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EUROPEAN UNION

ADRION ADRIATIC-IONIAN

European Regional Development Fund - Instrument for Pre-Accession II Fund

I-STORMS

Integrated Sea sTORm Management Strategies

GUIDELINES


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CONTENTS

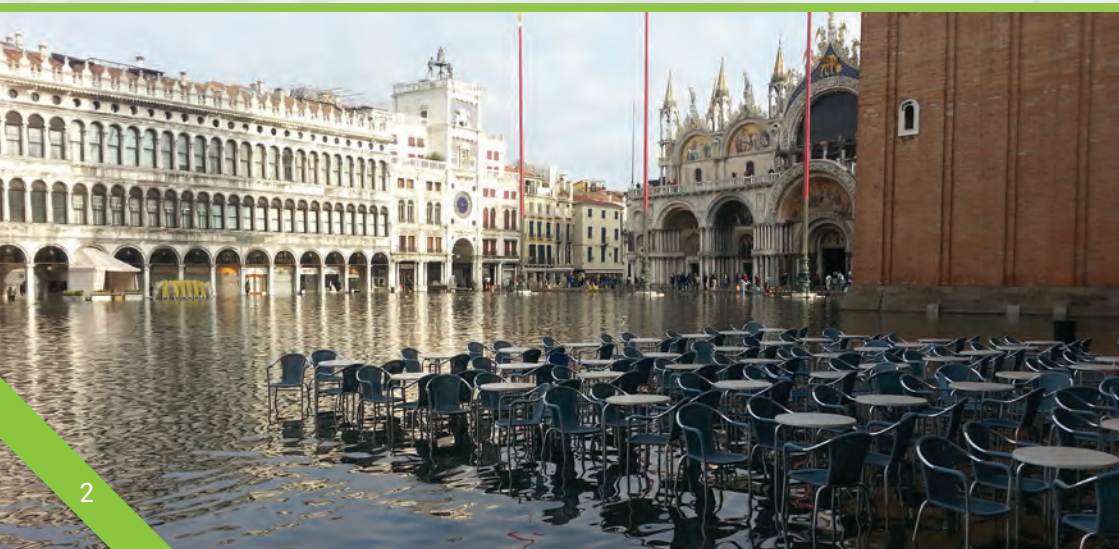
1. INTRODUCTION: GENERAL OBJECTIVES

The I-STORMS project deals with territorial challenges connected to coastal flooding in the Adriatic-Ionian (ADRION) region. Sea storms, storm surges and storm tides have significant impacts across many areas:

- Damage to the population and infrastructures
- Damage to cultural heritage
- Damage to the environment and ecosystems
- Damage to industry (aquaculture, fisheries, tourism)

The aim of this project is to enhance transnational cooperation sharing knowledge, data and forecasts through a common infrastructure. In this way, it will provide joint strategies to deal with sea storm emergencies whilst, at the same time, improving each country's capacity to work with data interoperability, early warning and civil protection procedures, in alignment with the EU Civil Protection Mechanism.

The marine-coastal events that are considered within the I-STORMS project are the following:



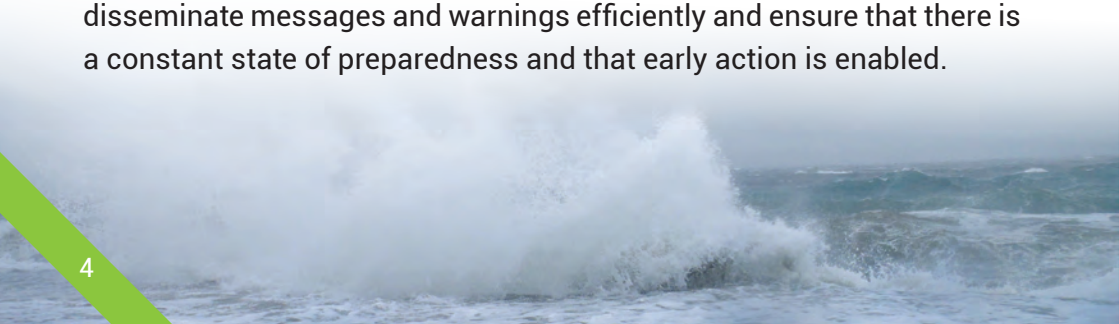
SEA STORM: Event of strong intensity and proportions, in terms of meteo-marine physical quantities, capable of significant impact on the coast, such as flooding, erosion, damage to infrastructure, etc. Their "local" characteristics are linked to the different impact that the same weather and sea conditions can cause on different portions of coastline. The nature and intensity of the impacts are determined by the extent and duration of adverse meteorological and marine conditions interacting with the morphological characteristics of the coastline (type, orientation, profile, bathymetry of the seabed, etc.) and from its vulnerability, in terms of defence works, infrastructures, inhabited areas and human activities. Fundamentally, different stretches of coastline can react to the same meteo-marine characteristics, modulating the level of risk and the concept of sea storm.

STORM SURGE and STORM TIDE: The storm surge is a tidal rise due to the effect of wind and pressure on the sea surface. The wind, due to the friction, propels the water against the coastline. This frequently happens in the Adriatic, where this phenomenon is commonly called "high water". The phenomena known as inverse barometric effect, can also contribute by means of the sea reacting to a low atmospheric pressure, and leading to a local rise in sea level. The storm surge amplitude, in a given location, is strongly dependent on the coastline's orientation, its conformation and local bathymetry, as well as the spatial and trend and intensity of the meteorological perturbation. These level components combine and then add to with the astronomic tide signal generating a storm tide, which (unless some other component due to the waves and their interaction with the coast) constitutes the total observed level of the sea. Therefore the most critical conditions, for the stretches of coastline subject to flooding, occur when the maximum meteorological phenomena occur concurrently (phase) with the the most favourable meteorological component, and even more so in the periods when the Sun, Earth and Moon are aligned with each other (syzygies).

METEOTSUNAMI: Meteotsunami (or meteorological tsunami) are large sea waves (similar to classical tsunamis) resulting from storm-like meteorological conditions. Unlike tsunamis, which are mainly caused by seismic events, volcanic eruptions or submarine landslides, meteotsunamis are a consequence of changes in atmospheric pressure associated with fast-moving weather events, such as strong storms, gusts of wind and fast atmospheric fronts. The generated wave spreads towards the shore and interacts with the bathymetry and the morphology of the coast: where the sea bottoms abruptly shrink and the shoreline consists of ports, inlets, narrow and long bays, it has an amplification effect and the wave expands and becomes destructive. The effects are more critical when the direction of propagation of meteorological phenomena coincides with a gradual lengthening of the bay.

I-STORMS Guidelines for translating data and forecasts to early warning and intervention procedures are meant to be an effective tool for the improvement and efficiency of interventions in the case of coastal risk. Without adequate warning systems and coordinated strategies, these events will cause major economic damage to a wide spectrum of coastal activities.

Early warning is a major element of disaster risk reduction. It can prevent loss of life and reduce the economic and material impacts of hazardous events including disasters. To be effective, early warning systems need to actively involve the people and communities at risk from a range of hazards, facilitate public education and awareness of risks, as well as disseminate messages and warnings efficiently and ensure that there is a constant state of preparedness and that early action is enabled.



The Sendai Framework for Disaster Risk Reduction 2015–2030[1] recognizes the benefits of multi-hazard early warning systems and enshrines them in one of its seven global targets. "In order to reduce disaster risk, there is a need to address existing challenges and prepare for future ones by focusing on monitoring, assessing and understanding disaster risk and sharing such information and on how it is created; strengthening disaster risk governance and coordination across relevant institutions and sectors and the full and meaningful participation of relevant stakeholders at appropriate levels".

Early warning will also contribute to sustainable development. The 2030 Agenda for Sustainable Development addresses early warning and gives it an important role across the Sustainable Development Goals, such as in food security, healthy lives, resilient cities, environmental management and climate change adaptation. The Paris Agreement stipulates early warning systems as one of the major focus areas in order to enhance adaptive capacity, strengthen resilience, reduce vulnerability and minimize loss and damage associated with the adverse effects of climate change.

Through the project Guidelines we intend to contribute by means of defining a standard for warning systems and civil protection procedures that can help to manage the coastal risk in the Adriatic-Ionian basin.

Guidelines have been developed for the Adriatic-Ionian basin and therefore must be consistent with the European framework (as shown in the following chapter 2). In addition to this, the civil protection systems will be described in the following paragraphs, as well as the methodological pathways to be followed and the Guidelines for coastal protection from severe sea storms.

