables (a) and to the north (b); 3. Roman pier under the modern port (Regione FVG- volo Trieste 2003, lotto 15, strisciata 38, fotogramma 33).

The maritime character is clear, since the Roman and Medieval age; from the beginning of the 12th century, at the start of the Venetian hostilities, the Venetian ships lay in ambush in the little harbour of Grignano, while the Triestine ships sought refuge in the same harbour….For the Roman age we can draw a more articulated system: a northern basin, the port of Grignano, with the greek pi-shaped pier known to Kandler and documented in the historical cartography and also by Degrassi in the last century; a second little landing place, or, better, boats to the south, at the mouth of the Aurisina creek. The researches carried out as part of the Interreg Italia-Slovenija *AltoAdriatico* project allowed us to document both the foundation of the pier in the Grignano bay and a breakwater – a 70 m long, 2 m high, L-shaped dry stone jetty - in front of the Miramare Stables.

Both the sites must be related to one or more important coastal residences, whose traces – mosaics, brick stamps, etc. - have been found in a kilometer long stretch of the coast. The submerged and geoarchaeological evidences could enrich the already wide offerings of the MPA, and could provide additional opportunities for training, educational and touristic programmes.

The *Storie dal* mare research project, carried out by the Trieste University and the Superintendency for Cultural Heritage of Friuli Venezia Giulia had as its primary focus **the lagoon area of Marano**, frequented since the Neolithic age and showing a strong role in trade supported by the waterways mostly evident from the Iron age. It is possible to reconstruct for the Roman age an articulated settlement framework with strategic landing places both on islands and on the lagoon perimeter, that represented strategic points in strict connection with the Aquileia harbour system.

Fig. 2: The Marano lagoon.

Fig. 3: The Marano Lagoon. Archaeological map.

The import from different Mediterranean areas (food, pottery and other goods) indicates the vitality of the trade flows, and, together with the shipwrecks in the riverbeds and probably also in the lagoon, put in light the area's role as an hub between the land routes, the rivers and the sea routes.

Near the two Regional Reserves, Foci dello Stella and Valle Canal Novo, there are some other archaeological sites, investigated during the Project, such as the room with mosaic at Piere d'Isela, the archaeological ceramic materials at Piere del Ficariol, the relevant building complex at Piere del Tribel, the

Early Mediaeval structures and deposits on the S. Andrea island, hypothetically referred to a Christian church, founded by the Patriarch Elia at the end of the 6th cent. AD.

As results of the project we have achieved

- an hypothesis of reconstruction of the paleo-landscape, through the study of the relative sea-level changes and the morphological evolution of the lagoon environment;
- the elaboration of the archaeological GIS of the Marano Lagoon
- knowledge-sharing events, such as the exhibition "*Alle porte del mare. Paesaggi d'acqua e di storia nella laguna di Marano"*, that was held in Marano, old fishery, 1st September – 3rd November 2013
- educational and touristic initiatives, such as laboratories, guided visits, themed dinners and tastings (*The flavours of history*)
- publications, such as papers in scientific journals and the exhibition catalogue R. Auriemma, P. Maggi (a cura di), *Alle porte del mare. Paesaggi d'acqua e di storia nella laguna di Marano,* Catalogo della mostra, Luglio Editore, Trieste 2013.
- the design of an archaeological itinerary, on the land, the islands and under water, linked to the existing environmental one, capable of enriching the high quality touristic offer.

In the **Southern Adriatic**, coastal landscape archaeological researches have been carried out in various areas, aiming at the continuous updating of the Archaeological Underwater Map / Web GIS of the Apulia Region.

In the natural **Reserve and Marine Protected Area of Torre Guaceto**, where the coast shows beautiful pocket beaches, the three islets of Torre Guaceto, in front of the promontory of the same name, and the 2 southernmost islets of Apani.

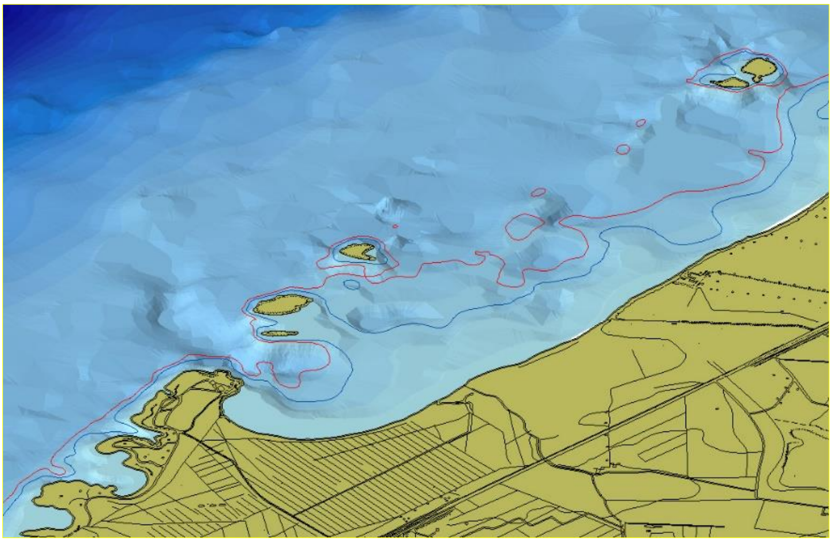

Fig. 4: Torre Guaceto. Bronze age (red) and Roman coastline (blu).

A vast Bronze age settlement extends at least 1 km along the coast, on the islets and also on the sea bottom, all scattered with post holes of different shapes and sizes, frequently aligned, up to a depth of 3.5/4 m.

Roman age deposits and a shallowly submerged quarry are on the second islet, that – as the landscape evolution analysis has demonstrated – was at that time a sort of headland used as a landing and loading point for little boats that transported local products – especially wine and oil contained in amphoras - to the Brindisi terminal.

Late antique deposits and the squared blocks foundation of a hypothetical tower/lighthouse are on the third islet. The stretch of water between the latter and the shore shows the scattered remains of a late antique shipwreck: ballast stones, amphoras and tile sherds, a rotary millstone, etc. This wreck demonstrates that at the end of the Roman Empire the relative sea level increase caused the sea ingression and the definition of the islets that represent the protruding fragments of the ancient coastline.

Archaeological and morphological data allow us to recognize important changes in the coastal profile, between the Bronze age and the medieval age (Auriemma R. 2004, I: 86-87; Auriemma R. et al. 2004. Scarano T. et al. 2008). The inhabited areas are located on high terrains compared to acoastal plain (larger than the current one) characterized by abundant water flows (Canale Reale), widespread swamps and lush vegetation.

In the 2^{nd} millennium BC, due to a medium sea level 3-4 m lower than current one, the landscape was characterized by sites in the most elevated points of the coastal plan, eminent in respect of other areas rich in fresh water (the water network of the ancient Canale Reale) and game.

After the Bronze age, the rising sea level started to undermine the MIS 5 dunes, and eroded and flooded the hollows behind. Underwater findings attest the existence of a landing place in Torre Guaceto during the late Republican and Early Imperial Roman age, functional to the nearby Apani amphoras kilns and to the significant oil and wine production in the hinterland, probably near the mouth of Canale Reale (Auriemma R. 2004, I: 91-94). During this phase, in accordance with the archaeological sea level markers of nearby sites such as Egnazia and Torre S. Sabina, with a sea level 2.5-3 m lower than current, the "caricatore" could have been located on a promontory coinciding with the two surviving islets. In the Late Antiquity the remains of a cargo in the shallows between the third islet and today's shore testify to the sea ingression, as do the vestiges of a presumed tower-lighthouse also on the third islet (Giardina B. 2010).

This site testifies that there is no valorization without a preliminary strategic research programme.

We identified the focal points in the homonymous look-out coastal Tower and in the **blue trails**, underwater itineraries with floral and faunal, geomorphological (the submerged sapping valley to the east of the Tower), geoarchaeological (the paleoshore) and archaeological points of interest, that are presented to the visitors with replicas of scattered cargos and decontextualized finds.

The interior of the Tower has been set up with a replica of a little cargo boat apt to transport amphoras to the Brindisi harbour from the loading place of Guaceto, inspired by a small "cabotatore" 8 m long, similar to the Cavalier shipwreck. Educational panels attractively illustrate the landscape context, the agricultural activities and tools, such as the grain milling, the wine and oil production, the amphora kilns and the transport of the goods by cart to the landing place, etc.

In the Ionian sea we have operated in some **Marine Protected Areas, such as that of Porto Cesareo**.

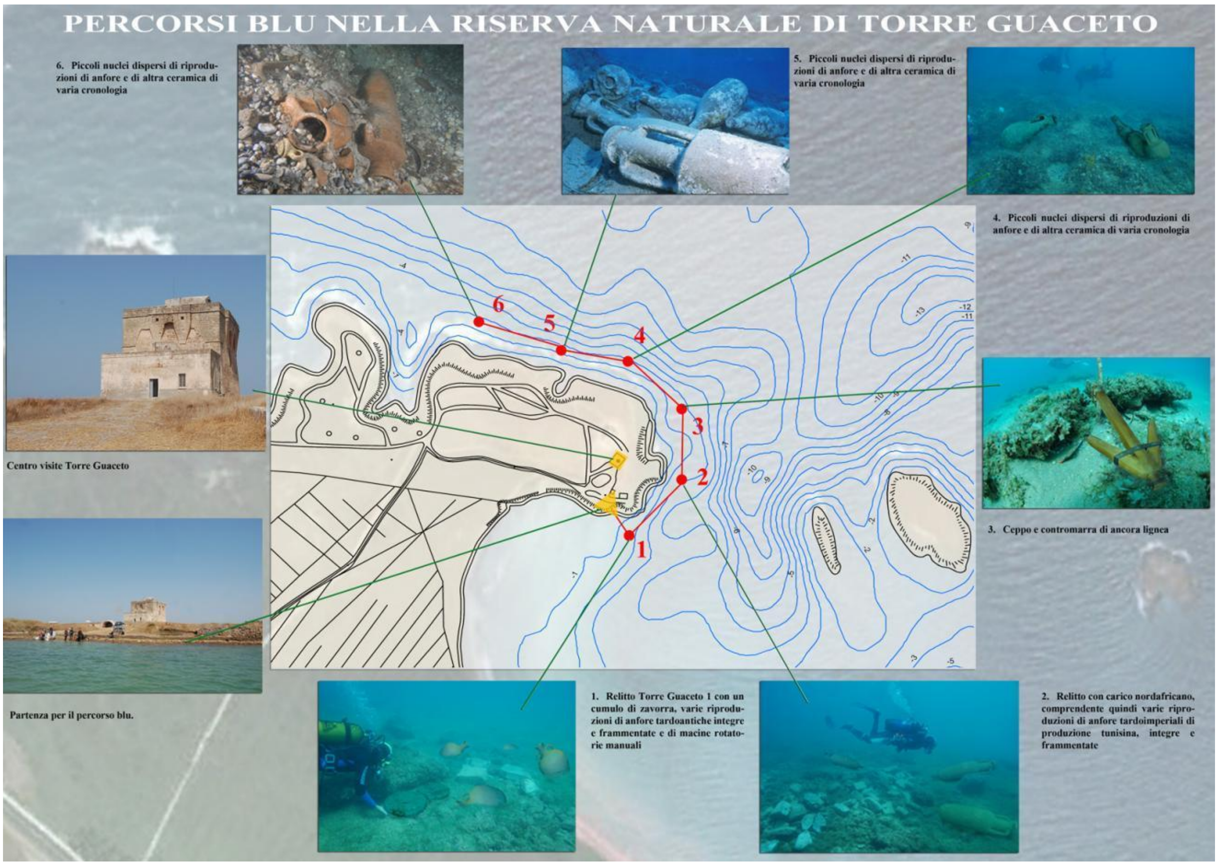

Fig. 5: Torre Guaceto: blue trails project.

Here there are some well-known underwater evidences, such as the **navis lapidaria** shipwreck, with the monumental cipollino marble column cargo coming from Eubea, that lies at a depth of 4.5 m, but also some decontextualized finds, including the small precious statue of the baboon-God Thoth, in green basalt and with hieroglyphics, some lead stocks recently found (one recovered), etc., that attest an intensive frequentation of this coastal stretch, both along fishing and cabotage pathways and the crossing route of the Ionian sea, towards Kroton.

The Torre Chianca headland and the nearby small peninsula show very conspicuous archaeological deposits dated back to the Roman age, exposed by erosion, as well as wall block foundations that delimit some settings, and a necropolis area, with limestone sarcophagi and tombs cut in the rocky bed, with skeletal remains, all now partially submerged, due to relative sea level changes that have caused the transformation of a headland into the island of Malva.

All these evidences can be referred to an extended settlement located around the bay, aimed at exploiting maritime resources.

A little further to the south of Torre Chianca, the promontory of Scalo di Furno hosts one of the most significant proto-historical settlements of the Salento coast, dating from the Bronze to the archaic age (18/17th – 8th cent. BC and further), that has offered also Mycenaean pottery.

Fig. 6: Scalo di Furno (Lecce). Bronze age settlement's lower terrace with the now submerged fortification and stone pavement; the yellow line indicates the ancient coastline – 4.5 m.

Subsequently, between the end of the 7th and the beginning of the 5th cent. BC, the site became a place of worship, with a small temple devoted to a messapic Goddess, altars and votive deposits and offerings.

The underwater survey between the promontory and the opposite islet allowed us to reconstruct a paleo-landscape completely different from present; we have recognized the lower terrace of the settlement, with the now submerged fortification wall and cobble stone pavement, that reveal a sea level rise of 4.5 m from the Bronze age and a relevant tectonic down-lift.

A further wreck has been brought to light recently; a beached wreck dated back to the Medieval age (770-1020 d.C.) by radiocarbon analysis and maybe referable to the Eastern Mediterranean environment.

Also in this case some blue trails have been designed and promoted to the public. Furthermore, we developed a VR replica of the column cargo ship that can be enjoyed by the visitors.

Since 2008 a vast coastal landscape research program (surveys and excavations on the land and under water) has been carried out in the **Natural Park of Porto Selvaggio and Palude del Capitano (Nardò),** partially contiguous to the Porto Cesareo MPA.

Fig. 7: Natural Park of Porto Selvaggio and Palude del Capitano (Nardò).

The investigations concerned the coastal settlement of Frascone, a maritime villa in the late republican phase and a fishing farm in the Roman Imperial stage.

The Municipality of Nardò requested to extend the park to the southerly bordering maritime stretch, up to Porto Selvaggio and S. Caterina; in this way, some shipwrecks could be included in the protected area: the cargo traces reported at P. Lea and the 2 ships sunken near S. Caterina harbour (dia): the hellenistic wreck of Scogli delle 2 sorelle (dia), of which scattered remains of the cargo are visible on the beautiful sea bottom; the well known wreck of S. Caterina-Punta dell'Aspide, with Greco-italic wine amphoras partially excavated, that has been proposed for the in situ preservation. Also the former could be enjoyed, even if heavily looted, through reproductions of amphoras and living on board objects, and 3D models.

The research program has allowed the very recent opening of an educational **Maritime Museum in Nardò**, displaying all the results and conceived particularly for a young public.

The strong relationship between naturalistic and cultural aspects of the sea constitutes the core of the **Museum-Aquarium of S. Maria al Bagno**, carried out within the interdisciplinary 'Aquaria for the Promotion of Environment and History' (A.Pr.E.H.) project financed by the European Territorial Cooperation Programme (E.T.C.P.) "Greece-Italy" 2007-2013. The mission of the 2 Aquaria of the project (in S. Maria e in Argostoli, Greece) will be the promotion, education, and information not only for the knowledge of the local marine fauna and flora, but also of the ancient, modern and contemporary history, through renderings and reproductions of some wrecks belonging to the various periods, from the Roman ship of S. Caterina to the II World War steamers and plane (Posi et al. 2013).

The coastal area of the Natural Reserve of **Le Cesine**, one of the surviving testimonies of the extended marshes along the Apulian shore, deserves a mention; various submerged and partially submerged evidences are known: Bronze age deposits, squared block structures, a presumed fishpond, basins for the salt production and walls.

Recently the hull of a modern copper-bottomed beached wreck with double planking has been discovered, of medium tonnage and presumably 30 m long. In close proximity 2 cannons lie in the sandy bottom 2,40 m and 2,10 m long.

The wreck is comparable, as far as the preservation, position and naval carpentry are concerned, with the contemporary wreck of Torre Rinalda, a little to the north, in the Municipality of Lecce.

Also in this case the in situ preservation seems the best option for the enhancement of the whole context and we proposed a trail around the cannons and the visible perimeter of the hull, 300-400 m long.

We can also quote **Ugentosommerso project**: naturalistic and archaeological underwater trails in the Ugento shallow waters; the project has foreseen a multilingual video and other informative and communication materials production.

The project MareMuseoSalento Università del Salento – Regione Puglia

A project of enhancement and in situ preservation of the Apulian underwater heritage is currently in progress: through the knowledge and the data base of the Southern Apulia Underwater Archaeological Map/webGIS, the purpose is to create an efficient touristic network of accessible submerged or partially submerged sites (structures and shipwrecks or cargos, isolated finds and harbour dumps). Along the Salento coast there are various and heterogeneous shipwrecks that are suitable to this project: marble cargos/*naves lapidariae* as well as amphoras and pottery cargos, beached wrecks, etc.

The goal is also to involve local actors – especially young people, through specific measures and calls for interest - for the setting of the sites (also with metallic cages), management and development of related activities, including the resumption of old trades such as the shipwright for building ships' **didactical replicas** or virtual replicas.

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Perspectives and obstacles for accessible underwater archaeological sites. The case of Crete

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An ongoing debate, lasting for almost two decades, takes place in Greece, mirroring a general need for the establishment of underwater archaeological sites that could accept visitors (divers or swimmers) like the open air archaeological parks on land.

In a cultural and tourist destination like Greece, the attractive underwater cultural heritage could absolutely be a multilevel and multipurpose surplus producer. However, the nature of the sea environment and the difficulty of access, the sensitive character of the underwater monuments and sites, the impediments in monitoring such sites and the consequent legal framework needed make the whole effort a demanding task. Despite all the above, it seems that recently steps have been done towards that goal.

Crete as the birth place of the first "thalassocracy", according to Thucydides, has always been a hub on the nautical routes of the Eastern Mediterranean during the centuries of the sailing navigation. With harsh weathers, rocky coasts and submerging at its eastern half, keeps at its waters and shores a plethora of ancient shipwrecks and submerged sites. Some of these sites would be really ideal for the development of accessible underwater archaeological sites that could offer much to the tourism industry of the island. This perspective is a great opportunity for the enhancement of the recording, protecting and promoting underwater cultural heritage of the island.

Keywords: Greek underwater archaeology, Cretan underwater archaeology, accessible underwater archaeological sites

Public Access to Underwater Archaeological Sites. Enjoying and Protecting our Maritime Heritage

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***Abstract*:** Following the guidelines on public outreach included in the 2001 UNESCO convention on the Proteccion of UCH, FECDAS/CMAS[55], in close cooperation with CASC-MAC[56], established the Department of Protection of Underwater Archaeological Heritage in 2010.

The department aims specially at sport divers as they represent an important ally who frequently visits their local waters/ sea bed. They can detect any aggression against the known archaeological sites and notify any new finds.

In order to raise awareness on UCH among society, FECDAS organise a set of year-round outreach activities including conferences, exhibitions, visits to maritime and archaeological institutions, etc. both for divers and non divers, but diving in the underwater archaeological sites while the archaeologists are working is one of our more didactic and exciting activities. Previous to the visit, an expert provides the information in order to understand the archaeological and historical context.

At the moment, FECDAS has organised several visits to the Roman shipwrecks "Cap de Vol" and "Cala Cativa" and the 19th century warship "Deltebre I". Both projects gained the UNESCO recognition of best practices of Underwater Cultural Heritage.

Keywords: UNESCO, "in situ" visits, sport divers, raising awareness, Roman Shipwrecks

1. SOCIAL AND LEGAL CONTEXT

Underwater archaeology has long been considered as an adventurous activity associated to treasure hunting. This misconception led to an irreversible damage to numerous underwater archaeological sites. At the same time, compared with other European countries Spain started to protect its cultural heritage through *ad hoc* legislation rather belatedly (Ley 16/1985), but this law did acknowledge and aim to protect UCH. Besides, the large number of Spanish shipwrecks beyond Spain's territorial waters led Spain to first support the creation of the 2001 United Nations Educational, Scientific and Cultural Organization (UNESCO) Convention on the Protection of Underwater Cultural Heritage and, a few years later, to ratify it (ratified by Spain on 6 July 2005).

Among other issues, the convention acknowledges recreational scuba divers as potential partners in the enjoyment and safeguarding of UCH as they are the main contributor of casual finds of maritime archaeological remains, and are one of the main participants in denunciating attacks on known UCH "Rey da Silva, (2013)". Accordingly, a number of recommendations were included in the Convention on the Protection of the Underwater Cultural Heritage of UNESCO[57] with the intention of promoting the safeguarding of UCH among sport divers. These include, among others, responsible and controlled public access to underwater sites.

[i] Federació Catalana d'Activitats Subacuátiques/ Confédération Mondiale des Activités Subaquatiques
[ii] Centre d'Arqueologia Subaquàtica de Catalunya- Museu d'Arqueologia de Catalunya
[57] http://www.unesco.org/new/en/culture/themes/underwater-cultural-heritage/2001-convention/

2. WHY INVOLVING SOCIETY?

Despite the current framework, the looting continues to be a daily reality due to ignorance, in some cases, the thrill of taking "souvenirs" or the desire of making illegal profit out of the archaeological artefacts.

In addition, thanks to the technical advances developed in diving equipment, the possibility of diving into greater depths is within the reach of more people. This fact cannot be ignored and raises a new challenge: anticipating to this scenario and making sports divers aware of the fragility and scientific importance of the UCH before the deeper archaeological sites are altered. Thereby, divers, as part of the society become our ally. These collaborators provide priceless assistance; being distributed throughout the Catalan coast, they constitute a dense network of informants keen to notify new discoveries, attacks on the known archaeological sites and also constitute a local pressure group for the local administrations in the development, investigation and value of their UCH.

But this relationship needs a fundamental counterpart. We understand that in order to respect and involve society in the protection of the UCH, first it must be known and enjoyed. Disclosure, therefore, appears as a key tool in this equation.

3. WHO ARE WE? FECDAS/CMAS AND CASC

The standards that have been proposed worldwide by UNESCO are generic and must be adapted to the local reality and mentality of each territory. Therefore, it is essential to take into account the opinion of local divers; their customs, their level of sensitivity and training in heritage.

Accordingly, the department of Underwater Archaeological Heritage was created within the Catalan Federation of Underwater Activities (FECDAS) in December 2009[58]. This federation represents the largest association of divers in Catalonia, with 170 associated clubs and more than 6000 federated individuals. It is also a member of the World Confederation of Underwater Activities (CMAS), institution that has signed collaboration agreements with UNESCO on underwater heritage. But our activities are not limited to our federates, but they are also open to all divers who want to discover maritime archaeology regardless of their diving scheme.

This active department collaborates and coordinates its activities with the Catalan Center for Underwater Archeology (CASC-MAC), within the Culture Department of the Autonomous Government of Catalonia. It is responsible for the management, research and protection of the UCH in the Catalan territory, and it is a member of the UNITWIN UNESCO network.

We, of course, were aware that disclosure of heritage is a delicate issue and requires a rigorous ethical approach, since there are a number of risks that should be avoided. On one hand, it is important to work to prevent trivialization of the tasks and responsibilities of the underwater scientist. Over-enthusiasm and the spectacular beauty of this activity is also a risk, since it might lead to the false consideration that underwater archaeology as an adventure instead of a science. We avoid spreading the error that any enthusiast can take the responsibility for an archaeological intervention. Likewise, public access to archaeological sites cannot jeopardize the physical integrity of their remains, exposing them to pillage or their deterioration. Thus, the department was created to have a permanent presence throughout the year, offering activities for both divers and non-divers, such as conferences, workshops, guided tours to museums, etc. It is essential to underline that the organization and management of the department is done within the sport diving federation.

Moreover, we encourage the human factor, since permanent communication is what determines which approach and what type of activities are optimal to achieve the objectives of the department. The archaeologist, within the ethical framework of his criteria will assess whether they are suitable or not. Thereby, the participants become active allies in the defence and dissemination of the UCH instead of mere spectators who receive information of something that is alien to them.

4. DIVING INTO THE HISTORY: "IN SITU" PUBLIC VISITS TO OUR LOCAL ARCHAEOLOGICAL SHIPWRECKS

Aware of the mentality of our divers, we understood that the best way to raise awareness on UCH was to bring them to the water. Always in close coordination with the CASC, we organized dives to visit the archaeological wrecks during their archaeological excavation and documentation process.

This was a pioneering activity in Spain that required a careful planning due to the risks involved. Fortunately, time has shown that these visits have become a successful instrument to disseminate UCH among divers. Not only did it allow direct access to the archaeological remains of shipwrecks, but it was also an ideal instrument to show the dynamics and organization of an underwater excavation in process.

Our first archaeological dive was in 2010 and we have since visited different underwater archaeological shipwrecks, from a 18th century warship to three Roman Shipwrecks.

After assessing several underwater sites together with the CASC, the "El Triunfante" shipwreck was chosen in 2010as the best candidate to start our project. It consists of the remains of a 18th century warship, sunk near the coast of Sant Pere Pescador in Girona. "El Triunfante" presents several characteristics that favored his choice for this first didactic experience. On the one hand, its proximity to the beach and its shallow depth, between 4 and 5 meters, make this site a safe and a risk-free place for diving. This allows the participation of any diver, regardless of the degree they hold. Moreover, due to the process of recovering material shortly after the sinking of the ship, the massive looting suffered during the decades of the popularization of sports diving or the massive salvage work by the Spanish Navy in the 70s, there were no archaeological remains of importance that could be plundered nowadays. Finally, the timbers of the ship, preserved in good condition thanks to the deposition of sediments, were uncovered temporarily during the archaeological study campaign, so that the visits did not produce any further negative impact to the conservation of the wood, since we organized the outreach activities whithin the the archaeological season.

