COASTAL MANAGMENT APPROACHES FOR SEA LEVEL RELATED HAZARDS

Case studies and Good Practices

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COASTAL MANAGMENT APPROACHES FOR SEA LEVEL RELATED HAZARDS

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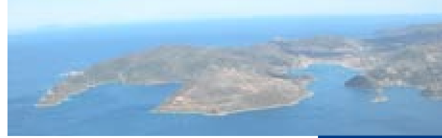

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ACKNOWLEDGEMENT

This compendium has been prepared in fulfilment of a task of the Tsunami Information Centre (NEAMTIC) Project of the Intergovernmental Coordination Group (ICG) of the Tsunami Warning and Mitigation System in the North-eastern Atlantic, the Mediterranean and Connected Seas (NEAMTWS).

Financial assistance in support for this workshop by the European Union's Directorate General ECHO is acknowledged and by the IOC ICAM Programme is acknowledged.

The document draws on UNESCO-IOC publications including IOC Manuals and Guides numbers 49 (UNESCO-IOC, 2008a), 50 (UNESCO-IOC, 2009a), 52 (UNESCO-IOC, 2009b) and 57 (UNESCO-IOC, 2011a); the Tsunami Glossary (UNESCO-IOC, 2008b); and the Compendium of Definitions and Terminology on Sea-level-Related Hazards, Disasters, Vulnerability and Risks in a coastal context (UNESCO-IOC, 2011b). It acknowledges the contributions of the United Nations International Strategy for Disaster Reduction (UN-ISDR) in their advice on disaster risk reduction, including tsunamis. The outputs of EU research projects including SCHEMA, SEAHELLARC, NEAREST, TRANSFER, CONSCIENCE, EUROSION, BEACHMED, FLOODSITE, SAFECOAST and MICORE provide important reference material.

The document has been illustrated by case studies and other contributions prepared by participants to a NEAMTIC/ICAM Workshop on Coastal Management Approaches for Sea-level Related Hazards held in December, 2011 (UNESCO-IOC, 2012). The authors include Adel Abdouli (Tunisia); Russell Arthurton (UK); Corinna Artom (Italy); Abdelouahad Birouk (Morocco); Françoise Breton (Spain); Yacine Hemdane (Algeria); Gonzalo Malvarez (Spain); Nurcan Meral Özel Seyhum, Püskülkü Gülüm Tanircam (Turkey); Daria Povh Škugor (Croatia); Paulo Sacadura (Portugal); Mohamed A. Said (Egypt), Maria Snoussi (Morocco) and Takvor Soukissian (Greece). All of these contributions are gratefully acknowledged.

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FOREWORD

Following the disastrous 2004 Indian Ocean tsunami, the Intergovernmental Oceanographic Commission of UNESCO (UNESCO-IOC) was given a mandate by its Member States to facilitate the expansion of global coverage of Tsunami Warning and Mitigation Systems (TWS) and to co-ordinate the establishment of a TWS for a region comprising the North-eastern Atlantic, the Mediterranean and Connected Seas. As part of this process, a Tsunami Information Centre (NEAMTIC) is being created to serve the needs of civil protection agencies and the public at large, providing information on warning systems, risks and good practices in respect of tsunamis and other sea-level related hazards.

This compendium forms a foundation for these objectives. It provides guidance in identifying, sharing, and disseminating good practices in plans, methods and procedures to strengthen preparedness for sea-level related hazards, including mitigation through Integrated Coastal Area Management (ICAM). It includes case-studies from Member States illustrating existing management approaches, and recommendations for enhancing coastal communities' awareness of, and preparedness for, sea-level related hazards.

For maritime countries within the European Union (EU), the document relates to the establishment or strengthening of National Platforms or focal points for disaster risk reduction, as promoted by the Hyogo Framework (UN-ISDR, 2005). It is relevant to the requirements of the EU's Floods Directive of 2007 in which Flood Risk Management Plans, focused on prevention, protection and preparedness, are required to be in place by the year 2015. It also relates to the requirements on Mediterranean countries that are Contracting Parties to the Integrated Coastal Zone Management Protocol of the Barcelona Convention, adopted in 2008 and entered into force in March 2011.