1. https://www.unisdr.org/we/coordinate/sendai-framework

2. THE EUROPEAN CONTEXT AND LEGISLATIVE FRAMEWORK

In drafting the Guidelines, risk assessment and flood risk management activities in the project partner regions were taken into account based on their European context, as well as the legislative references that represent the framework of the civil protection system.

2.1. THE EU CIVIL PROTECTION MECHANISM [2]

The overall objective of the EU Civil Protection Mechanism is to strengthen cooperation between Participating States in the field of civil protection, with a view to improving through prevention, preparedness and response to disasters. Through the Mechanism, the European Commission plays a key role in coordinating the response to disasters in Europe and beyond.

When the scale of an emergency overwhelms the response capabilities of a country, it can request assistance via the Mechanism. Once activated, the Mechanism coordinates assistance made available by its Participating States.

Disasters know no borders and can hit one or several countries simultaneously without warning. Having a well-coordinated joint response means that when national authorities are overwhelmed, they have one point of contact, rather than 34 to deal with. A joint approach further helps to pool expertise and capacities of first responders, avoids duplication of relief efforts and ensures that assistance meets the needs of those affected. By pooling together the civil protection capacities and capabilities, it allows for a stronger and more coherent collective response.

2. https://ec.europa.eu/echo/what/civil-protection/mechanism_en

The Mechanism also helps to coordinate disaster preparedness and prevention activities of national authorities and contributes to the exchange of best practices. This facilitates the continuous development of higher common standards enabling teams to better understand the approach of others and work interchangeably when a disaster strikes.

Following a request for assistance through the Mechanism, the Emergency Response Coordination Center (ERCC), the operational hub of the Mechanism, mobilises assistance or expertise. The ERCC monitors events around the globe 24/7 and can ensure rapid deployment of emergency support through a direct link with national civil protection authorities. Specialised teams and equipment, such as forest firefighting planes, high-capacity water pumps, search and rescue, and medical teams can be mobilised at short notice for deployments inside and outside of Europe.

Satellite maps produced by the Copernicus Emergency Management Service can also support civil protection operations. Copernicus provides timely and very precise geospatial information that is useful to delineate affected areas and plan disaster relief operations.

Whenever crises occur in developing countries, civil protection assistance typically goes hand in hand with EU humanitarian aid. Experts in both fields work closely together to ensure the most coherent analysis and response, particularly in response to complex emergencies.

Any country in the world can call on the EU Civil Protection Mechanism for help and it has intervened in some of the most devastating disasters and complex emergencies witnessed.

Participating States commit national resources for emergency response to the European Civil Protection Pool. This pool allows for better plan-

ning and coordination of response activities at European and national levels and thereby contributes to a faster and reliable EU response to disasters.

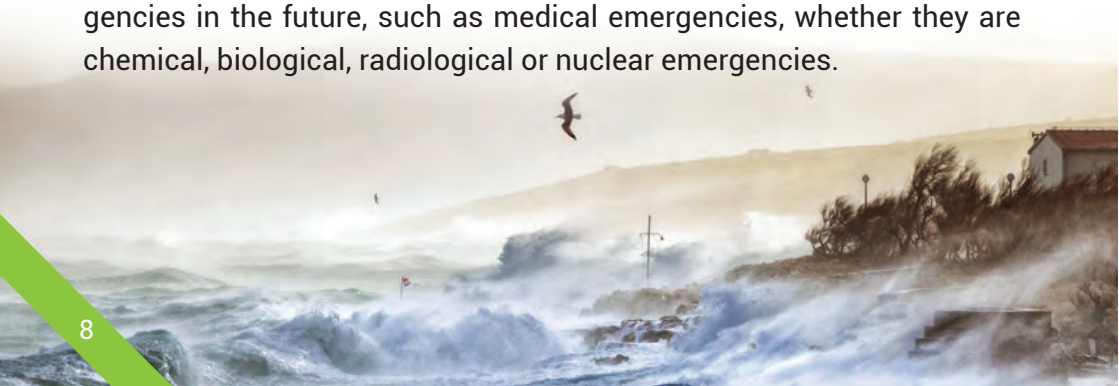
Prevention and preparedness

Prevention and preparedness activities mitigate the effects of disasters on lives, property and the environment. Well-trained teams are more effective in responding to disasters. A training programme for civil protection experts from all participating states ensures compatibility and complementarity between intervention teams, while large-scale exercises help focus on necessary skills for specific disasters each year.

The European Commission supports and complements prevention and preparedness efforts of Participating States by focusing on areas where a joint European approach is more effective than separate national actions. These include risk assessments to identify the disaster risks across the EU, encouraging research to promote disaster resilience and reinforcing early warning tools.

rescEU: Strengthening the EU emergency response in times of crises

In March 2019, the EU strengthened all components of its disaster risk management to better protect citizens from disasters. The upgraded EU Civil Protection Mechanism established a new European reserve of capacities (the 'rescEU reserve') that would initially include firefighting planes and helicopters. Through the strengthened Mechanism, the EU is setting the basis to be better prepared and respond to other emergencies in the future, such as medical emergencies, whether they are chemical, biological, radiological or nuclear emergencies.



2.2 METEOALARM EU [3]

Meteoalarm is a unique severe weather phenomena warning system in Europe, first and foremost intended for travellers and tourists moving around different regions of the project member countries. Information on the intensity and probability of severe weather phenomena is divided into 4 levels: green (no need for issuing warnings), yellow (a possibility of severe weather), orange (severe weather), and red (extremely severe weather).

Meteoalarm.eu provides the most relevant information needed to prepare for extreme weather expected to occur somewhere over Europe (as reported on the website):

- It will alert you to the possible occurrence of severe weather, such as heavy rain with risk of flooding, severe thunderstorms, gale-force winds, heat waves, forest fires, fog, snow or extreme cold with blizzards, avalanches or **severe coastal events**.
- In one glance you will be able to see where in Europe the weather might become hazardous. The colours used on the website maps indicate the severity of the danger and its possible impact. On the European map, each participating country is coloured in conjunction with the highest colour assigned to a current warning.
- For the higher awareness colours (orange and red) pictograms will be added to the regional information: the expected time period for any given event to happen, and also additional aspects, such as its intensity (e.g. snow amounts expected). It will indicate what types of weather are expected to cause disruption and potential danger.
- Meteoalarm.eu offers you the option of selecting severe weather information for today or tomorrow. If you require further detail on national warning texts you can follow the link to the relevant National Weather Service by clicking on its logo.
- Meteoalrm.eu integrates all important severe weather information originating from the official National Public Weather Services

3. http://www.meteoalarm.eu/

across a large number of European countries. This information is presented consistently to ensure coherent interpretation as widely as possible throughout Europe.

- Meteoalarm.eu is developed for EUMETNET, the Network of European Meteorological Services. This initiative is strongly supported by WMO, the World Meteorological Organization.

Participating countries:

Austria, Bosnia-Herzegovina, Belgium, Bulgaria, Switzerland, Cyprus, Czech Republic, Germany, Denmark, Estonia, Spain, Finland, France, **Greece**, **Croatia,** Hungary, Ireland, Iceland, **Italy,** Luxemburg, Latvia, Former Yugoslav Republic of Macedonia, Malta, Montenegro, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Sweden, **Slovenia**, Slovakia, United Kingdom

2.3 TSUNAMI REGULATION

Since 2018, the World Tsunami Awareness Day has been aligned with the International Day for Disaster Reduction and the "Sendai Seven Campaign" and will focus on Target "c" of the Sendai Framework for Disaster Risk Reduction which aims at reducing direct disaster economic loss.

It does not seem that there is a specific European directive on the Tsunamis, but for example in Italy, a national warning system for tsunamis has been established that allows enables quick response to these phenomena and a Tsunami Monitoring and Alerting System is also active in Greece.

Tsunami Regulation has been considered due to past Meteotsunami events being catalogued by the I-STORMS project. In fact, Meteotsunamis have the same coastal effects of Tsunamis even if generated by different factors.