Visiting the site and watching the archaeologist working allowed the visitors to understand the dynamics of an underwater excavation. The rigor in the implementation of the methodology, as well as the coordination of the archaeologists offered a completely different vision to what for years had been the image of underwater archeology for many of the participants. In this way, the information provided during the previous introductory talks was consolidated and the main objective was to present underwater archeology as a science that requires a complex study, developed from a scientific methodology and requires trained professionals to develop in a coordinated way these tasks and assume the responsibilities that derive from them.

However, of all the wrecks we have visited during these years, the two Iberio-Roman shipwrecks, "Cap de Vo"l and "Cala Cativa", stand out. For 6 years in a row, we have visited the two shipwrecks that took part in the commercial Roman routes. The divers have been able to witness the evolution of their archaeological excavations and documentation. Although they had also been previously excavated in the past, both wrecks were visited again to study them with updated techniques, methodology and a completely updated archaeological knowledge. In spite of the early interventions with an insufficient developed archaeological methodology, in addition to the pillage suffered, the study of the timbers that were part of the structure of the boat provided a great deal of new scientific data.

5. RESULTS AND INDICATORS

Undoubtedly, these experiences have offered divers a magnificent opportunity to immerse themselves and visit first hand an archaeological shipwreck accompanied by archaeologists. This initiative, developed over 8 years, has allowed showing the public how the underwater archaeological works progressed and how scientific information is extracted from the archaeological remains. This way of allowing access to wrecks has facilitated the awareness of divers towards the enormous fragility of archaeological materials and the importance of preserving the archaeological context undamaged.

Through these outreach actions and public awareness activities, we encourage the participation of society in safeguarding the UCH. Such experiences, specifically the underwater visits to "Cap de Vol" and "Deltebre I", gained the UNESCO recognition of Best Practices of Underwater Cultural Heritage.

There are clear indicators that show the success of these efforts. On the one hand, there has been an increase in the notifications of new archaeological findings by individuals. Their collaboration consists in the notification of potentially archaeological remains, their geo-location by means of GPS, photographic registry and video. In most cases, these data have been forwarded to the FECDAS department head who, in turn, notified the CASC so that the appropriate protocol was activated. These archaeological elements, when confirmed, became part of the Catalan Underwater Archaeological Inventory.

On the other hand, it should be pointed the enormous value of the cooperation of divers in the safeguarding of archaeological sites. During these last years, different clubs and private individuals have become our allies, alerting on threats against our archaeological heritage from furtive actions, the consequences of marine storms or public constructions without the due archaeological control.

Furthermore, UCH has provided cultural and economic benefits to local diving clubs and business. This heritage goes from being ignored, or even a nuisance, to becoming an opportunity for the economy of the territory. As an example, it is worth mentioning the collaboration of the diving centre Begur Dive in the elaboration of submerged archaeological replicas in the same site where several underwater archaeological campaigns were carried out. The initiative has developed a local interest to know the history and archaeology of the place, as well as added value to the dive centre.

In brief, the experiences presented in this text encourage developing this type of actions to disseminate, raise awareness and engage the public in safeguarding their own heritage and preserve it for future generations.

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"Hippocampus" the Microscopic Mythical Dragon of the Sea

Vasilis Mentogiannis[1]

[1]Hippocampus Marine Institute

More than ten years have passed since we first encountered a colony of seahorses in a particularly small, coastal zone.

Nowhere else in Greece, are we aware of a place where we can always and surely encounter seahorses. We can also say that it is a very rare phenomenon for the Mediterranean. In this particular area of Chalkidiki, Stratoni, for the past decade we have always encountered this magnificent phenomenon. What is even more unique is that in this area we sometimes find both species of seahorses found in Greek waters, Hippocampus hippocampus and Hippocampus guttulatus.

Since then, we have systematically observed the colony performing research, measurements and press publications. The result of this ten year effort, for the promotion and communication of this magnificent phenomenon was the creation of a marine research center, especially for the seahorse.

The scientific responsibility for our Institute is taken on by Dr. Kostadinos Dounas, Biologist, Research Director in the Institute of Marine Biology, Biotechnology and Aquaculture (IMBBC) of the Hellenic Centre of Marine Research (HCMR), President of the Hippocampus Marine Institute and Elina Samara, Marine Biologist (MSc), Ichthyologist for the Fisheries Research Institute, Dive Instructor, Field biology/Research officer of the Hippocampus Marine Institute.

In addition, The School of Naval Mechanical Engineering, of the National Technical University of Athens (NTUA) will deploy a prototype, submarine system for the visual monitoring of the seahorses and other organisms. The system has the capability of taking continuous pictures and video or regulating the times of monitoring along with a system for optical identification of the species.

Do we have time? After the last actions that we did at Stratoni Seahorse Colony, we are almost sure that the population is reducing.

Our next actions are to put more artificial constructions (mainly ropes) and try to avoid any type of fishing…..

Keywords: Seahorse, hippocampus, stratoni, hippocampus institute

A low cost equipment and SfM software photogrammetric survey of two shipwrecks in the sea area of methoni (in Soutwestern Greece)

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Abstract: The present case study deals with the use of fast and low cost procedures (field and office work) that combine modern photogrammetric techniques (Photogrammetry and Videogrammetry), SfM photogrammetry software and low cost field equipment (camera, stainless steel rods with fixed markers), so that scaled and photorealistic digital 3D models of Underwater Cultural Heritage (UCH) sites can be created. The underwater study sites were two shipwrecks nearby the sea area of Methoni Village, in Southwestern Greece. The first one was the Sarcophagi Bear Reliefs shipwreck and the second one was the Granite Columns shipwreck. At the first one the Photogrammetric Technique was used and at the second one the Videogrammetric Technique. In both sites the same field equipment was used and for both sites scaled 3D models, scaled 2D plan maps and illustration Videos for (dry) virtual tour of the Underwater Archaeological sites were produced.

The scaled 3D models were evaluated a) statistically with the use of SfM software algorithms and b) empirically by comparing dimensions of Antiquities that were measured underwater with the use of measuring tape, with those that were digitally measured on the 3D models with the use of SfM software linear measuring tools.

The results of the specific case study could be used for study of the two shipwrecks, for dry dive experiences to non divers or pre-dive briefing to divers that are about to dive at these sites as long as these UCH sites are officially declared Underwater Archaeological Parks (UAPs). It is also a way for qualified Employees of the Hellenic Ministry of Culture and Sports to periodically monitor the sites and the condition of the shipwrecks, comparing them with their condition as they are illustrated at the 3D models at the time the present study (2017) took place. Finally the whole method is a safe, low-cost and very fast way of surveying, 3D mapping and documentation of UCH sites.

Keywords: Underwater Cultural Heritage, Close range (SfM) Photogrammetry, 3D Model, Sarcophagi Bear Reliefs shipwreck, Granite Columns shipwreck.

1. UNDERWATER CASE STUDY SITES

The two underwater test field sites where the case study took place were:

a) The Sarcophagi Bear Reliefs shipwreck and **b)**The Granite Columns shipwreck. Both of them are located at the sea area around Sapientza Island nearby Methoni Village, in Southwestern Greece. On both sites there have been many scientific studies and field measurements with different methods which made them ideal for using them as survey sites so that there was a comparison with historical data.

1.1. Sarcophagi Bear Reliefs shipwreck

Sarcophagi Bear Reliefs shipwreck consists of four stone sarcophagi with their covers. Apart from one that is broken, the other three are almost intact and measure 2.20m x 0.80m. They feature simple, embossed decoration including floral motifs, bucrania and drums, while their covers are curved, with rudimentary and shaped plant decorations. The wreck dates back to the 3rd century BC. *"Aggeliki G. Simossi, Stella Argiri, Ekaterini Tagonidou, 2012"*.

Fig. 1: Sarcophaghi Bear Reliefs
"Photo: G. Michailidis 2017"

1.2. Granite Columns shipwreck

Granite Columns shipwreck can be found at a short distance from the Sarcophagi Bear Reliefs. 34 fragments of monolithic, non-ribbed columns were located, of which only one is intact, measuring 8m height and 0.9m in diameter. The columns are made of reddish granite of the same quality as the one found within the Methoni Fort, which was erected in 1493-4 by Admiral Francesco Bebo to commemorate the Castle's recovery from the Venetian Republic, placing the ship's sinking in earlier times. This type of granite is found solely in Egypt, Xanthi, Kavala and Mykonos.*"Aggeliki G. Simossi, Stella Argiri Ekaterini Tagonidou, 2012".*

Fig. 2: Granite Columns *"Photo: G. Michailidis 2017"*

2. CLOSE RANGE PHOTOGRAMMETRY, VIDEOGRAMMETRY, SFM 3D MODEL SOFTWARES

2.1. Close Range Photogrammetry/Videogrammetry

"***Photogrammetry** is the Art, Science and Craft that aims to extract reliable metric information of natural objects and the environment by means of recording, measuring and interpreting photographic images and other models of Electromagnetic radiation and phenomena". "IPET,2006-2019"*

Videogrammetry is the art where the still images for photogrammetric processing are obtained from frames of a high resolution video such us a 4K video. Nowadays the maximum resolution of frames/images in most cases is constrained to 8mpixel and in most cases there are no details of the shooting parameters of the frames/images *(e.g. Focal length, ISO, f-stop, Shutter Speed)* but just estimations of them.

Close range Photogrammetry/Videogrammetry is the field of photogrammetry where the images/frames*(Oblique and Nadir)*, are taken keeping the distance between the camera and the object of interest less than 300m. Of course in underwater projects this distance is kept less than 10m due to the low visibility, the fadedness of the colours and the need of artificial lighting as the depth increases.

2.2. SfM 3D Model Reconstruction Software

SfM*(structure from motion)* Software is the photogrammetric software that uses mathematical algorithms that fulfill the photogrammetric processing *(e.g. automatic process of common feature matches/tie points from different images with common areas, establish interior and exterior orientation, built 3d coloured point cloud)*, with the minimum interference of specialized in photogrammetry user. A very brief sequence of the processing is shown in the figures below **(Fig.4&Fig.3).**

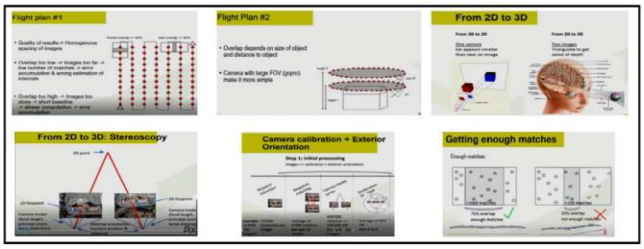
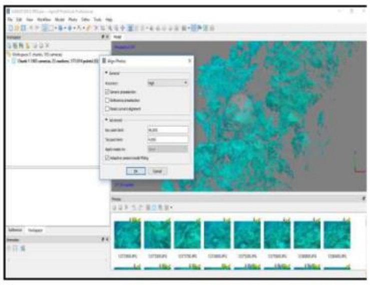
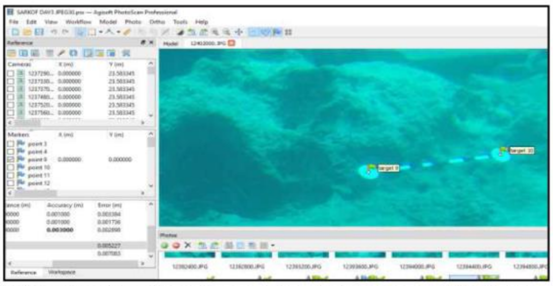


Fig. 3: SfM photogrammetric Processing
"Pix4D Webinar 1: Introduction to Modern Photogrammetry and Optimal Flight Plans/ https://www.youtube.com/watch?v=NGdZ8O2cWks"

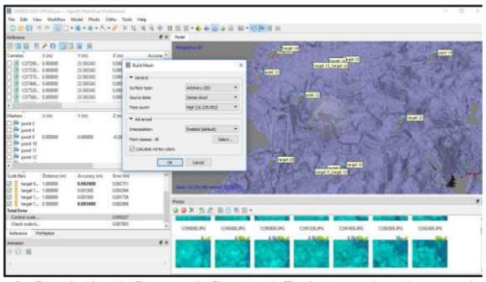


1. Align photos/Match Tie points

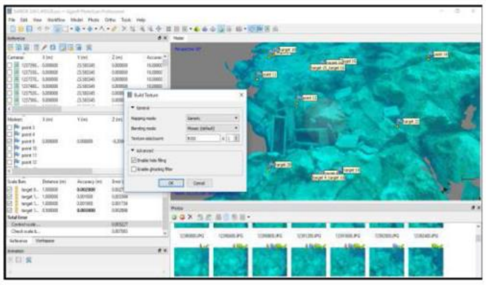


2.Selecting/Locating Ground Control Points and Scale Bars

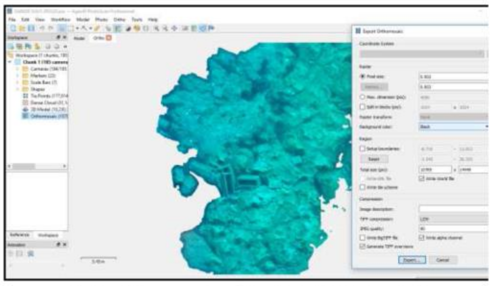
3. Building Coloured Dense 3D Point Cloud



4. Statistical Ground Control Point evaluation and "Mesh" creation



5. Creating "Texture"



6. Building and extracting Orthomosaic

Fig. 4: SfM photogrammetric Software Processing Stages "Agisoft /Metashape 1.5"

2.3. Advantages in using close range Photogrammetry/Videogrammetry and SfM Software:

- Antiquities under study can be digitally replicated/cloned.
- Fully automated procedure requiring minimal involvement by a specialized user in photogrammetry.
- The 3D model is digital, on a 1:1 scale and georeferenced to the reference system of our choice, on condition that we have measured a great number of Ground Control Points ***(GSPs)*** with significant accuracy.
- Field work time is significantly decreased, since all that is required is to carefully photograph and measure the Ground Control Points/Markers by means of architectural or surveying techniques.
- The main instruments used for the task are a good camera and a geodetic station or alternatively measuring tapes/rulers.
- Besides faithful geometric imaging, 3D models feature the texture and colour variation of a photograph taken in the visible spectrum **RGB***(Red, Green, Blue).*
- Georeferenced/Scaled orthomosaics of facades, plans, and cross-sections are produced.
- A point cloud with millions of 3D points is produced
- Direct 3D design and data export to CAD software is possible
- Three dimensional virtual tours ***(VR)*** are possible

2.4. Disadvantages in using close range Photogrammetry/Videogrammetry and SfM Software:

- Significant-computing power and storage space are necessary.
- There is a significant cost in purchasing SfM photogrammetric software.
- Carefully cleaning the perimeter of the **UCH** site to be photogrammetrically surveyed is essential.

- An auxiliary topographic/architectural survey of selected geometric check points/dimensions and **GCPs** is necessary.
- Completely surveying the monument is not always possible due to limited access, creating gaps in the survey.

2.5. Crucial Factors that determine the final results in SfM Software processing in underwater implementations:

- Visibility and undulation during underwater recording.
- The depth of underwater recording *(negatively affects colours).*
- Sun beam diffusion conditions during photographing.
- The possibility of underwater Ground Control Point placement and measuring and their dependence on land.

3. PROJECT PLAN AND STAGES OF FIELD AND OFFICE WORK

In the specific projects, two different approaches towards the two shipwrecks were conducted.

At Sarcophagi Bear Reliefs shipwreck, 12mpixel still photos were taken *(185 photos, Iso:100, F-stop:F/2.5, Focal length:3.8)*. On the other hand, at the Granite Columns shipwreck, frames of a 4k/30fps video were used *(379 frames of 8mpixel- 1 every 3sec)*. In both sites, due to the bad weather conditions that put the Geodetic Gnss/Gps Receiver in jeopardy, it was not possible to measure/connect and georeference specific points of the bottom of the sea with precise geolocated landmarks. Both 3d models that were produced are scaled with satisfied accuracy established by the use of accurate scale bars*(stainless steel rods measuring 0.5m and 1m in length).*

3.1. Stages of Field work:

The field work which took place in September 2017 included the following stages:

- Manufacturing of stable length, stainless steel rods measuring 0.5m and 1m in length with standardized markers on their edges.
- Manufacturing of rectangular, concrete sets with a buoy attachment hook.
- Gathering materials.
- Transportation to the dive sites.
- Reconnaissance dives.
- Placement of concrete sets and stainless steel rods with a uniform, as much as possible, dispersion within the antiquities site.
- Photographic/videographic coverage of the ***UCH*** sites with great overlap (70-80%), using a 12mpixel /4K (8MP/frame) underwater camera*(SJCAM/ SJ7STAR),* keeping the distance between the camera and the underwater object between 3-5m.
- Both **nadir and oblique shots** were used trying to take photos/frames following specific lines of dive routes. It is worth mentioning that the sd storage card must be formatted to take 4K videos more than 4Gbytes to avoid cutting the video, which causes serious problems on the aligning processing stage in SfM Software in the case of Videogrammetry.
- Measuring characteristic/distinct/unique element distances with a measuring tape to empirical evaluate the final photogrammetric products (orthophotomosaics, 3D model etc.)

- The last stage, namely the surface measuring of buoys hooked to rectangular blocks at the sea bed with a dual-frequency GPS receiver, was not possible due to bad weather conditions. Consequently, the photogrammetric survey data and their results were not georeferenced to the GGRS 87 Hellenic state reference system but to an independent *(free)* scaled system instead.

3.2. Stages of Office work:

Office work included the following stages:

- Camera data retrieval and classification/grouping *(12MP photos and 4K videos)* based on study site: a)Sarcophagi Bear Reliefs shipwreck, b) Granite Columns shipwreck
- Production of 8Mpixel photos from the 4K video frames mainly for the Granite Columns shipwreck, as due to deteriorating weather conditions and visibility, a decision was made to only cover this area by means of 4K video, in contrast to the Sarcophagi Bear Reliefs site where 12MP still photo coverage was possible.
- Importing data to the Agisoft/Metashape photogrammetric SfM software and further data processing which included the stages shown on **(Fig.4)**: **1**.Align photos/Match Tie points, **2**. Selecting/Locating Ground Control Points and Scale Bars, **3**. Building Coloured Dense 3D Point Cloud, **4**. Statistical Ground Control Point evaluation and "Mesh" creation, **5**.Creating"Texture", **6**.Building and exporting Orthomosaic.

3.3. Equipment that was used for underwater close range photogrammetric survey

For both projects the same low cost equipment was used:

- An SJCAM/ SJ7STAR underwater camera. It is a relatively low cost camera (≈200€) adapted on a steady stainless steel base. The technical features of the camera are shown at the figures bellow **(Fig.5).**
- Stainless steel rods of 0.5m and 1.0m with fixed markers on their edges that could automatically be detected by the specific SfM Software (Agisoft/metashape) or easily targeted by the user of the SfM software.**(Fig.6).**

Photo Resolutions	12 MP 4032*3024 10MP 3648*2736 8MP 3264*2448 5MP 2592*1944 3MP 2048*1536 2MP HD 1920*1080 VGA 640*480 1.3MP 1280*960	Video Resolutions	4K @ 30fps (native) 2K @ 60fps 1080P @ 120fps 1080P @ 30fps 720P @ 200fps 720P @ 60fps 720P @ 30fps
		Chipset	Ambarella A12
Sensor	Sony IMX117	Sensor Resolution	12 MegaPixels
Native Resolution	12 MegaPixels	Screen Size	2" LCD
Touchscreen	Yes	WIFI	Yes
Image Stabilization	Yes	Wireless Remote	Yes
Ports	Mini USB Port	External Mic Support	Yes
Maximum Storage	128GB	Battery Size	1050mAh
Battery Life (Approx.)	120mins	Body	Metal
Dimensions (L*W*H)	60×24.7×41 mm	Weight	74 grams
Max Bitrate	Up to 60mbps	Video File Format	MP4
Modes	Capture Mode, Self-Timer, Burst mode, Record, Video Lapse, Photo Lapse, FPV mode	Aditional Settings and Options	Auto Low Light, Slow motion, Metering, Gyro stabilization, Motion Detection, White Balance, Sharpness, Loop Recording

Fig. 5: SJ7STAR (camera) and its specifications
(source: https://sjcam.com/product/sj7/)

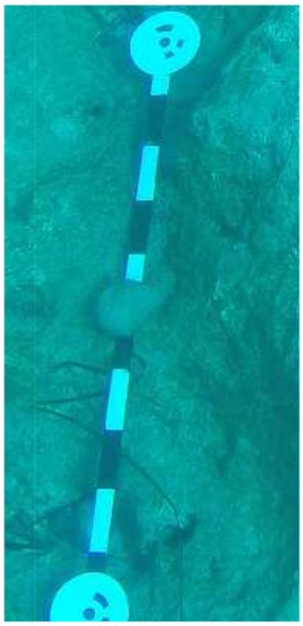


Fig. 6: Stainless steel rod of 1.0m with fixed markers on its edges *"Photo: G. Michailidis 2017"*

4. CLOSE RANGE PHOTOGRAMMETRIC PROCESS RESULTS

In both sites, scaled 3D models, detailed 2D plan orthomosaic maps *(scales 1:20, 1:50, 1:100)* and illustration Videos for (dry) virtual tour of the Underwater Cultural Heritage *(**UCHs**)* sites were produced. **(Fig.7-Fig.10)**

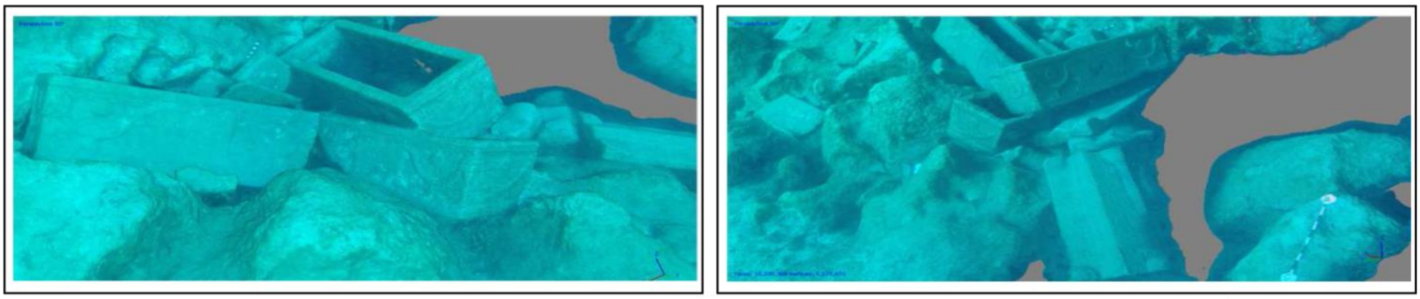


Fig. 7: Sarcophagi Bear Reliefs shipwreck 3D Model Print Screens

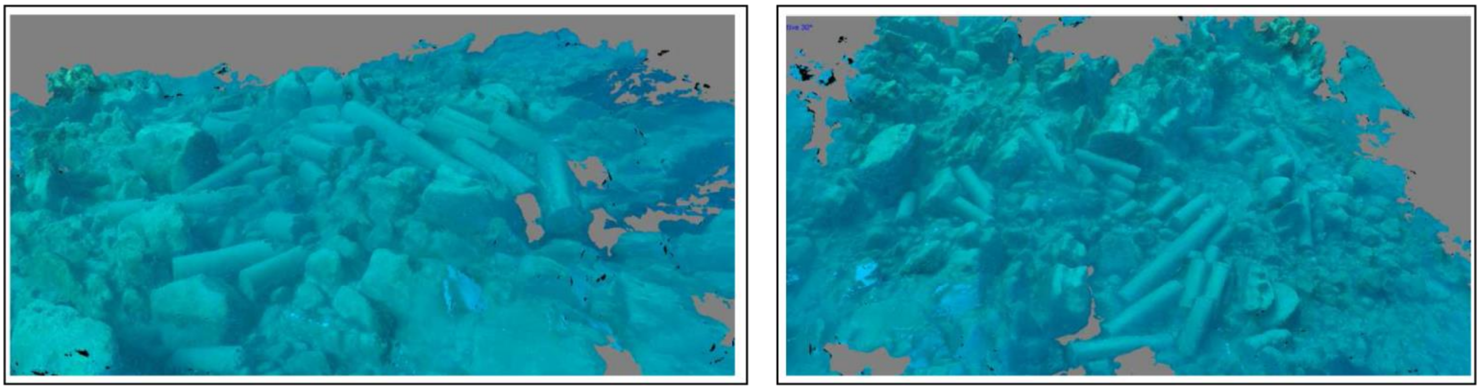


Fig. 8: Granite Columns shipwreck 3D Model Print Screens

Fig. 9: Sarcophagi Bear Reliefs shipwreck orthomosaic(2mm/pix) 2D map (scale 1:100)

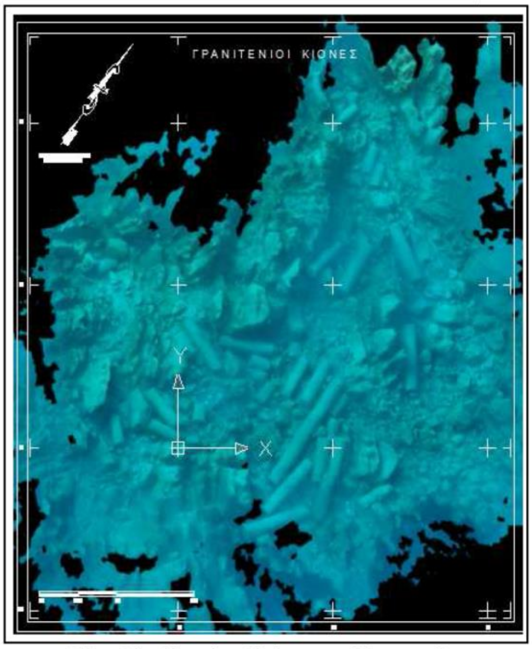
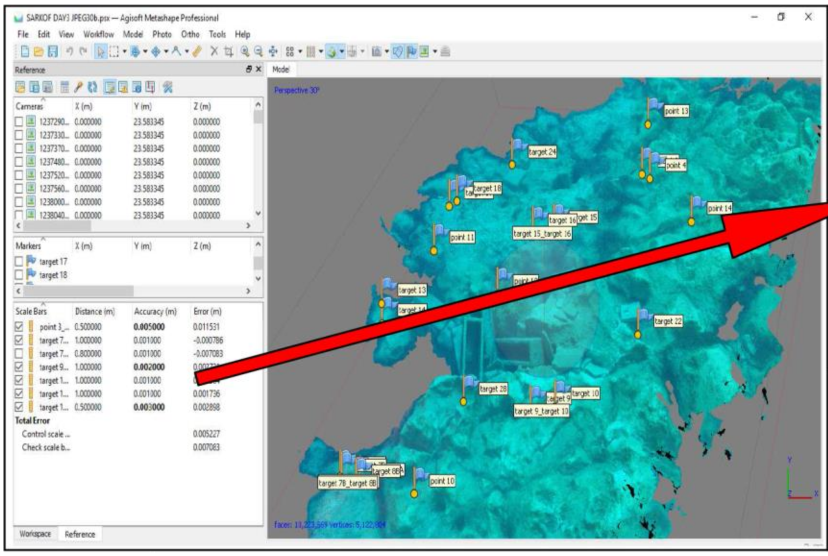


Fig. 10: Granite Columns shipwreck orthomosaic(2mm/pix) 2D map (scale 1:100)

5. STATISTICAL AND EMPIRICAL EVALUATION OF THE PHOTOGRAMMETRIC PROCESSING

The scaled 3D models were evaluated **a**)statistically with the use of **SfM** Software *(Agisoft/Metshape)* algorithms which calculate the **RMS***(Root Mean Square)* error for the standardized stainless steel rods that were used ***(Fig.11, Fig.12)***and **b**) empirical with the use of measuring tape by comparing dimensions of Antiquities that were measured underwater with those that were digitally measured on the 3D models with the use of SfM Software linear measuring tools***(Table 1&2 ,Fig.13, Fig.14)***.

