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HERMES

# Virtual International Conference abstracts

"Adapting to Coastal Zone Challenges and Risks: Innovative Approaches and Solutions for Local and Regional Authorities in the Balkan-Mediterranean area"

Online, 18-19 June 2020

# A HarmonizEd fRamework to Mitigate coastal EroSion promoting ICZM protocol implementation

## Virtual International Conference

**"Adapting to Coastal Zone Challenges and Risks: Innovative Approaches and Solutions for Local and Regional Authorities in the Balkan-Mediterranean area"**

**Online, 18-19 June 2020**


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HERMES

**Virtual International Conference**

“Adapting to Coastal Zone Challenges and Risks:
Innovative Approaches and Solutions for Local
and Regional Authorities in the Balkan-Mediterranean area”

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## FOREWORD

It is a well-known fact, that Municipalities in coastal areas across Europe, host an increasing share of the population which rises even more during the Summer season. This trend implies increasing human activity and, in most cases, various pressures on the coastal zone, which in combination with natural processes can put at serious risk the most precious and valuable natural capital of these areas, that is their shores and beaches. The Municipality of Paggaio with over 65 km of coastline and its 3km long Ammolophi beach, ranked as one of the ten most beautiful beaches in Greece, represents such a coastal community that must deal with these challenges.

The HERMES project is an initiative that the Municipality of Paggaio took to tackle the specific issue of coastal erosion within broader context set by the Protocol on Integrated Coastal Zone Management in the Mediterranean. Our ambition is to take the lead in triggering a process that will effectively empower local communities in the Balkan-Mediterranean region to design and implement solutions adapted to their specific conditions and real needs and yet capable to benefit from the most advanced knowledge and cutting-edge technologies developed globally. We consider having already succeeded in completing the first phase, which was to build a transnational alliance of place-based actors and partner with leading knowledge carriers at local and national scale. The HERMES Virtual International Conference (June 2020) was in this regard a major milestone as it enabled us to connect with over 250 key stakeholders and scientists, and thus highlight the fact that Coastal Erosion is an issue of major concern across the Mediterranean and beyond, which requires Nature Based Solutions fit to local conditions and needs.

The abstracts compiled here, are not only a testimony of the achievements of the HERMES partnership, but also demonstrate that Coastal Erosion in particular and Coastal Management in general, constitute real threats for local communities which are not however in any way without the possibility to turn around the situation. In effect, we consider that Coastal Erosion is a complex problem that could be dealt with by leveraging the opportunities offered by the Green Deal, rallying the involved stakeholders at local scale and building alliances across borders to increase knowledge and capacity.

In short, I hope that these abstracts contribute to a new effort that will build on the HERMES initiative and deliver tangible results for the citizens of local coastal communities in the whole Balkan-Mediterranean region.

**Philippos Anastasiadis**
**Mayor of Paggaio**

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# The Balkan Mediterranean Programme and Climate Change

**Themistoklis Chatzikonstantinou,** Head of Joint Secretariat of the Transnational Cooperation Programme "INTERREG Balkan Mediterranean 2014-2020", balkanmed@mou.gr

## The BakanMed Programme

The Balkan Med programme area covers the countries: Albania; Bulgaria; Cyprus; Greece; Republic of North Macedonia with a budget of approximately 40 million Euro.

## Climate Change Mitigation

Climate Change Impacts: Temperature shifts; extreme weather conditions (floods; storms and drought); reduced availability of water, polution, etc; wide-range effects on territories.

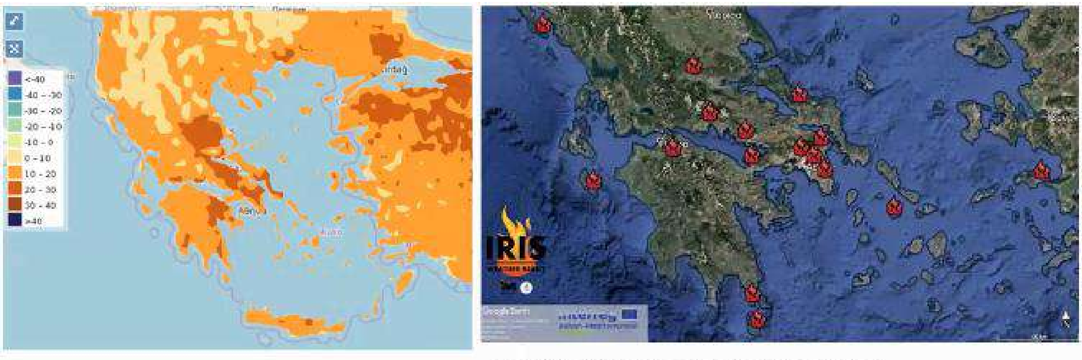
EU Policies: Energy efficiency management; low carbon policies.

BalkanMed 2014-2020: Invests 25,5 million Euro (65%) under Priority Axis 2 'Environment', with 23 projects being approved for funding under the 1st call for proposals.

## Indicative BalkanMed projects

*DISARM (Natural Disasters) - €1,028,247.50*

The key purpose of DISARM project is to develop, validate and demonstrate a set of services that employes state-of-the-art observational and modelling techniques, with the aim to assist interested authorities in better preventing, addressing and mitigating the adverse impacts of droughts and wildland fires, being intensified due to climate change.




Danger of Fire in Greece, due to Climate Change — IRIS: Forest Fire Spreading Prediction System

Figure 1: Indicative images of the DISARM project

*BalkanROAD (Agriculture/Farming) - €1,284,723.15*

The overall objective is to promote technologies that enhance the wide implementation of sustainable management strategies at farm level, in terms of resources management and reduction of carbon, waste and water footprint of agricultural products in the BM area.


Figure 2: Indicative images of the BalkanROAD project

*AIRTHINGS (Air Pollution) - €1,417,322.66*

The project supplies and installs approximately 100 Internet of Things intelliegent air quality measuring sensons in BM countries – providing real time date through internet – forming a network of interconnected cities, jointly monitoring air quality, alongside with cloud based “Open data” system with predictive analysis and advanced machine learning capabilities.


Figure 3: Indicative images of the AIRTHINGS project

*PV ESTIA (Energy Efficiency) - €1,237,442.15*

The overall objective of the project is to enhance the penetration of PV’s in the built environment, which is endangered due to their volatile nature and the limitations of the electical distribution grids. The ibjective is to transform the buildings into a controllable energy source, thus making them grid-friendly.


Figure 4: Indicative images of the PV ESTIA project

*<u>HERMES (Coastal Erosion) - €1,012,629.69€</u>*

HERMES is a network joint action aiming to upgrade the capacity related to coastal erosion mitigation and climate change resilience of local/regional/national authorities involved in the coastal zone management in the BM area.


Figure 5: Indicative images of the HERMES project

# Research Activities
# of the Laboratory of Harbour Works, NTUA in ICZM. Approaches and solutions for adaptation and resilience of coastal zone to climate risks

**Vasiliki Tsoukala,** LHW, NTUA (Greece), tsoukala@mail.ntua.gr

## Introduction

An overview of the research activities of the Laboratory of Harbour Works (LHW) of the NTUA in ICZM is hereto presented. In the first part of the presentation, a brief description of LHW infrastructure and experimental facilities are provided, while in the second part, the research activities of the laboratory's scientific staff concerning the adaptation and the resilience of coastal infrastructure and coastal zones to climate risks are highlighted. It is worth mentioning that the said activities are developed around 3 distinct, yet inherently connected axes: coastal flooding, coastal erosion as well as effective monitoring and forecasting methodologies for assessing climate change impacts and vulnerability of coastal zone and coastal infrastructure.

## LHW experimental facilities and infrastructure

The LHW of the Civil Engineering School, NTUA, is one out of the 14 Laboratories within the School developing fundamental and applied research activity related to port and coastal engineering.

D2 (left) and D3 (right) wave basins

Wave Flume F1 Wave basin D3

Figure 1: LHW Experimental Facilities

LHW is the only laboratory in Greece that has infrastructure for conducting 3D experiments on physical models, which is considered the most appropriate method, according to our opinion, both for investigating and optimizing solutions in the construction and operation of harbour works, but also for optimizing the design (technical and environmental) of coastal protection works. LHW is located in a building complex of 5.000 $m^2$ in Zographou Campus (Figure 1) and it consists of two large 3D basins: D1(26.8 x 24.3 x 1.0 m) and D2(35.2 x 27.8 x 1.0 m) for conducting experiments in physical models, unique for their kind in Greece. The basins are equipped, with an hydraulic system for wave generation containing a wave composition software for regular and irregular waves as well as timeseries. Furthermore, in the laboratory one can find an elongated basin D3( 20.0 x 6.2 x 1.0 m) and a wave flume F1(27.0 x 0.6 x 0.6 m) for regular wave generation. In order to measure wave characteristics, the experimental facilities are equipped with a) wave probes of resistance type, b) wave probes with echo-sounders, and c) an ADV for 3D water particle velocity measurements, together with the appropriate software for data analysis and data processing. At the same time, LHW is equipped with wave buoys current velocimeters, for wave and current measurements, and ROV manually-operated cameras for underwater inspections.

**LHW research activities**

To date, LHW has been distinguished for its study in physical modelling of more than 25 port facilities and multiple coastal zones. Some indicative examples include the expansion of the port of Piraeus for the service of cruise ships, the redisign of Agios Kirikos port at Ikaria island, the port of Kyparissia, the port of Sfakia, as well as coasts in Greece and Cyprus. In recent years, LHW has focused on composite simulation with the use of physical modelling for the calibration and validation of numerical models contributing to the optimization of port and coastal structures' design (eg. optimisation of flushing culverts design, impact of wave period on the stability of rubble mound breakwater etc.). The last 4 years, LHW has passed into a new era, facing continuous evolvement regarding its research spectrum, as the young skillful researchers, comprising its human force, are preserving the innovative status of the laboratory and expanding its comparative avantage in the physical modelling while, at the same time, they represent LHW in international and national research projects relative to adaptation, mitigation and resilience of coastal structures and coastal zone to climate risks. Some representative examples demonstrating the research effort of LHW include the following:

- Preparing for Extreme and Rare Events in Coastal regions – PEARL for the development of adaptive risk management strategies for coastal communities against extreme hydro-meteorological events minimising social, economic and environmental impacts and increasing the resilience of Coastal Regions in Europe.
- Evaluation and Prioritization of Erosion Protection Measures along the Coast of Avlida, South Evian Gulf to assess erosion' s evolution under climate change scenarios due to the region's touristic value.
- A Decision Support Tool for Navigation Management in Ports - Accu-Waves in order to provide reliable data on prevailing sea states aiming to upgrade port resilience.
- COASTFLOOD to predict and classify the imminent coastal flood risk, through the development of an early warning system to enhance coastal resilience.
- CoastruXion comprising a novel methodology and a user-friendly software to assess coastal structures' reliability with respect to storm events through the estimation of their failure probability.
- PORTFOLIO for the development of a novel decision-support tool to assess the resilience-vulnerability nexus of Aegean's domestic ferry seaports.

**Keywords:** Climate adaptation, Resilience, composite modeling, Laboratory of Harbour Works (LHW)

# HERMES: an overview of activities and achievements

**Prof. Georgios Sylaios and the HERMES Consortium,** Democritus University of Thrace, Department of Environmental Engineering, Greece, gsylaios@env.duth.gr

Coastal erosion, i.e., the phenomenon of long-term land retreat due to the sediment supply imbalance, and the impact of waves, currents and storms, is directly linked to economic losses due to coastal retreat and loss of land, ecological damage (especially of valuable coastal habitats) and societal problems. In the Mediterranean Sea, coastal erosion threatens 1/5 of coastlines at a rate of 0.5-2.0 m/y and creates significant problems to areas of high ecological values of 47,500 $km^2$. Presently only 5% of the Mediterranean coastlines is protected by hard engineering structures.