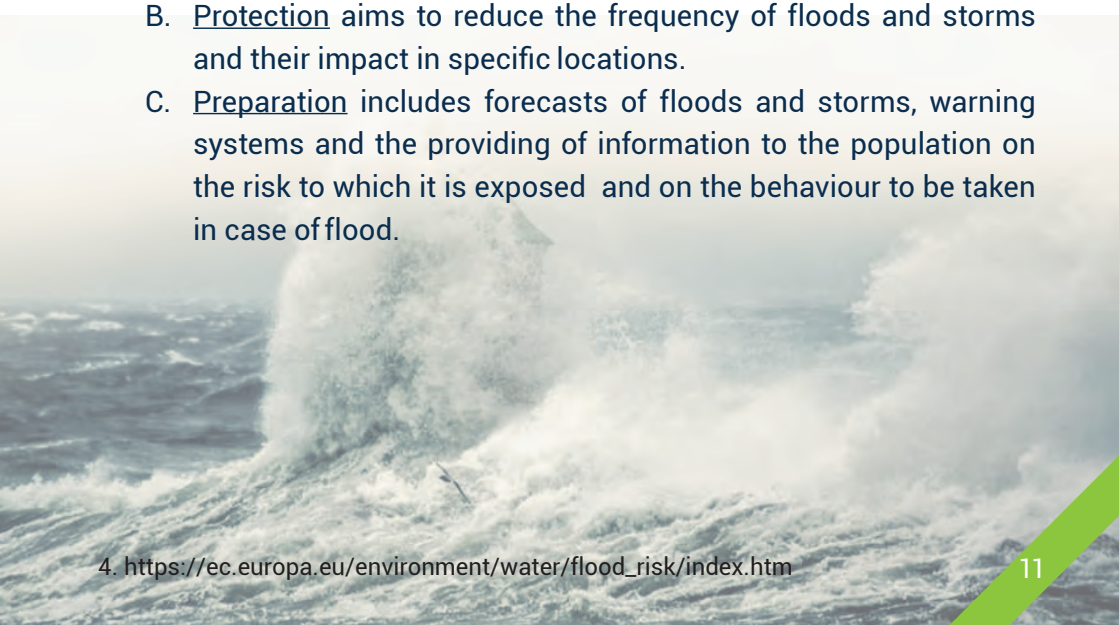
2.4. FLOODS DIRECTIVE [4]

Flood risk management aims to reduce flooding and its negative effects. Even storms are managed at European level under the Floods Directive 2007/60/EC which provides the common European framework for the risk of floods and sea storms.

The purpose of European Directive 2007/60/EC of 23 October 2007 was to establish "a framework for assessment and management of flood risks, aiming at the reduction of the adverse consequences for human health, the environment, cultural heritage and economic activity..." (Art. 1).

As indicated in the Flood risk management plans, the objectives are implemented with the following measures: **prevention**, **protection**, **preparation** (including emergency management), **reconstruction** and **post-event evaluation**.

A. Prevention can be achieved through sustainable land use practices and non-structural interventions.
B. Protection aims to reduce the frequency of floods and storms and their impact in specific locations.
C. Preparation includes forecasts of floods and storms, warning systems and the providing of information to the population on the risk to which it is exposed and on the behaviour to be taken in case of flood.



4. https://ec.europa.eu/environment/water/flood_risk/index.htm

D. Reconstruction must be included in the overall planning when operating in the areas hit by a flood/storm with methods that allow a rapid return to normal conditions, mitigating the social and economic effects on the population. Risk management also includes post-event evaluation, which is the analysis of everything that has happened and of everything that has been done to return things back to normal, as well as drawing lessons and implementing corrective and improving measures.

The Floods Directive (2007/60/EC) is of a framework nature, requiring the Member States to make a preliminary flood risk assessment by 2011, to prepare hazard and risk maps and and to eventually establish flood risk management plans across the EU, including coastal areas. In the long-term, the implementation of this Directive shall also contribute to the improvement of early warning systems, mainly through the identification of areas at risk.

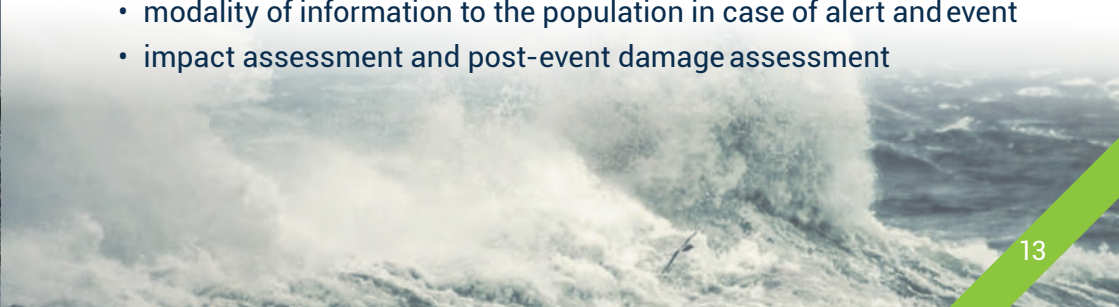
3. PROCESS AND METHODOLOGY

In order to gather input and useful information for the drafting of the Guidelines, a questionnaire addressed to the I-STORMS Network members has been prepared, according to Deliverable T3.1.1., in addition to the information collected in WPT1 about intervention procedures and existing coastal early warning systems and data implemented in the WPT2 tool. To gather more extensive information, it has been decided to consult both the institutional members of the network and the stakeholders and then two questionnaires have been prepared according to different targets.

Due to storms being managed at European level under the Floods Directive 2007/60/EC, which provides the common European framework for the risk of floods and sea storms, the sections of both questionnaires are organized and structured in accordance with the Floods Directive.

The questionnaires had the primary purpose of collecting information among the project partner countries, something useful for drawing up Guidelines on the following topics:

- existence of planning to prevent the risk of storm surges
- existence of risk protection measures for management of risk due to storm surges
- cataloguing of historical events
- presence of Early Warning Systems (EWSs) for storm surges
- presence of intervention and emergency management procedures
- modality of information to the population in case of alert and event
- impact assessment and post-event damage assessment

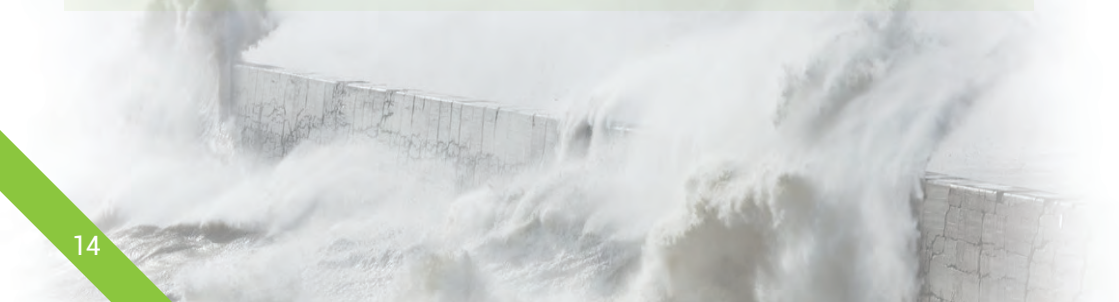


For the drafting of the Guidelines other inputs have been also important, such as those collected during the meetings with partners and with the Municipalities.

More detailed information on alert systems and civil protection procedures in those partner countries have been collected through the compilation of a document for each country prepared in accordance with the common scheme of contents:

- Introduction: main risks and characteristics of coastal areas
- Marine Observation network (instruments and data availability)
- Hydro-Meteo-Marine institutions, forecasting services and Early Warning Systems
- Civil emergency organization and structures that act at a national/local level
    - Specific civil protection procedure
    - Current procedures for emergency responses to sea storms
- Communication systems
    - Dissemination of warnings and format
    - Information during sea storms event or emergency
- Availability of Tools and Databases for coastal vulnerability and risk assessment
- What is necessary and what is lacking

All this information collected through different tools and methods has been analyzed and evaluated for the drafting of the guidelines.



4. EXISTING PROCEDURES IN THE ADRION BASIN

4.1 MAPPING OF DATA ON SEA STORMS ATLAS

The initial work phase focused on the analysis of the current situation and existing procedures in the partner regions and explored all the aspects. In order to define the elements for possible homogeneous guidelines, the necessary starting point was the knowledge of the different regional/national situations. This overview highlights the similarities, but also the differences and problems to evaluate and to work on.

The aim of the activity T1.2 was to review and map contemporary coastal disasters and existing procedures for emergencies response in the ADRION area related to sea storms.

The aim of the questionnaire, shared with a working group composed by each PP and other institutional network members, was to gather all information related to coastal disasters, intervention procedures and existing coastal early warning systems present in the region/country of each Partner.