5.1. Statistical Evaluation of the SfM photogrammetric processing and the final 3D model:

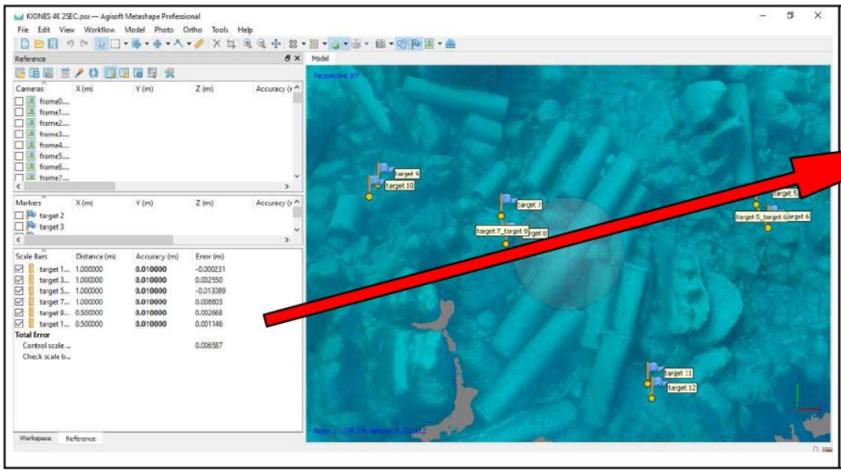


Scale Bars	Distance (m)	Accuracy (m)	Error (m)
point 3_point 4	0.500000	**0.005000**	0.011531
target 7A_target 8A	1.000000	0.001000	-0.000786
target 7B_target 8B	0.800000	0.001000	-0.007083
target 9_target 10	1.000000	**0.002000**	0.002731
target 14_target 13	1.000000	0.001000	0.003384
target 15_target 16	1.000000	0.001000	0.001736
target 17_target 18	0.500000	**0.003000**	0.002898
Total Error			
Control scale bars			0.005227
Check scale bars			0.007083

RMS=0.005227m ≈ 5mm

$$RMS = \sqrt{\frac{X_1^2 + X_2^2 + X_3^2 + ... + X_N^2}{N}}$$

Fig. 11: Statistical Evaluation of the standardized stainless steel rods at the Sarcophagi Bear Reliefsshipwreck



Scale Bars	Distance (m)	Accuracy (m)	Error (m)
target 1_target 2	1.000000	**0.010000**	-0.000231
target 3_target 4	1.000000	**0.010000**	0.002550
target 5_target 6	1.000000	**0.010000**	-0.013089
target 7_target 8	1.000000	**0.010000**	0.008603
target 9_target 10	0.500000	**0.010000**	0.002668
target 11_target 12	0.500000	**0.010000**	0.001146
Total Error			
Control scale bars			0.006587
Check scale bars			

RMS=0.006587m ≈ 7mm

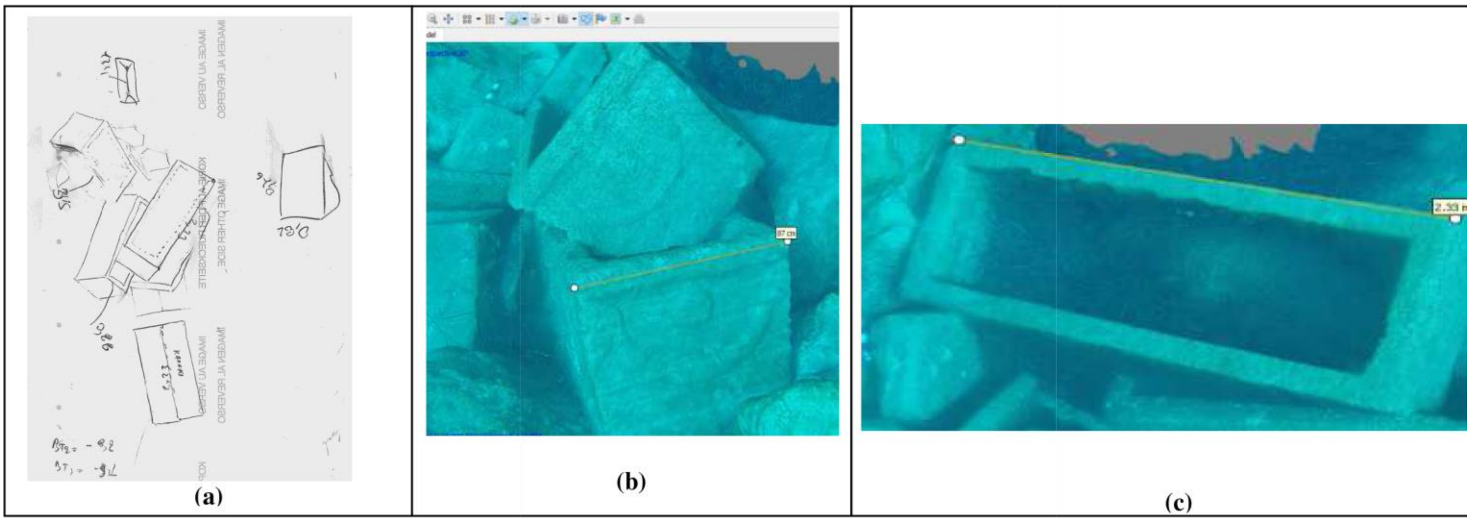
$$RMS = \sqrt{\frac{X_1^2 + X_2^2 + X_3^2 + ... + X_N^2}{N}}$$

Fig. 12: Statistical Evaluation of the standardized stainless steel rods at the Granite Columns shipwreck

5.2. Empirical Evaluation of the photogrammetric processing and the final 3D model:

Table 1: Distance Differences at the Sarcophagi Bear Reliefs shipwreck.
S=Distance measured underwater with measuring tape.
S'=Distance measured digitally on the SfM Software 3D Model.
dS= Difference S-S'

n/n	S(m)	S'(m)	dS(m)
1	2.33	2.33	**0.000**
2	0.88	0.87	**0.010**
3	2.15	2.14	**0.010**
4	1.27	1.25	**0.020**



(a) (b) (c)

Fig. 13: (a) Field sketch and underwater measurements , **(b)& (c)** Digital measurements on 3d model with the use of Agisoft/Metashape tools .-Sarcophagi Bear Reliefs shipwreck-

Table 2: Distance Differences at the Granite Columns shipwreck.*
S=Distance measured underwater with measuring tape.
S'=Distance measured digitally on the SfM Software 3D Model.
dS= Difference S-S'

n/n	S(m)	S'(m)	dS(m)
1	8.00	7.99	**0.010**
2	0.90	0.92	**-0.020**

*At the Granite Columns shipwreck due to very bad weather conditions the diving team(2017) had to cancel underwater tape measurements and the only underwater measurements available were those mentioned at HMCS/EUAWebsitehttps://www.culture.gr/el/ministry/SitePages/viewyphresia.aspx?iID=1369 **"**Aggeliki G. Simossi, Stella Argiri Ekaterini Tagonidou, 2012" where is said that '**only one (column) is intact, measuring 8m height and 0.9m in diameter**'.*

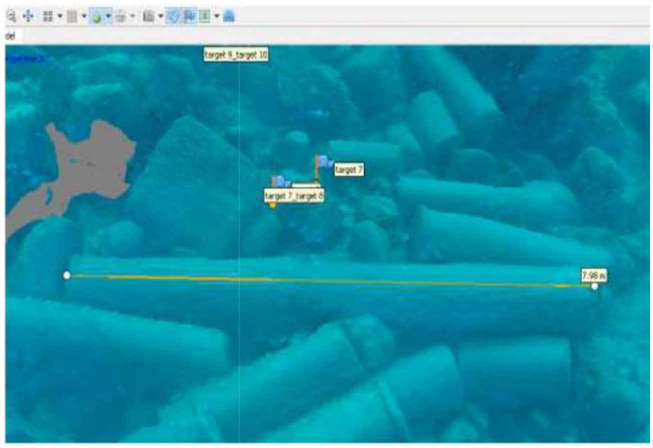


Fig. 14: Digital measurements on 3d model with the use of Agisoft/Metashape tools -Granite Columns shipwreck-

6. CONCLUSIONS

The evaluation of the underwater photogrammetric process results leads to the following conclusions:

- The implementation of modern photogrammetric surveying in the survey of the **UCH** sites resulted to very satisfying results from a geometric perspective, approaching the kind of accuracy*(**RMS**≈5mm-7mm)* required for large scale plan maps(*print scales 1:20, 1:50, 1:100).*
- Using standardized, stainless steel rods measuring 0.5m or 1m in length with standardized Markers or GCPs on their edges and with good dispersion on the survey site ensured high accuracy with respect to linear values, while giving the correct scale/dimensions to the site's 3D model.
- The underwater surveying speed was quite satisfactory*(3-4 Scuba dives of 30' minutes/dive in each site)*, considering the limited number of personnel involved*(3 divers*), with weather conditions and visibility and light dispersion conditions being the only inhibiting factors. Essentially, this process drastically reduced underwater field work time and the total number of personnel necessary for the project's fulfillment.
- The results were quite satisfactory both in terms of geometry*(**RMS**≈5mm-7mm)*, final resolution of the 3d model *(≈2mm/pixel)* and of aesthetics, despite using a low cost and limited technical features underwater photo camera.
- The result was aesthetically better in the case of the Sarcophagi Bear Reliefs shipwreck, as there was ample camera time.
- The use of still photos with specific shooting parameters (e.g. Focal length, ISO, f-stop, Shutter Speed) gives much better results, increases certainty and speeds up the processing time in the SfM Software in comparison to the use of frames of a 4k video.
- In the case of the Granite Columns the deteriorating weather conditions led to further deterioration of the already limited visibility and necessitated the rapid completion of all operations for safety reasons, negatively impacting the end result mainly aesthetically.
- Implementing modern photogrammetric methods of surveying and validation requires purchasing the necessary field and office equipment (cameras, software, computers, etc.), whose cost is relatively small compared to the end result.
- Personnel training for this type of operations is simple and safe.
- Using ROV's *(Underwater Remotely Operated Vehicles equipped with cameras)* can further simplify the process, increasing the safety factor for the diving personnel.

As mentioned at the Abstract section the results of the specific work could be used for:

- scientific study of the two shipwrecks
- dry dive experiences to non divers or pre-dive briefing to divers that are about to dive at these sites as long as these ***UCH*** sites are officially declared Underwater Archaeological Parks ***(UAPs)***
- periodically monitoring, by qualified Employees of the Hellenic Ministry of Culture and Sports, of the condition of the Shipwrecks by comparing them with their condition as they are illustrated at the time the present study (2017) took place.

Finally the whole method is a safe low-cost and very fast way of surveying, 3D mapping and documentation of Underwater Cultural Heritage ***(UCH)*** sites.

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Operating contemporary recreational submersibles in Kea's Underwater Historic Park

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Abstract: The sea surrounding the Cycladic island of Kea, hosts some really important historic wrecks, considered as monuments by the Greek legislation. All of them are located in Greek territorial water. Some of them, are worldwide famous. HMHS Britannic and S/S Burdigala, both sunk during World War I. Today, they are considered as the Everest of scuba diving, accessible for every experienced technical diver in the whole world. But being so famous, being so legendary, makes them attractive, even to non-divers. Nowadays, modern technology gives the opportunity to everyone to live this thrilling lifetime experience. Contemporary recreational submersibles are capable of conducting safe underwater expeditions to depth of up to 300 meters. Such operations twenty or thirty years ago, were not able to be practically conducted in such depth. In July 2018, after two years of consistent effort, we succeeded in organizing a trial expedition in the underwater area surrounding Kea, using a recreational submersible, provided by the EU based company that produces it. Keadivers, along with the team that designs and develops those recreational subs, conducted an absolutely successful 2-day trial operation. Doing a dry dive of about 45 minutes, in a depth range between 60-70 meters, everyone that used the submersible talked about a life time experience. Having a very close cooperation with the submersibles manufacturers, we strongly believe that we can include such an operation within the framework of a fully operational underwater cultural heritage park, making it feasible, safe and sustainable. We are ready to make certain proposals for such an operation.

Keywords: Contemporary Submersibles, logistics, safety, cost efficiency

1. INTRODUCTION

Historically the shipping route from the Black Sea to the Western Mediterranean and vice versa is passing, among other areas, between the islands of Kea and Makronisos. This is the main reason for having so many wrecks in this area, and some of them being important historically and extremely attractive to potential visitors. HMHS Britannic and S/S Burdigala, both of them among the bigger accessible ocean liners in the world, are considered as monuments, according to the Greek legislation. Especially HMHS Britannic, it is considered as the Everest of diving among the best and most experienced divers in the world. So far, divers that are willing to dive those wrecks need to make an application to the Greek Ministry of Culture for a permit. Those dives are very demanding, due to their location: shipping traffic, strong prevailing winds and waves, strong currents, depth. These factors make these dives really difficult. They can never be done by mainstream recreational divers. They can only be conducted by technical divers, using Open Circuit scuba gear or Closed Circuit Rebreathers and breathing mixed gases. Those divers need to be trained and certified, they also need to be in a good mental, psychological and physical condition for such a dive. Recently, many diving expeditions to those historical wrecks have been completed successfully. Most of them were based on the nearby island of Kea. The local society and the Municipality of Kea, realizing the importance of those wrecks to the island of Kea, intends to operate an underwater historic park, consisting of those historic wrecks. So far, the Municipality co-operates with the Euphorate of Underwater Antiquities of the Ministry of Culture for the establishment of this park, which will be unique for Greece.

1.1. Opportunities

Such an underwater historic park shouldn't be available for divers only. The wrecks could be available to be visited by recreational submersibles as well, giving the opportunity to everyone to have this lifetime experience.

When J Y Cousteau discovered Britannic back in the mid 70's, such an idea would be funny, crazy and not feasible, for sure. But since then, many things have been changed. Contemporary recreational submersibles are able to communicate with the surface support crew, use mechanical robotic arms to handle emergency situations, and are powered with strong durable batteries and breathing air supply systems which can provide breathing air and autonomy up to several days.

1.2. Risks

Nobody can claim that operating a passenger submersible at a depth of 120 meters in an area that might have strong currents, is an easy, risk free operation. There are always risks, but for such an operation, for any given risk, there is also a solution. In designing such an operation, a team of technical divers, standing by ready to dive is required, to perform rescue support in case of entanglement. Those divers need to be properly trained and equipped for such operations. Back in the seventies, those kind of rescue operations were extremely difficult. Today, many more divers are capable of conducting such dives, given the fact that modern diving equipment provides excessive safety. Technical rebreathers are providing excessive bottom times and are able to optimize decompression time with more precision than ever.

1.3. Technological aspects

Modern recreational submersible vessels are powered by strong lithium batteries, which provide an autonomy for moving in high speed for up to 8 hours. Equipped with 4 propellers the submersibles are able to move and manouvre with absolute precision. Furthermore, the pressure hull supports a 10cm thick acrylic globe at the front, providing an unobstructed view in every direction. The breathing air is provided in an environment of one bar surrounding pressure, same as at the surface. Passengers are able to breathe normally, and the carbon dioxide that they are exhaling is trapped in scrubber filters. Sensors continuously analyze the air and calculate the proper volume of oxygen that needs to be added, from 100 % medical oxygen banks, and mixed with the existing inert nitrogen, to create breathing air for the passengers. This system is very similar to the Closed Circuit Rebreathers system that is used recently in scuba diving. The oxygen banks and the scrubber filtering system have an autonomy to provide breathing air for up to 96 hours. After 96 hours, the scrubber has to be replaced and the oxygen banks to be refilled. Modern information systems provide all required data for the pilot: buoyancy, current depth, cabin pressure, air reserve, speed, battery power. Advanced systems are also available which relay GPS data to the submersible's on-board computer via integrated underwater modems. Modern joystick control devices give the ability to steer the subs very easily and efficiently. Considering information systems, contemporary subs can have Alarm System, Battery Status, Thruster Status, Sensor Status, Internal Pressure, Depth, Electrical Insulation Monitoring, Water Ingress Sensors, Buoyancy Tank Level Indicator, Internal and External Temperature sensor.

1.4. Safety features

Modern submersibles are also very safety oriented, having auto depth mode, which keeps the sub neutrally buoyant at a certain depth at any time. The Maximum Depth Protection systems can prevent the pilot from diving deeper than the submarine's maximum operating depth. Drop weight system can be manually released from within the submersible to increase the buoyancy of the submarine and return to the surface. Another interesting system is the DMS safety system (Dead man's system) which will automatically resurface the submersibles, in the unlikely event that the pilot becomes incapable of controlling it. The pilot needs to acknowledge the DMS every 10 minutes, otherwise it will initiate the ascent procedure. Safety buoys can be deployed, to mark the sub's position on the surface. Autonomous breathing devices are included of course. Underwater Telecom can be obtained by a single sideband acoustic telephone. Navigation can be achieved by echo sounders and electronic compass. Contemporary safety equipment include Locator Beacon Systems, Emergency Releasable Buoy, Fire Extinguisher and External Air Connection for diver-assisted ascent.

2. TRIAL DIVES

2.1. Organization

In July 2018 we organized some trial dives with a recreational submersible, capable of carrying two passengers plus the pilot. The objective of those trials was to test whether we could perform such an operation on a regular basis. We wanted to be sure that there would not be any issues in making such an operation not feasible. Our idea was to conduct dives at a maximum depth of 74 meters. The average operational depth was planned to be 60-65 meters in the area around the famous historic ocean liner of S/S Burdigala, that sunk during World War I, and which was discovered in 2008 at a depth of 74 meters. The wreck is located approximately one nautical mile from Kea's main harbor, Korissia. It is one of the best preserved ocean liners in the world, standing upright, intact. After Britannic, it is the second largest accessible historic ocean liner in the world, as her total LOA is 183 meters. She sunk due to a collision with a mine set by a German U-boat (U73), on the 14th of November 1916. No casualties were reported.

The trial operation was planned to be supported by a 40 meter long yacht. The stern of this vessel was properly modified with a powerful crain fitted to lift the sub, put it in the water and vice versa, and enough space for the sub to stay on the deck. Two more boats were supporting the operation. One rib with telecommunication crew and equipment (between the sub and the surface) and a speedboat rib with the safety divers and their equipment, ready to dive at 74 meters, if needed. A line was properly set, right next to the wreck, marking the diving area, with a big buoy on the surface. The line was the reference point for the sub. A third speedboat rib was transferring the passengers from the island directly to the diving spot.

2.1.1 Risks assessment

The location of the trial dive site is in the open sea, in an area that is affected very often by strong bottom currents. This is an important point that had to be tested: the ability of the submersible to move close to the wreck, with absolute precision, without being dragged and moved by the currents. Another possible hazard for the sub is that old wrecks have many fishing lines and nets, in which a potential entanglement could occur. Additionally, the passengers enter the sub directly from the supporting speedboat rib. This is also one of the reasons that a calm sea on the surface is needed, so that the passengers can enter and exit the sub after the dive, returning on the supporting vessel with comfort and safety.

2.2. Results and users feedback

Having calm weather for the two operational days, we managed to conduct 9 dives, of 45 minutes each. The submersible is powered by strong batteries that provide 8 hours of operation, before recharging. The 4 propellers of the sub proved to be really strong and were able to move the sub with absolute precision, fighting the current successfully. The transparent acrylic hemisphere of the sub provided excellent visibility. The passengers were amazed and everyone talked about a lifetime experience. Considering that Cyclades's waters are full of light, it is not so common to have such visibility elsewhere in the world. Even in a depth of 65 meters, passengers were able to have a clear view of a big part of Burdigala's 183 meter length deck features, while the submersible lights would highlight interesting details, like the canons at the wrecks bow. All of the people that had the opportunity to conduct those trial dry dives agreed that it was one of the best experiences they had had in their entire life, and that they would highly recommend it.

3. DISCUSSION

3.1. Operational options

Considering the operation of recreational subs, there are three different options: Shore-based operation, Yacht or utility boat-based operation, and Cruiser ship operation.

1. Shore based: In this option, the infrastructure required contains an on-the-dock facility, with indoor and outdoor areas for storage, maintenance and administration areas, fresh water for rinsing, electricity, and a crane to be able to lift the sub. For this option, the sub cannot stay overnight in the water. It has to be lifted on the dock after the daily operations. A powerful boat can tow the sub from the dock to the diving area. Considering that the tow speed is usually low, distance to the diving spot is a critical parameter. Supporting vessels are also required for transferring passengers and support crew (safety divers and equipment etc.)

2. Yacht or utility boat based operation: In this option, the yacht or utility boat needs to have space on deck and a crane strong enough to lift the sub. Supporting vessels are also required. The advantage of this option is that having the sub onboard, there is flexibility regarding the dive site. As a disadvantage, operating costs can be very high.

3. Cruiser ship operation: Similar considerations to Yacht or Utility boat based operations

3.2. Economic sustainability

This is the most difficult part of this operational design. The economic appraisal. The setup of the proper parameters defining this operation. There is not much previous experience for such an operation. It is difficult to make comparisons with similar projects that have been conducted in the past. The operational depth was much shallower, the size of the subs different, as well as the cost of the sub itself.

The financial risk is considered as high. First of all, we need to consider that the purchase prices for such submersibles are very high. They are related to the size, operational depth and accessories. A critical parameter that is not defined, is the economic life cycle of the sub. Maintenance cost is obviously critical as well. Considering costs, another important factor is the supporting vessels' costs (maintenance, personnel). Usually, the bigger they are, the more expensive they are. This is one of the reasons why shore-based operations can have lower running costs. In terms of revenues, we face two critical parameters. Pricing policy and duration of operational season.

3.3. Limitations

The length of the operational season is affected by weather conditions. In Kea, the area where the wrecks are located out in the open ocean, are usually affected by strong winds, waves and currents. There is an obvious limit for wind speed and wave height, to be able to conduct such operations. But regardless the wind speed, such an operation can be conducted from April to October for several reasons and for a maximum 7 months per year.

Pricing: Per person cost for a dive with a sub is not cheap. For all the reasons that we mentioned previously, running costs are very high. Which means that we have to target a group that can afford to pay a high ticket price. To attract such a target group, we need to be able to provide high end services in terms of accommodation, food services, transport, logistics etc.

3.4. Parallel activities

Besides sight-seeing dives at historic wrecks, recreational submersibles operations are a great asset for research support. Vast areas of the deep sea of Greece remain relatively unknown, and the submersibles could be applied in various scientific fields of marine and related sciences such as marine geology and geophysics, hydro and geochemistry, hydrology, marine biology and ecology, marine protected areas, coastal management and cartography, archaeology, surveys, inspections, search and recovery, assistance in salvage operations, to mention but a few. Research submersibles can be outfitted with a variety of different options depending on the application: 4K Video Camera with Pan & Tilt; Manipulator Arm with collection basket; Sampling devices; Geophysical Systems (magnetometers, side scan sonars, bottom profilers, sub-bottom profilers); Inspection Equipment (Gas Analyzers, Laser Scaling, Thermal Cameras, Radiation Meters); 2D / 3D Sonars; LBL & USBL Acoustic Positioning Equipment etc.

4. CONCLUSION

Making a dive with a contemporary recreational submersible, and having the opportunity to visit an untouched and pristine historic wreck, is like entering a time capsule returning to 1916, when the ocean liner sunk. It is a lifetime unforgettable experience, for every single person in the world, regardless of any kind of previous experiences. The future synergy between the operation of Kea's underwater Historic Park and the parallel operation of rec subs can create a unique mix of progressive, creative and innovative initiatives. It can be an ideal vehicle to promote and create global awareness for a small island, which needs and deserves it. Small Greek islands like Kea are struggling to survive economically, to create income and maintain a positive balance sheet. Such an initiative can have a definitely positive income for the local economy, creating new jobs and opportunities. Greece doesn't need to pay for such an operation. It can be financed by private funds. The only thing that is needed is an open, progressive way of thinking and to reform a contemporary, flexible legislative framework to let it happen in a safe, feasible, prudent and sustainable way.

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Reconstructing a submerged villa maritima: the case of the villa dei Pisoni in Baiae

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Among the activities planned for the MUSAS Project, the 3D reconstruction of the underwater sites constitutes a particular challenge, requiring a strong cooperation between archaeologists and technicians. The case of the villa dei Pisoni in Baia, one of the richest in the Phlaegrean territory, is particularly interesting: the architectural remains, already documented in the Eighties and now inserted in one of the diving spots of the Underwater Park of Baia, are disseminated on a huge surface, including quays, thermal complexes, a fishpond and a large, luxurious viridarium. The effort required for the 3D reconstruction of the ancient villa showed clearly the weakness of the previous knowledge and the lack of documentation even in a well-known site.