Focusing on the coastal erosion trends over the Balkan-Med space, it occurs that in Greece almost 30% of coasts are eroding or appear as vulnerable to erosion, in Cyprus this percentage reaches 38%, in Bulgaria almost 71% of Black Sea beaches are eroding, while in Albania, a country with 420 km coastline, coastal erosion is a significant issue for the northern and central parts.

HERMES is a territorial cooperation project funded by the Interreg V-B BalkanMed 2014-2020 Program, Priority Axis 2: Environment and Specific Objective 2.2: Sustainable territories. It has a total budget of 1,023,046.36 euros and a duration of 34 months. The project started on 28/8/2017 and is expected to end on 27/12/2020. HERMES aims to develop a unified and harmonized framework for coastal erosion mitigation and beach restoration covering the four partner countries (Albania, Cyprus, Greece and Bulgaria) through the implementation of a coherent ensemble of studies, the sharing of already developed technical tools and the design of joint policy instruments.

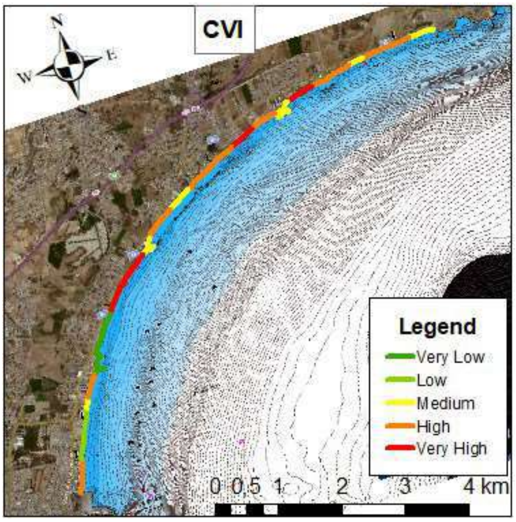



Figure 1. Coastal Vulnerability Index along the Albanian pilot site.

The HERMES Action Plan involved the following actions at each study site:

a) Analyze coastal erosion trends using historic satellite and Google Earth images;
b) Evaluate erosion and climate change vulnerability indicators;
c) Assess the relative influence of human interventions (river damming, illegal sand mining, uncontrolled urbanization, ports, etc);
d) Integrate environmental and socio-economic data into a coastal web-based GIS,
e) Develop a modeling toolkit (meteorological, hydrodynamic, wave and morphodynamic models);
f) Install a monitoring station of coastal waves and currents, thus developing a network of observing structures on erosion, storms impact and CC influence;
g) Test intervention scenarios and evaluate environmental-friendly technical works for coastal restoration
h) Develop the HERMES Training Pack - Seminars and workshops

Figure 2. Sand fences for coastal restoration installed in Ammolofi, Greece.

## An effective and accessible beach monitoring experience

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The coastal zone is one of the most developed areas, has socioeconomic and ecosystem value, provides protection from marine storms, and is strongly affected by sea level rise. The increasing pressure that the coastal zone is undergoing, forces management decisions with high economic and ecosystem impacts. The better the natural system and its behaviour under different conditions are known, the better management decisions could be made. Therefore, integrated and multi-platform coastal data set is needed, one of the biggest challenges for coastal facilities. Field campaigns provide unique data sets of physical and environmental parameters but due the high human and economic resources required, it is not possible to carry them continuously over time. Conversely, remote sensing systems have become a useful and applicable tool for monitoring coastal zones continuously and with high frequency. In 2011, the ICTS SOCIB started monitoring three beaches of the Balearic Islands through the deployment of the Modular Beach Integral Monitoring Systems (MOBIMS), a hybrid field campaigns-remote sensing system consisting of a low-cost open-source video monitoring system (SIRENA), an Acoustic Wave and Current Profiler (AWAC), a meteorological station, coupled with bi-annual field campaigns during which high-resolution bathymetries and topographies as well as sediment sampling are performed. Furthermore, extraordinary campaigns are developed during special events (e.g. extreme events). In this study we present the usefulness and effectiveness of this coupled beach monitoring systems for obtaining high-frequency and high quality data sets on hydrodynamic, sediment transport and morphodynamic processes at different time and length scales, from extreme events and shoreline changes to long-term sediment budget and sinks/sources trends. These data sets are the basis for better understanding near-shore processes that are key for a science-based management of the coastal zone.

We focus on the measurements obtained at Cala Millor station and their analysis. Cala Millor is an intermediate sandy beach, 1700 m long, located in the eastern coast of Mallorca (Balearic Island, Spain). Backed by a boulevard, it is an urban beach that suffered several anthropic interventions as well as nourishments, being one of the most important resorts in the region. The conflict between the natural dynamics of the beach and socio-economic interest turn this beach into a natural laboratory, drawing the attention of the Balearic Islands Coastal Observing and Forecasting System (SOCIB), which has historically been studying it.

Figure 1 shows the beach evolution of Cala Millor beach as a result of the MOBIMS. Higher Hs are associated with erosion processes and mild wave conditions with beach recovery. Alongshore differences can be found, being the central area wider and most dynamic. Considering a period of almost a decade, a beach width decrease trend is found.

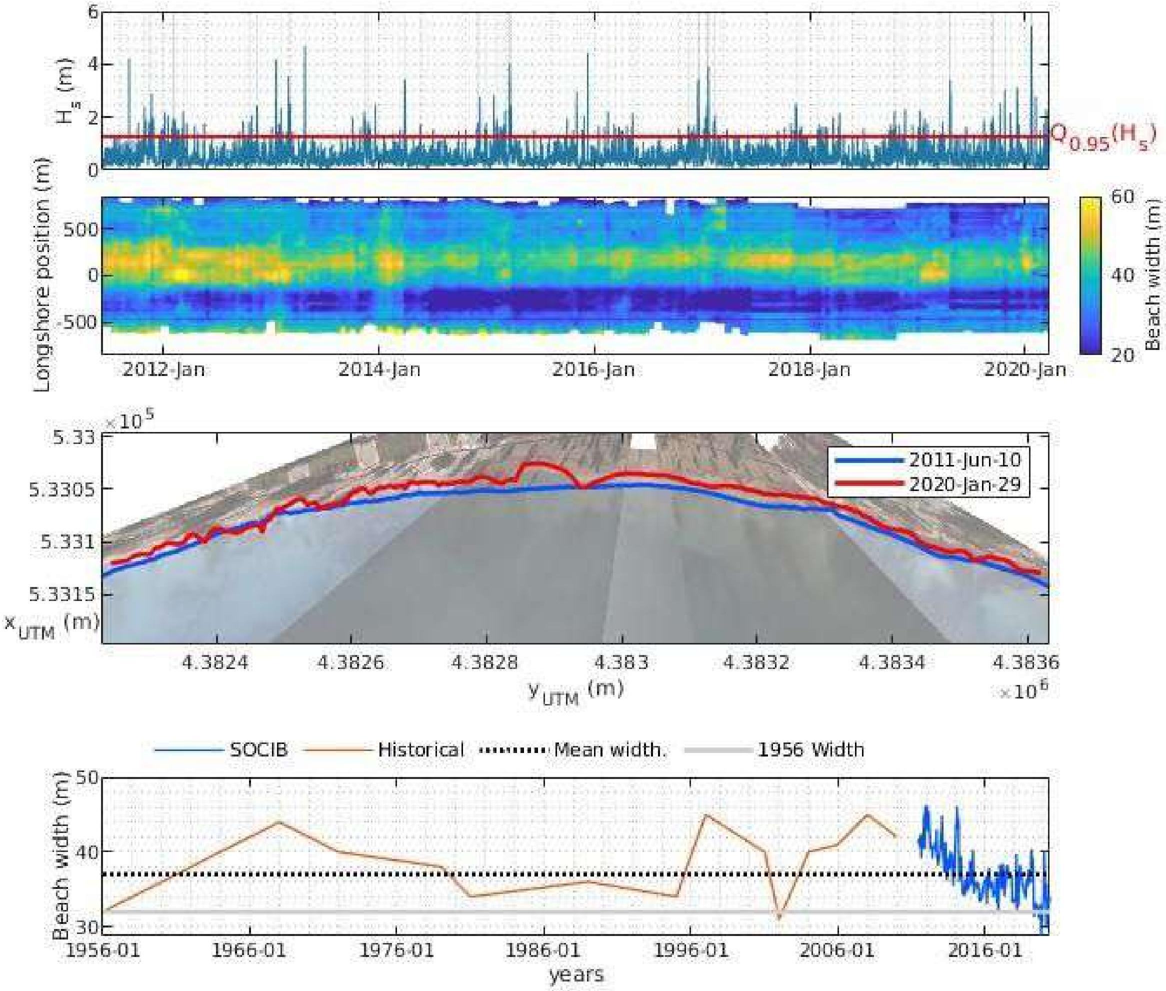


Figure 1:From top to bottom: significant wave height (Hs), alongshore shoreline width, shoreline position and historical averaged shoreline width evolution.

We have brought here just an example of the analyses that can be carried out with this kind of data set, provided by coastal facilities with a Modular Beach Integral Monitoring Systems. These facilities turn the necessary beach monitoring of ours coasts economically viable, providing key information for coastal management.

# Redefining the application limits of well-known breaking criteria

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**Introduction.**

This work describes the laboratory observations of limiting gravity waves targeting on the improved description of of breaking waves. Motivation lies in the necessity of accurately predicting the upper-limit of the underlying water particle kinematics, because of the effect that these have on the applied forces to coastal structures, and the better prediction of the of wave induced currents relating directly with morhodynamics. Indeed, a better understanding the wave breaking limit may be used an an improved input to numerical models that calculate sediment transport and therefore can predict the evolution of the coastline.

The experimental study involves a large series of random wave simulations of highly nonlinear real ocean spectra evolving over a mild bed slope ($m = 1/100$) in a 60m long laboratory flume including observations from the deep-water to the very shallow end of the tank.

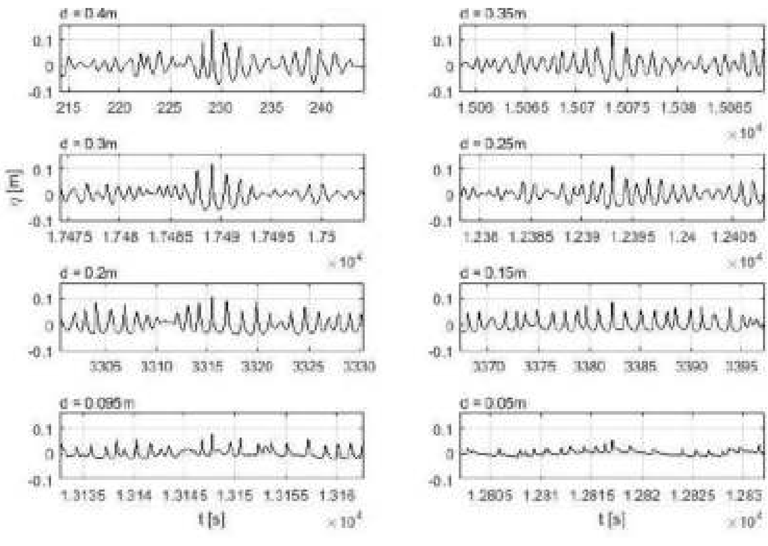


Figure 1: Maximum measured crest elevations for a Sea-State described by $T_p = 1.2$s and $H_s = 0.119$m.

**Results.**

The investigation shows (Fig. 1) that the characteristics and the formulation of limiting waves are critically dependent on the effective water depth reflecting the peak period and local water depth. The largest events appear to be of three fundamentally different types; a focused-type wave event, driven by linear dispersion and similar to those arising in deep water; a much less focused wave type arising in front of a quasi-regular wave train, driven less by linear dispersion and more by wave modulation; and a solitary-type wave form, undergoing only gradual changes in its wave shape.