Wendy Watson-Wright
Assistant Director General, UNESCO
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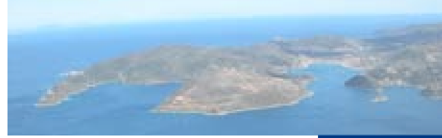


EXECUTIVE SUMMARY

Coastal communities around the world are experiencing unprecedented rates of change due to population growth, human induced vulnerability, and global climate change. The effects of this change are placing communities at increasing risk of inundation from coastal hazards including tsunamis, storm surges and shoreline erosion.

The sustainable development of coastal zones relies upon effective management of the risk of inundation both now and in the context of increasing impacts of climate change. Improving risk management and mitigation by providing the tools to better inform planning policy is now a consensus view in light of the disastrous impacts on already pressurized coastal zones. The concept of risk management embodies prevention, preparedness, mitigation, response, relief and recovery and rehabilitation.

This compendium aims to provide examples of good practice in preparedness for, and awareness of, tsunami and other sea-level related hazards, selected from the case-studies presented at a NEAMTIC workshop (UNESCO-IOC, 2012), complemented by experience gained from countries outside the NEAM region. It presents examples on how to prepare, respond to or mitigate/reduce such hazards. Short descriptions of these initiatives are given, highlighting interesting and innovative elements, approaches, tools, etc., that could be replicated, given similar conditions, or to provide a basis for the development of new approaches more appropriate for other areas. It aims also to stimulate new ideas and further action for mainstreaming coastal hazard preparedness and awareness in ICAM, in a hope of creating safer coasts in the future. The examples compiled here enhance awareness and preparedness and provide useful insights and lessons for coastal risk and climate change managers and policymakers, development planners, and practitioners at national and local levels. Case studies illustrating mismanagement and/or poor planning are also presented, raising important issues of awareness and preparedness.

The key recommendations proposed for improving awareness of, and preparedness for, sea-level related natural hazards are set out in the final section of the document.

For improving awareness, the main steps identified are: identifying stakeholders and stakeholder analysis; developing a communication strategy; preparing educational materials; communicating, discussing, informing, workshops. Recommendations in respect of these steps are presented as responses to the following questions:
How to provide education and outreach to Member States and localities on coastal risks and available tools to reduce them?
How to increase awareness of stakeholders about coastal risk management, planning objectives and existing trade-offs (e.g., related to economic development, flood risk and nature conservation)?
How to increase the participation of local communities and authorities in coastal risk planning and management?
How to test and implement emergency plans with the local coastal communities?

For preparedness, the recommendations are presented as responses to the following questions:
Which actions should be promoted to achieve a more integrated approach to coastal risk management?
Which measures are most appropriate to reduce coastal risks?
What (preparedness measures) are the knowledge gaps on coastal risks?
Which characteristics should an early warning system include?

1 INTRODUCTION

1. INTRODUCTION

1.1. Background

One of the most tragic aspects of the devastation caused by the 26 December 2004 Indian Ocean tsunami is that many of the lives lost could have been spared, had warning systems and preparation for such events been adequate. Affected countries have since then undertaken remarkable efforts to ensure that such a tragic failure will not be repeated. Nowadays, it is recognized worldwide that the impacts of disasters can be substantially reduced if authorities, individuals and communities in hazard-prone areas are well prepared and ready to act, and are equipped with the knowledge and capacities for effective disaster management.

Preparedness involves developing and regularly testing warning systems, evacuation plans and other measures used during an emergency alert period to minimize loss of life and damage to property. It also involves the education and training of officials and the population at risk; the establishment of policies, standards, committees and operational plans to be applied following an inundation hazard event; and the securing of resources. Coastal inundation hazard planning includes not only structural preparations, but also includes behaviour change, community preparedness, education, and outreach. Communities that actively engage in hazard and resiliency planning are less prone to disaster, recover faster from disasters which do occur, and endure less economic hardship than those communities which do not. The six main tasks for enhancing community awareness and preparedness which are addressed in the following sections of this compendium are listed in Box 1.1.