In this presentation we will retrace the long path from the acoustic basemap to the 3D model, the numerous challenges, doubts and uncertainties in the recreation of the original spaces, and the support offered by the ancient sources, both literary and iconographic, in solving archaeological problems.

Opto-acoustic 3D Reconstruction and Virtual Diving on the Peristera Shipwreck

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***Abstract*:** The paper describes the pilot activity conducted in the contest of BLUEMED project to create an interactive virtual scenario of the underwater site of the Peristera Shipwreck. The wreck lies just off the coast of Peristera, an uninhabited island located at about half nautical mile from Alonissos (Northern Sporades), at a depth of about 22-28 meters. The applied methodology, based on the combined use of optical and acoustic technologies, enables the chance to provide a high-quality digital 3D reconstruction of large-scale and complex underwater scenarios. This digital model represents the starting key element from which a Virtual Reality (VR) system has been developed. The VR system will be accessible to the general public, as well as researchers and archaeologists, inside a Knowledge Awareness Center located in the town of Alonissos

Keywords: opto-acoustic 3D reconstruction, underwater cultural heritage, interactive virtual scenario

1. INTRODUCTION

Methods to record and document underwater archaeological sites have evolved considerably in the last two decades. Nowadays, the combined use of optical and acoustic technologies enables the chance to provide a high-quality digital 3D reconstruction of large-scale and complex underwater scenarios. These digital reconstructions when combined with computer graphic techniques, like Virtual Reality (VR) and Augmented Reality (AR), [1-2] present an enormous and partially unexploited potential for the tourism sector in order to make the underwater cultural heritage more accessible and enjoyable for the general public.

In this context, the INTERREG MED BLUEMED takes advantage on the recent evolution of digital technologies to promote, on the one hand, diving tourism by improving the divers' experience in the underwater site and, on the other hand, to promote the induced tourist activity through the development of an innovative, educative and attractive virtual tour of the site.

To this end, the paper presents the pilot activity conducted in the underwater site of the Peristera Shipwreck. A methodology that combines data captured by acoustic and optical systems has been used for the creation of a multi-resolution textured 3D model of the underwater archaeological site. This digital model represents the starting key element from which generates, with the addition of further digital contents, an interactive virtual scenario made accessible to the public, researchers, and archaeologists by means of VR systems.

2. ARCHAEOLOGICAL CONTEXT

The wreck lies just off the coast of Peristera, an uninhabited island located at about half nautical mile from Alonissos (Northern Sporades) at a depth of about 22-28 meters. Nothing is currently visible on the seabed from the ship itself, probably because it has been completely destroyed from erosion and/or marine currents as well as sea life. However, its reach cargo signals the area of the shipwreck and provides us with valuable information about navigation and maritime trade during the classical era. A systematic excavation and the study of the cargo materials, conducted by the Ephorate of Underwater Antiquities under the scientific direction of the archaeologist and then Director of the Ephorate Dr. Elpida Hadjidaki during the years 1992-1993, 1999 and 2000-2001, demonstrated that the cargos' weight is about 126 tons and it includes thousands of amphorae distributed on the seabed in an area of about 25 x 12 meters. This scientific research and the bibliography produced [3-6] revealed also a lot about the ship's identity and its trip. The amphorae, which carried wine, are of two types, Mende (Chalkidiki) and Peparethos (Skopelos island). The load of the ship includes also some black painted fine ceramics, probably of Athenian production. Some indications about shipbuilding and navigation matters are given by findings such as the collar of an anchor and stones of the ballast as well as by few traces of wood. The wreck of Peristera can be dated between 420 and 400 BC and constitutes one of the largest naval loads of classical age that is currently known.

The "transformation" of the shipwreck into an exhibit, either real or digital, for the needs of an Underwater Museum (Law 3409/2005: Recreational diving and other provisions) or an Open to the Public Archaeological Site (Common Ministerial Decision, Official Government Gazette, Volume 2, Number 119, 21-01-2015), presupposes a series of actions. Among these, a common need for the real underwater visit with scuba diving as well as for the virtual visit at the information centers (Knowledge Awareness Center – KAC) is to define the points of archaeological or environmental interest, at which the visitor is presumed to stop, or even the sequence, according to which he/she must approach them, and their hierarchy as well (i.e. general views, special findings etc.). Finally, the information to be given must be prepared.

As far as the virtual visit of Peristera is concerned, only textual information is given, in English and in Greek, at every point of interest. The same text can also be heard at the preference of the virtual visitor. At this phase it was chosen for the visitor not to receive further multimedia information in this application, since other KACs digital applications cover this need. Thus, the visitor feels that he/she is at the seabed and can observe the shipwreck without any other distractions. The contextual information on Peristera focuses on: (a) general information for the shipwreck; (b) the presentation of individual archaeological findings which remain in situ; (c) environmental data; and (d) the excavation process that took place. The texts[59], brief and easily understandable by the average visitor, were based on the existing scientific literature and have been written in such a way to operate independently, as each one chooses the route that he/she will follow during the digital visit. At the same time, their presentation order has been determined in case the visitor chooses to follow the digital guide, which is available at the application. Texts for the needs of the virtual visit of Peristera are reported in Tab. 1.

Table 1: Texts for the archaeological and biological Point of Interests of Peristera shipwreck

1. Peristera's shipwreck
Around the end of the 5th century BC, a large merchant ship, probably an Athenian one, sank near the small island of Peristera. The ship is one of the biggest well known of the classical antiquity: it is estimated that it could carry more than 3000 amphorae.
2. A unique finding

[59] The scientific documentation was provided by the archaeologists of the Ephorate of Underwater Antiquities, Dimitris Kourkoumelis, Theotokis Theodoulou, Despina Koutsoumpa, who participate in the BLUEMED project team, while the writing and museological work was undertaken by the archaeologist-museologist Elia Vlachou.

In 1985, a fisherman, Dimitris Mavrikis, discovers an ancient shipwreck at a depth of 28 meters. Hundreds of amphorae form a pile lying to an extent of 25 meters in length. The huge volume of the cargo indicates that the ship was larger in size than the other ships known of that time. The impressive shipwreck of the classical antiquity shows that large cargo ships, over 100 tons, travelled in the Mediterranean since the 5th century BC.

3. Can you see the ship?

The ancient ships were made of wood. Peristera's shipwreck was built according to the "shell first" technique, which is used for every ship in antiquity: first the shell is "built" on which the inner skeleton, the "frames", is gradually adapted. The wooden hull was not preserved in the sea. However, the position of the cargo at the seabed helps us to understand the outline of the ship and its dimensions, which are estimated to 25 x 9 m. approximately. However, it is difficult to locate where the bow and where the stern of the shipwreck is.

4. A rich cargo

The hold was loaded with thousands of wine amphorae from Mendi (ancient city of the peninsula of Chalkidiki) and Peparethos (today's island of Skopelos), areas known for their wine in antiquity. The ship also transported several fine black-glazed vases that were used in the Athenian symposia: cups, plates, skyphoi, as well as small cups with the initials LY engraved on the bottom. Finally, some simple, everyday courseware and lamps were located, which probably were used by the unfortunate crew.

5. Amphora: a practical trade vase

In the 5th century BC, the Athenian commerce dominates, from Sicily and Marseille to the Black Sea. Ships transport mainly grain, wine and olive oil. The liquids are carried in "pointed-base" amphorae, vases that weight approximately 8-10 kilos and have a capacity of 15-25 liters. They are perhaps of the most cleverly invented and practical vases of the antiquity: they have two handles which help to carry them, a narrow tall neck and a pointed ending to be safely stowed on the hold. In the competitive market of the antiquity, the origin and quality of the product are ensured with variations regarding the shape, seals, engravings and decorative elements.

6. "Pointed-base" amphorae of "Peparethian" type

The "rich in grapes Peparethos" (today's island of Skopelos) was known for its wine, which it exported mainly to the Black Sea. It developed an amphora with its own characteristics, which contained 26 kilos of wine. A large number of pointed-base amphorae of "Peparethian" type was found at the shipwreck. How many can you locate? Remember that their body is taller and thinner.

7."Pointed-base" amphora of "Mendenean" type

Mendi, a colony of the ancient city of Eretria on the coast of the peninsula Chalkidiki, was famous for its wine. The pointed-base amphorae of "Mendenean" type were among the most widespread types of amphorae in the Mediterranean at the time of the shipwreck (5th century BC). Each one them could carry 36 kilos. They bear a fingerprint at the base of each handle which was a distinctive element that helped the identification in relation with the particular area. The amphorae of "Mendenean" type were the main cargo of the ship. Can you tell the differences from the amphorae of "Peparethian" type? The body of the amphorae of "Mendean" type is wider and cone-shaped.

8. Ballast for stability

The ballast is probably a pile of stones beneath the deepest layer of the cargo which was loaded in the hold, in order to ensure stability and better buoyancy. The ballast usually consisted of heavy objects placed at the deepest point of the hull of the ship and mostly along the "keel". The ballast often consisted of stones, as in this case. Sometimes though it could also be part of the ship's cargo.

9. The shipwreck

We will never know for certain why the ship sank. Did a fire break out as the carbonized wooden remains located underneath the cargo indicate? Then again, the reason was greed: the ship was overloaded and traveled during the Peloponnesian War (end of the 5th century BC), a time when the elevated product prices were tempting enough to overload the ship. Or maybe an average or even a wrong handling or appreciation of the crew.

10. What was the ship's course?

Merchant ships stopped in various ports, unloaded goods and loaded others to continue their journey. We cannot know the precise route of the ship that sank in Peristera, but the cargo gives us evidence of its course. Symposium vases are probably from Athens. The amphorae from Mendi refer to one of the most important trade ports: it was probably a product for exchanging wine to the Athenian black-glazed vases. The amphorae from Peparethos come from the nearby island of Skopelos. So, it is likely that the ship was heading for ancient Ico (today's island of Alonissos) or it was departing from there and so it sank not far from the port.

11. How do we know when the ship sank?

Researchers use several scientific methods to date the findings of an excavation. In this case, the "absolute" dating, with the analysis of the carbonized remains using the ^{14}C radioactive carbon method, shows us that the wood for the construction of the ship was cut somewhere between 480 and 420 BC. The "relative" dating, that is, the comparison of the typology of the vases, and in particular of the Athenian pottery, allows us to place the shipwreck in the last quarter of the 5th century BC, after 425 BC.

12. How do the archaeologists dig at the seabed?

In Peristera's shipwreck, the excavation trench that remains still open gives us exactly the sense of the volume of the cargo carried by the ship. The cargo of Peristera's shipwreck spreads over layers lying to an extent of 25 x 12 m. In order to gain access to the lower level, the amphorae must be removed from the upper layers during the excavation. This is done after they have first been designed, photographed and measured at the location where they have been found. The well-known tools of the archaeologist (shovel, pickaxe, cart, etc.) cannot be used in the underwater excavation. So, the sand of the seabed must be removed with other ways. Usually either a water pump is used or an air extractor to create suction with a pipe and remove the sand and the small rocks from the excavation site.

13. The excavation changes the image

The concentrated amphorae that you see here are not in the position where they were located in the shipwreck. The excavators removed them from the excavation trench in order to investigate what was hiding underneath. You can look for the gap that they have left in the area of the shipwreck. Some of them have been salvaged, preserved and studied by the archaeologists. Others were concentrated at this point, near the area of the excavation, and give us an image of the volume of the cargo and its diversity.

14. The plant of Poseidon

Peristera's shipwreck is surrounded by *posidonia* meadows, a unique underwater Mediterranean ecosystem. The underwater plant of Poseidon [*Posidonia oceanica (L.) Delile*] creates large meadows to the depth of 30 meters at the area of the Marine Park of Alonissos.

15. Colors at the seabed

The area of the shipwreck has been colonized by colorful *sponges* and *bryozoans* and colonies of polychaete worms, creating an impressive marine ecosystem.

16. The shipwreck gets a new life

The amphorae provide accommodation to octopuses and several species of fish, with the *moray (Muraena helena*) as a typical inhabitant, while schools of damselfish *(Chromis chromis)* accompany divers archaeologists at each of their visit.

The creation of this digital application, which reflects the latest conquests in the technology field, completely overturns the data of potential accessibility of the elements of the cultural heritage which "hide" in the seabed, and constitutes a valuable tool for people of culture both in the direction of presenting underwater monuments even to non-divers and in the scientific recording and their fuller documentation.

3. OPTO-ACOUSTIC SURVEY

The methodology used for the 3D reconstruction of the Peristera Shipwreck focuses on the integration of data captured by acoustic and optical systems to obtain a complete representation of the underwater scene. The first step of the process consists of the inspection of the underwater site and aims to identify the locations of the archaeological remains and classify them by order of importance and appealing from an archaeological point of view. The following steps deal with the acquisition of the optical and acoustic data which, according to the specific needs, can be carried out by scuba divers or by underwater Remotely Operated Vehicles (ROVs) or Autonomous Underwater Vehicles (AUVs). Once the survey activities ended, the optical and acoustic data are merged to create a multiresolution textured 3D model of the underwater archaeological site and the surrounding seabed.

The underwater optical survey of the Peristera shipwreck has been carried out according to a standard photogrammetric technique using a Sony A7II mirrorless camera with a CMOS sensor size of 36 x 24 mm and a resolution of 6000 × 4000 pixels (24 effective megapixels), equipped with a Sony Zeiss 16-35mm f/4 lens used at 16mms. The system was mounted inside an Easydive Leo3 Wi house equipped with a spherical 125 Ø port and two Ikelite DS161 underwater strobes. A dataset of 1044 images has been acquired and, then used for the 3D reconstruction of the site. In detail, a textured 3D model of 20.000.000 of polygons has been obtained by using the commercial software Agisoft Metashape Pro (Fig. 1).

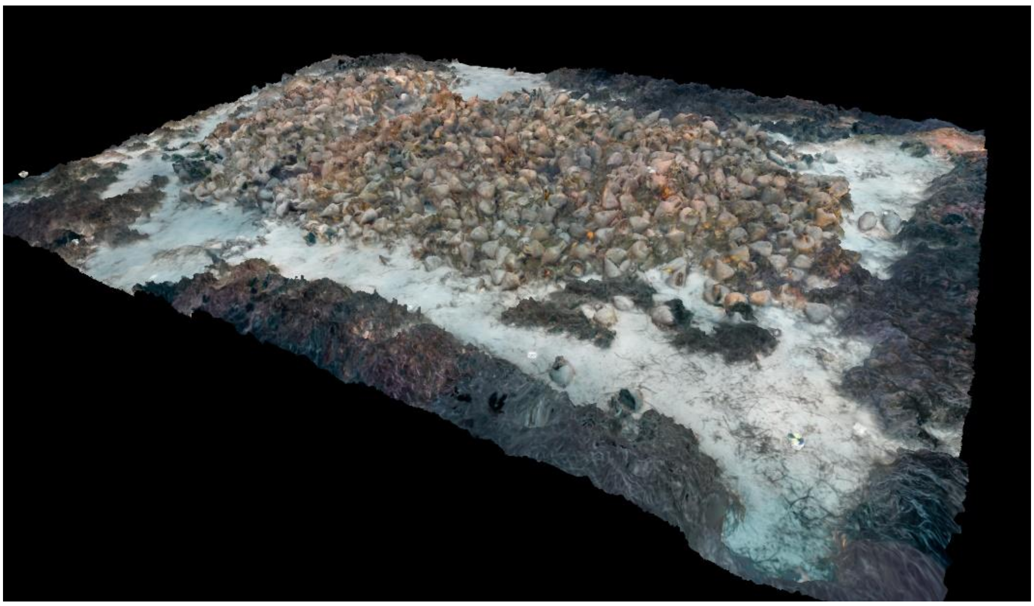

Fig. 1: 3D textured model of the Peristera Shipwreck

An unmanned aerial vehicle (UAV) DJI Phantom 4 was used to gather photos of the Peristera island's coast just in front of the pilot site in order to reconstruct it by photogrammetry. The resolution of its photos is 12MP. The resulting 3D model, based on the elaboration of 381 photos, is given in Fig. 2.

Fig. 2. 3D reconstruction of the part of Peristera island in front of the pilot site

A multipurpose autonomous surface vehicle (ASV) [6-7] equipped with a Norbit WBMS 400/700KHz multibeam sonar, an Applanix navigation and a high-precision Trimble GPS antenna was used to acquire the acoustic data (Fig.3). In total an area of approx. 300x300m in front of the Peristera island was covered. Low across-track overlap percentage lawnmower missions were performed for the surrounding area of the shipwreck, while a detailed high across-track overlap percentage crosshatch missions were performed directly above the shipwreck.

Fig. 3 Autonomous surface vehicle PlaDyBath with Trimble GPS antennas in the back and WiFi antenna on the left (left), close-up of the mounted multibeam sonar (right).

4. INTERACTIVE VIRTUAL SCENARIO

Once the survey and 3D reconstruction activities ended with the generation of the textured multiresolution 3D model of the Peristera wreck site, this model has been adopted as starting point to develop an interactive virtual scenario. A game engine 3D Unity based application was used to the programming and development of the virtual interactive environment.

Fig. 4 Terrestrial environment of the interactive virtual scenario

The exploration of the underwater archaeological site starts above the water surface in the diving spot. The buoy and an inflatable boat have been added to the virtual scene, as well as the 3D reconstruction of the stretch of coastline that overlooks the diving site (Fig. 4).

Once the user dives in the submerged virtual environment, he/she is guided by a directional 3D arrow toward the archaeological site (Fig. 5). The realism of the underwater virtual environment has been enhanced with graphical effects and physically accurate simulations, such as light rays, refractions, fog, caustics, particles and bubbles. The virtual scenario has been also populated with 3D models of the flora and fauna typical of the specific marine ecosystem. In particular, the vegetation has been reproduced by means of texture effects that mimic the movements of the real plants. The interaction between the user and the virtual scenario occurs by means of a number of points of interest (POIs), placed on the sea floor in form of 3D large head map tacks, which colour depends on the category they belong to, e.g. yellow for the historical and archaeological information and green for biological ones.

Fig. 10 Underwater virtual scene of Peristera Shipwreck.

7. CONCLUSION

The paper has presented the application of technologies and methods developed by the BLUEMED consortium partners for the creation of a virtual interactive scenario, focusing on the case study of the Peristera shipwreck site. The interactive virtual scenario is an efficient instrument for communicating and making accessible the Underwater Cultural Heritage because of its capability to allow users to explore an accurate and realistic 3D replica of the underwater archaeological site and to provide them a scientifically sound virtual reconstruction of the archaeological and architectural ruins. This engaging representation of the underwater sites presents an enormous potential for the tourism sector in order to make the underwater cultural heritage more accessible and enjoyable for the general public.

ACKNOWLEDGEMENTS

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Remotely operated group of vehicles for underwater scientific exploration and intervention

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The "Bubblots", a group of remotely operated vehicles, specialized in underwater scientific exploration and intervention, are currently developed at Hublot R&D in Nyon, Switzerland. The initial conception of the idea for the creation of the Bubblots was based in the need for remote supervision and underwater archaeological intervention at the Antikythera shipwreck site in Greece. The Bubblots integrate a selection of technological and analytical tools accessible through a web-based interface at their control centre: optical positioning, real-time 3D vision and recording, wide-angle vision, metal detection, metal oxide analysis, sediment aspiration and storing, and others, with all acquired data being stored within an open-source database. The initial deployment of the group of vehicles is planned to take place at the underwater archaeological site of the city of Gela, in Sicily, in spring 2019, in the framework of a collaboration between the Sciences of Antiquity Department of the University of Geneva and the Research & Development Department of Hublot, with usage results being verified in real time by underwater experts. The system will then be available for extended operations at the underwater landscapes of Antikythera Island, possibly also contributing to the work of the Ephorate of Underwater Antiquities of the Hellenic Ministry of Culture and Sports, at the famous Roman era shipwreck. After the completion of the pilot missions scheduled for the year 2019, the Bubblots could also be available for use by selected non-divers to explore the unique richness of distinguished underwater sites, such as those of Kythera and Antikythera islands, as well as other interesting locations. Its 3D vision system can offer a unique dry-dive experience to non-divers, and its interface can serve the purpose of such an application.

Monitoring and protection of accessible underwater cultural heritage

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Sensing, mapping and reconstruction of the Underwater Environment is a demanding task still possessing a great amount of scientific and technological challenges. The main active (e.g. multibeam echosounders) and passive (e.g. RGB camera) sensors deployed on supporting ships, remotely operated vehicles (ROVs), autonomous underwater vehicles (AUVs) producing a significant amount of data (images and point clouds) towards addressing mainly the critical tasks of (i) bathymetry mapping, (ii) seafloor mosaicking and (iii) seabed classification, targeting a vast variety of application fields and communities like submarine archaeology, geology, oil and gas, energy power cables, pipelines, and others.

State-of-the-art equipment and instrumentation along with the combinatorial analysis and processing of geophysical data validated through intensive sampling, manual examination and data interpretation enable marine archeologists to address challenges occurred from the hostile deep marine environment. The discovery and study of shipwrecks at greater depths, the study of coastal settlements and harbors, the re-creation of ancient shorelines, the hydrodynamic observations, the study of the ancient climate and its relation to the development of the civilization, the protection, promotion and rational management of our marine cultural inheritance, as well as the sustainable management of the marine environment are some of the objectives of oceanographic research related to the monitoring of the Underwater Cultural Heritage (UCH) sites and UCH diving parks. Moreover, by fusing and processing the acquired underwater observations from multiple sensors and systems, the reconstructed sites can be presented through various visualization manners tackling both technical as well as dissemination tasks through cutting-edge virtual and augmented reality tools. In particular, underwater archaeological sites can be demonstrated through story maps in GIS environments by employing versatile tools for visualizing geospatial information including multimedia assets (e.g. photos, videos, 3D models, maps) and narrative text which can provide support for scientific storytelling in the protection of UCH sites.

Keywords: accessible Underwater Cultural Heritage, mapping, reconstruction, monitoring, management, preservation, virtual and augmented reality, story maps

In situ conservation of cannons in marine environment: cathodic protection, cleaning treatment and coverage with geotextiles

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***Abstract*:** This project aimed to study a comprehensive conservation plan for archaeological iron in seawater using cathodic protection as the main conservation technique. Nine cast iron cannons were discovered in 2000 just off the coast of Marettimo island (Sicily, Italy), dated between 17th and 18th century at about 15m depth, dispersed as a consequence of the sinking of a Spanish ship.

The fieldwork (2017-2018) investigated two cannons, C and D, to connect them to a cathodic protection system, study degradation processes and assess how the cleaning treatment could affect corrosion processes.

An innovative cathodic protection system was designed to minimize its aesthetic and physical invasiveness and, throughout the project, measurements of surface potential in different points along the external surface of the cannons had been taken. Data-loggers were used to collect time series of temperature of the water and surface potentials.

One of the two cannons chosen for this research was cleaned and then its potential measurements were compared to the other one that was not. The aim of this procedure was to make the archaeological objects more recognizable and easier to study for a larger audience by partly removing marine encrustations. By cleaning the surface, exposed metal could be sandblasted and eroded; thereby a protective layer was essential. A polipropilene geotextile was used to test how effective it was as physical barrier against erosion and biological growth.

Keywords: *In situ* conservation; under water park; metal conservation; cathodic protection; geotextile.

1. PROJECT SUMMARY

Over the years, the preservation of underwater archaeological sites *in situ* has assumed increasing importance[60]. However, by preserving in situ, there is the threat that the richness of underwater cultural resources becomes less visible to the public.

The chosen archaeological site is near the coast of Marettimo island (Sicily, Italy) where nine cast iron cannons were discovered in 2000, dated between 17th and 18th century at about 15 m depth, dispersed as a consequence of the sinking of a Spanish ship. In 2007 the Italian Superior Institute for Conservation and Restoration (ISCR) studied a comprehensive conservation plan that included cathodic protection (CP) along

[60] UNESCO (2001).

with the local superintendence, Soprintendenza del Mare, for making this area a marine archaeological park, but unfortunately this project was only partially achieved[61].

In 2017 the Honor Frost Foundation granted an award for a new project to develop a protocol to understand and to slow down degradation processes as well as to improve the readability of iron artefacts in underwater cultural sites. This project aimed to study a comprehensive conservation plan for archaeological iron in seawater, still using CP as the main conservation technique.

During the field work cannons' conditions were investigated, such as graphitization and corrosion potential (E_{corr}), and how environmental characteristics influenced CP and the anode weight decrease. A major part of this study was also focused on improving the enjoyment and the comprehension of iron objects in underwater parks by non-specialists (e.g. diving enthusiasts), through the mechanical removal of marine concretions from the cannons' surface and the use of geotextiles as protective coverage.

2. METHODOLOGY

The project was organized in six research trips on the field, three for every year (2017-2018). This organization allowed the measurement of the environmental parameters in different seasons, two years in a row on two cannons, C and D (fig.1). Data-loggers, used to collect time series of temperature of the water and surface potentials, were left on site in a watertight case. Unfortunately, an act of vandalism by unknown damaged the equipment left *in situ* and first year of data was lost.

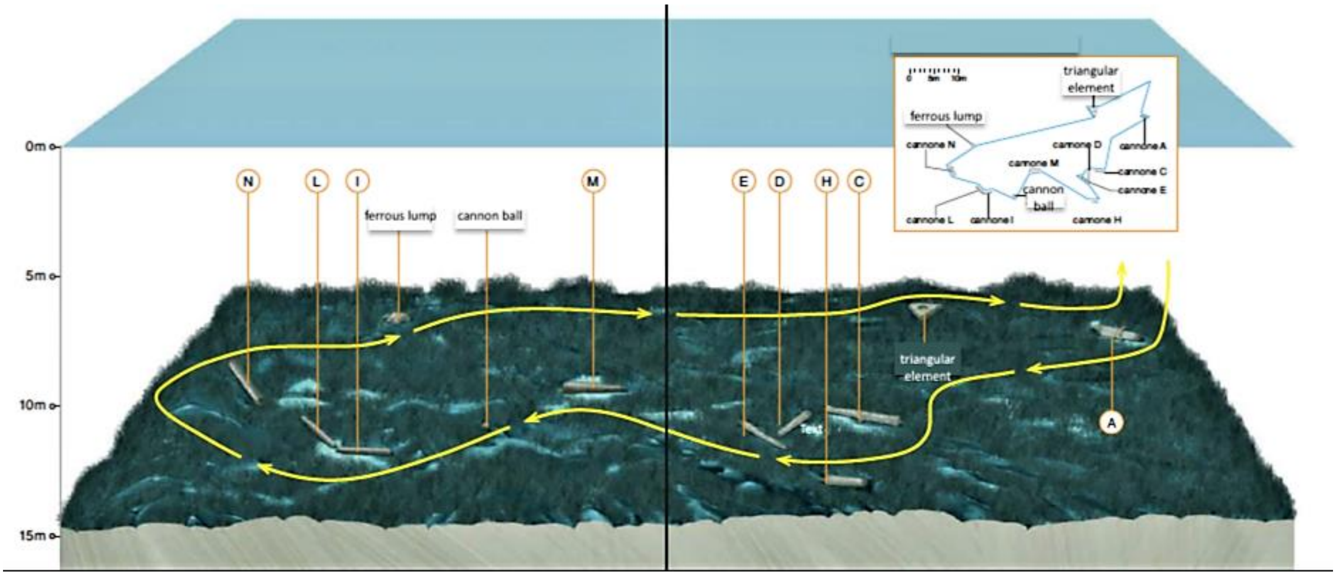


FIG. 1: MAP OF THE SITE WITH THE CANNONS CHOSEN FOR THE RESEARCH, C AND D.