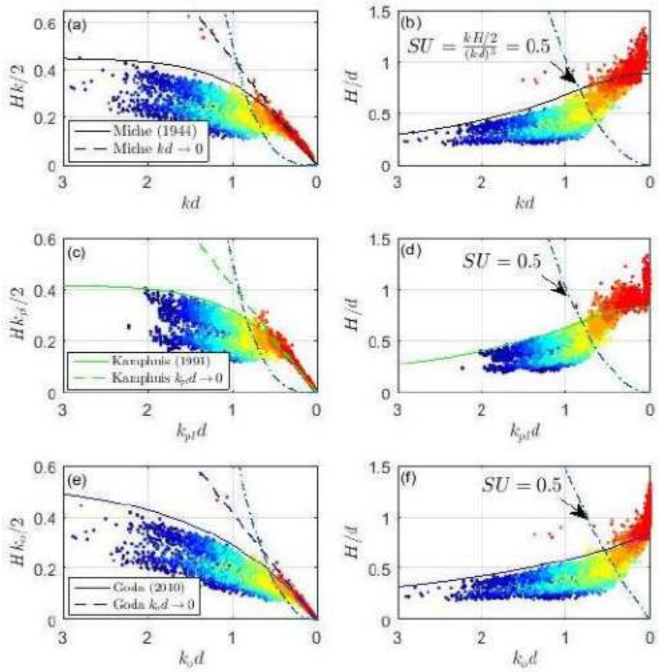


Figure 2: Wave steepness and wave height to depth ratio, expressed according to well-known wave breaking criteria.

This study works upon previous work on wave height statistics (Katsardi et al, 2013) and revisits well-known wave breaking criteria (Miche, 1944; Kamphuis, 1991; Goda, 2010), paying attention to their proper application originally proposed by the researchers, highlighting (Fig. 2) and extending their limits of application while proposing improved solutions based on the detailed laboratory data.

**Discussion.**

The limiting characteristics of water waves depend on a Stokes-Ursell number $SU = (kH/2)/(kd)^3$. The application range of the well-known wave-breaking criteria is limited for $SU < 0.5$.

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**Evolution of the coastal strip Shëngjin-Delta of Buna**

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**Abstract**

This presentation aims to evidence morphologic transformations in the coastal strip of Buna-Shëngjin over the recent years,analyze the endogenic and exogenic causes having dictated the extraordinary dinamics of the coastline,as well as its tendencies in the future.There has been briefly examined the role of the geologic factor in these spatial changes, by mentioning in order of importance the lithologic and structural composition,as well as neotectonic movements.
Coastal regimes have changed due to sediment erosion and deposition caused by wind, tidal, wave and floods of the Buna, Drini and Mati rivers. The coastal strip of Drini Buna delta has been drawn to some parts of the coast in the mouth of Buna with about 500 m since 1936 and about 50 m in the last 20 years. This coastal area is a protected zone. Protected areas are most effective when they have good capacity, efficient management, agreed governance structures and strong support from local and resident communities. Ideally protected areas and conservation needs should be integrated into wider landscape and seascape strategies. The best protected areas are inspirational models for maintenance and management of natural ecosystems. In many places where population or development pressures are particularly strong, protected areas are the only remaining natural ecosystems and thus play a particularly critical role in regulating the supply of ecosystem services.

**Key words:** erosion, coastline, geomorphology, delta of Buna

**Beach erosion: A framework to assess and respond at regional and local level in the Balkan-Mediterranean area**

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Beaches are ecosystems of significant aesthetic, environmental and socio-economic value, as they not only function as environments of leisure, but also provide dynamic protection to the coastal infrastructure/assets they front. Beach erosion, which is already prevalent at most of the global coastline, is expected to deteriorate under climate change, due to the mean sea level rise (SLR), increasing extreme sea levels (ESLs), reductions in the riverine sediment supply and 'not-fit-for-purpose' coastal protection schemes. Many eastern Mediterranean and Black Sea beaches, most of which are already under erosion, have been projected to face increased erosion risks under climate change, with potentially devastating impacts on the beach hedonic value and earning potential, as well as increasing flood damages/losses for the backshore coastal infrastructure/assets. The problem has already been recognized and several international and European legislative instruments are already in force, such as the 2008 ICZM Protocol to the Barcelona Convention that prescribes adaptation plans under a changing climate (including the allocation of 'set- back' zones), and the 2007/60/EC (the Flood Risk) Directive, to name but a few. Therefore, effective coastal management approaches and protocols that can guide the efficient allocation of resources and the design of appropriate technical responses and plans under a changing climate are urgently required. Against this background, the aim of this contribution is to present a generalized protocol that assesses the risks and design responses to beach erosion under climate change. This is based on (i) erosion assessments under different scenarios of mean (slow-onset) and extreme sea level changes at the regional level (e.g. island, or regional authority levels), using appropriate forcing projections and ensembles of cross-shore beach morphodynamic models; (ii) detailed assessments of the beach erosion risk at local level under mean and extreme sea level changes, for individual beaches with particular socio-economic significance which are based on state-of-the-art field approaches and the application of appropriate modeling techniques; and the (iii) the design/assessment of effective technical adaptation measures under a changing climate.

# The HERMES Web GIS monitoring and forecasting system

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## 1. Short Introduction

Coastal erosion is undoubtedly one of the most important environmental concerns faced by coastal communities, aggravated by the prospect of accelerated sea level rise due to climate change and the accumulated negative effects of mismanagement practices. In the framework of the HERMES project a friendly user Web GIS was developed to provide access in NRT of in-situ data from the HERMES buoys network and from the CMEMS Med and Black Sea MFC and CYCOFOS downscaled forecasts in the four domains of the HERMES project.

## 2. The HERMES forecasting network

The downscaled CYCOFOS hydrodynamic models provide forecasting data in two domains of the HERMES project, i.e. in the North Aegean Sea and in the SE coastal area of Cyprus in the Levantine basin, while the CMEMS Med MFC and the CMEMS Black Sea MFC provide forecasting data in the SE Adriatic Sea and the SW Black Sea. The CYCOFOS sea state forecasting system provides wave data for the four HERMES domains, both in the Mediterranean and the Black Sea. Furthermore the high resolution SKIRON wind data covering the Mediterranean and the Black Sea are also used for the needs of the HERMES Web GIS. Finally, the in-situ data (sea currents, waves, sea level variations, sea temperature and suspended particles) gathered from the four monitoring stations of the HERMES project are transmitted in near real time to the dedicated HERMES Web GIS system for visualization and further dissemination for the needs of the project

## 3 The HERMES monitoring network

The HERMES monitoring stations were deployed in the four pilot sites of the HERMES project in Greece, Cyprus, Bulgaria and Albania (Paggaio, Larnaca, Varna and Shengjin). The pilot sites in Greece are situated within the boundaries of Paggaio Municipality in Thracian Sea–North Aegean Sea near the Strymonas river. The selected pilot sites in Cyprus located at the northeast coastline of the Larnaca Bay, particularly in Oroklini and in Zygi at the southern coastline of the island, both faced serious coastal erosion. The selected pilot sites in Bulgaria are coastal areas stretches along the northern and the southern shore of the Municipality of Varna. Both areas are affected by coastal erosion. The selected pilot sites in Albania are located along the northern coastal areas of Albania near the Shëngjin city and Buna River mouth. In order to take actions, the starting point is the knowledge of the complex phenomena governing the coastal hydrodynamic and sea conditions.

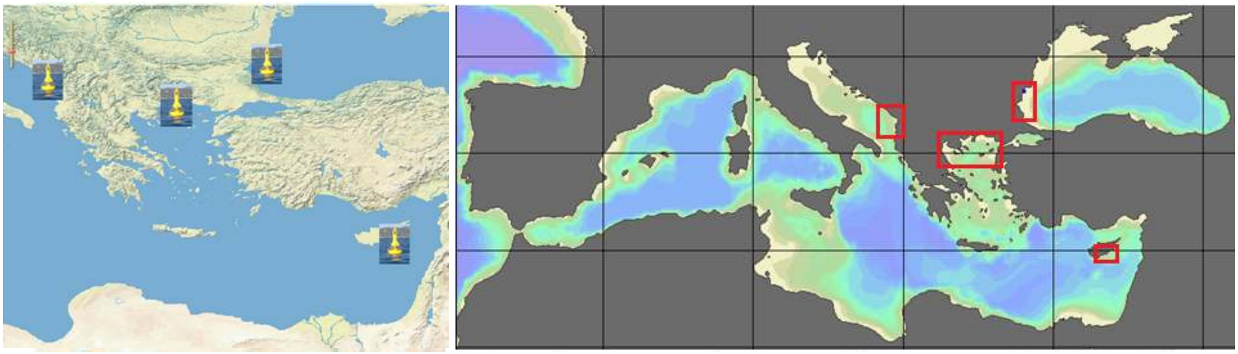

*Figure 1 : The HERMES buoys monitoring network (left) and the HERMES forecasting domains (right).*

### 4. The HERMES Web GIS

The HERMES Web GIS system visualizes the in-situ sea currents and waves data from the HERMES monitoring buoy network, which were deployed in the coastal areas of the four participating countries. Moreover, the Web GIS system provides the visualization of the forecasting sea currents, temperature, salinity, waves and winds data from the Copernicus CMEMS Med MFC, the CMEMS Black Sea MFC and the CYCOFOS in the four domains of the HERMES project. The HERMES WEB GIS includes the HERMES Server and User Interface. The HERMES server provides the archiving of the HERMES buoys data. Each HERMES buoy has its own local FTP which accumulate the data provided from the buoy. Few times a day the HERMES server download the data from the FTP servers to it's HERMES buoys database. The HERMES buoys database is realized at the base of MySQL and consists of 8 tables, i.e. 2 tables for each HERMES buoy's data. The HERMES WEB GIS User Interface provides data access of the in-situ and forecasting data. To access the forecasting data it is necessary to select the region and the forecasting parameters such as wave, current, temperature, salinity), hour, date and water depth. To access the in-situ monitoring data it is necessary to select the buoy's name and the parameter (current or wave parameters) and the time interval. The result is presented as a time series plot.

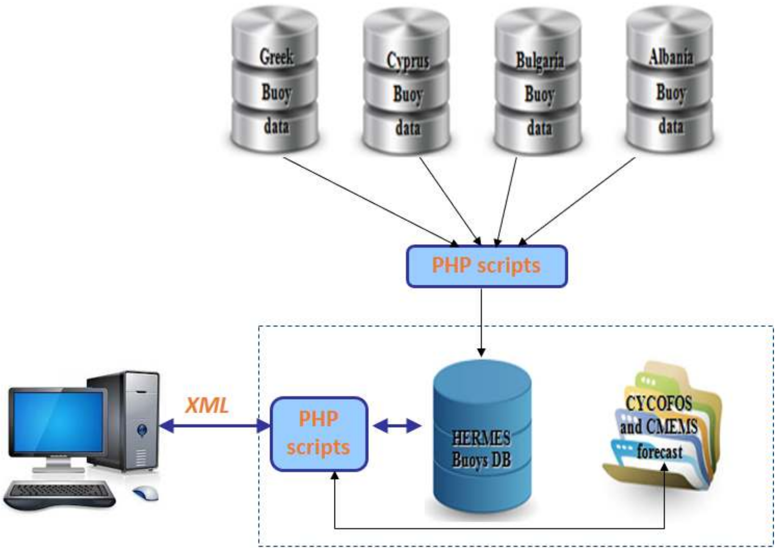


*Figure 2 : The HERMES Web GIS structure.*

# Assessment of Coastal Erosion Trends at Four Study Sites Using the Satellite Imagery

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The present study was carried out in the framework of an Interreg Balkan-Med co-funded research project ("HERMES: A HarmonizEd fRamework to Mitigate coastal EroSion promoting ICZM protocol implementation"), involving partners from Greece, Cyprus, Albania and Bulgaria. The study areas in each country (Buna, Shëngjin, Kune-Mat beaches in northern Albania; Galata, Pomorie-Aheloy, Byala, Burgas and Kranevo beaches in Bulgaria; Oroklini and Zygi beaches in Cyprus and Kariani and Ammolofi beaches in Greece) were selected based on their high economic and aesthetic values and their potential vulnerability to coastal erosion. Assessment of coastal erosion trends utilized consecutive historical Landsat satellite images during 1986 – 2017. For each image, the appropriate georeferenced method was applied and vector files were imported into a GIS environment. The rates-of-change and net shoreline movements have been computed by a statistical approach based on the Digital Shoreline Analysis System (DSAS). Severe erosion activity is mainly detected in Shengjin and Kune – Mat coastline in Albania and in Zygi and Oroklini in Cyprus. The Bulgarian coastal areas are the least eroded, mainly due to the construction of protection and reinforcement works. Focusing on the latest period, increased erosion rates are detected in Albania and in Greece (Ammolofi and Kariani).