BOX 1.1

The key tasks to enhance awareness and preparedness for tsunamis and other sea-level related hazards

Communicating and enhancing awareness of risks.
Planning and implementing the key operational requirements of an early warning system.
Promoting "Community-based Disaster Risk Management".
Enhancing the resilience of coastal communities to hazards.
Keeping preparedness going over the long term.
Selecting the strategic approaches to risk reduction.

Source: UNESCO-IOC, 2009a

During the recent decades, coastal risk management and reduction has been promoted in a systematic way through various national and international initiatives in the context of Integrated Coastal Area Management (ICAM) and Disaster Risk Reduction. The UN-ISDR, the UNESCO-IOC ICAM and Tsunami programmes and European Union (EU) research projects on coastal risks are some of the attempts to implement such initiatives.

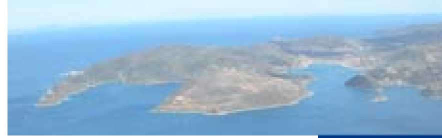
Through its Tsunami Programme, UNESCO-IOC supports its Member States in improving capabilities for tsunami risk assessment, implementing early warning systems and enhancing the preparedness of communities at risk.

The ICAM Programme has well-established experience in supporting the coastal nations in addressing the issues of cost-effective strategies for sustainable coastal area planning. The guidebook "Hazard Awareness and Risk Mitigation through ICAM" (IOC Manuals and Guides No. 50, UNESCO, 2009) aims to assist managers in the reduction of the risks to coastal communities, their infrastructure and service-providing ecosystems from tsunamis, storm surges and other coastal hazards within the phased framework of ICAM.

Table 1.1. IOC programmes in coastal hazards/inundation

Source: Barbière, 2010

Hazard	Tsunami	Storm surge	Wind-driven waves	Sea level rise	Coastal erosion
Frequency	Decades to centuries	Annual to decadal	Annual to decadal	Ongoing but accelerating	Ongoing but accelerating
Magnitude (run-up)	From cm to meters	1-2 meters or more	1-2 meters or more	Average +0.5-1.7 cm	Several m/yr
Duration	Hours to 1 day	Few hours to few days	Hours to many days	Ongoing	Ongoing
Impact	Inundation and drainage surges	Single event inundation	Multiple localized inundations	Progressive sea level rise	Progressive
Area	Local run-up	Hydrological modelling	Terrain modelling	Terrain modelling	Long-term trends
Warning	Minutes to hours	12 hours to 2 days	1-3 days	Decades	Decades
IOC programme	TSU	JCOMM	JCOMM	GLOSS	ICAM



Building on these guidelines, UNESCO-IOC, through its North-eastern Atlantic, Mediterranean and Connected Seas Tsunami Information Centre Project (NEAMTIC), organized a regional workshop on "Coastal management approaches for sea-level related hazards in the North-eastern Atlantic, the Mediterranean and Connected Seas Region" (NEAM) in Paris, December 5-7, 2011 under the scope of its ICAM and Tsunami programmes (UNESCO-IOC, 2012). This workshop aimed to fulfil the NEAMTIC project's task on "Identification, sharing, and dissemination of good practices, in plans, methods and procedures, to strengthen preparedness for sea-level related hazards, including mitigation through Integrated Coastal Area Management" (UNESCO-IOC, 2011c).

This compendium aims to provide examples of good practice in preparedness and awareness for tsunami and other sea-level related hazards, selected from the case-studies presented at the NEAMTIC workshop (UNESCO-IOC, 2012), complemented by experience gained from countries outside the NEAM region. It presents examples on how to prepare, respond to or mitigate/reduce such hazards. Short descriptions of these initiatives are given, highlighting interesting and innovative elements, approaches, tools, etc., that could be replicated, given similar conditions, or to provide a basis for the development of new approaches more appropriate for other areas. It aims also to stimulate new ideas and further action for mainstreaming coastal hazard preparedness and awareness in ICAM, in a hope of creating safer coasts in the future. The examples compiled here aim to enhance awareness and preparedness and provide useful insights and lessons for coastal risk and climate change managers and policymakers, development planners, and practitioners at national and local levels. Case studies illustrating mismanagement and/or poor planning which raise important issues of awareness and preparedness are also presented.