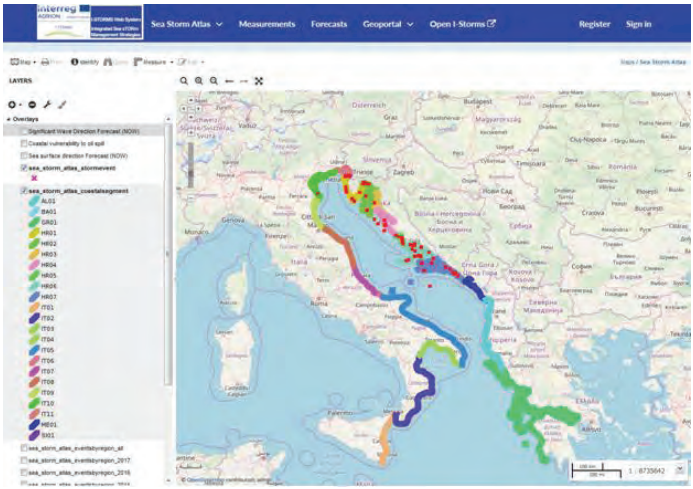
Despite the lack of information and the lack of homogeneity among the collected data, information has been organized and mapped in the Sea Storms Atlas according to the following criteria, in order to graphically present storm impacts and monitoring networks:

1) larger parts of the coast have been split, according to geographical characteristics or by management; a code was associated with each stretch of coast in the Adriatic-Ionian basin and mapped on a interoperable WebGis.

2) each partner/segment of coast is associated with a card that summarizes the main information on the existing Early Warning Systems and procedures:

- Early Warning System (EWS) for coastal event due to sea storms (yes/no) and for which kind of hazard
- Institutional forecasting service to predict sea state and sea level (yes/no)
- Specific Civil Protection procedure to prevent and manage coastal disasters due to sea storms (yes/no)
- Intervention procedures in case of coastal event due to sea storms (yes/no)
- Risk sources
- Network for marine measurement/observation (wave, sea level, tsunami) (yes/no)
- A post-event monitoring system (yes/no)

3) for each partner/segment of coast the number of historical events per year is shown and if there is related information, the impact of the event is also reported. Given the considerable difference in the details of the data collected by each partner relating to past occurrences and additional information on the events is contained in specific in-depth information sheets.



THE ATLAS IMAGE REPRESENTS THE STARTING POINT THAT ALLOWS TO GRAPHICALLY VISUALIZE THE SYNTHESIS OF THE EXISTING PROCEDURES AND DATA IN THE PROJECT COUNTRY PARTNERS

4.2 ASSESSMENT OF COASTAL RISK: IWS-WEB INTEGRATED SYSTEM

Sea storms represent the main threat in coastal areas. In fact, they directly impact on the citizens' quality of life (especially in urban areas where part of the inhabited areas is seldom covered by water), they damage the many cultural heritage sites exposed to these phenomena, and they affect businesses too (aquaculture, fisheries, tourism, beach facilities) and the environment at large (coastal erosion, floods). The potential future effects of global climate change emphasize the need for strategies based on an anticipatory approach particularly in coastal areas at immediate and high risk. In order to address the territorial challenges related to sea storms effect on the coastal areas, a shared and interoperable system (I-STORMS Web Integrated System- IWS) has been developed to allow a better exchange of information at a basin scale. Therefore, available resources can be accessed simultaneously in an aggregated and standard way.

The IWS has been designed to specifically store, visualize and share the following category of geospatial and informative contents:

A. Historical and real-time (or near real-time) time series' recordings of sea level and wave from fixed-point sensor networks

B. Outputs from existing oceanographic operational forecast models

C. Localization and description about coastal sea storm events (past and more recent) that have damaged the environment as well as social-cultural and economic assets

D. Bi-dimensional geospatial layers to provide georeferenced representations of the study area. *Such layers are organized into thematic categories (e.g. terrestrial and maritime boundaries, ports, shorelines, morphology and bathymetry, cultural heritage, coastal defence work)*

E. Datasets, model outputs and time-series metadata to improve discoverability and proper re-use of the shared resources.

Transnational integrated web system (IWS) for sharing observations and forecasts across the Adriatic and Ionian seas allows for and improved knowledge on sea storm events in order to better prevention and protection measures integrated into coastal defence planning and procedures. IWS implementation follows standards that are all products of the scientific communities in oceanography, meteorology and climate sciences and are designed to specifically meet their needs, providing coherent access to a large collection of real-time and archived datasets from a variety of environmental data sources at a number of distributed server sites.

The monitoring networks

A joint asset which could be exploited through fruitful cooperation is the presence of large networks and stations across the Adriatic coastal area which all countries could benefit from. **The Adriatic-Ionian region is monitored by 56 tide gauges and 20 wave buoys**.

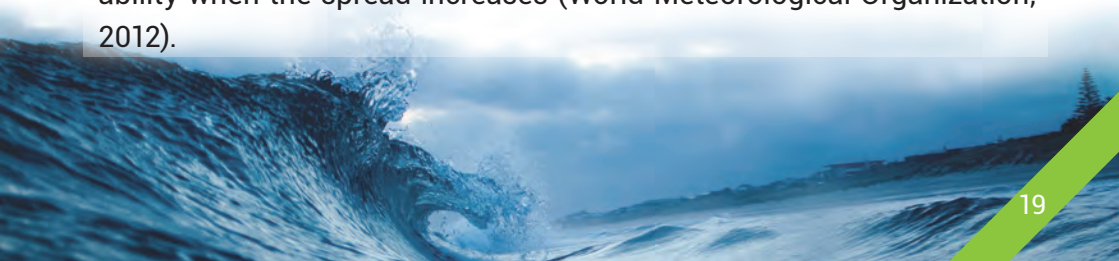
The forecasting systems

A Transnational Multi-model Ensemble System (TMES) was developed to combine the results from existing operational forecast systems aiding in estimating the forecast accuracy and reliability. In the Adriatic region we combined **12 forecasting systems currently operating** with **7 predicting sea level height** and **7 predicting the wave characteristics**. There is some variability in model outputs in terms of temporal and spatial resolution, spatial scale, spatial domain (e.g. Mediterranean Sea, Adriatic Sea, local areas), grid arrangement (e.g. structured or unstructured) and data format (e.g. NetCDF, GRIB).

It must be taken into account that meteorological and ocean models provide solely an approximation of reality, despite their continuous development and improvements. Moreover, the interactions between atmospheric, oceanic and coastal processes are not fully understood, resulting in major uncertainties when predicting coastal flooding, in particular, under extreme conditions. Small errors in the initial conditions of a numerical weather prediction model grow rapidly and affect predictability; forecasted atmospheric conditions are then affected by errors. However atmospheric forcing is not the only source of uncertainty in storm surge forecasting.

Many other sources of uncertainty, as the model numeric, resolution, parameterization, boundary conditions and initial sea state, contribute non-linearly to the final forecast uncertainty. The awareness of these uncertainties and prediction errors has led many operational and research flood forecasting systems around the world to move toward numerical forecasts based on a probabilistic concept: the ensemble technique.

On this basis, the IWS allows to strengthen the forecasts with useful information around their degree of uncertainty and hence analyse the propagation of uncertainty towards the coastal forecasts, starting from the meteorological models. In order to improve sea storm predictions, a transnational multi model ensemble system has been implemented for the Adriatic-Ionian macro-region which combines several existing oceanographic and wave forecasting systems. The magnitude of ensemble spread is a good indicator of how the forecast accuracy varies between different forecasting situations, indicating a decrease of reliability when the spread increases (World Meteorological Organization, 2012).



The aggregating approach for collecting and sharing observations is crucial for providing real-time information about the sea state and its evolution to be used by several countries for prompt emergency response and to increase the overall preparedness to sea storms.

Real-time observations and numerical model forecasts required to address environmental management problems such as sea storms are commonly excessively intricate for civil protection and stakeholders use. IWS is equipped with geoportal functionalities and interactive geo-visualization tools for simplifying search and access to geospatial data (including forecast model outputs) and monitoring networks time series. Such tools help and assist people who want to use IWS concepts, databases and their results for the line of work and to support their activities. Moreover, a dedicated web site (http://www.seastorms.eu/), designed to foster the data dissemination according to the community-based paradigm and that containing the Open Data principles (https://opendatacharter.net/), will allow the public data, the forecast results and related statistics to be explored by non-experts on the Internet through the use of shared maps, dashboards, graphics, tables and other interactive geo- visualization tools.

Slovenian Adriatic Coast 2019

4.3 INFORMATION ON PROCEDURES AND EARLY WARNING SYSTEMS IN COUNTRY PARTNERS

From the collection of information through the documents compiled by each partner, general considerations and common criteria for the Guidelines can be drawn.