*Figure. Annual rate of shoreline movement in the HERMES project study sites; a. Study sites of Albania, b. Study sites of Bulgaria, c. Study sites of Cyprus, d. Study sites of Greece.*

Keywords: Coastal erosion; satellite image analysis; rates of shoreline change; semi-automatic image classification; DSAS.

# Joint Monitoring System Deployment and Operation - Pilot Implementation of the Methodology at the four sides

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**HERMES BG1 oceanographic station description.**

The Oceanographic station HERMES BG1 was deployed on July 28th 2019 at the western coastline of Black Sea, near the Bulgarian city of Varna and in front of Saint Constantine and Helena beach at the depth of 22 m approximately (fig. 1). The oceanographic station transmits the measured parameters in real time and includes an AquaDop600 (current speed and direction for the entire column), a TideDroid (tidal gauge, a radar on a pole facing down), a WaveDroid (small directional wave buoy – wave parameters) and a CamDroid (time-laps camera) for parallel visual observation.

The measured parameters are stored in the internal memory of the deployed devices. The wave and sea-level data are also transmitted to onshore station in real time. The velocity data is periodically retrieved by cable to an onboard computer of a survey boat. A real-time ADCP-data transmission was successfully tested and will be activated soon. The DUTH approach for the Data Post-processing for SPM determination will take place at a later stage, when all the dataset is retrieved from the ADCP (cable connection to the buoy) and the unknown described above are supplied by Nortek.

**Free surface fluctuation - Tidal analysis.**

The analysis was carried out in MATLAB environment with the implementation of the application WORL TIDES by John Boon (Boon, 2020) based on the method known as Harmonic Analysis, Method of Least Squares (HAMELS). The results showed that the water level fluctuations in the study area can be mainly attributed to the meteorological forcing with ranges reaching up to 23 cm. On the other hand, the astronomical tide amplitude is very low, no more than ±1,2 cm. The type of the astronomical tide was defined as mixed semidiurnal with the calculation of the F constant (1.36) (Defant 1958).

**ADCP recordings analysis – description of wave climate.**

The wave data acquired by the HERMES BG1 buoy covered the time period between 28/07/2019 and 08/04/2020 producing a data set of approximately 12.000 recordings, one taken every 30 minutes. The parameters included wave significant height, wave peak period and wave direction.

The average Hsig was found to be approximately 0.68 m with a maximum of 3.2 m observed during a storm event. The correlation between Hsig and the peak propagation direction showed that in the study area the wave climate is characterized by waves coming mainly from south to east – northeast directions. The maximum wave heights are observed coming primarily form east-northeast directions but are also well distributed over the rest of the observed directions.

**SWAN wave model application and validation.**

SWAN wave model was implemented for the same time period producing for every hour results for the significant wave height, peak period and mean wave direction for a total of approximately 6000 sets. The same statistical analysis that was computed for the WaveDroid recordings was also applied here. The results showed that the simulation gave a good prediction for the main wave direction (east) and in total for the entire arc where the propagation directions are distributed (covering east-northeast to south). The average Hsig predicted by the model is 0.45 m and the maximum value is 1.92 m.

Regression analysis was carried out between the HERMES BG1 station and the SWAN model wave data showing a good agreement regarding the Hsig parameter with $R^2$ = 0.638 but poor agreement regarding the wave peak period with $R^2$=0.178.

The regression analysis between SWAN wave model predictions and WaveDroid recordings for the Hsig parameter during the storm events showed a relatively poor agreement ($R^2$ = 0.021) mainly due to the model's underestimation of Hsig which increases with the wave height.

**Hydrodynamic circulation – FINEL model validation.**

AquaDop600 was used to collect current speed and direction data from the entire water column below the buoy. The data were recorded every 10 min with a vertical resolution of 1 m (cell height = 1 m). A statistical analysis was carried out for the surface and bottom cell and the frequency distribution of speed- direction was calculated. According to the results the surface average current speed is 0.153 m/s, half of the correspondent average of the bottom current equal to 0.305 m/s. The prevalent directions for the surface currents are the north and north-northeast from which the maximum speeds are recorded. The bottom currents maximum speeds are recorded from the south and south-southwest direction which also present the highest frequencies. The surface current direction follows the general wind climate (Rusu et. Al., 2018) in the study area for the northern directions traveling parallel to the shore. The maximum speeds are 3.352 m/s and 3.365 m/s respectively for the surface and bottom currents.

The current data recorder by the AquaDop600 and those produced by the FINEL model were compared and the result showed a good agreement regarding both speed and direction.

# The role of sea dynamics to the coastal erosion in North-West Albania

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The Kune-Vaini and Patok lagoons are located in the northwest of Albania and are formed in sea bays by sediments transported by rivers. The hydro-geomorphologic dynamics of this coastal area is conditioned by the hydrology of the rivers and regime of the Adriatic Sea. The complex picture of the circulation is conjectured to be a balance between conventional forcing (tides, atmosphere, and buoyancy) and the effect of river plumes as small scales instabilities in the coastal regions of strong horizontal convergence under the effect of climate change. River mouths and deltas, lagoons system, sandy beaches, dunes covered with vegetation represent here an important natural area of great values. The coastline geomorphology is conditioned by the geological setting of the western side of Albanides. It is important also for the role of sea dynamics and solid discharge of Albanian Rivers to the Adriatic Sea and their sediment transport along the coastal zone. Climate determines coastal morphology through sea level and coastal processes. Coastal processes are mainly steered by wind waves, which produce the littoral currents able to transport littoral sediments. The coastal answer to fluid-dynamic actions is the origin of the morphodynamic changes, which so depends on climate changes.

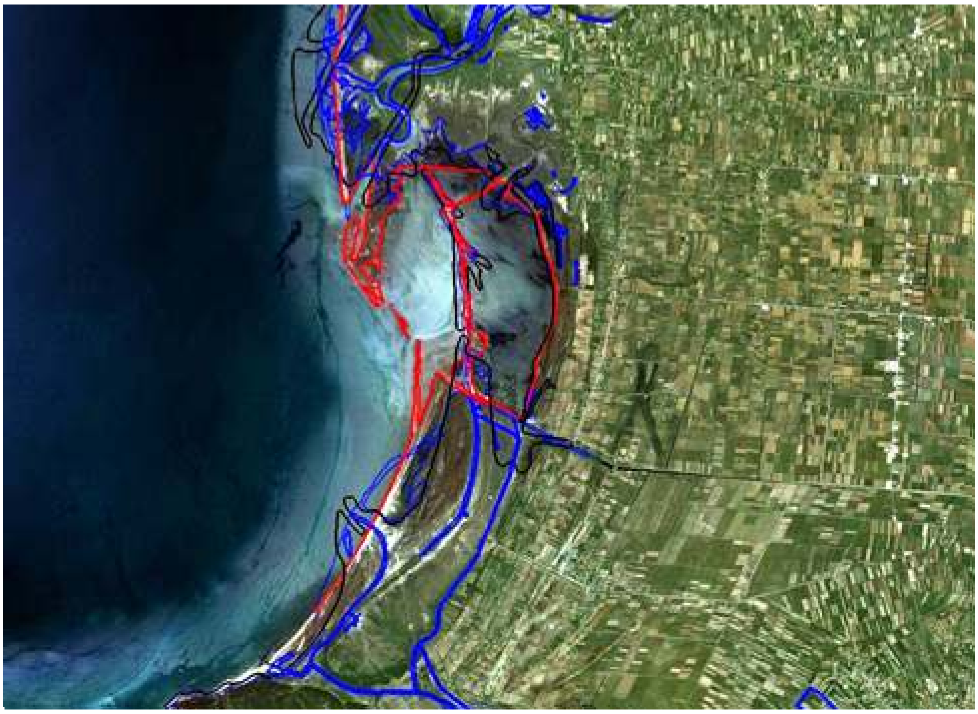

Figure 1: Patok lagune coastline movement 1956 Black, 1972 Blu, and 2020 Red

During the last half of the twentieth-century climate changes have been analyzed also based on the hydrometeorological data. There is an estimated continental water flow, created by atmospheric rainfalls and its impact on processes of the forming and circulation of the Adriatic Sea water mass has been analyzed. Albanian Adriatic Coastline study is based on integrated marine and onshore survey. Sandy's littoral belt along the coast has a width of up to 5 km. Dunes are situated along this belt. Dunes belts have a length of 25 km and an average width more of 50–100 m. Generally, the granulometry of quartzite sand deposits represented by fine sand. Erosive zones were developed in the littoral of the Adriatic Sea. In the erosion coast, usually, the sea bottom is sandy. During the period 1972–2020 coastal water line has changed of 175 m toward the mainland. The warming period in Albania is accompanied by changes in the rainfall regime, wind speed, and storms. Inland water resources change has an impact on the hydrographic regime of the Adriatic Sea (Pano, N., 2008). Because of complex mechanisms, nobody expects to be able to reproduce all aspects of nonlinearity. The climate changes have their impact on the country water system, on and water resources, on the erosion processes, and the hydrographic regime of the Adriatic Sea. The strong influence of river discharges in the general circulation pattern is revealed by the results.

# The I-STORMS Strategy. Toward a more appropriate management of coastal flooding in the Adriatic-Ionian (ADRION) region.

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**Keywords:** coastal risk management, coastal risk strategy, I-STORMS project, storm surge, sea storms

**The I-STORMS Strategy** addressed to **national/regional key players** of the **ADRION basin** aims at suggesting the most effective way to deal with **management of data and forecasts and related Early Warning procedures**. The strategy is based on the findings of the I-STORMS Guidelines and provides a link with the EU Civil Protection Mechanism and a consistency with the European legislative framework. Climate change has created a new reality with more intense and destructive extreme weather conditions and the results are more catastrophic than ever. Hence, it is necessary that the cooperation mechanism be developed in order to be able to cope with the new challenges related to climate change effects. Current efforts shall be strengthened, while **new technologies will be used** in order for draft and implement effective strategies.

The I-STORMS project (https://istorms.adrioninterreg.eu/) aims precisely to give an answer to these events in terms of **prevention** and **early warning**, and in doing so, to provide citizens, civil protection and authorities with the tools to develop **appropriate management measures** to deal with territorial challenges connected to coastal flooding in the Adriatic-Ionian (ADRION) region. **A strategic and integrated approach** can help all ADRION countries in managing coastal risk through cooperation and the exchange of knowledge and good practices, working on two levels:

1) **International level**, which includes transnational cooperation for information and data exchange and integrated risk management
2) **National level**, which concerns the development of legislation, plans and tools for managing sea storms risk coordinated between the state, regions and local authorities.