2.1. Cathodic protection

Electrical protection of submerged steel components is a common practice for industrial or civil structures that can be efficiently preserved by applying an external cathodic current to their surface using sacrificial

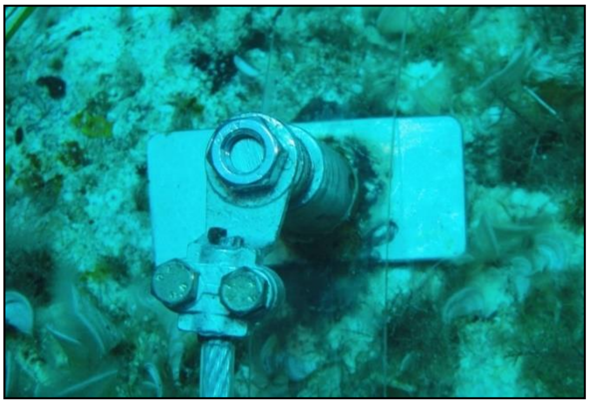
[61] Bartuli C., Petriaggi R., Davidde B. et alii (2008).

anodes. In the case of components of artistic or historic importance, particular care must be taken to guarantee the lowest impact on the object. In the late 1980s, I.D. MacLeod successfully used this method on many wrecks, some of them with metal structures; others, from the 18th and 19th centuries, with wooden hulls but containing iron cannons and anchors, such as the wrecks from Duart Point (Scotland)[62]. For the wreck of San Pedro (Florida Keys, USA), designated an archaeological marine reserve in 1989, the protection and in situ museum display was carried out by protecting the iron anchor using a zinc bar sacrificial anode[63].

Cathodic protection (CP) is an electrochemical method that can only be applied to metals exposed to conductive environments, and objects immersed in seawater can be efficiently protected due to the very good properties of electrical conductivity of the medium. The fundamental principle of the method is based on the possibility of modifying (reducing) the open circuit potential of an actively corroding metal by applying a continuous current between an electrode, made of a less noble metallic material (sacrificial anode), and the object to be protected.

The two chosen cannons (C and D) were both connected to the CP system, which consisted of two zinc anodes placed on the muzzle and on the breech. The number of anodes and their size was calculated according to standard formulae in CP literature[64], which take into account the wetted area of the iron structure to be protected. Average values will indicate whether the object is in thermodynamically safe conditions (close to the immunity potential, normally assumed as about - 800 mV) or if it is actively corroding. Throughout the project, measurements of surface potential (E_{corr}) in different points along the external surface of the cannons had been taken.

Continuing the project started in 2007 by the local superintendence, in collaboration with ISCR and Sapienza University of Rome, we developed a different system by which the zinc anodes were connected to the cannons' surface, trying to minimize its aesthetic and physical invasiveness. Two spring-loaded tips made of 316 stainless steel were kept firmly in place by bolts and transparent Melinex[65] strips, ensuring an electrical connection with the cast-iron under the graphitization layer (fig. 2 and 3). The previous system to connect the metal tips to the cannons was made using a stainless steel arch and two insulated pressure caps (for stabilization). This method gave satisfying corrosion potential values but it was considered too invasive aesthetically.


a)

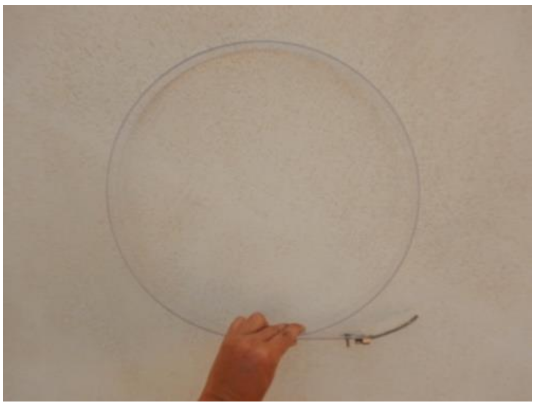
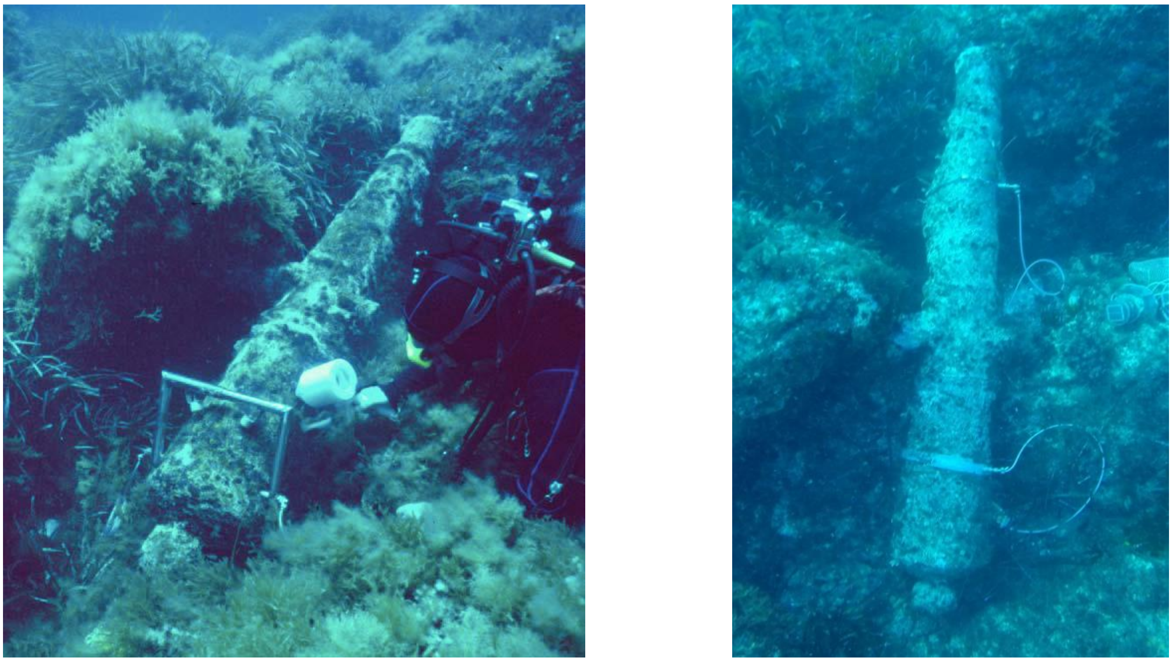

b)

Fig. 2: Photographs of the new system for connecting the anodes to the cannons; a) detail of the tip placed under the graphitization layer and b) the Melinex strip.

[62] MacLeod I.D. (1995).
[63] Scott-Ireton D.A. (2003).
[64] Heldtberg M. (2004).
[65] Melinex® is a high clarity polyester film (PET).

During the whole project, potential measurements were carried out using an underwater rust reader device[66]. This device is a self-contained measuring probe designed for hand held diver operation, consisting of an Ag/AgCl reference electrode encased in a common water resistant shroud together with a digital voltmeter and connected to a replaceable hardened stainless steel tip enabling good electrical contact with the metallic surface.



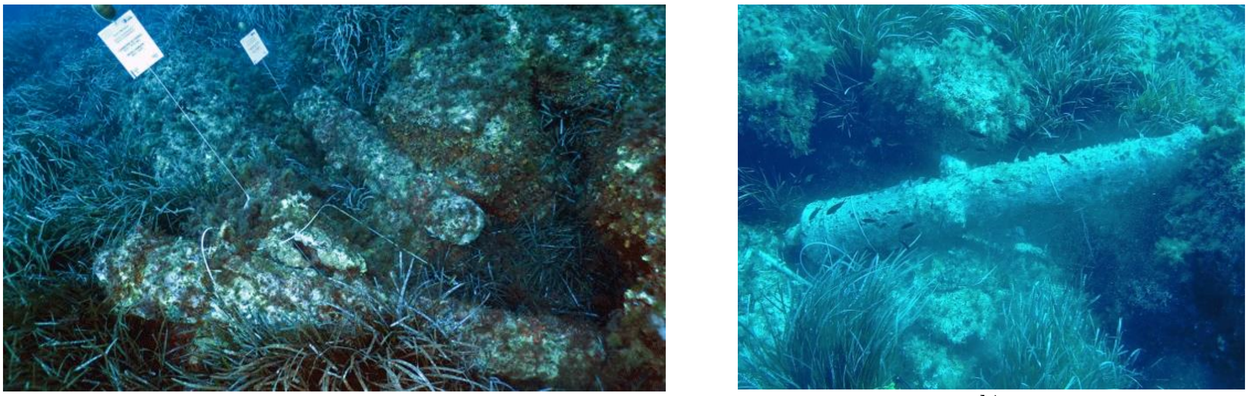
a) b)

Fig. 3: Comparison of the two different methods to connect the anodes to the artifacts: a) the system developed in 2007 with an arched structure and b) the new system implemented during this project.

2.2. Cleaning treatment

In order to test how a cleaning treatment of the cannon's surface could affect its conservation underwater, one of the two cannons chosen for this research was cleaned and then its potential measurements were compared to the other one that had not been cleaned. The aim of this procedure was to make the archaeological objects more recognizable and easier to study for a larger audience by removing the marine encrustations (fig.4). The cleaning treatment concerned only the biological concretion layer and it was performed mechanically, using small hammers, chisels, metal spatulas and scalpels. We also had the opportunity to test brushes mounted on an underwater rotary tool[67](fig.5).

[66] Corrintec Marine House, Chesterfield, UK.
[67] Rodon 100 is the first underwater drill that allows the operator to replace the battery directly underwater thanks to Tech4sea patented system. The device was kindly provided by Dr. Fabio Bruno, University of Calabria (UNICAL).



a) b)

Fig. 4: a) Cannons before treatment b) Cannon "C" after treatement.

Fig. 5: Underwater drill Rodon 100, Tech4sea patented system.

2.3. Coverage with geotextile

The use of geotextile sheets to protect underwater artefacts from biological and mechanical degradation has been experimented in different archaeological sites, such as Baiae (Naples, Italy)[68] and the Zakynthos wreck (Ionian Islands, Greece)[69]. Usually these materials are used mostly on mosaic floors or flat surfaces. Therefore, this project provided an opportunity to test them on three-dimensional objects made of metal.

By cleaning the surface, exposed metal could be sandblasted and eroded; thereby a protective layer was essential. Geotextile sheets provide a smooth, continuous barrier across the seabed, which promotes a stable, often anaerobic, environment beneath it. A polipropilene geotextile TNT PP150-A70 was wrapped around the cleaned cannon to create a physical barrier against erosion and biological growth. This kind of textile was chosen because is easy to lay underwater and allows periodic inspections. One side of the coverage was closed with a string sewn to textile.

[68] Ricci S., Priori G.F. and Bartolini M. (2007).
[69] Pournou A. (1998).
[70] Geotextile was provided by Officine Maccaferri Italia Srl.

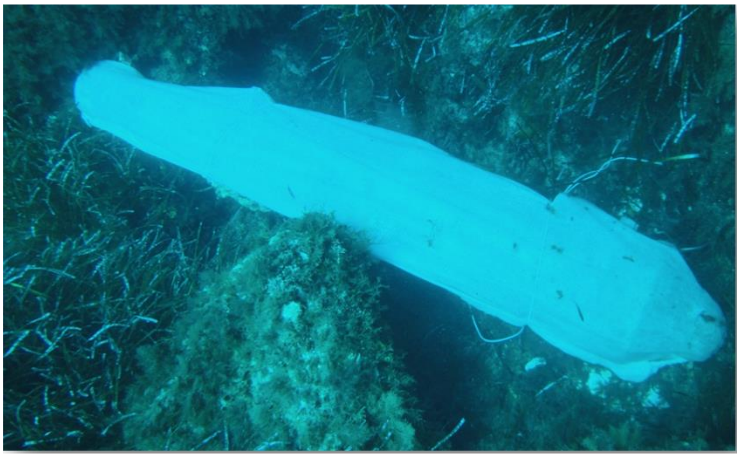


Fig. 6: Cannon "C" covered with textile.

On the last dive of the project the geotextile was not found on the cannon, it is therefore possible that in the eventuality of archeological sites subject to strong marine currents textiles need to be secured in a more durable way.

3. RESEARCH QUESTIONS AND TENTATIVE ANSWERS

The main objectives of this research were:

- Archaeometric study of the archaeological site;
- Assess how CP is affected by the surrounding environment;
- Combine CP with a mild cleaning treatment to make the archaeological objects more recognizable and easier to study for a larger audience;
- Test geotextiles as protective layer for three-dimensional objects underwater;
- Develop a conservation management plan for the archaeological area;
- Promote the site to develop sustainable tourism and increase accessibility.

Local superintendence staff has collaborated with us throughout the project and kept monitoring and documenting the cannons and the other archaeological remains. During the first dive in the archaeological site, cannons measurements and physical-chemical data were gathered (table 1).

TABLE 1: MEASUREMENTS OF THE CANNON "C" AND PHYSICAL-CHEMICAL DATA OF THE SITE.

Geometry of the cannon "C":	Environmental characteristics:
– Length: 2.1 m – External diameter of the breech: 0.34 m – External diameter of the mouth: 0.17 m – Internal diameter of the mouth: 0.11 m	– Depth: 13.3 m – pH: 8.1 – Dissolved oxygen: 7.8 mg/l

The surface potential measurements taken during every dive in different points along the entire length of the cannons gave answers to different questions. They confirmed that two anodes placed on the breech and on the muzzle could guarantee a good protection overall the cannon's surface. The average values of surface potential indicated that the cannons were in thermodynamically safe conditions and the yearly corrosion rate of the iron alloy does not seem to change significantly during the different seasons (fig.7). This new way to connect the anodes to the cannons' surface proved to have a lower visual impact and invasiveness than the one tested in the previous project and its installation and maintenance costs were reasonable.

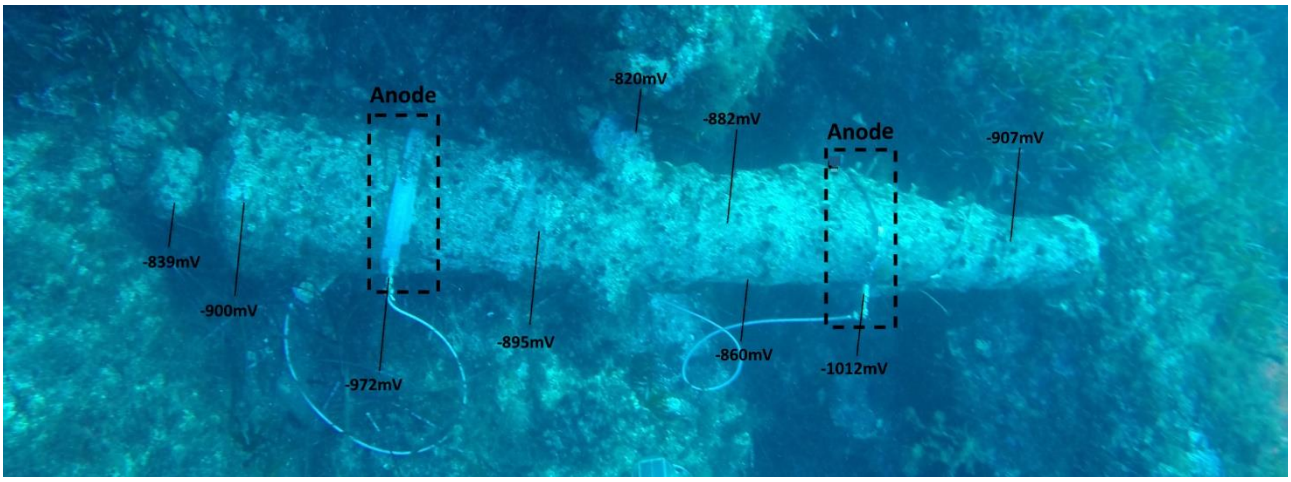


Fig. 7: The average values of surface potential ($E_{corr)}$ measured on cannon "C".

Another useful information was that the surface potential values ($E_{corr)}$ measured on the cleaned cannon and on the other one still covered in marine concretions, were comparable. This outcome was especially significant because it would prove that mild cleaning treatments on objects connected to CP systems do not affect their conservation underwater. Furthermore, the treatment might help the local superintendence to promote the site, develop sustainable tourism, raise awareness, build local identity and increase accessibility. Diving clubs that are already in the area can now include this archaeological site to their tourist offer and we might imagine that underwater parks with well-conserved artefacts will attract more visitors as well as improve the accessibility of sites to the public.

As regards the coverage with geotextile, we were not able to collect enough data because the textile was removed in the act of vandalism and the one we laid after that episode got lost, probably after extreme marine conditions. The archaeological site where the cannons are located is at only 13 meters of depth therefore tides and wave motion could have been too intense and prevent textiles to stay on place.

The anodes, after almost a year being connected to the cannons, still did not need to be replaced. It was not possible to weight them but they were nearly at their full capability and it could therefore be said that they need to be replaced every two years. The information gathered prove how the conservation underwater of small artefacts can be inexpensive compared to the retrieval and the full conservation treatment of the objects.

4. CONCLUSIONS

The conservation management plan should consist of two dives every year, preferably at the beginning and at the end of touristic season. Every year the superintendence staff should remove geotextile coverage to make the cannons recognizable *in situ*; monitor biological growth to plan possible future treatment; replace anodes when needed and check the connection between cannons and the CP system.

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Underwater Archaeological Sites as a touristic and educational resource. The Isla Grosa Project.

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***Abstract*:** In recent years, the tourist sector and policymakers are being attracted by the underwater archaeological heritage as a sustainable tourism resource. In the case of the Region of Murcia (Spain), this is evident given its wide Maritime History and the strong business fabric related to diving activities. During 2014 a pioneering project was developed which sought the creation of an underwater archaeological trail, for the first time in Spain, in one of the most iconic sites in the Mediterranean, the Phoenician wreck of the "Bajo de la Campana" (VII B.C.).

This two-month pilot project was done entirely through private funding and was an initiative of the National Museum of Underwater Archeology (ARQVA) friend's society. The active collaboration with local entities, diving centers, and tourism managers allowed the success of this activity, helping to achieve the goals of promoting UCH social awareness and the sustainable and responsible management of UCH. Through this paper, we will present the project, from its conception to its results, as well as the problems derived from the management and public access to UCH in the Spanish Mediterranean.

***Keywords*:** Underwater Archaeological Trail, underwater heritage, public access, Blue tourism, Bajo de la Campana shipwreck.

1. INTRODUCTION

Given the difficulties and limitations faced by the administrations for the protection and control of the submerged archaeological heritage, education proofs to be an essential tool for its conservation (Scott-Ireton, 2003; 2007; Cerezo-Andreo, 2011). In fact, the UNESCO Convention itself (Paris, 2001) highlights "the importance that research, information and education have for the protection and preservation of said heritage", with the conviction that "the education of the public contributes to a better knowledge, appreciation and protection of that heritage". The ICOMOS Charter for Interpretation and Presentation of Cultural Heritage Sites (Quebec, October 4, 2008) also highlights the importance of public communication.

In Spain, The Libro Verde of the National Plan for the Protection of the Spanish Underwater Cultural Heritage (VV.AA., 2010) shares this position and also speaks about the need to build a clear and powerful, suggestive and rigorous image of the authentic nature of the PCS, with special emphasis on three aspects: knowledge and understanding, involvement of citizens, and responsible access. In this regard, the III International Congress of Submarine Archaeology (Barcelona, 1961) was already enunciated, with a recommendation that is still valid today: "(it should) be fostered among divers and archaeologists the spirit of collaboration". The Libro Verde recalls that "the implication of fishermen, divers and inhabitants of the area in the conservation of local sites has been shown as the most effective protection measure".

In conclusion, correct awareness and education through, among others, dissemination in situ, favours the involvement of communities and their active participation in the protection of this heritage (Bombico et al. 2012), not only because it makes other people "guardians of the past" (Leshikar-Denton and Scott-Ireton, 2007) but also because it has a direct impact on the local economy fostering sustainable development and strengthening the idea that preserving the heritage can be much more profitable than passively assisting its dispossession (Maarleveld, 2013; Suvanatap, 2014)

At this point, it seems important to stress that, due to the fragility of heritage and other conditioning factors, this type of activities are not always feasible. However, the 21st century has shown an increasing involvement of researchers in dissemination efforts, generating, testing and analysing, different models and solutions for in situ dissemination (Jameson, 2015). Thus, the bibliography on this subject has been increased in recent years and there are already numerous experiences in all types of underwater sites: underwater archaeological parks in open waters such as the one linked to the Naval Battle of Santiago de Cuba, those of Baia or Santa Maria di Castellabate in ltaly, Florida Keys or Caesarea Maritima (Israel), and also in confined waters, such as Lake George in New York or Thunder Bay in Michigan; thematic routes such as the Spanish galleons in Florida or the battle of Saipan in the Mariana Islands, or independent sites such as the "caged wrecks" of Croatia.

In Spain we can also find some experiences of this kind, whether they are isolated wrecks such as the Bou Ferrer in Villajoyosa, diffusion through the use of replicas in underwater trails (cases of Ampurias, Nieto, 2007, or Cala Cativa) or the occasional visits to sites in excavation process, such as those that were developed between 2007 and 2011 in Bajo de la Campana or those carried out periodically by the Federation of Underwater Activities (FECDAS), in collaboration with the Center for Underwater Archeology of Catalonia (Aguilar, 2011), to name but a few cases.

There are not two equal sites so there are no two equal experiences, and, as is logical, among all these projects there are lights and shadows. However, it is a reality that, thanks to these works, in situ conservation has opened new paths for research, conservation and protection of this heritage (Davidde, 2002).

2. CONTEXT

This project was developed in the surroundings of Isla Grosa: a small island of volcanic origin located in the area of La Manga del Mar Menor, in the Region of Murcia (Spain).

Murcia has followed the mass tourism model that is implanted in the Mediterranean Sea since the 50s, reinforced by the residential boom that is observed from the 90s, and articulated around the binomial sun and beach (Espejo and García, 2011). A model that has been described as outdated, insufficient, and even exhausted and harmful. The area of La Manga del Mar Menor, space in which the Isla Grosa project takes place, remains a great abandonment in the cultural sense despite the urgency, as we shall see below, of finding new development models for this highly degraded area.

2.1 The Mar Menor area - Cabo Palos and Isla Grosa.

La Manga del Mar Menor is the only case in the Mediterranean of sandbar between two seas (Morales Yago, 2013): an open sea (the Mediterranean itself, colloquially called "Mar Mayor") and another interior or lagoon (known as "Mar Menor"), more saline, warmer and shallower.

The exceptional climatic and geographical characteristics of this environment, its natural diversity, the excellent nautical conditions of the inland sea and the curative properties attributed to its waters and mud, have contributed to convert this area into the first tourist destination in the Region of Murcia.

However, or perhaps because of this, it is one of the areas that has suffered the most from the effects of malpractice, not only in tourism but also in general management. In this privileged environment, pollution and the consequent destruction of ecosystems are a tangible reality in what is considered a real environmental catastrophe

Even though environmental agencies have been warning about the degradation of this area during the last 20 years, only recently have palliative measures begun to be taken including, among others, contemplating alternative tourism resources to a model that has proved unsustainable and uncompetitive (Morales Yago, 2013). One of the priority objectives for the development of this area is to break seasonality. In this sense, differentiation has been sought as a quality tourist destination for the practice of water sports throughout the year, as the weather permits71 One of the most powerful attractions in this sense is diving, for which a powerful business network has already been created, and which has two differentiating claims: diving in the Cabo de Palos natural reserve and diving in historic wrecks.

2.3 Historic wreck tourism

Cabo de Palos is considered one of the ten destinations72 of the most interesting diving in the world, not only for the marine reserve, but also for the numerous sunken ships that rest on its bottoms. This has made diving a very active industry. Thus, this town of about 1 000 inhabitants concentrates in the mouth of its port more than a dozen diving centres.

Cabo de Palos (and its surroundings) is an authentic cemetery of boats, with at least fifty shipwrecks of modem times (and many others of ancient ships). It is necessary to be aware that many of the so-called historical wrecks are being exploited economically and as a tourist resource not only in the Region of Murcia but in general in our country, without the possibility of effective control, without adequate appreciation, and without respecting their heritage values. Although the level of awareness of sport divers is increasing, and there are diving centres that work in an extremely respectful way around this type of diving, in other cases these conditions do not occur with the consequent loss and degradation of fragments of our History.