The following is a summary of the general results.

a) Civil protection and the alert system are further based on 3 levels:

Level 1- Central responsibility-National level /Level 2- Regional responsibility-County level /Level 3- Local responsibility-Towns and municipalities

All partners report that this level of complexity of the systems requires effective coordination between the various levels and subjects.

b) Risk management and the alert system requires a 24-hour duty service, every 7 days a week.
c) Sea storms coastal flooding emergency and response plan is a minor part of general "Flood emergency and response plan" and there is often no specific procedure for emergency responses to sea storms.
d) There is a great efficiency and geographical distribution heterogeneity of weather and marine monitoring networks; they are often the combination of networks by State Institutions, Academic Institutes and in some cases also stakeholder organizations.
e) There is a need to have reliable forecasts, monitoring data and all the information needed to prevent and deal with weather-marine phenomena.
f) Annual plans and civil protection local plans are widespread.
g) The warnings issued by the bodies in charge are disseminated im-

mediately, subject to their preparation, to the authorities of the national EWS and then they are diffused to general public.

h) Volunteers in general are an essential element of the civil protection systems, and without them the efficiency of the whole mechanism would be compromised.

Main information, considerations and what is required in each country partner

ALBANIA

The technical and operational capacities of the Albanian institutions regarding forecasting, monitoring and warnings from hydro-meteorological data are still considered to be insufficient in order to cope with the multitude of risks posed to the country.

It is necessary to establish a portal where all the information gathered on sea situations can be shared with all the interested parties/actors.

The Institute of Geosciences, Energy, Water and Environment (IGEWE) publishes daily the bulletin related to natural disasters. The responsible centre has been operating for seven years and assures daily information covering weather conditions and possible risks of disasters. This public structure covers warning systems related to adverse weather forecasts or floods caused by rivers or heavy periods of rains yet no warning system exists relating to sea conditions, sea storms and how to intervene and manage sea transport.

It is important to draft a manual on the procedures and roles of each player at local and regional level toward sea hazards management, respecting EU standards and a manual easily accessible by all the interested parties.

The institutions in charge for the maintenance of the sea warning systems must have established funds to realize it.

CROATIA

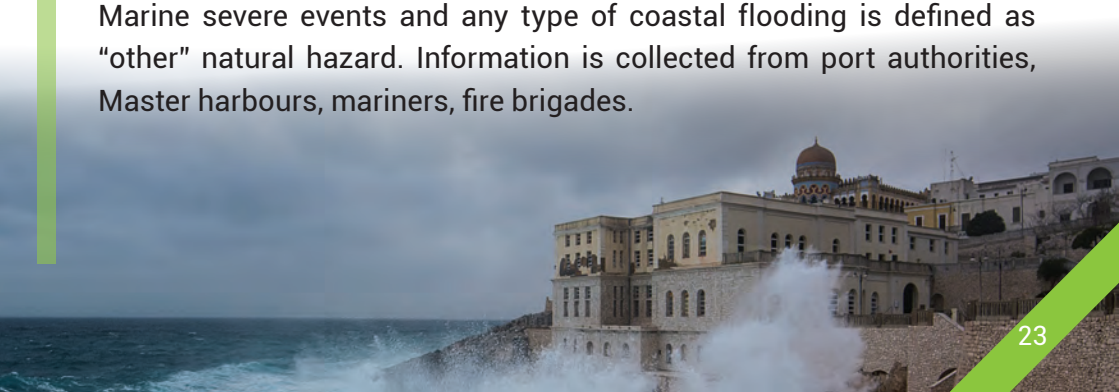
The Meteorological and Hydrological Service (DHMZ) provides Early Warning Systems for the natural hazards in Croatia for:

- Severe weather conditions (severe wind, heat wave warning, cold wave warning, intensive precipitations, phenomena like snow, black ice, poor visibility)
- Severe flooding conditions (at river basins, for flash floods)
- Drought prediction
- **Severe marine meteorological conditions** (wind, sea state, thunderstorms and visibility) 4 times daily for the following 24 hours available for public, plus 3 day outlook twice daily only for authorities and special users.

Networks are operating according to WMO and EEA standards. Observations are available on-line, by demand and via WMO's Information system WIS. DHMZ has also a rich database of historical data that is available on demand.

The marine observation network is operating at several levels: at main meteorological stations, at automatic meteorological stations along the Adriatic coast and at lighthouses.

Marine severe events and any type of coastal flooding is defined as "other" natural hazard. Information is collected from port authorities, Master harbours, mariners, fire brigades.



Emergency responses are provided without any specific procedures by:

- local civil protection units along the coastline (towns and municipalities)
- Harbour Masters
- Search and rescue units (SAR) at the sea.

Meteorological services for the Croatian Adriatic are performed by the Marine Meteorological Center (Pomorski meteorološki centar – PMC) in Split, which is part of the DHMZ. The PMC monitor and forecast severe meteorological phenomena, creates weather surveys, severe weather phenomena warnings and marine weather forecasts. The results of their work are: marine meteorological bulletins and warnings for ships, bulletins and warnings for ports and anchoring sites; weather notifications for Search and Rescue services, weather notifications for nautical tourism, sports activities, and tourism in general (in English, German and Italian), special meteorological notifications for marinas, shipyards, marine constructions, for towing and dangerous goods shipping and other maritime works.

Daily operative cooperation between DHMZ and the civil protection community is based on the long-range experience of their joint work and previous mutual contacts in ordinary and extra-ordinary situations. According to the lows, DHMZ is the provider for "single official voice" procedure for weather warnings and weather inducted phenomena.

As a result, the standard operative procedure for the use of DHMZ weather forecasts has been formulated regulating the content of forecasts and warnings, time of delivery, transmission methods and receiving of specific warnings as well as additional data and interpretations.

The Croatian Water Authorities are responsible for all types of flood warnings. The flood risk assessment of the Republic of Croatia includes:

the Danube river basin and Adriatic water area as part of Croatian Water Authorities.

Due to the large coastline and little urbanization areas and very rare measurements and observations the special distribution of coastal flooding is the matter of hind cast mapping.

GREECE

In accordance with Article 115 of L.4249/2014 (Government Gazette A 73/24-3-2014), the "National Early Warning System" has been established, at least legally.

In the middle of the year 2018, the Hellenic National Water Commission approved the Regional Flood Risk Management Plans for the 14 Water Districts of the country. The foreseen measures include the Updating of Emergency Plans that include Public Awareness and Readiness Measures.

Moreover, in May 2019 the public consultation about the draft law on the new National Civil Protection System was completed. At the heart of the legislative initiative is the establishment of the National Civil Protection Authority, which is set up as an independent public service, subject to the Minister of Citizen Protection. 19 "Emergency Operations" (E.O.) are specialized and established, on the basis of which the Civil Protection System will be organized. The main and supporting bodies will be organized on the basis of Coordination Protocols in order to coordinate the respective "Emergency Operation". Indicatively the "E.O. 3: Informing and warning citizens" aims at providing coordinated, timely, useful, functional and accessible information to citizens and the media in the event of an emergency.

Within the framework of the National Authority, the National Coordination Center for Civil Protection (NCCCP) will function as a Special Authority of the National Authority.

The mission and the core competencies of the NCCCP include:

- Informing citizens and stakeholders
- The operating of the European "112" and the citizens' alert system.
- An Independent Citizen Information and Warning Department is established, which is responsible for:
    - collecting, verifying, coordinating, and disseminating information about the cause, size, current event status and committed resources, including citizen self-protection guidelines, the usage of available communications networks;
    - the operating of the European 112 call number and its logistics infrastructure for the geo-location of the caller and the sending of information and warning messages to the population, at central, regional and local level, in accordance with the distribution of responsibilities under this Act, in areas under emergency, utilizing the available communications networks to this end.

The First Pilot Demonstration took place in the context of testing the 112-Citizen Alarm System project on July 31, 2019. Subsequent trials followed.

Greece has been actively participating since 11/6/2019 with two Canadair CL-415 air- craft, in the transitional period of the RescEU Programme of the European Civil Protection Mechanism, in response to a call that the country received from the European Commission.

The Hellenic National Meteorological Service (HNMS) is the official provider of meteorological information in Greece, providing forecast reports to citizens and state institutions, which have the same form. These bul-

letins are forwarded with warning signals to all stakeholders in order to get in a state of increased preparedness so as to address emergency needs due to the prediction of extreme, hazardous weather conditions, such as severe rainfall and storms. Each of these bulletins is marked by a distinctive colour, based on the colour code used by all Europe's meteorological services.