**I-STORMS Strategy** for reducing coastal risk at a National and International level is mainly based on **4 pillars**:

1. Data & Information sharing for integrated tools
2. Cooperation & Coordination
3. Communication & Stakeholder involvement
4. Exercises & Volunteers

The strategy starts from **sharing data, tools and information at all levels** to meet the need for reliable forecasts, monitoring data and all the information useful in preventing and dealing with weather-marine phenomena. These data and forecasts, shared between the countries along the Adriatic-Ionian basin, must allow for the creation of **early warning procedures connected with**

**predefined risk scenarios** taking into account vulnerability and exposition of territories and **cost/loss models**.

In addition to the integrated and interoperable databases, it is essential that those **human resources** that perform the activities required by the alert systems **are guaranteed.** Currently Civil Protection **volunteers are a fundamental and important resource** for event monitoring and emergency management and without them the efficiency of the whole mechanism would be compromised. It is therefore important to promote **laws, procedures and mechanisms that strengthen those staff in charge and extend the resources of civil protection volunteers**.

**Cooperation** among ADRION partners is ensured even beyond the duration of the project through **a permanent cooperation table** at the Adriatic-Ionian basin level to evaluate annual developments and tools in the coastal risk sector and to discuss and make the existing and new tools available as well as their implementation. In order to strengthen intra-regional and national coordination among stakeholders it is important to build **effective Governance structures** and to create **thematic networks** for the **sharing of knowledge and good practices**.

Further still, **the enhancement of communication through institutional channels**, responding to users' information needs, is an important step in increasing the effectiveness of warning systems and their results in terms of reducing damage to people and property. **Institutional sources** that are recognized and perceived as reliable, in particular those closest to local level, **should give all available and useful information clearly to citizens**. **Communication protocols** have to be identified and used to satisfy these requirements. It is important to develop **communication strategies coordinated** between the different levels of governance (national, regional and local) and these must take into account all the types of recipients to whom they are addressed.

Information on these issues is essential and should start from **schools** with specific **training**. Coastal communities have **to be prepared and this is possible through appropriate education programs**. Even with near real-time warning systems, sea storm events and tsunamis require rapid reactions from potentially affected populations in order to prevent damage. It is therefore important that **coastal communities be equipped with appropriate emergency response plans**.

Governments alone cannot address risk management. The opportunity to **involve stakeholders** in the management and communication of sea storm risk is fundamental, in particular Civil Protection associations, port authorities, beach manager cooperatives and other sea-related activities, schools and all potential stakeholders in the tourism sector.

Finally it is fundamental that **the alert systems and defined intervention models are tested** by the operators of the system, but also by stakeholders and coastal communities, in a practical way through **exercises** and so providing feedback on their effectiveness as well as critical issues encountered in order to improve the response to storm surge events.

# Numerical modeling of waves, currents and morpho-dynamics in western Thracian Sea (HERMES Modelling Toolbox)

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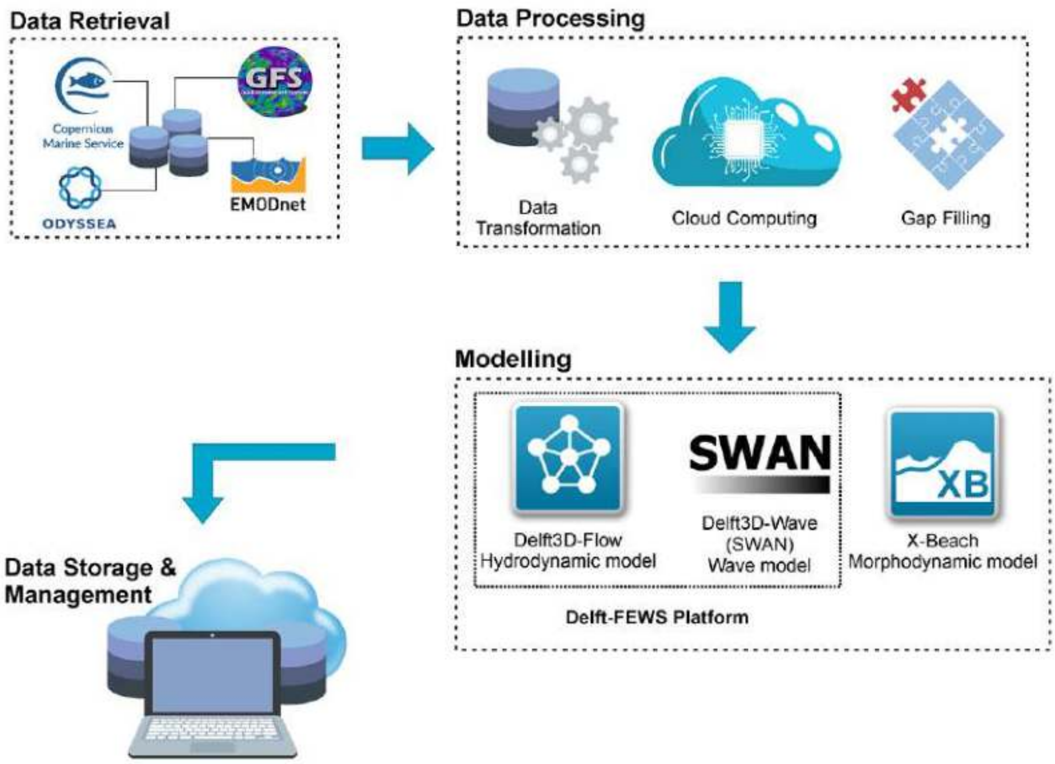
**Abstract**

This presentation examines the integration of modeling systems (a hydrodynamic model named Delft3D-FLOW and a wave model called Delft3D-WAVE) into a unique toolbox capable to provide operational forecasts of oceanographic properties in the nearshore zone of the pilot study areas. Parameters as waves (significant wave height, wave period and wave direction), currents (speed and direction at various layers throughout the water column), water temperature, salinity and density profiles will be produced as short-term forecasts through this system. Both models run in operational mode to forecast the conditions prevailing at the open sea and the nearshore zone. Models' grid is downscaling the existing Copernicus modelling products grid, thus the system provides high-resolution forecasts of marine conditions over the entire Thracian Sea, focusing on the area along the Paggaion Municipality coastline.

Wind data from the Climate Change database were analyzed to derive the probability for extreme value events affecting the Paggaion Municipality coastline. More specifically, the mean daily wind data from year 2006 to year 2100 retrieved from CORDEX RCM model runs, exhibiting the most frequent storm events in the broader Thracian Sea area, were analyzed using Extreme Value Analysis These winds served the forcing for extreme deep-to-nearshore extreme waves, simulated by the SWAN, to assess the risk of climate change at certain locations of the Paggaion Municipality shoreline.




For this reason, the period at the beginning of the 21st century (2006-2030) were considered as representing the near-present climatic conditions, while the period at the end of century (2060-2090) were considered as including the effects of climate change expected throughout this century. The expected extreme winds induced a JONSWAP wave spectrum propagating over the study area to affect the nearshore zone. The influence of wave shoaling and refraction were estimated as well as the breaker zone dynamics were computed deriving values for the effective longshore current and the annual longshore sediment transport, and the impact of these extreme waves on the beach-dune erosion were evaluated. The impact of the wave characteristics on the beach dynamics under climate change conditions were assessed by the implementation of the nearshore morpho-dynamic model X-Beach with the creation of three different scenarios of extreme waves.

**Key words:** operational modelling, Delft-FEWS, X-Beach, morpho-dynamic modelling, nearshore zone, high-resolution forecast

# MHI information resources to support the research of the Black Sea coastal zone

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### Introduction

The status of the coastal zone environment and the processes taking place in this area have a significant influence on human living being and marine economy of the seashore countries. Solving problems of the integrated coastal zone management, studies and analysis of the processes determining its evolution, and forecast of possible changes need reliable information support. At present, new information resources to support the survey and research of the Black Sea coastal zone such as dedicated databases, GIS and web site were recently developed in the Marine Hydrophysical Institute of the Russian Academy of Science (MHI-RAS).

### Database

The dedicated database for supporting the coastal research in the Black Sea consists of two blocks. One of them includes oceanographic data in the coastal area; the other one contains data obtained from the survey and from remote sensing monitoring of the coastal zone (Figure 1).

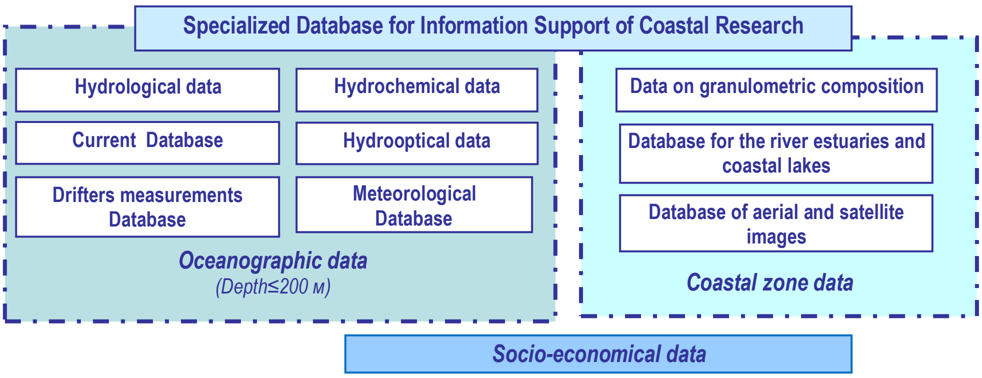


Figure 1: The structure of the specialized database for information support of coastal research.

The oceanographic block is constructed using the Black Sea specialized database of the oceanographic data bank of MHI-RAS [1,2]. It contains more than 55,500 oceanographic and 11,000 hydrochemical stations. The socio-economical data includes urban population, population density, infrastructure (roads,railways and etc.), industrial production, and etc. The main source of this information is government statistics site (gks.ru).

### Data access software

The Black Sea GIS software developed at the MHI-RAS [2,3,4] was taken as the basis to provide the data access via Internet. This software enables selecting and visualizing tabular data kept in relational databases, as well as textual and graphical information. The Black Sea GIS module structure gives an opportunity for a further extends of the dedicated databases. An example of the results of the queries for oceanographyc data in the Black Sea coastal zone and for the granulometric composition of the Anapa bay-bar (photo of landscape for the selected profile) are shown in Figure 2.

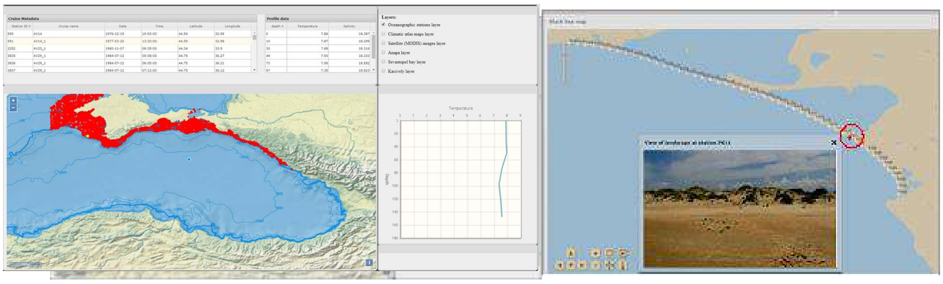

Figure 2: a – Result of oceanographic data selection; b – Photo of landscape for the profile.

**Web site "The sea coast of Crimea»**

Web site "The sea coast of Crimea» (http://coast-crimea.ru/) has 8 main sections: sea coast of Crimea, overview, expeditions, bibliography, research team, publications, projects and news. The main page contains general information about the types of sea coasts, anthropogenic impact on the coastal zone, information about the monograph album «Sea coast of Crimea».