For a general account of the NEAMTWS, the reader is referred to guidance prepared as part of the NEAMTWS implementation – "Reducing and Managing the Risk of Tsunamis" (UNESCO-IOC, 2011b). It aims to support and supplement countries' established procedures in respect of preparedness for, and response to, natural hazards and disasters, highlighting the special features of the tsunami hazard and the particular challenges faced by civil protection agencies in being prepared for, and responding to, a tsunami event.

1.2. RATIONALE FOR ACTION

Coastal communities around the world are experiencing unprecedented rates of change due to population growth, human induced vulnerability, and global climate change. The effects of this change are placing communities at increasing risk of inundation from coastal hazards including tsunamis, storm surges and shoreline erosion.

Vulnerability in the coastal zone is increasing as more people move to the coast and natural buffers such as wetlands and dunes are lost to development and erosion. There is an obvious relationship between the consequences of flooding events (loss of lives, economic damage) and the extent of coastal spatial and infrastructural developments in terms of land use, buildings, infrastructural facilities and related values, driven by population and economic growth. It also has become evident that, even without a major catastrophic inundation, many coastal communities are poorly resilient to normally recurring hazards. Indeed, high coastal population density coupled with projected increases in storm frequency and severity may exacerbate the impacts of coastal disasters and slow subsequent recovery and community rebuilding efforts, raising the question of how to increase community resilience.

Recent events such as the tragic 2011 tsunami in Japan (the largest in Japan's history), the Indian Ocean tsunami in 2004, Hurricane Katrina on the United States' Gulf Coast (the costliest and one of the five deadliest in the USA) and the storm "Xynthia" along the western coasts of France and Spain in 2010 have illustrated how significant the social and economic costs can be when a major natural hazard impacts a developed coastal area.

Coastal managers are challenged to strike the right balance between a naturally changing shoreline and the growing population's desire to use and develop coastal areas. Challenges include protecting life and property from coastal hazards; protecting coastal wetlands and habitats while accommodating the need for economic growth; and settling conflicts between competing needs. The potential impacts of sea-level rise will add to the challenge of managing these competing interests effectively and in a sustained manner. Coastal managers must now decide how or whether to adapt their current suite of tools to face the prospect of more and more people and economic and environmental assets at risk from flooding in the decades to come.

In summary, the sustainable development of coastal zones relies upon effective management of risk both now and in the context of increasing impacts of climate change. Improving risk management and mitigation by providing the tools to better inform planning policy is now a consensus view in light of the disastrous impacts on already pressurized coastal zones. The concept of risk management embodies prevention, preparedness, mitigation, response, relief and recovery and rehabilitation.

Since the1990s several recent international agreements have recommended the concept of ICAM and environmental decision-makers have taken it as a suitable way to achieve the sustainable management of the coastal zones (Suman, 2002). Thus it is imperative to integrate hazard, vulnerability and risk within the ICAM context in order to better address management of these issues as they affect coastal communities.