The METEO.GR site was launched in June 2001. It is the Greek and simplified version of the already existing page of the National Observatory of Athens. The development of the meteo.gr site was made with the purpose of providing simplified weather forecasts to the general public. It includes forecasts for a total of about 500 areas and cities in Greece. The HNHS publishes in printed and/or electronic format, navigational aids and instructions, notices, messages and announcements, wave forecasts and oceanographic information, contributing to the promotion and development of shipping and navigation safety.

The Hydrographic Service maintains a network of permanent sea level recorders. The stations enable the analog recording of any change to sea level, round the clock. The data are also recorded digitally at selected stations and in the context of network upgrading, which enables telephone transmission of the data in virtually real time. Also, the recordings of four stations are directly available on the internet through the HS website. In the future, all analog sea level recorders will be gradually replaced by electronic ones.

The Hellenic National Tsunami Warning Center (HL-NTWC) is a unit of the Institute of Geodynamics of the National Observatory of Athens (NOA-IG), which is the leading earthquake analysis and monitoring Center in Greece. The HL-NTWC provides warning services, as well as public awareness activities.

For the control of the sea level changes the HL-NTWC is supported mainly by its own tide-gauge network which has been developed since 2013 and is rapidly expanding in the frame of several national and international projects. The real-time tide-gauge network of NOA currently consists of 18 real-time stations equipped with radar and/or pressure type sensors with a very high frequency sampling rate, which is suitable to record tsunami waves and to support tsunami operations. Moreover, useful data, both of hydro-marine (http://marine.copernicus.eu) and the climatic type (http://atmosphere.copernicus.eu/), can be derived from Copernicus that provides satellite data on a free, full and open access basis.

ITALY

The hydrogeological-hydraulic risk in Italy is governed by Directive 27/2/2004, but there are also other types of risks that are evaluated and linked to meteorological variables. Among these is the maritime and coastal risk, not dealt with directly in the aforementioned Directive. Lacking a rule of this kind that explicitly details the ways in which this risk is managed within a shared governance between State and Regions, at the moment some Regions have faced the problem, subsisting the need, and others of them, between the 15 regions that have coastline have established objective and quantitative alert criteria for sea storms (sea-state and/or coastal risk), as well as defined methods and technologies to evaluate the risk (use of weather-marine models used at various levels of detail, use of thresholds). In the near future the methods of alerting for this type of risk, as well as those relating to risks of a purely meteorological level must be defined officially within one or more specific Directives, also establishing criteria for the homogenization of the activities and products rendered, in the same way as has been sought out with the hydrogeological-hydraulic risk.

As regards the "at sea" risk conditions, it is worth remembering that storm warnings are meteorological messages- in Italian and English- aimed at the safety of maritime navigation and the meteorological protection of Italian coastlines; they are under the jurisdiction of the CNMCA (National Aeronautical Meteorology and Climatology Center), which is the A.M. designated to carry out the maritime vigilance service aimed at issuing storm warnings for the maritime area.

At national level, the coastal risk is currently treated both in the National Weather Forecast Bulletin and in the Synoptic Forecast, evaluating the state of the sea near the coast from a level of the Douglas scale from "very rough" upwards (level 4 and up) signalling the danger of the state of the sea in Notices of adverse national weather conditions.

As regards the Italian regions that are in the Adriatic basin and are partners of I-STORMS project, The **Region of Veneto** has no planning tools in place (e.g. Civil protection plans, adaptation plans, urban development plans) and specific intervention procedures that regulate the assessment and management of the risk due to storm surge. However, the **City of Venice** has a Civil Protection plan for the high tide, *'Piano Integrato degli interventi in caso di alta marea e bassa marea'* and *'Piano Comunale di Protezione Civile'* that defines the actions the several stakeholders (Civil protection, public security and rescue forces, transport companies, services) adopt in case of high tide.

In the **Region of Emilia-Romagna** the competent regional bodies define a warning level (green-yellow-amber-red) for both coastal event and sea-state conditions, to which a predefined event scenario is associated. For the purpose of alerting in the forecast phase the regional territory has been divided into 8 alert zones further divided into 15 subzones; these are homogeneous territorial areas in terms of climatology and morphology and two sub-zones have coastal areas, so are affected

by the risk of sea storms. Civil protection procedures relating to storm events are divided into three phases: forecast phase, during the event (emergency management) and after the event (overcoming of emergency). During the forecast phase, an alert for critical coastal conditions is issued when certain parameters are exceeded (wave height and sea level). This criticality is associated with a colour code and the activation of a corresponding operating phase. When the event occurs, a specific operating phase is activated on the basis of its criticality.

In **Region of Puglia** there is no system for forecasting, monitoring and alerting for sea storms. The only document that refers to the concept of storm risk is contained in the criticality bulletin and eventually in the warning messages in which, because of the adverse weather conditions that determine strong winds, the phrase "storm surges along the exposed coasts" is inserted.

SLOVENIA

In Slovenia, the term 'civil protection' is used to describe particular operational units addressing tasks relevant to the intervention and rescue in emergencies linked to specific events that cannot be managed by other state forces. The term 'civil protection' includes also operational leadership/coordination structures in case of accidents, composed of civil protection commanders and their staff (organized at national, regional and local levels).

The storm surge coastal flooding emergency and response plan is a minor part of the general "Flood emergency and response plan". There is no specific procedure for emergency responses to sea storms in Slovenia. In Slovenia there is also a lack of sea storms and flooding action plans and vulnerability studies for Civil Protection – coastal flooding is only partially covered in The Flood emergency and response plan with main focus on continental flooding. Forecasting and responding

to coastal events is of different type than continental storms and flood events therefore specialised action plan for coastal area is needed.

Based on measurements and model forecasts, the Slovenian Environment Agency- ARSO draws attention to the flooding of rivers, lakes and the sea. ARSO issues hydrological warnings in the alert process. In particular, with a predicted intensification, with more extensive and prolonged precipitations and expected floods, it is now that ARSO issues hydrological warnings with a yellow, orange or red colour code in advance, and planning can begin with operational activities for the preparations against flooding. Procedural alarms include alerting about flood risks to signalling the end of floods by means of audible signals, and activating certain units, services and operational forces. The concept of flood response is based on the possible consequences to citizens, nature and objects. On the basis of measurements, ARSO draws attention to the floods of rivers and seas, and also works with services in neighbouring countries.

5. GUIDELINES AND KEY ADVICE

5.1 GUIDELINES BASED ON FLOODS DIRECTIVE PHASES/QUESTIONNAIRE RESULTS

The I-STORMS Guidelines are organized in accordance with the phases of the Floods Directive that inspired the elaboration of the questionnaires as a common framework:

- "**Prevention of risk due to sea storms**" concerns non-structural actions, that correspond to regulatory and administrative measures envisaged for the reduction of coastal risk and which may regulate land use, but they do not involve the construction or maintenance of works or the modification of the state of these work places.
- "**Protection from sea storms**" refers to structural actions representing interventions that involve the construction or maintenance of works or the modification of the land cover morphology.
- "**Preparation for risk due to sea storms**" refers to the early warning systems (including forecasting systems and communication procedures) and the emergency management procedures (also exercises and information to the population) and represents the most significant part of the Guidelines.
- "**Post-evaluation event and reconstruction**" concerns procedures and tools available to estimate the impacts from sea storms events and measures adopted for restoration after a sea storm event that has caused damage.

Actions and recommendations have been included for each phase, in particular with regard to communication, and in the end general guidelines have been inserted that are not related to the different phases.

PREVENTION

In the PREVENTION phase, the partner countries should:

- prepare civil protection plans including sea storms coastal flooding events that define:
    - event scenarios and major risk areas
    - the responsibilities and tasks of those who should intervene if an event occurs and expected event scenarios, based on the data and indications
    - available resources to be engaged during emergency
    - recovery areas for population assistance
    - how to inform the citizens during the emergency
- Identify and map the areas with the highest coastal risk on a regional scale and create a vulnerability map on which the individual local administrations must implement specific preventive measures (e.g. road signs and luminous signals that can be activated remotely, prohibition of road stretches along the flooded coasts, alerting managers of coastal road and rail infrastructure, managers of technological networks, etc.)
- encourage the development of adaptation plans that contain references also to the sea storms risk
- work on a Strategy for coastal risk at a national and international level that inserts prevention programs and measures
- encourage the self-assesment of risk by the citiziens (e.g. using a questionnaire).

It is important that plans and strategies take into account the differences between the summer season and the other seasons, since activities and civil protection actions can be significantly different between the two periods.