**Conclusions**

MHI-RAS is currently working to develop a comprehensive common system for the needs of a wide range of coastal zone researchers, with an optimized query system, while addressing the integrated database, having the capabilities to add new data to the databases.

**Acknowledgements**

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# Smart Ways for Discerning Marine Debris at the Sea and the Shores

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**The Problem of Marine Debris.**

Marine debris currently constitutes one of the chief threats to marine and coastal life, as shown in Figure 1. Plastics and other durable materials could harbour marine life and could act as a springboard to the introduction of alien species in other marine and coastal zones. When plastic and other objects decompose, they form microscopic fragments which usually exhibit toxic properties. As a pre-prerequisite to formulating effective remedies for addressing the problem of marine debris there is a need to acquire a good understanding of the type and distribution of floating marine debris objects. Towed nets are currently used to retrieve anthropogenic marine debris from the sea as the typical way of gaining an idea as to the composition and extent of marine debris that litters the sea.

Figure 1: Left snapshot shows a marine turtle trapped in a fishing net while the right hand image reveals the ingested objects encountered in the stomach of a sea gull that possibly cost the bird's life.

**Research Methodology and Results.**

To overcome the limitation of having to rely entirely on manual means, that are both time consuming and expensive, to retrieve marine debris here we outline an intelligent way for identifying marine debris at the sea and the shorelines. The approach utilizes the bottleneck method which is able to classify seven (7) categories of inanimate objects plus one (1) category of marine life. Results, as illustrated in Figure 2, yield a 90% success rate. Categories comprise plastic bags, bottles, buckets, food wrappings, straws, derelict nets, fish and other bodies. We have also demonstrated that the deep-learning approach is literally insensitive of the resolution of the image. Concluding, we believe the proposed method with help develop and deploy smart and efficient tools able to identify floating debris at the sea surface, the seabed and the shores.

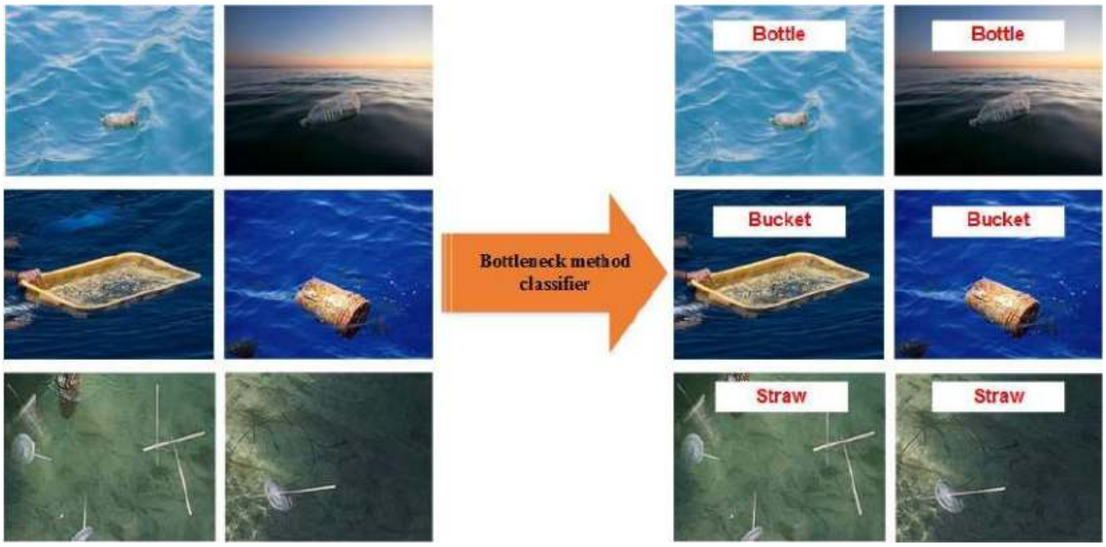


Figure 2: Images display a sample of the marine debris objects that were successfully identified by the image recognition technique. Labels appearing to images, on the right matrix, denote correct classifications.

# A new model for cross-shore surf and swash zone morphology evolution induced by nonlinear waves

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## Introduction

Erosion poses a continuous threat for coasts and coastal communities worldwide. Nowadays coastal erosion is being intensively investigated due to the expected impact of climate change on the intensity of the drivers behind it (both natural- and human- induced) and its direct association to the iunndation of low-lying areas. In the above context, numerical models are indespensable tools for the design of coastal protection and adaptation measures and, as such, their accuracy and reliability is continuously tested in both research and engineering applications.

In the present work, a new model for surf and swash zone morphology evolution induced by nonlinear waves is tested against laboratory measurements of profile morphology evolution. The innovation of this work is the validation of a new Boussinesq-type morphopology model under both erosive and accretive conditions in the foreshore (accretion is rarely examinded in similar studies), which the model reproduced very well and without the use of an erosion/accretion criterion.

## The wave and morphology evolution model

The advanced phase-resolving wave model based on the higher-order Boussinesq-type equations used in this work is described in detail in Karambas and Samaras (2014), following the work of Karambas and Koutitas (2002). Regarding the sediment transport module, this work builds on the improvements introduced by Karambas and Samaras (2014) and adopts the latest update of the transport formula of Camenen and Larson (2007) proposed by Zhang and Larson (2020).

Bed load and sheet flow transport is simulated using (Zhang and Larson, 2020; plese see reference for full analysis):

$$q_{sa} = a_w \sqrt{\frac{f_w}{\tan\Phi_m}} d_{50} \hat{u} K_n^{1/2} \left| \frac{dh_e}{dx} - \frac{\partial h}{\partial x} \right|^{1/2} \text{sign}\left( \frac{dh_e}{dx} - \frac{\partial h}{\partial x} \right) \theta_{cw,m} \exp\left( -b \frac{\theta_{cr}}{\theta_{cw}} \right) \quad (1)$$

(1)

In Equation (1), it is noted that $\theta_{cw,m}, \theta_{cw}$ are the mean and maximum Shields parameters and $\theta_{cr}$ is the critical Shields parameter for the inception of transport, while both the phase-lag and acceleration effects are introduced as in Camenen and Larson (2007). Suspended load is simulated as in Karambas and Samaras (2014). The methodology adopted for the series of model applications can be encoded into the steps also described in Karambas and Samaras (2014).

**Applications and Results**

In this work, the wave and morphology evolution model is tested against two sets of experiments on beach profile change, namely the U.S. Army Corps of Engineers (CE) experiments and the Central Research Institute of Electric Power Industry (CRIEPI) experiments, as presented in Dette et al. (2002). Figure 1 shows the comparison of the computed and measured profiles for Tests 1-3 and 3-1 of the CRIEPI experiments.

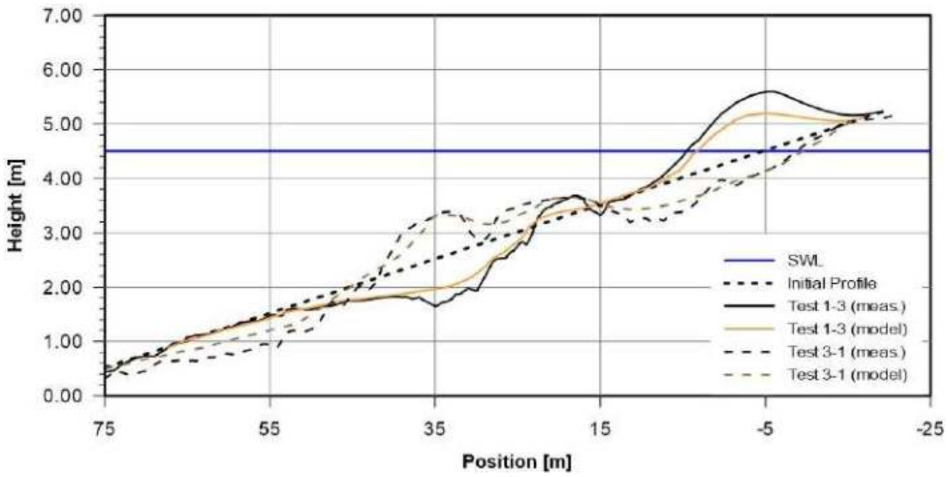


Figure 1: Comparison of the computed and measured profiles for Tests 1-3 and 3-1 of the CRIEPI experiments.

**Conclusions**

This work presents a new advanced phase-resolving nonlinear wave, sediment transport and bed morphology evolution model, building on previous work by the authors and adopting a new formula for the calculation of sediment transport. The model is tested againg laboratory measurements of profile morphology evolution. Model results are in very good agreement with the experimental datasets, focusing in particular on the representation of accretive conditions in the foreshore (rarely examined in similar studies). The presented set of applications highlights model capabilities, as well as its suitability for coastal erosion mitigation and beach restoration design.

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# Evaluating coastal erosion risks in the Ugento shoreline: a Machine Learning approach supporting multi-scenario analysis

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Climate change is causing severe threats to natural and human systems worldwide, with relevant impacts on coastal areas where land-sea interaction occurs. According to the IPCC scenarios, they will be increasingly exposed to erosion, as direct consequence of rising sea level and changing patterns of extreme events. Located at the land-sea interface, coastal areas are dynamic environments where natural and anthropogenic pressures interact at diverse spatio-temporal scales modifying their geomorphological, physical and biological features. Against this interplay, coastal managers are increasingly calling for new approaches supporting a multi-scenario evaluation of multiple risks arising from natural and anthropic stressors.

Moving beyond traditional approaches for coastal erosion risk and vulnerability appraisal, a GIS-based Bayesian Network (BN) approach was developed, exploiting functionalities of machine learning to evaluate the probability and uncertainty of coastal erosion risks, and connected water quality variation, against multiple '*what-if'* scenarios, including different management measures (i.e. nature-based solution) and climate conditions (e.g. higher coastal waves) (Figure 1).

According to the spatial resolution of the available data for the case study of the municipality of Ugento (Apulia Region-Italy), the proposed BN-model was trained and validated by considering oceanographic and water quality parameters over the 2009-2018 timeframe, allowing to capture local-scale shoreline erosion dynamics and related driving forces.

The resulting output from the BN-based scenario analysis showed, even if in a minor extent, a nexus between oceanographic drivers, shoreline evolution and water quality parameters (i.e. suspended matter and diffuse attenuation), with increasing probability of high erosion/accretion along the coast and higher turbidity under potential rising maximum significant wave height.

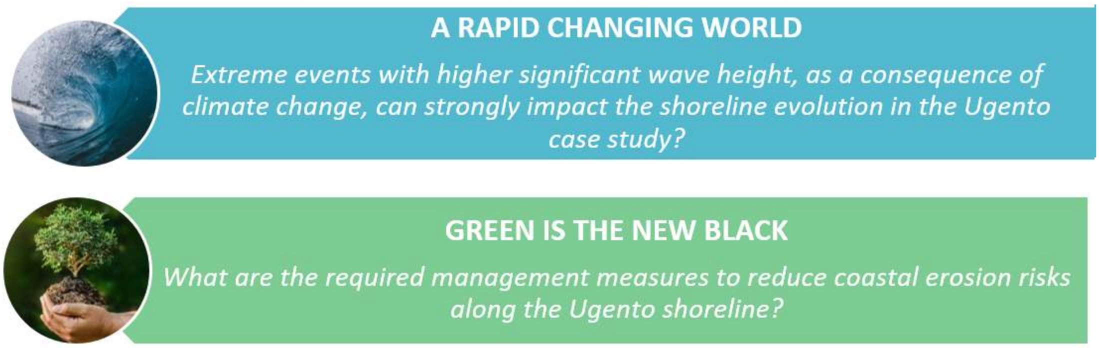


Figure 1: Scenarios envisioned for the Ugento shoreline case study

Despite constraints posed by the spatial resolution of the available data for the investigated case, the outcomes of the performed assessment represent valuable information to support adaptive policy pathways in the context of Integrated Coastal Zone Management and Disaster Risk Reduction in the Ugento shoreline.