3. UNDERWATER AND MARITIME CULTURAL HERITAGE OF MURCIA (SPAIN)

The Southeast is in a natural crossroads that since prehistory has been conditioned by being a strategic passage zone, both terrestrial and maritime. Its rich coastal heritage allows us to get closer to the origins of civilization in the Mediterranean, the first explorations of the Phoenician peoples or the wars between Rome and Carthago for the control of the empires that were beginning to take shape. A place that, due to its proximity to Africa, soon became a hinge territory that connected the north of the Mediterranean with its southern shore. For this reason, the Byzantine Empire established its base in the city of Cartago Spartaria (today Cartagena). During the Muslim period, for almost 600 years, this territory was intimately linked by sea to Tunis and Algiers. After the Christian conquest, however, and for the next 500 years, it was a frontier area of conflict, marked by war and North African berber piracy. With the arrival of the Bourbons to the Spanish Monarchy, one of the only three naval arsenals of the Península was built in the city of Cartagena, being, thereafter, the industrial engine of the territory. He also witnessed great tragedies and losses, such as the Sirius (Italy), or the sinking of vessels such as the 'Tordhisa', (Norway), 'Doris' (Italy), 'Alavi' (United Kingdom), Despina Michelinos' (Greece) or Francolí (Spain) torpedoed during the First World War. This brief and superficial tour of the key points of the maritime history of the environment barely creeps into the feet of the visitor who bathes in its waters.

[71] Region of Murcia: MEMORY INTEGRATED TERRITORIAL INVESTMENT (ITI) OF MAR MENOR. March 2017 http://www.canalmarmenor.es/documents/575990/603277/Memoria+ITI
[72] https://viajes.nationalgeographic.com.es/a/mejores-lugares-para-bucear_10011/1

This heritage becomes a remarkable opportunity for the use it as a tourist attraction that allows contributing to the education and awareness of the visitor not only in maritime history but, especially, regarding the Underwater Cultural Heritage (UCH).

4. UNDERWATER ARCHAEOLOGY ON ISLA GROSA. THE FOUNDATION FOR AN AWARENESS PROJECT

Isla Grosa, and the surroundings of Manga del Mar Menor and Cabo de Palos, is an extremely rich space, in terms of material evidence of this maritime cultural past. Wrecks, anchorages, ports, are remains of this history that are regularly visited by recreational divers, and in some cases, looted. From our perspective, the looting that takes place in this area is due to a general lack of knowledge about this heritage. It is not known, it is not explained to the visitor and therefore does not value it, does not understand it and does not respect it. It is an expolio because of ignorance, which does not seek an economic benefit, but a souvenir of experience.

Since 1970, some researchers (Cerezo-Andreo et al., 2019, Mas García, 1985, Pinedo Reyes, 1996), have been working on this underwater heritage. This diachronic variety and extensive knowledge allowed us to generate a heritage dissemination project that transcended beyond the specific site and allowed us to cover a more complete and complex view of the Underwater Cultural Heritage. This permitted us to explain to the public that, as far as patrimonial values are concerned, there is no difference between an amphora and a dish of a twentieth century steamboat.

5. CREATING THE UNDERWATER ARCHAEOLOGICAL TRAIL

Isla Grosa Project was launched as a pilot project of valorisation of the Underwater Cultural Heritage of the area, seeking participation and social return through the direct involvement of the diving centres of the Region, the awareness of recreational divers and their education in responsible diving in heritage environments (Cerezo -Andreo et al., 2019).

5.1 Objectives

The project covered three areas that fed back on each other: a research project on Underwater Archaeology, the creation of a field school site within that research framework and the development of an underwater route. In this paper we will focus on those related to the underwater route.

The objectives of the project were clear, to educate recreational divers and diving centres in responsible diving in archaeological sites, to generate a positive experience in relation to heritage that would go beyond the "do not touch, do not see, do not communicate" phase to arrive to a responsible enjoyment and interaction without negatively affecting the heritage, to demonstrate to the diving centres that the protection and enhancement of the heritage adds value to the experience of the diver and compensates in economic terms (rather than passively assisting its degradation or destruction), involve local agents, highlight the value of the rich underwater and maritime heritage of the area as a resource to be considered (responsibly) and, finally, demonstrate the economic sustainability of the initiative, which would be carried out without any public funding or aid of any kind (a rare thing in our country).

5.2 Methodology

To achieve these objectives, a whole network of activities was planned in which the aim was to involve and meet the needs of different types of public, both divers and non-divers. It was a transversal project in which activities were carried out "on land", through talks, heritage routes, children's workshops, conferences and visits to museums and "in water" through the creation of an underwater route in the site of Bajo de la

Campana. In this way we created a circular activity in which it fostered an educational process around the Underwater Cultural Heritage. However, our priority was the recreational divers and the rest of the agents and companies involved, mainly Dive Centres.

5.2.1 Previous study of target audience

In view of the general lack of public studies related to the profile of divers in general and in order to evaluate the training gaps and adapt the educational tools, an analysis was made through a series of face-to-face surveys in the diving centres of the Region with the following results. 200 divers of different ages, gender and origin participated in this survey73.

Most divers (60%) were between 35 and 50 years old, with an almost equitable balance in terms of gender (43% female - 57% male). Most of the participants came from the Spanish Mediterranean. Highlights the high percentage that responded to the survey of foreign divers, around 20%. These data allow us to advance some results that can contribute to a public not only regional, but in general European.

In order to verify if a greater knowledge of diving techniques is accompanied by a better training and greater patrimonial awareness, data regarding the certification and diving habits were also collected. The most widespread certification among divers was the Advance Open Water Diver PADI or two stars FEDAS-CMAS, equivalent to an intermediate level in recreational diving. Next, with 23%74 the one of divemaster or superior; that is, monitors or dive instructors that can now operate at a professional level. Technical diving, which is a type of recreational diving, but with an increasing level of difficulty and specialization, reached 18% among respondents, and 16% of them had the PADI Open Water Diver or was a star of FEDAS, which is considered the initial level in recreational diving. 3% of the surveyed were couples, friends or relatives of the divers and accompanied them to dive, but they stayed on the surface diving in snorkel.

As can be seen in figure 3, although 72% of the divers showed great interest in underwater archaeology and heritage, 55% had received little or no related information and only 12% had a very complete training. Or that was their perception. The survey included a series of control questions related to heritage and the basic rules of responsible diving. According to these questions, 36% of respondents did not know what Underwater Cultural Heritage is, only 11% knew the most basic legislation and 90% did not know how to report a casual finding.

That the divers know how and to whom to report a casual finding is fundamental for the preservation of the heritage. The sea is a dynamic environment with variable conditions, so that the patrimonial remains can be seen or buried depending on the time and circumstances. Given that it is impossible to monitor the entire seabed in real time, if a diver accidentally finds a series of remains, it is essential that this information reaches the proper institutions and archaeologists. They can establish if it is a new discovery, and include it in the archaeological chart, or a known site, in which case the information continues to be important in order to monitor the possible exposure or level of degradation of material.

[73] For full survey please see Perez-Reverte and Cerezo, 2020.

[74] The percentage is so high because we also surveyed the staff of the diving centers in order to assess their knowledge of heritage and responsible diving practices.

Divers are constantly exposed to the possibility of encountering archaeological remains of historical interest. Ignorance of the ethical code of diving75, the lack of specific training and the absence of a positive relationship between divers and heritage, not only prevents their participation in the protection of the same one but may result in harmful actions for the patrimonial remains. ln fact, the survey found that 84% of the surveyed had already dived in a wreck at some time, and 56% had done so in an environment with recognizable archaeological remains.

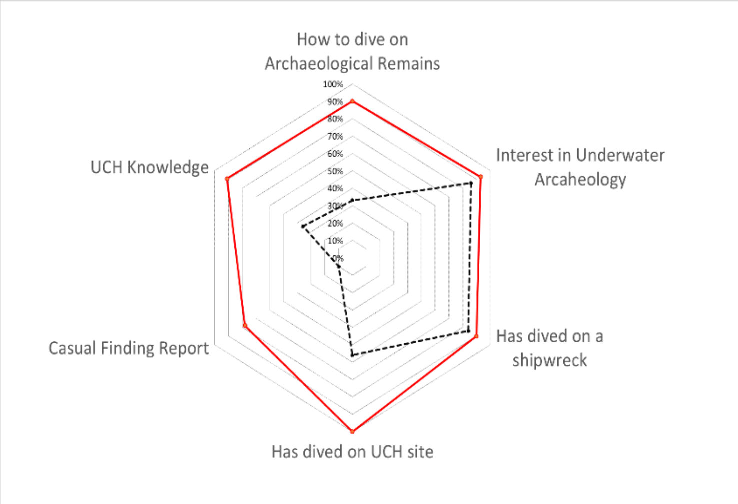

FIG.1: DIVER SKILLS IN DOT BLACK LINE BEFORE THE EXPERIENCE, IN RED AFTER THE

With the data collected, a profile of the average diver was drawn in the area, marked in black in Figure 1:

As can be seen, the polygon of Figure 1 traces an outline of the diver's skills with respect to his knowledge of the UCH and his qualities as a diver. Before the experience (in black), we see how it is clearly decompensated: we speak of a diver with a high level of interest, who dives in wrecks and areas with archaeological remains, but does not have the desirable training in the ethical guidelines of responsible diving in patrimonial environments, or other recommended knowledge about heritage. However, the survey also reflected other positive data: along with the high level of interest, the divers were 99% receptive to receiving more information from their diving centres and 95% believed that this type of activity (immersion and formative) should be done together with an underwater archaeologist. In red, the diver's profile is reflected after having carried out the activity.

After the activity, another survey was made to the visitors with control questions like the first one, in order to see if the educational objectives had been reached, at least in the main fields. As can be seen and as will be discussed later in the conclusions, the red polygon shows a greater balance between interest, practice and knowledge.

5.2.2 Heritage evaluation

The route was located at the botton of the Bajo de la Campana (Isla Grosa) in the Phoenician wreck site excavated by the researchers Juan Pinedo and Mark Polzer between 2007 and 2011, with the collaboration of the Institute of Nautical Archaeology (USA) and the ARQVA Museum (Spain). The selection of this zone obeyed several reasons: visibility conditions (up to 14 meters); temperature (average around about 20 degrees); depth (14-21 meters); relevance of the site (Pinedo Reyes, 2014, Polzer, 2014); and, finally, absence of "expoliable" material: the area had already been excavated and the site had already been published by what was known locally. It was, moreover, a regular diving spot.

In addition, one of the results of this patrimonial evaluation was the identification of all other series of heritage elements with clear maritime connection that existed in the environment and had never been related such as lighthouses, defensive coastal towers, anchorages, modern or contemporary wrecks, in short, the Maritime and cultural landscape of the environment.

[75] Ethical code for divers about submerged archaeological sites (UNESCO): http://www.unesco.org/new/es/culture/themes/underwater-cultural-heritage/partners/diving-community/code-of-ethics/

5.3 Development.

The activity was planned as an extension of the ARQVA Museum76, where the original materials of the excavation of the site are exhibited. After the route, participants would be invited to visit the museum to, beyond the museography, place these materials in an enriched context, thanks to the experience.

The first interventions for the adaptation of the site and the installation of the didactic resources and underwater signalling were developed throughout the month of June 2014. At the same time, a strategy of visits with the diving centres was designed, establishing a maximum of two daily dives, in small groups of 8 divers, always accompanied by an archaeologist guide and an instructor of the visitor diving centre. Before the dive, the divers received a brief talk from the archaeologist-guide explaining what they were going to visit, the importance of underwater archaeology as a research discipline, as well as the basic rules of diving in wrecks and archaeological sites elaborated by UNESCO. In addition, educational brochures were designed to make them available to the centers permanently.

After the formative briefing, the boarding was carried out. During an approximate 40-minute navigation to the surroundings of the Bajo de la Campana, the guide-archaeologist continued his work of heritage by putting the site in context not only in antiquity but until today, explaining to divers, ultimately, the Maritime History of the space in which they were and the culture associated to it.

The guided dive was done following a predefined route, marked with a guide rope. In some points of interest, explanatory panels with complementary information were set. Thus, along the route, the visitor could see where and how some of the objects exhibited in the Museum had been extracted and, at the same time, thanks to the support of interpretive tools, he knew the importance of Underwater Archeology and of heritage preservation. Given the absence of materials and with the didactic objective already mentioned, the excavation that had been developed between 2007 and 2011, was faithfully recreated. In this way, during the tour the recreation of different excavation areas, a prospecting area, the different techniques applied in the archaeological methodology could be observed and, in addition, the visitor was allowed to interact with the tools of this science (Cerezo Andreo et al., 2019). In short, we wanted to offer the visitor an experience of positive and responsible relationship with the underwater cultural heritage and the method and techniques of Archaeology.

The dive lasted approximately 50 minutes. Once finished, in the return navigation, the archaeologist-guide maintained with the visitors a relaxed conversation in which doubts were clarified offering more detail where it was required. Finally, divers were invited to visit the ARQVA Museum and to write an email to the project management indicating what they had thought of the exhibition. 87% of the divers visited the ARQVA Museum in the following days. The feedback from these emails was very positive; the materials were placed in a unitary context (the site) despite being in different showcases. For the visitors, they ceased to be "generic" archaeological objects to become "specific" archaeological objects: they knew them (and therefore they recognized them), they knew their origin, their peculiarities, their individual and collective history. They had appropriated their cultural and patrimonial value.

[76] With the aim of expanding the social return of this initiative, during the summer of 2014 complementary activities were developed for non-divers such as children's workshops, guided tours on land and informative talks in different hotels and cultural centres.

6. RESULTS

The mass tourism model of sun and beach has proven to be insufficient in the Region. One of the key objectives in recent years in this regard has been to break with seasonality. The Region of Murcia has diversified its offer significantly in recent years. In this process, both the heritage and the sea have been two of its strategic points. However, not homogeneously and even less jointly. Although at present if a "wreck tourism" is active, it cannot be considered a type of cultural tourism since it does not imply a cultural value, and the information that the divers receive, their interaction with the wrecks and the process of interpretation are at the discretion of the diving centers.

Although the first experiences in Spain related to visits to underwater sites were not as positive as would have been desired (Nieto, 2007), the lack of incidents and the exemplary behaviour of divers and diving centers during the development of this activity, shown that their general awareness has improved greatly in recent years.

The results of environmental education among divers, the experiences we have cited at the beginning of this work and the results of this route confirm that working with divers and their education has a direct impact on their behaviour. The responses to the surveys of the participants in this activity and their feedback pointed not only to a better knowledge of the heritage and the mechanisms to relate to it in a responsible way, but also to a better understanding and a greater connection. Although the situation in the Region of Murcia has greatly improved in recent years in terms of education of divers, the plundering of souvenirs continues to be a problem and has devastated numerous wrecks and sites in the area. In our opinion, if the legislation and the actions of the authorities are the best solution against commercial plundering, education is the only possible when we speak of a collective as nourished as that of recreational divers, in an area with a heritage so vast that it is impossible to.

The project was proposed with the intention of involving different sectors and local agents, and had the participation of different companies, associations, universities, town halls and other entities, demonstrating that there is a genuine interest in facilitating and promoting these lines of work in the local community and in the Region itself. An interest that should go beyond the tourist field: the fragility of the heritage and its conservation advise that these practices are carried out from Underwater Archaeology, with the participation of other professionals, and always under the supervision of the public administration, whose active participation, in addition, it is essential for the management and sustainability of this type of initiative.

The Isla Grosa Project was conceived with the dual purpose of educating and raising awareness among divers, and the local community in general, and collaborating with the diving centers in the generation of a complete experience for the diver that allowed them to enjoy the heritage in a responsible manner. Despite not having visible archaeological remains, the experience was valued in an extremely positive way by the visitors. This demonstrates the importance of an adequate process of interpretation and proper planning.

On the other hand, the dissemination, visibility and economic viability of heritage are also mechanisms of protection and survival. In order to value the maritime culture of the Region and to protect, preserve and disseminate the heritage associated with it (of which wrecks or underwater cultural heritage are only a small part), collaboration between different specialists related to heritage and tourism is necessary. The collaboration with private and local agents was fundamental for the viability of this project, which did not receive any type of public aid or subsidy and demonstrated its potential long-term economic sustainability. As well as the consideration of the site not in isolation but as part of a social and cultural landscape with different heritage resources associated/associable.

As we have seen, the area of La Manga-Mar Menor has a great patrimonial potential with remains and sites from different eras both in the terrestrial and underwater environments. The enhancement of this heritage and maritime culture that gives context, could serve not only to diversify the tourist offer but also to improve the protection and survival of these fragments of history.

Finally, we believe that the lack of public studies with respect to divers is a major obstacle for this type of initiatives since it is difficult to plan or establish control tools that allow us to evaluate the results. In our case, we opted to carry out this research locally, but there is no doubt that it would have been very useful to have these studies beforehand.

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Western Black Sea underwater cultural tourist routes

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***Abstract*:** The "Western Black Sea Underwater Cultural Tourist Routes" project aims to promoting scuba diving adventure tourism and developing the tourist potential of the Western Black Sea region (Bulgaria and Romania), by means of identifying and promoting the common underwater archaeological and natural heritage located on the Western coast of the Black Sea. The overall objective is to encourage the diversification of the supply of sustainable European cultural tourism products and services, by developing a transnational tourism product based on the underwater cultural heritage of the Black Sea; to improve, preserve and promote the underwater cultural heritage of the Western Black Sea; to promote transnational cooperation among various stakeholders in the field of underwater cultural heritage. The new tourist product includes the following tourist routes, which can be combined according to the travel deal of tour operators and the tourists' requirements: 1. The route including wrecks and artificial reefs; 2. The "old submerged roads" route (underwater archaeological sites and artifacts); 3. The natural underwater heritage route; 4. The route of artifacts exposed in museums.

Keywords: Bulgaria, Romania, cultural and natural heritage

1. MAIN OBJECTIVES

Submarine archaeology represents, after submarine biology, geography and geology, the fourth new scientific branch determined by the research of the submarine environment. The uniqueness of maritime cultural landscape is due to the interaction between different, but close to each other spaces – land and sea. The maritime cultural landscape is a result of interaction between human processes on the coastal surface over time and the environment, which includes sea, coastal line and land. Part of the maritime cultural landscape is the coastal historical remains and these underwater along with their surroundings. It includes archaeological sites, historical settlements, fortresses, harbours, lighthouses as well as all of the geographical, archaeological and ethnological implications (Vladimirova 2016).

The whole tourist product is in direct relationship with the Blue Economy and the Blue Growth, which target providing of more relevant information of stakeholders with aim to improve the quality and diversification of offered tourist services.

Along the Western Black Sea the underwater archaeological investigations has more than 60-years history beginning in Bulgaria in 1959, and in Romania in 1966. Among the main tasks of underwater archaeology is the study submerged prehistoric settlements, parts of neighbourhoods and harbour installations of Antique cities, as well as the most attractive part of maritime archaeology, namely searching of ancient shipwrecks (Peev 2019).

The main goal of the paper is to increase consideration of cultural heritage in maritime landscapes and to outline how maritime landscapes could be implemented in cultural tourism in order to guarantee a sustainable development of a seaside region.

2. DESCRIPTION OF THE ROUTES

2.1. Route of wrecks and artificial reefs

As a result of the prospecting campaigns, so far there have been formed eight underwater routes to the wrecks on the Romanian and the Bulgarian seaside. The route of shipwrecks and artificial reefs consists of five routes in Romania and three routes in Bulgaria. The sites that are included for visit by divers are situated at accessible depths and do not represent sites that are protected by the UNESCO Convention on the protection of the underwater cultural heritage (UNESCO Convention 2001). This is done solely for the purpose of protecting cultural monuments from harmful tourists. The wrecks are iron ships, the visit of which does not pose a threat to the health and life of the divers:

1. Route 1: Port Tomis – SC213 – Arkadia – Port Tomis – 26.7 nm (nautical miles)(Romania)
2. Route 2: Port Tomis – Sadu, You Xiu – Paris – Port Tomis – 7.2 nm (Romania)
3. Route 3: Port Tomis – Moskva – Sophie – Port Tomis – 28.7 nm (Romania)
4. Route 4: Port Tomis – Medy – Tuzla Wreck – Port Tomis – 28.5 nm (Romania)
5. Route 5: Port Tomis – Maria Bacolitsa – M Class – Port Tomis – 37.6 nm (Romania)
6. Route 6: Tyulenovo – wreck Stefan Karadza – 0.550 nm (Bulgaria)
7. Route 7: Sozopol – Mopang – Pioner – 8 nm (Bulgaria)
8. Route 8: Sozopol – Rodina – Pioner – 12.5 nm (Bulgaria)

2.2. The “old submerged roads” route (underwater archaeological sites and artifacts)

In Antiquity, especially after the Hellenic colonization, the harbour system along the West Black Sea coast expanded. The permanent settlement of Ancient Greek communities along the Black Sea coast is referred to the 7th century BC. Some city-states established their colonies (άποικία), but no one was able to surpass Miletus (*Plin.E.* NH IV, 29, 112). Miletus was the most prosperous city on the Ionian coast and the main trading center in Aegea. Its colonies in the Euxinian Pont were among the largest and most significant cities: Sinope, Panticapaeum, Olbia, Histria, Tomis, Odessos, Apollonia. Another metropolis which founded many colonies is Megara (Peev 2018).

The route of “old submerged roads” include eight sites, as two of them are in Romania and six in Bulgaria. The sites are ancient trade centers that were one of the most significant in the ancient history of the Western Black Sea coast.

The Western Black Sea offered a favourable environment for human settlements and trade relations between the native Thracian population and the ancient traders at sea. The underwater archaeological information about submerged prehistoric settlements and submerged parts of ancient cities of the Western Black Sea have been included in the Old submerged roads. The sites are listed below:

1. Tomis (modern Constanta, Romania)

Together with Histria, Tomis appears in the process of colonizing the Greeks from the Left Pontus, from the 7th to the 6th centuries BC. The city of Tomis enjoyed a privileged status, being in the 1st and 2nd centuries AD. the centre of the West Greek Pontic Association (*Pentapolis* later became *Hexapolis*). During the period of the Antoninians and the Severians reached the peak of its prosperity (2nd - 3rd century AD): many public buildings and the new wall of the fortress were erected.

2. Callatis (modern Mangalia, Romania)

Callatis was a Dorian colony, founded by Pontic Heraclea which, in turn, founded by Megara. Archaeological excavations have shown an early habitation level, dating not earlier than the 4th century BC.

3. Bizone (modern Kavarna, Bulgaria)

Bizone (modern Kavarna) was founded by Dorian settlers in the 4th century BC. At the end of the 4th century BC, settlers from Messambria moved to Bizone, where they formed one of the last colonies on the Black Sea's western coast. The city developed rapidly and, if we were to judge by the number of anchors found on the seabed, it became one of the most important coastal commercial centers of its time.

4. Dionisopolis (modern Balchik, Bulgaria)

The name Dionysopolis occurs in a number of short messages: Pseudo-Scymnos, the Anonymous Periplus of the Pontus Euxinus, Plinius the Elder, Strabo. According to ancient literary sources on the topography of the polis, the modern town of Balchik coincides with the ancient Dionysopolis. Archaeological excavations date the most ancient evidence to no earlier than the 4th century BC. In the spring of 2006 a team of archaeologists discovered a temple dedicated to the Hellenistic goddess Cybele.

5. Odessos (modern Varna, Bulgaria)

According to the ancient authors, Odessos was established during the second half of the 6th century BC. The earliest pottery are dated to the middle of the 6th century BC. Archaic artifacts dated to the same period were also found. In the Gulf of Varna, four ancient ports are known (Kastritsi, Odessos, Karantinata and Galata), and two of them have harbour structures – Karantinata and Galata. Details about the exact location of the ancient port of Odessos are unavailable. It could be assumed though that at the commencement of the construction of Varna port in the late 19th century it occupied the same spot as the one of Odessos established back in the 6th century BC.

6. Cape Sveti Atanas (modern Byala, Bulgaria)

Archaeological investigations in 2009-2013 at a Late Antique fortified town located on Cape Sveti Atanas yielded several sacral complexes, dated between 6th century BC – early 7th century AD. The most interesting discoveries belong to the Early Christian period.

7. Mesambria (modern Nessebar, Bulgaria)

The ancient Messambria was established at the end of the 5th century BC by Dorrians settlers. It was originally a Thracian settlement. During the Middle Ages within the city walls were erected and operated about 40 churches and monasteries, some of which since Early Byzantine period (5th – 6th century AD). The modern Nessebar is World Cultural Heritage Site of UNESCO since 1983.

8. Apollonia Pontica (Sozopol, Bulgaria)

The ancient city state of Sozopol was established at the end of the 7th century BC by colonists from Miletus. Archaeological surveys in Sozopol started in the late 19th century. According to the artifacts of human activity, life in the area started during the Late Eneolithic and Early Bronze Age. Nowadays, the fortifications from the Late Antique and the Medieval Period are well preserved and date from the 6th to the 14h century. Many structures from different historical periods have been excavated and restored.

2.3. The natural underwater heritage route

The route of underwater natural heritage makes direct link between cultural heritage and marine protected areas (MPAs) in Bulgaria and Romania. All of selected tourist sites that are included in the proposed routes are located next to the shore and the transport access is facilitated to the maximum extent.

The route includes the MPAs from the southern part of the Romanian littoral and MPAs from the Bulgarian coast, aiming to show their high ecotouristic potential. Being hotspots of biodiversity and representatives for the spectacular underwater landscapes, which shelter European and national important habitats and species, the conservation and protection goals accomplishment are of primary importance. The route contains six Romanian underwater protected areas and eight Bulgarian underwater protected areas, as follows:

1. The submerged beach Eforie Nord – Eforie Sud (44.0480 latitude N; 28.6447 longitude E)(Romania)

2. Tuzla Cape marine area (43.9927 latitude N; 28.6661 longitude E)(Romania)
3. Costineshti – 23 August (43.9313 latitude N; 28.6348 longitude E)(Romania)
4. Cape Aurora (43.9313 latitude N; 28.6348 longitude E)(Romania)
5. The underwater sulphide seeps from Mangalia (43.8177 latitude N; 28.5887 longitude E)(Romania)
6. Vama Veche – 2 Mai marine reserve (43.7653 latitude N; 28.5782 longitude E)(Romania)
7. Rocky formation north from Tyulenovo (43.502570 latitude N; 28.590755 longitude E)(Bulgaria)(fig1)
8. Small island north from Rusalka (43. 418757 latitude N; 28.522496 longitude E)(Bulgaria)
9. Caves in Complex Kaliakra cliffs (43.400289 latitude N; 28.490682 longitude E)(Bulgaria)
10. South coast of Pomorie (42.559036 latitude N; 27.634970 longitude E)(Bulgaria)
11. Underwater stone forest (between Sozopol and Sveti Ivan island) (42.428062 latitude N; 27.695445 longitude E)(Bulgaria)
12. Cape Maslen nos (42.3076 latitude N; 27.7896 longitude E)(Bulgaria)
13. Varvara underwater canyon (42.1241 latitude N; 27.9130 longitude E)(Bulgaria)
14. Ahtopol (42.102561 latitude N; 27.947309 longitude E)(Bulgaria)

2.4. The route of artifacts exposed in museums

This route focuses at the tourists who do not have a diving training but are keen to get acquainted with the achievements and the artefacts of underwater archaeology in both countries. It includes nine museums as four of them are in Romania and five in Bulgaria. These are museums where are exhibited a various of artefacts which have been found during the underwater archaeological explorations in last sixty years.