Regarding INFORMATION from the prevention phase that helps citizens to get information about the risk and prepares them before sea storm events, the recommendation is:

- mainly use digital material on the web to promote prevention measures and also videos and paper materials;
- organize public meetings to meet stakeholders and citizens directly;
- involve citizens' associations and Civil Protection associations;
- organize specific meetings with school students.

PROTECTION

As regards PROTECTION, the specific structures that are considered most effective are common defence structures like reefs, breakwaters, dunes, dams and groynes, so:

- the use of the common defence structures is recommended;
- innovative solutions in this field and good practices must be shared and in particular the use of Natural Based Solutions should be promoted.

PREPARATION

The guidelines for the PREPARATION phase are divided into: Early Warning Systems and Emergency Management.

Early Warning Systems

Early Warning Systems for coastal risk due to sea storms are not widely spread among the project partner countries and there is a poor knowledge about forecasting and alert systems in general.

For effective Early Warning Systems for sea storms it is necessary to:

- have online weather, marine and coastal observation networks (tide gauges, wave buoys, videomonitoring systems, wind and pressure sensors, etc.);

- have an integrated and interconnected geodetic network (e.g. GNSS stations) that allows the monitoring of the height of the land and define local references used by the observation systems;
- elaborate/have available weather, marine and coastal forecasts (also expressed in probability or forecast reliability), and high quality and reliable forecasts of sea levels for citizens and protection services (the refinement of forecasting models aimed at issuing alerts is also required); a clear explanation of probability as well as forecast uncertainty sources is strongly suggested, because it is essential in order to correctly communicate the coastal risk due to sea storms.
- define combined thresholds (e.g. wave height and tide level, and if possible also with rain precipitation) and scenarios to establish procedures for assessment and management of coastal risk;
- define a warning level (green-yellow-amber-red) for sea storm and sea conditions, to which a predefined event scenario is associated;
- share real time data (sea level and wave) between the countries along the Adriatic in order to improve the forecasts in the northern part of the Adriatic Sea, where the problems are most severe.

Also for what concerns the Public/Institutional body that issues the alert, a general lack of knowledge has been found, therefore:

- public/institutional bodies that are responsible for the alerting system in general must increase public awareness about forecasting and alerting systems;
- the concept that only few and specific Public/Institutional bodies are responsible for issuing alerts and for communication related to the alerts must be strengthened.

As regards INFORMATION in preparation, the main sources of information on sea state forecasting and possible sea storms risk are the institutional sites, in particular National Civil Protection, Regional Civil Protection, Met Office and Municipality, therefore:

- institutional sources that are recognized and perceived as reliable, in particular those closest to the local level, should give all the clear and useful information to citizens.

Bodies in charge must take into account stakeholders' preferences and habits regarding information and therefore they should:

- inform citizens through messages (above all SMS, but also on app and social media), institutional websites and information on radio and TV;
- involve local users in dissemination as well as voluntary associations, schools and education structures, research institutes, infrastructures managers, port authorities and all potential stakeholders in the tourism sector in order to strengthen the alerting system for sea storms risk.

It is essential to gain feedback from the stakeholders on clarity of information issued. This could be obtained by an online questionnaire on the institutional websites, investigating whether the information provided is understood and reflects the stakeholders' needs.

As regards the EXERCISES on the coast and focused on coastal risk, since they are not widespread and considered enough to be part of the institutional civil protection procedures:

- coastal risk exercises must be a mandatory activity because they really help to test the alerting and emergency management system, and therefore all the phases (e.g. briefing and debriefing) should follow standards and protocols.

As regards TRAINING, it is strongly suggested to organize training sessions addressed to Civil Protection operators, volunteers and Municipality Mayors. Some training topics could be on: public awareness of forecasts and alerting systems, weather-marine shared and interoperable systems (e.g. IWS-Web Integrated System).

Emergency management

In the ADRION Basin there are few defined and institutional procedures to manage the alerting and intervention system during coastal emergency situations: the observational systems and the monitoring procedures for sea storms are widespread whereas the intervention procedures to limit damages during a sea storm event are less diffused.

For better emergency management it is advisable to:

- define a set of actions based on the main/available observational systems and monitoring procedures;
- share real time data and good practices between the countries along the Adriatic and Ionian seas;
- identify methods for the joint and integrated management of monitoring between the bodies involved, in order to ensure 24h presence and thus guarantee constant focus on the territory;
- create a monitoring system for sea storms, coastline evolution and damage evaluation through a network of institutional and private video-monitoring;
- adopt tools for coordinated management of sea storms risk as a messaging institutional forum (or chat) for rapid information sharing at various levels, but in particular at local level.

Specific intervention procedures to limit damage during an event could be:

- taking preventive or minimizing measures
- interventions to restore artificial dunes on the entire shore
- river beds and runoff management
- the movement of the endangered population/evacuation plans
- a number of port procedures including: temporary closure of goods movement, insurance of equipment and cargo.

Dubrovnik, Croatia © Boris Bašić

Civil Protection VOLUNTEERS are a fundamental and important resource for event monitoring and emergency management, hence they must be supported, strengthened and enlarged.

In an emergency phase for activation it is useful to have tools, like a web platform, for the management of voluntary organizations signed up in the register of associations in the field of Civil Protection.
Regarding COMMUNICATION to citizens during sea storms events the partner countries should:

- follow nationally standardized protocols and use redundant dissemination channels, i.e. combine sirens with TV spots or radio emissions; (several states are testing new dissemination technologies such as mobile-broadcast)
- create integrated communication systems between regional and municipal website sections on alert system
- create social network accounts dedicated to early warning communication.

Institutions must take into account stakeholders' preferences and habits regarding information and therefore they should:

- diffuse information first of all through messages (above all SMS, but also on apps) and also through institutional websites, social media, radio and TV.

In fact, stakeholders prefer to receive push communications on mobile by SMS or through apps, more than mass communications on traditional media.

Timely warnings are only one element in an effective EWS. Coastal communities have to be prepared through appropriate EDUCATION PROGRAMMES. It is therefore important that coastal communities are equipped with appropriate emergency response plans. These should in-

clude evacuation routes, regular drills and exercises to ensure that the population is aware of the risks and acts appropriately in such an event. Appropriate educational programmes may be integrated into school curricula.

RECONSTRUCTION AND POST-EVENT EVALUATION

As regards RECONSTRUCTION AND POST-EVENT EVALUATION, results about the procedures and tools available to estimate the impacts (economic, social, etc.) caused by sea storm events show a great heterogeneity and a lack of well-defined standard procedures.

The most diffused procedures are:

- damage reports by technical services (National and Regional Services, Municipalities, facility management)
- reports by Municipalities
- aerial photos/land surveys and sometimes aerial surveys
- direct and indirect damage assessment, recovery plans, site inspections
- social and economic assessments.

In order to overcome this lack of homogeneity, it is important to establish formats and tools for collecting damage estimates that are standardized and available before the occurrence of events.

Considering that the reports of damage are used for various purposes (for example the request for compensation and the inclusion in databases for historical analysis) it is important to avoid the duplication of information and establish integrated data collection methods.

Regarding the measures adopted for restoration after a sea storm event that has caused damage to people, buildings and/or productive activities, the list of the main procedures is the following:

- allocation of funds to regions and municipalities, reconstruction funds
- administrative deeds, interventions in field planned to prevent future damage
- public support and compensation to the citizens that suffered damage to their properties, recognition of damage to private individuals and businesses activities
- insurance policies could be considered by private citizens as a form of compensation for damage incurred
- highly urgent interventions to restore safety (restoration of winter banks, restoration of beach coastlines), ordinary and extraordinary maintenance of structural works and beach maintenance.

5.2 GENERAL GUIDELINES

It is possible to identify indications and recommendations that do not apply to a specific phase of risk management, but can be considered general guidelines and are therefore grouped below.

Creation of historical databases

Historical databases about previous sea storms are not so diffused along the Adriatic Basin as they should be, and of course these technical tools must be developed and/or improved as the historical cataloguing of sea storms allows for a better studying of the types of events, impacts and their evolution. Creation of standardized databases between the Adriatic-Ionian regions would allow to expand the analysis and comparison of coastal events at a basin scale.

It would be useful to have a database of structural interventions carried out along the coasts that have introduced changes to the morphology of the coast over time: dunes, ports, docks, breakwaters, brushes, maintenance etc.

Stakeholders engagement

The opportunity to involve other subjects in the management and communication of storm risk is recognized as fundamental.

The most interesting categories in the field of coastal risk are: associations (Civil protection association and others), port authorities, beach managers cooperatives and other sea-related activities, aquaculture/ fishery companies, sectoral agencies (trade, tourism), locally specialized and trained subjects, schools and schools boards, research institutes.