# Assessment of coastal erosion and climate change vulnerability using environmental and socioeconomic indices

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Climate change has significant repercussions on the natural environment, triggering changes in the natural processes that might have a severe socio-economic impact on the coastal zone; where a great number of human activities are concentrated. So far, the estimation of coastal vulnerability has been based, primarily, on the natural processes and, secondarily, on socio-economic variables, which would assist in the identification of vulnerable coastal sectors. The present investigation examines the vulnerability of a coastal areas in Larnaca bay. Larnaca with 94 Km of coastline and 46,666 inhabitants covers the central part of the southern shoreline on the island of Cyprus.More precisely, this research is focused at the coastal zone of Oroklini and Ormideia. The Lanaca bay coastal area host many land uses e.g. agricultural, industrial and tourism but also an important natural monument, the Larnaca Salt lakes. Larnaca is very rich in cultural heritage, especially from the ancient periods and are closely related to tourism. The coast in Larnaca District is mainly flat or slightly hilly with sandy and rocky beaches. During the last three decades, the island experiences a very rapid touristic development, which is by 90% concentrated along the coasts. To prevent coastal erosion, it decided in the late 70s to construct various types and sizes of small-scale groynes and breakwaters were constructed along the shoreline, but the erosion phenomena contineu to be a major issue.

The methodology is based on the combination of socio-economic indicators and existing environmnetal indicators, GIS-based, of the coastal vulnerability index (CVI) for sea level rise and related wave-induced erosion. This approach includes three sub-indices that contribute equally to the overall index. The sub-indices refer to coastal forcing indicators related to extreme natural events; (ii) socio-economic indicators, such as those of population, cultural heritage sites, transport networks, land use and protection measures; and, (iii) indicators of coastal characteristics (CC) sub-index that refer to both geological variables (i.e. coastal geomorphology, historical coastline changes, and regional coastal slope) and marine processes (i.e. relative sea level rise, mean significant wave height, and tidal range). All variables are ranked on a 1-5 scale with the rank 5 indicating the highest vulnerability. The socio-economic sub-index includes, as indicators, the population of the study area, cultural heritage sites, transport networks, land use and protection measures. The coastal forcing sub-index includes the frequency of extreme events, while the Coastal Vulnerability Index includes the geological variables (coastal geomorphology, historical coastline changes, and regional coastal slope) and the variables representing the marine processes (relative sea level rise, mean significant wave height, and tidal range). Estimations using CVI show that, the 39.93%) of the coastline is characterized as High vulnerability areas. A very small percentage (0.2 %) is classified as low vulnerability areas. Very High vulnerability areas correspond to 17.06 %. Very low and medium vulnerability ranks represent the 12.53 and 30.26 % of the total coastline length respectively. The schematic presentation of the CVI classification is shown in figure 1b. According to the results of the index SocCVI, there aren't any areas with Very Low, low and Very High vulnerability, while 87.46 % of the coastline is characterized as Medium Vulnerability coasts, and the 12.53% as High. They consist mainly of areas with low slopes and human constructions in the coastline, mainly touristic and industrial. The schematic presentation of the sub-indices are shown in figure 1a, while the SocCVI classification is shown in Figure 1b.

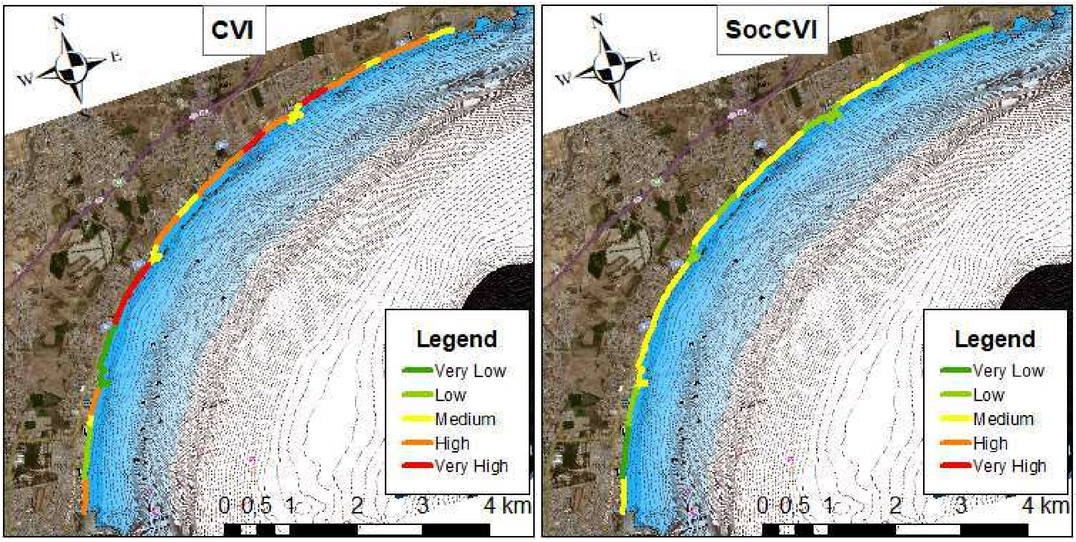


Figure 1a ;b: Vulnerability ranking for CVI and SocCVI.

The comparison of the results from the two indices shows that the CVI ranks most of the coastline to the category of high vulnerability with the remaining part to the extreme categories i.e., Very Low and Very High. It seems to be controlled mainly by the morphological variables. On the other hand, the SocCVI characterises the coastline mainly as of Medium vulnerability. This is explained by the addition to the natural variables, those expressing the socioeconomic value related to man-made structures and heritage sites. In areas where there are no human activities, the ranking is lower even if the area is more vulnerable in terms of its environmental setting. In addition to the above, the relative influence of each of the three sub-indices of the SocCVI index has been estimated too. In addition to the above, the relative influence of each of the three sub-indices of the SocCVI index is presented graphically in Figure 1b. Moreover, the sub-indices of coastal characteristics (CC) seem to dominate the overall SocCVI score. The indicators that are selected for the coastal vulnerability analysis can strongly influence its final justification. The addition of socio-economic variables in coastal vulnerability indices based initially only on natural processes is of high importance, even though the accurate quantification of most of them remains a serious challenge. The input of socio-economic variables in a coastal vulnerability assessment studies could be proved a useful tool for making coastal management decisions more focused to the actual needs of the society.

# The organization of coastal space of Velipoja -The challenge in economy and urban development

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This presentation aims to evidence the economic transformations in the administrative unit of Velipoja. The challenges facing today man in relation to the territorial nature require a review of its activities, in terms of organizational of all potential elements of society, who can influence and help avoid injury and regeneration of caused. During the transition process is not given much importance of territorial planning initiatives. Dynamic urbanization process without a certain strategy was associated with a total negligence on the coastal environment of Velipoje coast area has been assessed more frequently, as a high value area development, but actually underwent speculative development. The commune of Velipoje territory has a very good location but the remaining coastal developments uncontrolled speculative and far from administration and planning in accordance with the principles of sustainable urban development.

**Key words**: economy, urban planning, social impact.

# Early studies of Land Cover Change in coastal East Surabaya, Indonesia Using Remote Sensing Data

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Surabaya is one of the coastal cities in Indonesia, where the condition of the coastal dynamic nature of changing every moment. In recent years, changes land cover in Surabaya coastal area has affect of coastline. Multitemporal monitoring coastal areas can use the technology of Remote Sensing. Surabaya coastal are scattered in West Surabaya, North Surabaya and East Surabaya. Based on visual data from remote sensing, showed changes land cover in Eastern Surabaya coastal area is so dynamic, monitoring coastal area is needed.

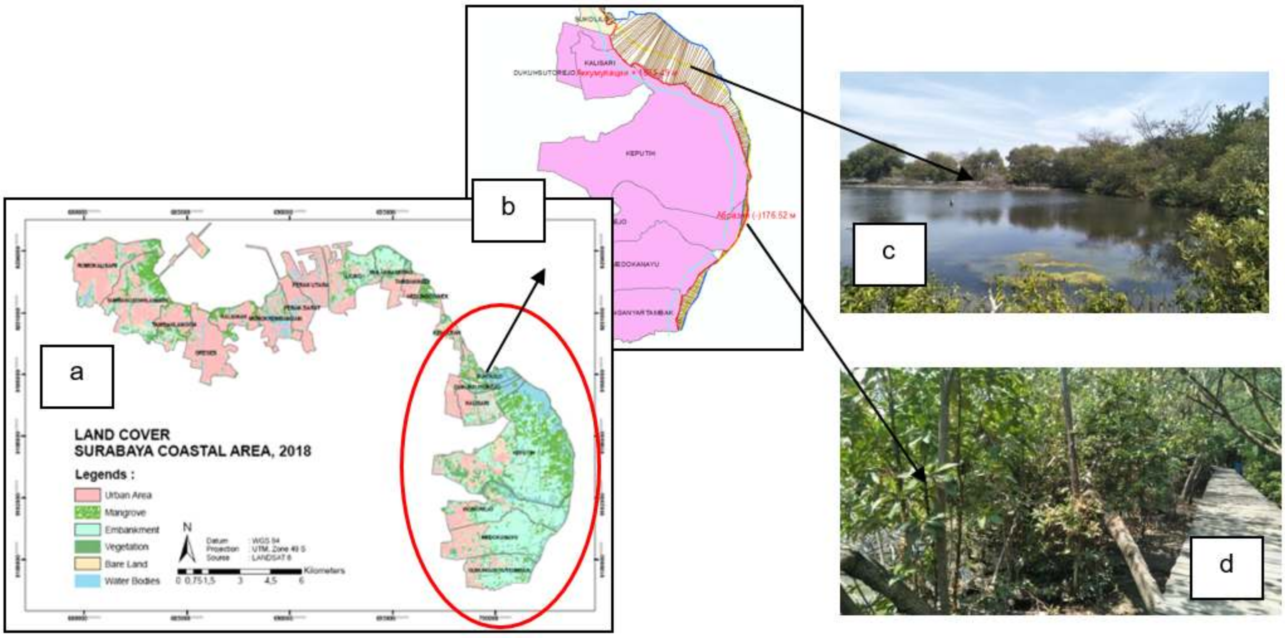


Figure 1. Map of Research (a); Eastern Surabaya Coastal area (b);

Conditions of Embankment (c) and Mangrove Area (d)

The purpose of this study is to determine the dynamics of land cover change in Surabaya coastal areas, particularly in the East of Surabaya (year 1994-2018). Data used in this research were Landsat 5 (1994) and Landsat OLI 8 (year 2018). The method analysis using the maximum likehood method (MLM), indicates that there are several land cover classes in all districts of East Surabaya. Since 1994-2018, coastal area has erosion coastline process, mangrove area was reduced about -0.981 km2 and accretion coastline process looks quite large in Dukuh Sutorejo district, Kalisari district, and Keputih district. Data analysis showed that the data for additional land cover changes caused by the growth of the housing area (settlement) of 4.9059 km2 and reduced the bare area of -4.3236 km2. The reduction of bare area caused by the addition of residential areas and industry, beside that based on field data, land cover changes also into the fish ponds. More than 20 years, the total change in area of East Surabaya by 7.0992 km2.