1. Museum of History and Archaeology - ICEM Tulcea (Tulcea, Romania)

Set up in 1950, the Tulcea Museum of History and Archaeology was opened in its current building – located in the Independence Monument Park on the site of ancient city of Aegyssus – in 1975.

2. National History and Archaeology Museum of Constanta (Constanta, Romania)

The National History and Archaeology Museum of Constanta is currently hosting an impressive cultural heritage. The Museum is located in very impressive building on the Ovidiu square.

3. Romanian Navy Museum (Constanta, Romania)

The Romanian Navy Museum, located in the imposing building of the former Naval School, was set up in 1969.

4. Museum of Archaeology Callatis (Mangalia, Romania)

The Museum of Mangalia is located in its current building since 1987 which was erected over the papyrus tomb.

5. Kavarna History Museum (Kavarna, Bulgaria)

The Kavarna Museum owns rich collections of prehistoric, antique and medieval artifacts unique for this part of Europe. The Museum hosts the exposition "Dobrudzha and the sea".

6. Varna Museum of Archaeology (Varna, Bulgaria)

The Varna Museum of Archaeology is the largest one outside the capital city in Bulgaria and its covers all historical periods. Among the most interesting finds are the oldest proceedings gold in the world, discovered in Varna in the Eneolithic necropolis (4600 – 4200 BC).

7. Naval Museum (Varna, Bulgaria)

The Naval Museum presents and promotes the maritime and naval history of Bulgaria. With the Museum is connected the first underwater archaeological survey in Bulgaria. For 125 years of existence are collected tens of thousands of exhibits.

8. Archaeological Museum of Nessebar (Nessebar, Bulgaria)

The Archaeological Museum of Nessebar is located immediately behind the city gate of ancient Messambria. Artifacts starting from Eneolithic Age (4400-4200 BC) up to the Late Middle Ages (17^{th} – 18^{th} c. AD) provided glimpse on the city rich historical past.

9. Regional Historical Museum Burgas (Burgas, Bulgaria)

The Regional Historical Museum of Burgas is located in beautiful buildings – cultural monuments in the city centre. The exposition presents collections of archaeological findings related to ancient Thrace, the Greek colonies along the Black Sea coast and the time of the Roman Empire.

FIG. 1: UNDERWATER CAVE IN THE AREA OF TYULENOVO, BULGARIA..

3. RESULTS

On a transnational level between Romania and Bulgaria, tourism is the economic branch that displays a valuable growth potential not sufficiently tapped yet and that can become a source of attracting both investors and tourists. The adventure tourism market has experienced a positive evolution and continues to grow. The demand for adventure tourism (Scuba Diving) that would allow tourists to gain an insight into the transnational underwater cultural heritage is increasing and may further contribute to the prosperity of both the Romanian and the Bulgarian communities located on the Western Black Sea seacoast.

The Romanian-Bulgarian partnership is supported by historical and regional factors, and the two countries' inclusion in the same political and geographical area. During the implementation of the project, the new "Western Black Sea Underwater Cultural Tourist Routes" product includes four tourist routes, which can be combined according to the travel deal of tour operators and the tourist requirements. The sites have been selected and classified as the most attractive transnational objectives (wrecks, archaeological sites, artefacts, protected marine areas, underwater landscapes, and artefacts exhibited in the coastal museums). These routes can be combined depending on the wishes of tourists and/or tour operators.

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New institutions for diving tourism: Diving Parks, Archaeological Diving Parks, Modern Shipwrecks

Implementation opportunities and problems in Greece

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Abstract: This study is an interdisciplinary examination of Underwater Visitor-Accessible Archaeological Sites (UVAASs) and other organized diving sites including Diving Parks (DPs) and modern wrecks, with a short overview of their current status, focusing on the significant contributions of diving tourism to sustainable development and sustainable protection of the natural and cultural environment; a statistical evaluation of the results of the Greek law 3409/2005 on the diving tourism in Greece; and discussing exceptional established UVAASs as well as DPs, as new tools and their benefits. We look at the problems facing these and propose immediate, specific and achievable solutions, particularly on the requirement that DPs must be located further than 3 nautical miles from UVAASs, a provision without merit and destructive for both institutions; the fact that tourists must be accompanied by civil servants, which has rendered UVAASs non-functional and meaningless. We propose fundamental institutional solutions to help deregulate and improve diving tourism in all countries. These include making use of existing, expert and monitored human resources in the sector (Greece maintains a Register of Providers of scuba diving services in accordance to law 3409/2005 and we propose that this become a Chamber and that these providers work at DVs and UVAASs); instituting accompanied diving as a protection measure (empowering providers of diving services to accompany visitors to organized diving areas, notifying the Authorities digitally, so there is ongoing monitoring of the providers and the activity); creating a national and international network of organized diving areas (to provide opportunities for exchange of information, expertise and best practices; to contribute to sustainable regional development; to support the economy; and to protect, preserve and promote underwater antiquities, the environment, biodiversity and modern wrecks).

***Keywords*:** Diving Tourism, Diving Parks, Underwater Antiquities, Modern Wrecks, Diving Park Network

1. OVERVIEW OF EXISTING SITUATION

1.1. The significance of diving tourism for sustainable development and for the protection of the natural and cultural environment.

Tourism constitutes a definitive factor for economic development. As a tourism sector it makes a direct contribution to a country's revenue growth and indirectly to the economy through the multiplier effects it generates.

The fact that tourism contributed 10.4% of the global GDP and 10% of overall employment in 2018 is indicative how important it is to the global economy; whilst in Greece, where tourism is a major industry, in

2018 the values of the same markers are more than doubled, given that it provides 20.6% of Greek GDP and 25.9% of overall employment in the country (*WTTC, 2019*).

Diving tourism in particular, has grown rapidly over the past years throughout the world due to the great popularity of recreational diving, and is a sector that provides a high level economic, cultural, social, ecological tourism as well as being a high performance field for professionals in the diving sector, which has a beneficial impact on local and national economies, where it takes place.

For example, hospitality and the growth of diving tourism contribute to:

(a) Developing the economy for certain destination areas as well as the country in general.

Diving tourism contributes 70% of local GDP in the general area of the town of l' Estartit on the Mediterranean coast of Spain, solely due to the presence there at a distance of 1 nautical mile of the small (smaller than 1 sq.km.) marine park of the Medes islands (the name is was derived from Medes given by the ancient Phocean colonists), which was also responsible for the creation of 200 job positions through 16 new enterprises (*European Commission, 2012,* and *Sala et al., 2013*).

(b) Differentiating and enriching the tourism product offered.

During the eighties Egypt, Greece's neighbor to the south, started to expand its tourism offering beyond culture tourism (pyramids, antiquities) to mass ecotourism, with the point being taken by diving off the coral reefs of the Red Sea.

Indicative of the rapid rate of tourism growth that followed, is the fact that, whereas at the start of the eighties there was no diving tourism along the Red Sea coast, in 2000 11% of the tourists visiting Egypt (566,000 of a total of 5.1 million visitors) were divers, who participated in that year in 4.2 million dives (*Cesar, 2003*).

(c) Upgrading the quality of the tourism offering.

International statistics and numerous studies throughout the world regarding the profile of amateur divers indicate that the majority of these are highly educated higher social class individuals, of middle to high income, with a particularly acute environmental consciousness.

(d) Extending the tourist season.

Diving in the Medes Islands Marine Reserve in Spain created an expanded tourist season extended from 3 to 8 months per year (April to November). For the months of April-May and October-November, when sun and beach tourism is at low levels, diving tourists constitute 90% of all visitors (*Mundet & Ribera, 2001,* and *European Commission, 2012*).

Greece is an ideal place to attract and develop diving tourism, potentially the most ideal diving destination throughout the Mediterranean and Europe.

As a land of immeasurable natural beauty, with by far the longest and most diverse coastline and the most islands of all the Mediterranean countries, with an ideal geographical location in the oligotrophic Eastern Mediterranean, with a secure and civilized regime, with warm and clear waters that can be dived year-round, with spectacular sea beds without any dangerous sea life and without extreme weather phenomena, with modern diving legislation and which can take advantage of the favourable international conditions (lack of wars or terrorist attacks and extreme natural disasters, which exist in competitor markets), Greece can and should expand into the diving market and become the "**Caribbean of Europe"**.

However, the Greek seas, despite being ideal for diving, lack sufficient marine life, a problem shared by all Mediterranean countries, which means they lack interest for divers.

Over-fishing, illegal fishing, pollution and overexploitation of the coastal zones of the Mediterranean by human activities over the past decades have brought about a dangerous decrease in biodiversity, threatening many marine ecosystems with destruction (*Boero, 2007,* and *European Environment Agency, 2010*). In fact, according to FAO, the impact of human activities on the Mediterranean, which is a semi-enclosed sea with low productivity, are the worst worldwide.

1.2. Promoting the institutions of Diving Parks (DPs) and Underwater Visitor-Accessible Archaeological Sites (UVAASs) as tools to develop diving tourism.

In order to rejuvenate and provide constant ongoing protection of the marine environment, as well as create a competitive diving market in Greece, Greek scientists have proposed the **establishment of diving parks** as these are formally provided for in Greek legislation for recreational diving (article 13 of Law 3409/2005, as replaced by article 10 of law 4296/2014).

For additional information on diving parks, their concept, significance, benefits, issues and capabilities, see *Markatos & Koutsis (2008),* as well as *Koutsis, Christofilogiannis & Markatos (2011)*, both available in Greek and English at www.tridentstar.gr.

The basic difference between diving parks and more traditional National Marine Parks or Marine Protected Areas lies in that the DPs are comparatively far smaller in size; their focus is not scientific results but economic growth; they are far simpler to license, manage and monitor; they operate independently and sustainably, governed as they are by the rules of the private sector (even though they belong to public agencies), in other words they focus on revenue rather than only on expenditure; and can entertain participation and funding from private individuals, particularly local entrepreneurs.

Beyond diving parks, Greek legislation (article 11 of L. 34409/2005) also makes provision for the establishment of "underwater museums", i.e. diving parks within established underwater archaeological sites, which, it being established that their initial moniker was erroneous, have now been re-envisioned and re-named by article 44, par. 1 of L. 4179/2013 as Underwater Visitor-Accessible Archaeological Sites (UVAASs).

We shall show that this name is also unnecessarily complex and not user-friendly, as these spaces simply constitute "archaeological diving parks", as they should be named in order to indicate the uniformity of the institution.

The provisions in the law for archaeological diving parks serve as an equally important tool, which attempts to utilize and highlight the exceptional and unique comparative advantage that Greece offers, which is its countless underwater antiquities, which are, however, unknown and mostly unguarded, at least those which are at a relatively shallow depth, in order that they can be visited by amateur recreational divers.

International examples, such as the instances of the Pozzuoli and Baiae areas in the bay of Naples, in the neighbouring country of Italy, where entire settlements from the Roman period have sunk into the sea due to volcanic activity and which since 2001 can be visited by divers, have proven, on the one hand, that accompanied recreational diving is absolutely compatible with preserving the safety of the submarine antiquities, in fact it can be expressly concluded, that underwater antiquities are protected more effectively and over a greater expanse following the commencement of tourist diving than before, and, on the other hand, the great developmental benefits of archaeological diving tourism to local economies of the areas in question (*Stefanile, 2014,* and *UNESCO, 2013*).

1.3. Brief statistical evaluation of the results of L.3409/2005 on diving tourism.

Law 3409/2005 went into effect in February 2006, opening room for the diving industry of Greece to develop, while the provisions of the law received only praise both from amateur divers and from both diving and tourism professionals.

The Greek diving sector immediately started to flourish, following the deregulation of recreational diving. Data from the Greek diving market indicates that within two years of the law going into effect the number of certified diving centres throughout the country doubled (from approx. 70 operating in 2005 to approx. 140 at the start of 2008), with a simultaneous rise in the number of amateur diver certificates issued.

Since that time there has been a steady increase in the number of certified dive centres and those employed in the sector, which corresponds to a very significant rise in the number of amateur dives, which are carried out annually a growth ranging on 10% to 40% year on year. In May 2019, there are 271 licensed diving centres operating in Greece (Siatra, 2019).

It is also worth noting that the Archaeology Service does not report any increase in the incidences of theft of underwater antiquities.

2. PROBLEMS NOTED

2.1. Concerning diving parks: The matter of prohibiting DV within 3 nautical miles of Underwater Visitor Accessible Archaeological Sites.

To date the institution of simple (non archaeological) diving parks has remained inactive for the following reasons:

To begin with, in 2005, when L. 3409/2005 was instituted, and up to 2014, the Government did not issue the Joint Ministerial Decisions required by article 13 of said law, in order to designate the prerequisites for establishing and operating diving parks. This is how the first decade was lost.

Fortunately, article 13 of 3409/2005 was replaced by article 10 of L. 4296/2014, which, voided the need to issue a Joint Ministerial Decision, and set out clearly in the law what the prerequisites for establishing and operating a diving park were. Unfortunately, this same amendment also included a new, unexpected impediment added by an unknown source, and pursuant to par. 4, subpara. 2, required that:

> "*Diving parks are prohibited from being sited at a distance less than three (3) nautical miles from established underwater archaeological sites*".

This is obviously an error, included in the legislation by omission, as a remnant of an older mentality, as this particular regulation harms without making any contribution whatsoever (Markatos, 2014).

This particular limitation is <u>disastrous</u> for the institution of diving parks because:

(a) An archaeological site of a single point, such as an isolated ancient wreck, carries with it a marine exclusion zone with a diameter of 6 nautical miles, within which it is prohibited to create a diving part. Even greater damage is caused by larger underwater archaeological sites, which are far more extensive, such as those of the Northern Sporades islands. This prevents diving in the greater part of Greek marine areas, as there are only a very limited number of positions appropriate for DV, which meet all the criteria and can always be dived due to weather.

This provision rules out areas that would otherwise provide exceptional diving, including Elafonissos in Lakonia, due to the underwater archaeological site of Pavlopetri; Makronissos in Attiki, after the pointless establishment of such UVAASs; Falassarna in Crete; as well as Alonnisos, which cancels out entirely any diving potential even at the very few marine areas that are free of archaeological remains and also puts out of action the important and award-winning innovative developmental and environmental programme of a network of diving parks for Ano Magniton Nisoi, which the Region of Thessaly was already attempting to implement there.

In general, this ruled out any potential development of diving tourism on all small islands that happen to have or may later gain an underwater archaeological site, whereas those are the places that would stand to gain the most from a diving park, in order to have sustainable growth with minimal investments. Even worse, if an ancient wreck were to be discovered less than 3 n.m. from a DP after that was already established and operational, the DP could lose its license because it would, after-the-fact, lack the legal prerequisites to exist. This would lead to a loss of all the relevant investments undertaken and a loss of reputation and clientele, which a diving park would have brought to the general area. It is doubtful that with such a prospect any serious investors could be found (whether public or private) or benefactors to push forward such projects (*Markatos, 2014*).

(b) This limitation is <u>useless</u> as regards its goal of protecting underwater antiquities, as, pursuant to article 13 par. 9c, as currently in effect on the basis of article 10 of law 4296/2014, in order to establish a diving park there needs to be a previous consenting opinion from the Ministry of Culture.

(c) Moreover, the limitation is <u>harmful</u> as regards protecting underwater antiquities.

As on the basis of L. 3409/2005 article 11 recreational diving is permitted throughout all the marine territory of the country, with the exception of areas proclaimed as underwater archaeological sites, anyone can dive legally up to the borders of any proclaimed underwater archaeological sites, which are operated under the general supervision of the Hellenic Coast Guard and then enter the site underwater.

Conversely, diving parks do not allow private diving; only diving accompanied by known, authorized and recorded providers of diving services, in accordance with the provisions of Law 3409/2005.

Additionally they, as well as the marine space of the diving park are not only policed under the general oversight of the Hellenic Coast Guard (L. 3409/2005 art 13 par. 17), but are also under mandatory 24-hour monitoring by guards of the operating agency on penalty of having their DP license revoked. These guards are entitled by law to provide immediate protection themselves, in accordance to articles 985 and 997 of the Greek Civil Code (L. 3409/2005 articles 13 par. 15 and 19), so as to ensure that no illegal fishing takes place, which is first and foremost of interest for the continued existence and sustainability of the diving park.

So it is practically impossible and certainly exceptionally difficult for a solitary or unaccompanied diver / visitor to enter and dive in a diving park without being observed, or for any visitor to exit the boundaries of the park.

Consequently, underwater archaeological sites not only do not need to be distant from diving parks, on the contrary <u>the best possible policing would be achieved it they were located within diving parks and surrounded by them</u> (*Markatos, 2014*).

(d) The 3 n.m. prohibition greatly and without reason increases the distances involved in diving excursions and those between DP and UVAASs, that are established in proclaimed underwater archaeological spaces.

This makes combined diving excursions exceedingly time consuming and cost-ineffective, but also hard to arrange and less pleasant for diving tourists and ess profitable for providers of diving and related services. Consequently they have a negative effect on the sustainability of the corresponding businesses and thus on that of the DPs and UVAASs.

Simply put, the 3 nautical mile prohibition loses Greece the exceptional and unique comparative advantage at its disposal, to match up packages of multiple environmental or of environmental and archaeological tourism dives, providing visitors with an exceptional, complex and variable diving tourism product, which would render the country a diving tourism destination, by converting purposelessly diving and underwater antiquities from first rate allies into mutually exclusive and mutually destructive competitors (*Markatos, 2014*).

2.2. Regarding Underwater Visitor-Accessible Archaeological Sites: The issue that tourists diving at UVAASs must be accompanied by diving guards who are antiquities guards or archaeologists.

The exception to the prohibition of diving amongst antiquities, set out in L. 3409/2005 article 11 par. 1 subpar. 2 and permits proclaimed underwater archaeological sites to be characterized as "underwater museums", an institution that has never been put into practice, so has not to date had any of the expected results, despite the great initiatives that have taken place in the meantime.

In 2009 the Municipality of Pylos – Nestoras established two Underwater Visitor-Accessible Archaeological Sites in Pylos (Navarino) and on Sapientza in Messinia.

The Region of Thessaly established four more, in the Northern Sporades Islands and in the Pagassetic Gulf, as part of the award-winning innovative programme "Ano Magniton Nisoi". None of those parks has operated to date.

In 2016, the administration of the Greek Ministry of Culture and Sport and the Region of Attica triumphantly proclaimed a further six (6) UVAASs in the region of Lavrio and the Southern Gulf of Evia, knowing that none of these could function due to the institutional grounds and obstacles, that we will immediately set out.

The first reason for non operation of the UVAASs was the initial use of the term "underwater museums", which caused conflicting reactions and confusion, as it strongly evoked, certainly in the mind of the public, references to the legislation on terrestrial museums, an institution that is entirely different and not comparable to non-museum archaeological sites, like underwater visitor-accessible archaeological sites.

This issue was resolved by L. 4179/2013 article 44 par. 1, wherein, in order to avoid confusion with legislation concerning terrestrial museums, underwater museums are renamed Underwater Visitor Accessible Archaeological Sites (UVAASs) and legislated the capacity for further concession of the organization, administration and exploitation of UVAASs to agencies (either legal entities under state law or private law), under article 100, par. 5, of L. 3852/3010 "Kallikratis", on the basis of which the Joint Ministerial Decisions were issued for the first two UVAASs in Messinia.

However, the main institutional issue and roadblock to the creation of UVAASs consists of the fact that, pursuant to of L. 3409/2005 article 11 par. 1 subpara. 2, visitors to underwater visitor-accessible archaeological sites must be accompanied at all times "*divers who are antiquities guards or archaeologists*".

This is an entirely incomprehensible and, more significantly, unfeasible provision, which has rendered all those UVAASs that have already established dead in the water and their proclamation empty of all meaning.

This because the requirement that all tourists diving at UVAASs be accompanied by diving antiquities guards or archaeologists is interpreted zealously by the current Administration of the Ministry of Culture, that they needs must be employees of the Archaeological Service, i.e. public servants.

This interpretation, irrespective of the current economic downturn the country is facing, renders hiring the required number of diving guards or archaeologists practically impossible and renders the provision impossible to implement, while even were an UWAAS to be established, it would be unsustainable financially.

Additionally, this particular requirement can be avoided, as the very few diving employees of the Ministry of Culture and Sport are required to be available for more general more general inspection, guarding and policing of underwater archaeological sites, including those that are visitor-accessible, and <u>cannot be allowed to waste their time accompanying tourists</u>, just as they do not accompany them at archaeological sites on land.

While land visitor-accessible archaeological sites generally allow unaccompanied private visits, and, additionally, any professional tour guides or tour companions are not monitored by the Archaeological Service or by other competent Services of the Ministry of Culture and Sport, with this incomprehensible provision, they require people to be accompanied either by antiquities guards or archaeologists in order to dive at UVAASs. As long as this requirement holds sway, any new proclamation of UVAAS is pointless.

2.3. Regarding tourist dives at modern wrecks.

Besides underwater antiquities, Greece is also full of modern wrecks that sank from the start of the twentieth century forward and particularly a lot from WWII. The sea battle of Leros, one of the greatest between the Allies and the Axis has made the great bay of the island one immense potentially historic diving park, one of the best in the world. In the USA they purposefully sink old war ships in order to create similar sites.

Modern wrecks constitute amazing diving sites without even requiring the establishment of a diving park, as the interest of the sunken ships themselves (as is the case with underwater antiquities) renders them immediately interesting, without requiring any waiting time to re-establish and develop marine life, and also without requiring constant guarding in order to avoid illegal fishing.

Unfortunately the Ministry of Culture issued a Ministerial Decision in 2003 (Υ/ΑΓΔΑΠΚ/ΑΡΧ/Α1/Φ43/48604/3385/2003, GG B΄ 1701/19-11-2003) and in its usual prohibitory manner, pronounced all the country's wrecks that were older than fifty years old to be monuments, prohibiting thence forward any recreational diving whatsoever.

<u>The aforementioned prohibition is one of dubious legality</u>, as the Council of State (3094/1993 and 1742/2002) and the Legal Council of State (568/1994) have both ruled that the Minister of Culture does not have the legislative authority to impose generalized prohibitions throughout the territories of Greece, but rather only for the protection of specific individual locations which are of archaeological interest.

Additionally the foregoing prohibition is similarly inapplicable and ineffective, as these are not proclaimed archaeological sites, they are not designated by law to particular coordinates and cannot be proved to be known to citizens. Therefore no punishment can be levied on anyone choosing to dive despite the prohibition, as it cannot be proven that they knew that a wreck existed at that spot and that it was, in fact, older than fifty years old. Every year wrecks increase in age and citizens can't be expected to keep up with the age of each wreck.

The above prohibition on diving modern wrecks does, however, have a comic aspect, as it has allowed the looting of modern wrecks for 50 years and then considers that they should be protected after nothing is left but the bare bones.

As they are forbidden to dive modern wrecks, amateur scuba divers, as well as professionals in the recreational diving sector lose interest, as they cannot expect to profit from these. As they do not visit modern wrecks, and as the Coast Guard is unable to monitor them constantly, the only individuals who retain an interest are illegal divers, whose interest will have a negative impact on the protection of wrecks.

It is further worth noting that on the basis of legislation in effect, the competencies for the planning and use of modern wrecks fall within the scope of the Directorate for Modern Cultural Reserves and Intangible Cultural Heritage of the Hellenic Ministry of Culture and Sport, while the Ephorate of Underwater Antiquities deals with them due to its general competencies. Despite this, the Ministry of Culture and Sport potentially is the least able to document particular individual features of the naval wrecks that come under the owner ship of the Cooperative Fund of the Navy, which expertise lies mainly in the hands of the Greek Navy.

For all these reasons, <u>the prohibition on diving modern wrecks is, in its current form, only harmful</u> both to the wrecks themselves and to the Greek tourist diving industry, which loses out on a great resource in modern wrecks and consequent comparative advantage for our country.

2.4. Achievable and immediately implementable solutions proposed to date.

<u>As regards the issue of the 3 n.m.:</u>

Initially and for the reasons set out above, L. 3409/2005 article 13 par.3 subpara. 2 as in effect should be immediately abolished, ridding the institution of the useless encumbrance of requiring a distance of 3 nautical miles from any proclaimed underwater archaeological site.

A draft of the abolishing provision with a fully documented introductory report has been before the Ministry of Culture for quite some time.

<u>As regards the issue of accompanying</u> visitors <u>to UVAASs:</u>

In order to remove the impasse, the Ministry of Culture, moving in the right direction, accepted with its legal Service and with the active assistance of the scientific team of the Hellenic Association of Friends of Diving Parks that, if article 13 of L. 3409/2005 does not make reference the mandatory reference to the legislation on state guards of antiquities or archaeologists, visitors to UVAASs could be accompanied by authorized providers of diving services providing accompanied dives in accordance with the provisions of L. 3409/2005, who have undergone special training, approval and monitoring from the Ministry of Culture, while the competency of who guards and polices underwater antiquities must at all times fall under the competence of the archaeological service3, i.e. the Ephorate of Underwater Antiquities and the Hellenic Coast Guard.

This solution was in fact taken for an operational contract executed on the 19/12/2014 between the Ministry of Culture, the Municipality of Pylos – Nestoras and the Region of the Peloponnese, in accordance with “Kallikratis” L. 3852/2010 article 100 par. 5, to create the two UVAASs in Messinia we have already referred to. The same operational contract also made the concession of the specific UVAASs to the Municipality, in order that they undertake the implementation, organization and exploitation thereof, while paying a concession fee to the Ministry of Culture.

Unfortunately a change of government brought the Ministry of Culture and Sport back to its previous interpretation of the law, putting off yet again the establishment and operation of UVAASs, despite the well-meaning effort of certain members of staff at the Ministry to resolve the issue.