In order to improve the cooperation and promote the exchange of knowledge and data, a permanent Network of all relevant actors of the ADRION area affected by sea storms – like the one set up in the I-STORMS project – is strongly desirable.

Testing of innovative systems and procedures

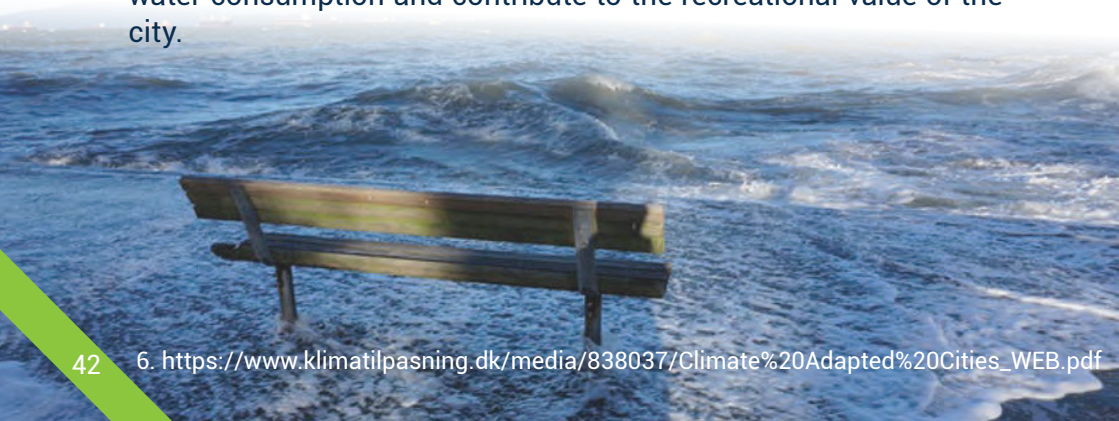
A new modernized system and solution to prevent, alert and restore damages can be tested on locations and areas with specific characteristics that make the experiment useful and exportable (one example are protected areas, because of their mission and more or less authorities similar in all the countries).

5.3 BEST PRACTICES AND REPLICABLE EXPERIENCES

Best practices concerning a specific geographical area or field can be the inspiration for solving similar problems that arise elsewhere in risk management and the sharing of good practices can be used also to optimize early warning systems and coastal risk management, avoiding repetition of efforts and duplication or errors.

For this reason, the following experiences and suggestions have been collected in the Guidelines.

- It is opportune to consider the necessity of an effective codified system of acoustic warning, also to consider the need to be able to forewarn non-resident persons, in a particularly relevant number in a coastal area affected by massive seaside tourism. The system presently in use in Venice has been successfully working for over 30 years now. It's based on acoustic alert (sirens) and dissemination of continuously upgraded water level forecast through SMS and social networks, even during the event.
- The concept of "adaptation pathways", a diagnostic and analytical tool to assist in adaptive planning and decision-making, is gaining respect as a way of framing and informing climate adaptation. Coastal adaptation can replace adaptation pathways as a useful concept for decision-making and planning, especially when considering the participation of stakeholders in pathway development.
- The combination of holistic planning with the "state of the art" adaptation technology ensures urban life and planning function with green growth through synergies that provide for public-private collaboration on management and protection with an integrated approach, as in Danish experiences (e.g. Copenhagen adaptation plan[6]). Climate protection and coastal protection can be integrated with other ecological and recreational purposes. The best examples of climate adaptation are those that manage to solve more than one problem simultaneously, rethinking urban development towards more resilient and livable cities. For example, the use of rainwater in solutions for the city that at the same time minimize water consumption and contribute to the recreational value of the city.



6. https://www.klimatilpasning.dk/media/838037/Climate%20Adapted%20Cities_WEB.pdf

6. CONCLUSIONS

Operational guidelines concerning hydrogeological-hydraulic risk (and therefore, flood risk) have been defined in each partner country, although with some differences in the level of scientific-technological evolution of forecasting and observation systems, but regarding the sea storm risk no national procedures have been defined for risk and emergency management almost across all regions.

Coastal risk, and in particular sea storms risk, has not been defined officially within nation specific Directives in the same way as the hydrogeological-hydraulic risk has been; but forecasts and response to coastal events are of a different kind than continental storms and flood events, for this reason **specialised and specific action plans for coastal areas are needed**.

The risk management strategies and plans to reduce damage due to sea storms are issues that **must be managed and coordinated** at a national level, even if they have local peculiarities that must be studied in depth and addressed depending on the specific situation.

In order to improve **the cooperation** and promote **the exchange of knowledge and data**, it is also important to set up **a permanent Network** of all relevant actors from the countries of the ADRION area exposed to sea storm risk (like the one set up in the I-STORMS project) and to establish **thematic working groups** focused on tools, plans and good practices for coastal risk management.

To overcome the lack of integrated data and information, it is essential to establish **formats and tools for collecting data, information, damage reports** that should be standardized and available before and during the events. Data sharing must be coordinated centrally and must cover all levels of the system (local, regional, national). It is important to avoid

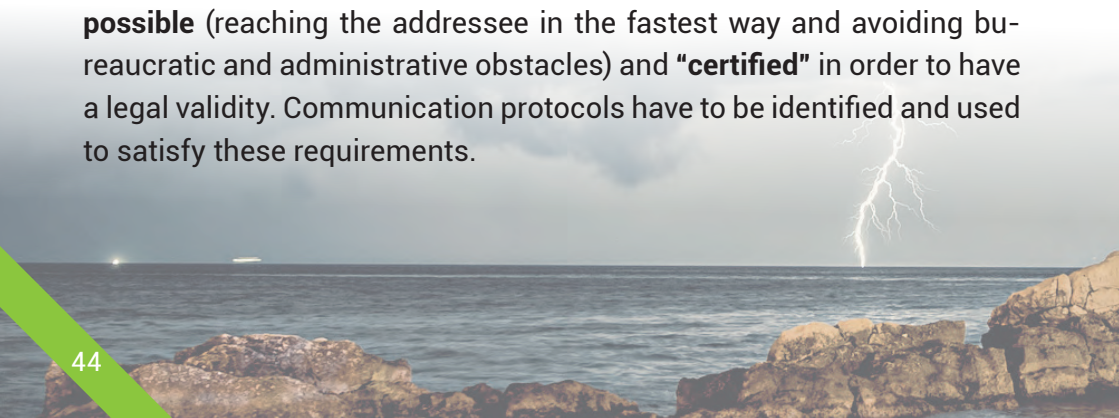
the duplication of information and to create **standardized and integrated databases** between the Adriatic-Ionian regions to expand the analysis and comparison of coastal events at a basin scale.

For **effective Early Warning Systems for sea storms** it is necessary to have online **weather, marine and coastal observation networks and share real time data** between the countries along the Adriatic Sea; it is also a requirement to have **weather, marine and coastal forecasts available** (also expressed in probability or forecast reliability) and high quality and reliable forecasts of sea level for citizens and protection services. Starting from these data and from these forecasts, **early warning procedures based on thresholds and predefined scenarios** are needed.

Public/Institutional bodies that issue the alerts must **increase the public awareness** about forecasting and alerting systems and strengthen their role as responsible for issuing alerts and for communication. Institutional sources that are recognized and perceived as reliable, in particular those closest to the local level, should give all clear and useful information to the citizens.

Information on these issues is essential and should start from **schools** with specific **training**.

Alert Messages to the public and **communication among all players** belonging to the alert system must be, at the same time, **as quick as possible** (reaching the addressee in the fastest way and avoiding bureaucratic and administrative obstacles) and **"certified"** in order to have a legal validity. Communication protocols have to be identified and used to satisfy these requirements.



The opportunity to **involve stakeholders** in the management and communication of sea storm risk is recognized as fundamental, in particular Civil Protection associations, port authorities, beach managers, cooperatives and other sea-related activities, schools and all potential stakeholders in the tourism sector.

Civil Protection **volunteers** are a fundamental and important resource for event monitoring and emergency management, hence they must be supported, strengthened and enlarged. Such a complex system, that implies the alerting and emergency management, needs a lot of human and instrumental resources. I**t is thus necessary to think about how to strengthen the system and expand the availability of volunteers**.

Finally, it is important that the alert and intervention procedures for sea storms risk, once they have been defined, should be tested through **exercises,** that help to test in a practical way the alerting and emergency management system, highlighting criticalities and keeping people and institutional players trained and up to date.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Contact:

City of Venice
European Policies Department
istorms@comune.venezia.it

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