# Facts, Fables and Political Opportunism
# with regards to coastal erosion and climate change

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**Introduction**

Climate change is often blamed for increasing the problems with coastal erosion. However, analysis shows that often political opportunism is a much more driving factor for (apparent) coastal erosion. To analyse this it is good to distinguish two types erosion:

- Chronic erosion: erosion caused by a gradient in longshore transport or by sea level rise
- Acute erosion: erosion cause by attack during storms

**Chronic erosion.**

A gradient in longshore transport has nothing to do with climate change. But human works may also create such a gradient (like groyne construction). Local decision makers prefer in such cases not to blame the groyne construction, but the climate change. Then they assume responsibility is elsewhere.

The effect of sea level rise can be determined quite accurately with the Bruun rule. This rule assumes that the shape of the coastal profile is not changing due to sea level rise, and that there is no supply or depletion of sand from elsewhere (so no gradient effect). For a typical non tidal beach it is shown that 1 m sea level rise will result in approx. 20 m of coastal retreat of the waterline and 30 m retreat of the dune line (example from Shkorpilovtsi, Bulgaria). At that specific location this does not cause any problems.

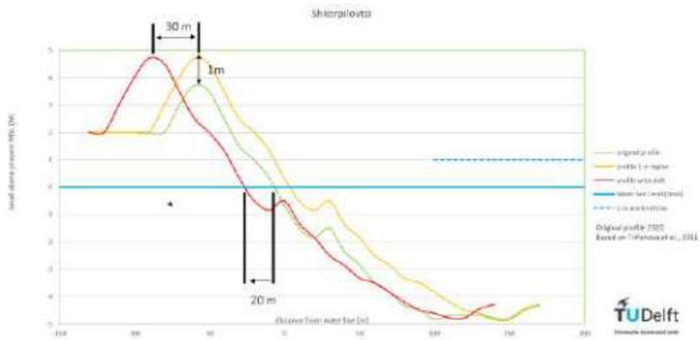


Figure 1: Coastal erosion due to 1 m of sea level rise at Shkorpilovtsi using the Bruun rule

When projecting the same erosion on a very developed beach (e.g. Golden Sands, Bulgaria) it is shown that the useable beach area decreases considerably. It seems that only one third of the beach remains. However, other beach developments have already taken a large part of that beach, in the order of tree times the expected erosion in the next 100 years.

Practically there are two solutions for this location: removing the existing development on the beach or execute beach nourishment. Probably beach nourishment is most economic, it will cost in the order of € 100,000 per year for this 2.5 km of beach with a high economic value.

**Acute erosion.**

During storms the waterlevel will rise by wind set-up. The combination of a higher water level and the big waves will result in an adaptation of the coastal profile to a typical storm profile. Basically this means that sand is transported from the higher beach and dune front to deeper water (in the breaker zone). When there is no gradient in longshore transport on the long run (mainly during calm weather) this sand dumped in deeper water will come back to the higher beach and dune front. However, for developments on the beach or on the seaward side of the dune it means that they are destroyed.

Preventing problems due to acute erosion is technically simple, one should determine a set-back line and building seaward of this line no constructions should be allowed. However worldwide maintaining such set-back lines is a political problems. The value of seafront property is very high, so politicians are easily convinced to allow sea front development in hazardous zones because the (rich) owners of the property are extremely influential.

**Example.**

As an example the construction of a dance club along the coast near Varna (Bulgaria) is considered. This is a steep cliff coast with a generic shortage of sand and a small longshore transport. Supply of sand is limited, the main source of beach sand is the eroding cliff itself. But due to cliff-foot protection the supply of sand has become virtually zero. To avoid disappearance of the beach a number of T-groynes have been constructed. The beach of the city centre itself remains in position because of the big harbour breakwater at the south side of this beach.

The beach is at this moment relatively stable, although there are minor fluctuations, depending of the wave conditions of de subsequent years. During storms some sand will erode to deeper water, this will come back in the following summer season(s). At the northern end of te beach on a narrow section of the beach the discotheque Xtravanganza has been constructed. The owners complain that the beach in front of the property disappears. However, comparing maps before and after construction show that the waterline was not changed at all. The beach has disappeared because it was completely used by the club building.

After some years the building was seriously damaged by a storm. The beach was partly washed away, but recovered quite fast. And the owners decided to rebuild it (in a more expensive way) on exactly the same place.

**Conclusions.**

Climate change may cause extra coastal erosion, but for a sandy coastline the effect is limited. A change in wind direction might have a substantial effect. Increase of storminess is a problem, but can easily be accommodated for. However because of the high economical value of coastal property there is a unhealthy pressure to compromise set-back lines. The effect of lousy coastal zone management is more severe than the effect of climate change. But politically it is very handy to blame climate change.

# Climate Change Expected Impacts and Nature Based Solutions design for coastal protection

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The IPCC climate change scenarios at the HERMES Greek pilot study area is examined and assessed. Specifically, the methodological approach followed is based on the use of climate data obtained from COordinated Regional climate Downscaling Experiment (CORDEX), for a period of almost 100 years (2006-2100). The retrieval of climate data was achieved with the development of an algorithm for reading and writing subsets of the variables in remote server of the Earth System Grid Federation (ESGF) Peer-to-Peer (P2P) enterprise system.

Analysis involved the processing of wind data from the Climate Change database, to derive the probability for extreme value events affecting the Paggaion Municipality coastline. More specifically, the mean daily wind data for the period 2006 to 2100 as retrieved from the Dataset 12 of the various CORDEX RCM model runs, considered as exhibiting the most frequent storm events in the broader Thracian Sea area, will be further analyzed using the Extreme Value Analysis Theories. Analysis aimed to determine the probability of theoretical storm occurrence within certain return periods (25, 50 and 100 years). EVA was applied on two distinct datasets: a) the period representing the wind conditions at the beginning of the 21st century (2006-2030), considered as the near-present climatic conditions, and b) the period at the end of century (2060-2090), considered as including the effects of climate change expected throughout this century. The expected extreme winds were fitted on a Jonswap wave spectrum, propagating over the study area to affect the nearshore zone. Results of EVA analysis forced the morpho-dynamic model XBeach implemented in the study area to understand the changes expected under the Climate Change in the present century.

**Table 3. Return levels for the periods 2006-2030 and 2060-2090.**

| Return Levels (in m/s) | Period 2006-2030 | Period 2060-2090 |
|---|---|---|
| 25 years | 17.627 | 19.689 |
| 50 years | 18.835 | 21.621 |
| 100 years | 20.043 | 23.627 |

In the area of Kariani a coastal marine was built, disrupting the sediment balance of the area. The whole coastline up to 2.5 km to the west of the marina was highly affected by the small harbor, thus a large mean annual erosion rate of ~ -1.8 m/yr and a maximum rate of around -5 m/yr. The total eroded area is estimated around 0.068 $km^2$. In parallel, along the western pier of the marina, a significant amount of sediments is being deposited with annual rate of ~ +0.7 m/yr. The total area of deposited sediments is around 26,139 sq. m with an average accretion rate of 1.4 m/year.


Figure 1. The coastal erosion (in red color) and deposition (green color) along the coastal zone of Kariani.

A sediment transport model, following the Pelnard and Considere (1956) approach was implemented. Model results showed that the time needed to accumulate sediments along the whole length of the groin is 2,350 days ~ 6.43 years. This leads to a ratio of sedimentation length to total groin length of 0.0583. As the sediment transport trapped by the groin is 0.0027 $m^3/s$, the total amount of sediment entrapped by the groin over the 6.43 years is ~ 548,200 $m^3$. Part of this material could be used to fill the geotube and nourish the eroded beach at the western (downstream) part of the marina.

Considering that the entrapped sand deposited along the eastern pier has collected approximately 548,200 $m^3$ over 6.5 years, the required sand volumes for beach nourishment and geotube filling for the three scenarios will be just 1.37%, 1.16% and 1.83% of the total deposited sand volume, respectively.

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## The HERMES project partnership

Lead Beneficiary

**Municipality of Paggaio**, *http://www.dimospaggaiou.gr*

Partner Beneficiary 2

**Democritus University of Thrace, Department of Environmental Engineering, Laboratory of Ecological Engineering & Technology**, *http://www.env.duth.gr/labs/ecological.en.shtml*

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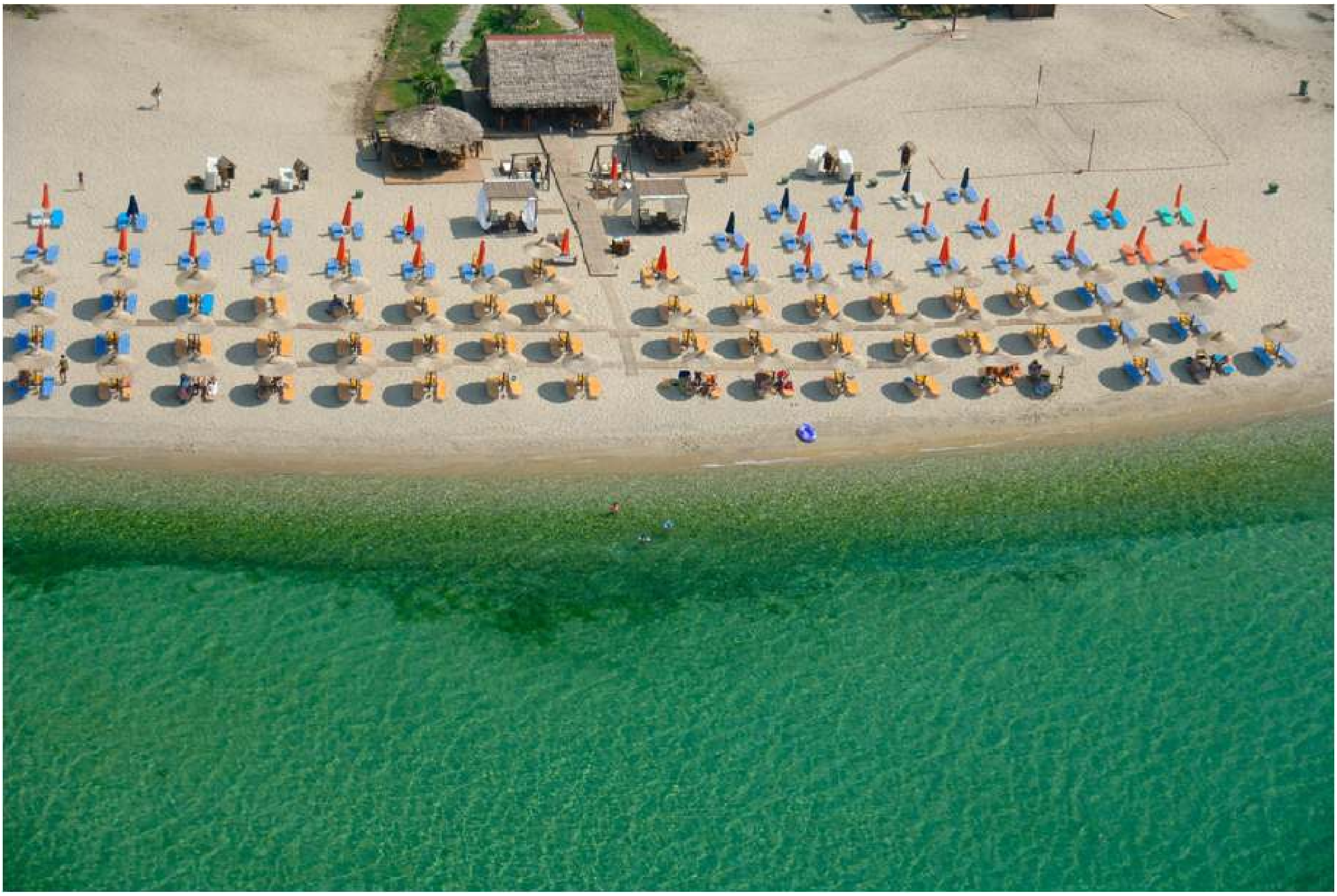

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