In June 2018, at a developmental Day Conference in Lavrio, the current administration of the Ministry of Culture jointly with the new Head of the Ephorate of Underwater Antiquities announced that they were aware of the issue, that they had taken seriously into consideration the proposals put forward by the diving world in order to resolve it and had designed their own specific solutions and committed themselves to resolving all the issues concerning UVAASs immediately. To date nothing has been done. UVAASs remain an inactive institution and DPs can similarly not be established due to the issue of the three nautical miles, which remains unchanged.

3. RADICAL INSTITUTIONAL SOLUTIONS, PROPOSED BY THE CURRENT STUDY TO DEVELOP ALL FORMS OF DIVING TOURISM

3.1. Regarding the issue of the 3 n.m.

Concerning the issue of the 3 n.m. the only radical solution is the one already set out, i.e. to abolish L. 3409/2005 article 13 par.4 subpara. 2 as currently in effect.

It would be most effective and supportive for the correct implementation of the law and the institution to set out explicitly that UVAASs can even exist within the broader extent of lawfully established DPs.

3.2. As regards UVAASs, modern wrecks and ecologically-sensitive areas: Staggered progression in Marine Protection.

In order not to risk the institution of UVAASs to one-off interpretations of the law by the Administration and the leadership of the Ministry of Culture and Sport, as well as attacks before the Council of State by those who believe in a nostalgic past, the issue of accompanying visitors diving at UVAASs should be resolved legislatively.

In fact the new method of dealing with these should not concern UVAASs in isolation but should finally provide a more general strategy, **a new dogma**, which can be followed precisely, in order to allow for the joint development of all forms of diving tourism, without, at the same time, overlooking the matter of monitoring and controlling marine areas that require increased protection. And to achieve this without generalized prohibitions but rather with a graduated staggered increase in severity, which shall be required in each instance by each individual protected area.

Specifically, recreational diving areas shall fall under the following categories:

Category A: Free to dive marine areas

This describes the greater part of the Greek seas, as diving is allowed freely without any requirement to inform the authorities pursuant to L. 3409/2005, in effect since 2006.

Category B: Diving Parks

These are diving parks pursuant to article 13 of L. 3409/2005, as currently in effect, which only allows accompanied dives, i.e. dives accompanied by lawfully recognized providers of diving services. The limitation is sensible, as it prevents illegal fishing, which becomes ever more attractive to malicious individuals when fish life rebounds; and to create a sense of trust with the public that those guarding the area won't turn a blind eye.

Category C: Areas that require mandatory accompanied diving with an obligation to inform the Authorities.

This is the essential innovation in the system, which the present study proposes, in order to increase the areas of the country that can be dived, making the majority of the areas that are currently access-prohibited without any clear reason accessible and yet protected,

Category C areas include Underwater Visitor Accessible Archaeological Sites, modern wrecks (and in fact all wrecks and not only those that are more than fifty years old), as well as environmentally sensitive areas, as well as the zones of National Marine Parks that are outside the core park but are protected, particularly from illegal fishing, but where recreational diving is not prohibited, as it has now been scientifically proven that, if certain rules are followed (lack of contact with the sea bed, prohibition on removing any organic material or objects from the site etc.), diving is completely compatible with the protection of the marine natural and manmade environment.

In Category C areas diving is permitted not only requiring that divers be accompanied by authorized providers of guided diving services, as in diving parks, but with the additional requirement that the provider be obliged to inform the competent Coast Guard authority, that the specific provider will be performing an accompanied dive in that particular area.

This notification can either take place in writing (either on a form or digitally) beforehand, or, depending on what the provider chooses, by having on board the diving vessel a satellite or wireless device / beacon (utilizing the mobile phone network or other private networks), which constantly transmits its location, course, and identity to the Coast Guard. Such constant Vessel Monitoring Systems (VMS) are widely utilized and reasonably priced and in certain instances mandated by law, as is the case with certain categories of fishing vessel pursuant to the European Council Regulation (EC) 1224/2009.

Utilising the increased monitoring potential offered by accompanied rather than private unaccompanied dives and making use of the human resources in the country already trained in the recreational diving sector, automatically achieves the global handling of the matter of monitoring recreational diving in areas where increased protection is required without mandating absolute prohibitions.

On the basis of L. 3409/2005, providers of recreational diving services are not only trained to a high level of expertise, which they receive at their own expense; they are checked out thoroughly from all standpoints, in order to receive state licensing required to be able to exercise their profession.

Even following their official licensing, they remain under constant supervision from the state, are registered in a special registry pursuant to L. 3409/2005 art. 8, which registry is monitored and constantly updated; and are subject to severe penalties including removal of their ability to work in this particular field for actions that infringe against the diving legislation (L. 3409/2005 art. 15) and the law in general.

Moreover, recreational diving professionals were the first to be interested in the existence of and conservation of underwater sights, as their livelihood depends on these. Therefore it is obvious that, if the State proceeds to trust them and to make use of them, they shall constitute a first class tool, to implement a correct and sustainable development of diving tourism as well as for the protection of the natural and manmade environment, with the additional benefit of not placing any additional burden on the national budget.

This ensures that tourist diving visitors can carry out recreational dives, in accordance with the rules by which these should be governed.

Making accompanied dives mandatory and requiring prior notification to be lodged with the competent Coast Guard in category C areas does not substitute for nor does it lessen the requirement for protection of the submarine natural or man-made environment by the competent State Authorities (Coast Guard, Archaeological Service, Ministry of the Environment, Management Agencies for National Marine Parks), which continue to monitor and police them as they do today and as required by the Greek Constitution.

On the contrary, inclusion of an area under Category C increases and facilitates the exercise of protection by the competent Authorities of the State as well as those who benefit directly from tourism diving activity in those areas.

International examples including the parks at Medes islands in Spain and Port-Cros in France have proven that raising awareness regarding protection of the marine environment in professionals in the diving sector and the tourism sector in general, who benefit from these, so that this can be preserved in a state worth visiting and thus revenue producing, will increase as diving tourism grows and, consequently, benefits increase for them. Even instances of isolated individuals who remain obdurate, individuals who always have existed and always will exist, are minimized through constant supervision of the spaces by visitors, who can ascertain any infringements and, most particularly, by the other professionals, who shall not hesitate to report and certainly prevent anyone from infringing, not willing to submit to their interests being adversely affected for the short-term and pointless benefit of certain others.

Combined with the levying of extremely severe penalties on those professionals who break the law, which will be instituted at the same time as the trust which is shown to them on the part of the State, the Coast Guard shall be able to monitor and protect category C areas far more easily and effectively, putting under close watch providers of diving services active in said areas. The latter, fearing they would lose their professional benefits from this particular activity will, in turn, be particularly careful and strict in observing the law and local regulations regarding monitoring diving, which is carried out accompanied by them.

Category C area protection also involves the participation of visitors themselves, who, being offered the opportunity to enjoy a space that they were previously forbidden to enter, gain motivation and interest in protecting that space themselves, in order to maintain it in the best possible condition.

In contrast, in areas where recreational diving is prohibited, and from which the parties involved, i.e. professionals and visitors, cannot have an expectation of gain, their interest wanes and is discouraged so the only ones who remain interested are illegal divers, with the understandable impact on the protection of the areas.

Of course, depending on the particular nature of each category C area, special restrictions may be put in place where necessary. For example, in UVAASs, as first provided for in the archaeological diving parks of Pylos and Sapientza, provision is made that diving expeditions shall commence and end in a single specific location, staffed by an Archaeological Service guard, who shall be entitled at any time to check the luggage of any incoming or outgoing visitor, and no vessel shall be allowed to approach the diving boat at any other point along the diving route nor shall the diving boat itself be allowed to approach land throughout the route.

Additionally, as the position of each dive shall be known beforehand to the competent Authority, a competent state guard / diver shall be able to carry out surprise spot checks whenever deemed necessary by diving at that particular point.

What is important is that, by instituting category C areas, areas that had previously been prohibited are opened up to diving tourism and become productive for the national economy and the country's development, as are numerous modern wrecks which to date were abandoned to their fates and to fade from memory, hosts only to illegal divers, with all the consequences of their activities, while classified under category C, they gain for the first time increased and constant supervision and protection.

At the same time this resolves the impasse of how to operate UVAASs, which to date could not function.

Category D: Areas of Absolute Protection.

These are areas where for specific reasons and for National or State interests (archaeological, defense, environment, economy, security or other), absolute prohibition of diving is required and reasonable.

Inclusion of these areas under category D, rationalizes and minimizes the prohibition on diving, which shall be in place precisely where it is required, without stamping areas that fall under other categories en bloc and without real reason as areas where diving is not permitted, with a negative impact on the country's very necessary and productive wealth.

3.3. National Network of Diving Destinations.

Deregulating various forms of diving tourism can also lead, in the most rapid way possible, to the creation of a National Network of Diving Destinations, which shall include Diving Parks, UVAASs, the most important Modern Wrecks and major areas of particular environmental interest.

The creation of such a network would allow for decentralization; for central monitoring and strategic planning in the diving industry in Greece; for the cumulative use of the results of scientific interest in the consolidation and repetition of proven good practices; and, primarily, for a more economic and effective joint and unified promotion of the national diving product in total to the international diving market.

3.4. National Council for Diving Tourism.

Diving Tourism is a national implement and far too important to be left to its luck and the occasional and fragmentary involvement of state bodies whose purview is other, whenever it so chances, if it chances that they engage in it. It requires central planning and coordination and monitoring of the implementation and improvement of said planning.

To that end it becomes necessary to establish a central interministerial agency entitled "NATIONAL COUNCIL FOR DIVING TOURISM" (NCDT).

NCDT should have few members for increased flexibility, with representatives solely from the ministries directly affected (the Ministries of Tourism, the Environment, Culture, the Economy), as well as from the professional diving sector.

NCDT would serve a double purpose: (a) sustainable development of diving tourism in Greece; and (b) the creation of a national network of diving sites (diving parks, visitor-accessible archaeological sites, modern wrecks, underwater manmade sites).

NCDT competencies would include: to inform / consult the state; to listen to professionals in the sector; to propose a national strategy for diving tourism; to process and submit legislative proposals; to collaborate with the Regions for appropriate actions for decentralized growth in diving tourism; to collaborate with the agencies of formal and non-formal education in order to establish awareness of diving and the marine environmental; collaborate with other countries and international organization to exchange data, programmes and good practices; to propose and implement actions to promote Greek diving tourism.

NCDT funding could be achieved without burdening the state budget from: revenues from ceding the use of marine areas to diving parks; a special duty on those using the sea (shipping, cabotage, coastline tourism, fish farms etc.); grants from private individuals, companies and agencies; European and international programmes.

The results of instituting and operating NCDT would certainly be the following:

(a) Diving tourism would be benefit from central planning, with broad ranging information exchange between all those involved; it would be implemented in a decentralised manner; monitored constantly and measurably; and improve with the appropriate interventions.

(b) A National Network of Diving Destinations, which shall include diving parks, UVAASs, modern wrecks, underwater man-made sights, shall be designed rationally and implemented as a tool to permit diving tourism growth,

3.5. Chamber of Diving.

In order to have effective and fair participation of diving professionals in the NCDT, their representatives should be legalized democratically but also have a valid and official capacity as representatives of the sector.

The work towards formalizing this has already been done and included under L. 3409/2005 article 8, for this exact future purpose, which made provision for maintaining a Registry of all active authorized providers of diving services. This Registry exists and is maintained by the Ministry of the Merchant Marine, whose members will be those included in the Registry, who can elect representatives for their sector through a process of election.

In this way the diving sector would gain an official voice and acceptable representation and the state would have a reliable partner on all matters concerning diving.

4. EPILOGUE / CONCLUSION

Classification of diving areas

The proposed classification of Greece's recreational diving areas is a system, which frees up the field for smooth development of diving tourism and the creation of a large number of job positions without burdening the state budget but instead lessening the burdens thereon, while, at the same time, ensuring a more effective and ongoing protection of the underwater natural and cultural environment.

Because all of the above will bring about solely benefits for all those involved and for the country as well, it appears that the only impediment to achieving them is the attachment certain individuals in the Administration have to the old ineffective practice of generalized prohibitions and conflict with the citizens, instead of mutually beneficial collaboration, without which it has been proven that protection of the marine space is not achievable.

Instead of the State frittering away its few resources by ineffectively maintaining the general prohibitions, which bring about, if not the enmity, certainly the indifference of the population to protection of underwater sights, it must invest in trust towards its citizens and particularly in those involved professionally with underwater activities, whom the State can transform into an army of unsalaried guards who protect its assets by teaching them the potential of enjoying the direct material benefits of exploiting their underwater heritage.

NCDT, Diving Chamber

The proposed general institutional interventions (NCDT, Diving Chamber) would allow for ongoing, rational planning and sustainable development of diving tourism in Greece, with a reliable and transparent collaboration of the state with diving professionals.

In general

THIS should be the national strategy for the sustainable development of Diving Tourism in Greece.

What is sought is the rare, brave, political intent, which will help rational debate and arguments hold sway over obsessions and lead our country, with its many incomparable underwater tourism advantages to the position that befits it in the world diving market, gaining it the position it deserves as Greece, the "**Caribbean of Europe"**.

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Creation of a virtual museum and a diving park east of the island of Lemnos on the site of the wreck of the Svyatoslav ship

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***Abstract*:** Svyatoslav is a 80-gun sailing battleship in the Baltic Fleet of the Russian Empire and a member of the First Archipelago expedition during the Russian-Turkish war of 1768-1774. On September 17, 1770, when passing the island of Lemnos, Svyatoslav ran aground east of the island and subsequently sank at the depth of 6-8 meters. A virtual museum and an underwater park would create an interesting tourist site, and greatly increase the number of tourists from Russia and other countries visiting the island of Lemnos.

***Keywords*:** Virtual Museum, Photogrammetry, 3D modelling of historical events, Lemnos, diving park.

1. BRIEF HISTORICAL BACKGROUND

Svyatoslav was a battleship in the Russian Empire Baltic Fleet. The ship took part in the First Archipelago Expedition during the Russian-Turkish war of 1768—1774. Despite the war with the Ottoman Empire, Russia did not have a fleet on the Black Sea. Therefore, a plan was developed to use the Baltic Fleet to strike the Turkish navy forces from the Mediterranean Sea.

As a result, the Turkish fleet was destroyed in the battles of Chios and Chesma (Fig.1).

Fig.1 *The Chesme battle*. I.Ayvasovsky. 1848

On September 6 (17), 1770, due to a mistake made by the English sea pilot Gordon, *Svyatoslav* ran aground east of the Greek island of Lemnos. Other ships from the fleet tried to help *Svyatoslav*, but a storm hindered the rescue activities. The crew was saved but almost everything else was lost, including guns and ammunition. Afterward, the ship was set afire and sank.

In the log of Captain S.P Khmetevsky, who took part in the First Archipelago Expedition, there is a detailed description of the accident, as well as a map indicating the ship loss location. Khmetevsky's manuscript is now housed in the Vladimir-Suzdal Museum (Fig. 2).

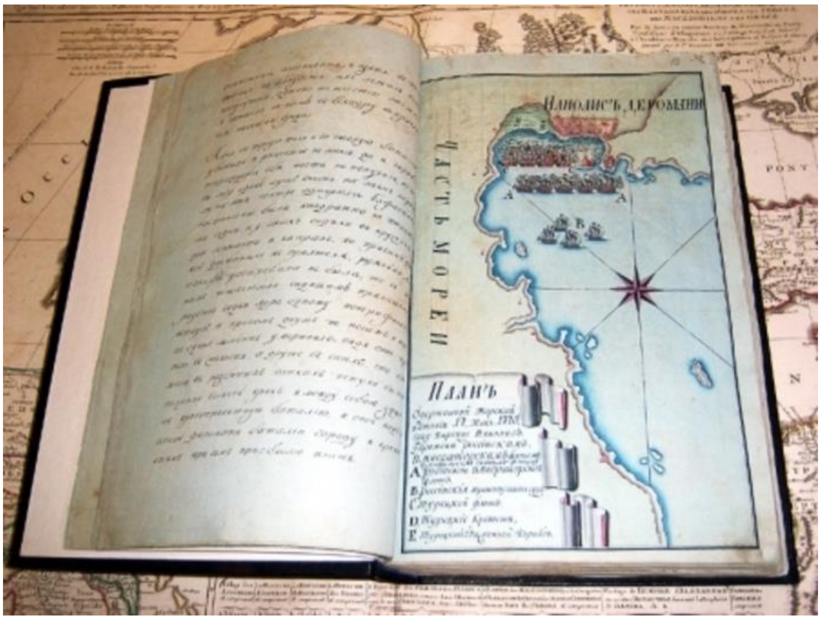

Fig.2 The map indicating the location where Svyatoslav sank as recorded by S.P.Khmetevsky.

2. INTRODUCTION

In order to preserve and promote the information about this key period of Russian naval development, we propose creation of a virtual museum devoted to *Svyatoslav* battleship. During this period much of the Russian Navy expansion took place in the Black and Mediterranean Seas.

3D reconstruction of the sea floor around the shipwreck was obtained during the 3D mapping of the area. This will be the core of the display. We propose recreation of the course of events resulting in the shipwreck using this reconstructed ship model. Detailed historical materials featuring the circumstances immediately preceding the loss of the ship, description of the accident and its consequences, will help to provide detailed supporting information.

Project implementation objectives:

1. Confirm that the identity of the discovered ship is actually the *Svyatoslav,* serving as a reminder of this tragical moment in Russian Navy history.
2. Highlight the importance of preserving Russian maritime and underwater heritage abroad.
3. Expand knowledge on naval shipbuilding, armaments and way of life on the ships of the 18th century as an integral part of maritime heritage.
4. The project materials will help enrich various educational programs that promote patriotism and interest in maritime history.

3. VIRTUAL DISPLAY

Steps to create a virtual display include:

1. Collect related historical documents from archives.
2. Develop an interactive method to present historical materials related to the events.
3. Photogrammetric survey of the shipwreck and production of a detailed 3D map of the site (Fig 3-4).

Fig.3-4 An example of the sea floor survey and 3D sea floor model done by the participants of our workshop.

4. Create detailed imaging of the wreck, including original 3D models and 3D models with reconstruction.

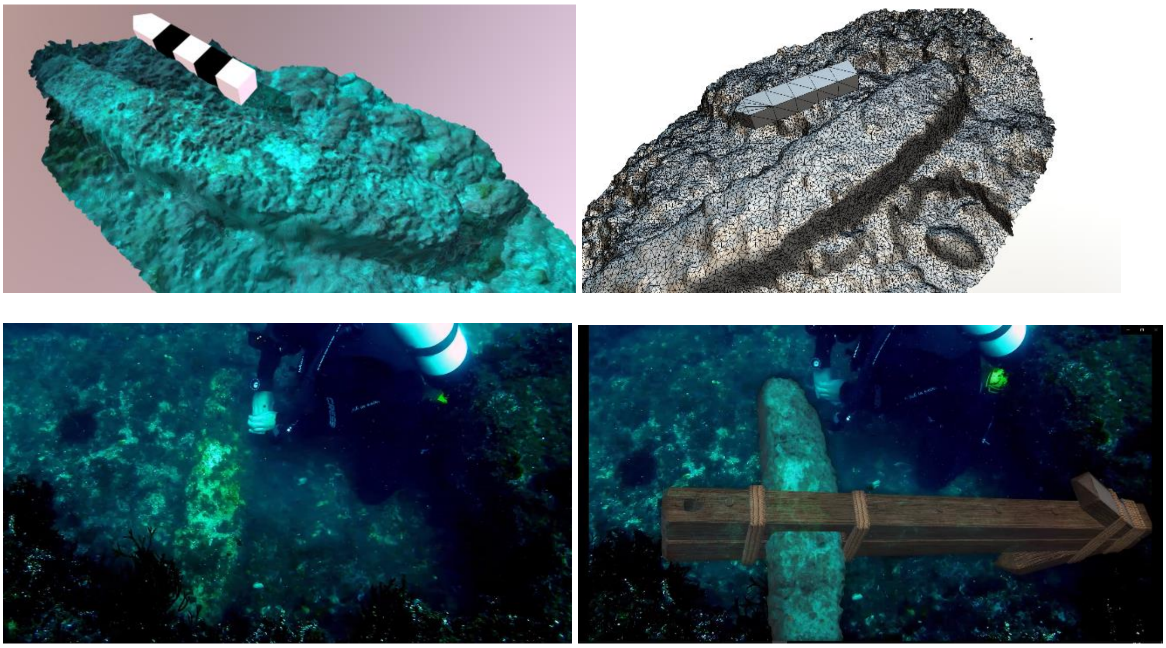

Fig.5-8 An example of a 3D model of the stone anchor stock done by the participants of our workshop.

5. Create detailed 3D models of the ship and related objects, in cooperation with designers, historians, museologists and underwater archeologists.
6. Reconstruct the most probable sequence of events based on historical materials and 3D mapping data.
7. Install ship models on the 3D mapped sea floor. Reconstruct the accident site on the 3D mapped sea floor. Fig. 9-10.

Fig.9-10. An example of a 3D model of the ship on the mapped sea floor.

The virtual museum will be made available online. Collected reconstruction materials can also be used at the Museum of the Lemnos island or at various Russian museums by means of 3D glasses. These glasses simulate the experience of being present at the shipwreck site. Another benefit of this virtual display is the ability to examine the historical site without direct intervention, as the wreck has been left in situ.

Proposed contents of the virtual display:

1. Historical background
2. Reconstruction of events resulting in the shipwreck
3. Overall view (current state)
4. Cabins (Virtual display to showcase reconstruction of traditional objects used on the ships, offering an inside-the-ship view)
5. Underwater excursions (A number of underwater locations with various reconstructed objects)
6. People
7. Maps

The virtual display offers an interactive interface that appears as a navigation map hanging on the cabin wall of the 18th century ship. Access to various parts of the display is provided through a series of highlighted, easy-to-read buttons representing elements of the described interior (Door, Portrait, Clock, Map, Ship model etc.).

There will also be cross links between various parts of the virtual display.

The virtual museum should be optimized for mobile devices, possibly using VR headsets.

Further expansion of the project can include usage of the content for developing underwater excursions with AR elements *in situ.*

Information technologies to be used:

Photo and video stereo cameras and 360º cameras are planned to be used for sea floor and drowned objects survey with the help of ROV and divers. Based on the obtained data a 3D model of the ship, a 3D map of the shipwreck as well as 3D models of selected objects will be developed by means of photogrammetry.

We also propose to develop virtual video tours by means of 360º cameras where a visitor wearing a VR headset will virtually visit the shipwreck site surrounded by divers. At a later stage recreated 3D objects will be integrated into the 360º video.

Also, by means of 360º view photos we plan to create a 3D virtual tour with 360º panorama view using arrows similar to those used in Google Street View technology.

In order to display detailed 3D data for a large number of visitors simultaneously it will be practical to use cloud technologies, special virtual museum cloud tours, or free Sketchfab service.

The virtual museum operation will start with basic information about the events, their place in the history of the Russian Navy, and the First Archipelago Expedition. Further updates of the display will be phased in, as new content becomes available. Promotion of the virtual museum, significant updates and additions will be communicated to keep visitors interested over time.

4. SCIENTIFIC STRUCTURE OF THE PROJECT

The project will be implemented by the Department of museology, faculty of History of Art of the Russian State University for Humanities.

The first stage includes searching for, collecting, systematizing and verifying data on the ship and the people associated with the ship, such as:

- information on the construction of the vessel,
- complete and reliable technical documentation,
- history of the ship from its construction to the wreck,
- information on the crew,
- biographics of the key persons related to the history of the ship.

The second stage includes developing a thematic and exposition plan based on the collected data.

On the third stage a field survey of the shipwreck will be conducted and 3D model of the shipwreck will be developed by means of photogrammetry.

After the completion of the third stage, a wreck preservation and museumification project should be developed.

5. UNDERWATER PARK

An underwater park can become an interesting addition to the virtual museum. It can include various underwater tours, a lecture hall and a dive center. Augmented reality technology can be used for providing information support. For example, underwater tablets, smart glasses will significantly enrich underwater tours and museum experience as a whole.

6. PARTNERS AND INTERNATIONAL COOPERATION

The key project leads from the Department of Museology, History of Art, Russian State University for Humanities will be represented by participants of our workshop *Marine, River and Underwater Heritage*.

The Russian Confederation of the Underwater Activities will provide diving and technical support.

A key success factor for this project is establishing scientific cooperation with Greek counterparts. Joint activities to coordinate efforts aimed at studying, preserving and museumization of the *Svyatoslav* shipwreck site near the Greek island of Lemnos can become the basis for such cooperation.

Integrated management plan for the preservation and promotion of cultural and natural environment at Pavlopetri (Elafonissos, Greece)

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The underwater cultural heritage and its surrounding natural environment are inextricably linked, as a result of their long interdependence through the millennia, but also as a result of more acute stressors (such as pollution) affecting ancient remains.

In the case of submerged prehistoric coastal settlements, coastline and sea-level changes are determinants of their state and fate. Studying a prehistoric coastal settlement requires good knowledge of modern and paleo-environmental factors shaping its evolution. This integrated approach is crucial in informing decisions on sound conservation and management.

The submerged prehistoric settlement of Pavlopetri (Municipality of Elafonissos, Region of Lakonia) lies within a NATURA 2000 Special Area of Conservation, between Vigklafia beach and the islet of Pavlopetri, amidst sandy seabeds and scattered *Posidonia oceanica* meadows. A cemetery with craved graves lies on volcanic rocks, surrounded by sand dunes, juniper forests (*Juniperus macrocarpa)* and the *Lake Stroggyli* coastal wetland. The wider sandy coastline between Pavlopetri and Maggano is also known to host an important spawning population of the endangered sea turtle *Caretta caretta*.

This rich natural environment is not only part of the submerged settlement's identity, but also an added value to the Pavlopetri visitor experience, offering opportunities for the designation of joined eco-archaeological routes. The ecocultural approach in safeguarding and promoting ancient heritage can attract a wide range of interested visitors, while offering multiple benefits to local and regional communities.

This integrated management proposal puts forward facts and recommendations for promoting an ancient site surrounded by high ecological richness as an alternative tourist destination. Such an approach requires early consultation, collaboration and support of local authorities and communities.

Keywords: integrated management, underwater cultural heritage, NATURA 2000, Pavlopetri, eco-archaeological routes