1.3. Is the NEAM Region prone to sea-level related hazards?

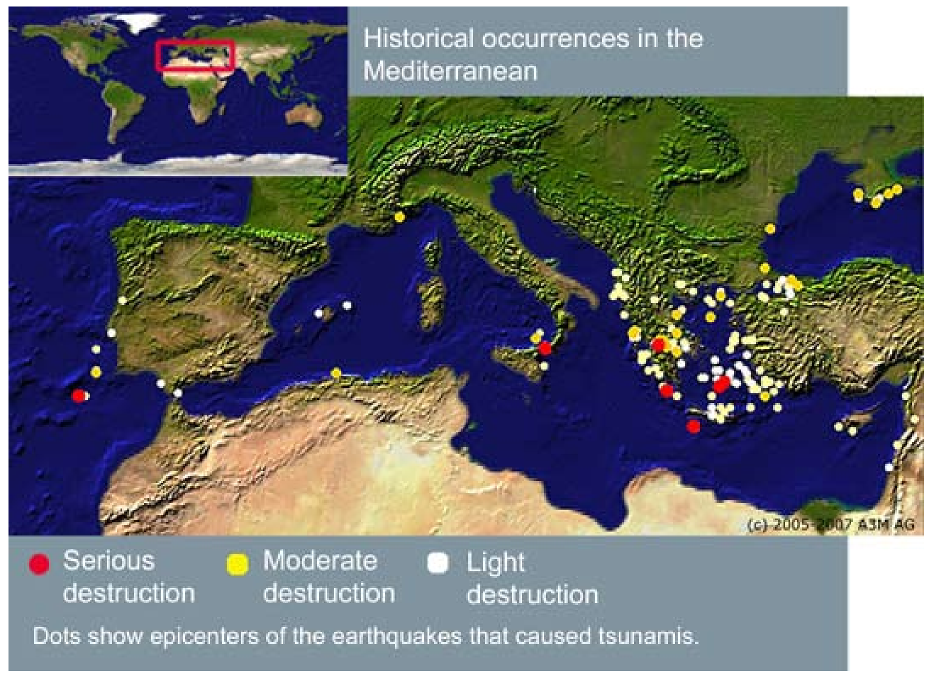
Historically the North-eastern Atlantic, the Mediterranean and Connected Seas (NEAM) Region is one of the most tsunami prone regions in the world. Major tsunamis with ten-thousands of casualties and severe damage to coastal cities occurred in 365 (Santorini, Greece), in 1775 (Lisbon, Portugal) and in 1908 (Messina, Italy). Even recently, in 2002 (Stromboli) and 2003 (Algeria), tsunamis have been generated, though fortunately not very damaging. According to the EU/TRANSFER project, there were 324 events in the region from 6150 B.C. to 2007 (Fig. 1.1).

Tsunamis

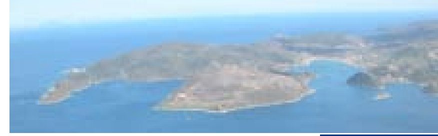
Ten per cent of all tsunamis worldwide occur in the Mediterranean. On average, one disastrous tsunami takes place in the NEAM region every century. Geological research and historical records provide evidence of many powerful tsunamis that have taken the lives of thousands over the ages, mostly affecting Greece and southern Italy. Figure 1.2 shows the historically recorded tsunamis run-ups, as well as the tsunami hazard potential in the region.

There are numerous tsunami sources including earthquakes, landslides, and volcanic eruptions that may cause catastrophic events in major coastal cities such as Lisbon, Naples, Messina, Istanbul, Heraklion, and Cairo (Box 1.2). As elsewhere, in the Mediterranean the cause of most tsunamis can be linked to seismic events, but the effects of volcanic activity as far as Vesuvius, Etna and the Aeolian Islands are concerned, in particular Stromboli and Vulcano, must not be underestimated. The coasts most at risk are those of southern Italy, i.e., Apulia, Sicily and Calabria. Most of the sources are very close to the coast and tsunamis may hit in a few minutes, exceeding the current ability for warning based on the national and regional real-time seismic, monitoring networks installed in the area.

Figure 1.1. Historical tsunami occurrence in the Mediterranean



Source: http://www.tsunami-alarm-system.com/en/phenomenon-tsunami/occurrences-mediterranean.html



Box 1.2

The largest known tsunamis in the Mediterranean

MAY 2003
After a quake near the coast of Algeria, a tsunami was generated; this destroyed over 100 boats on Mallorca and flooded Palma's Paseo Maritimo.

17 AUGUST 1999
A large destructive earthquake struck north-west Turkey and generated a local tsunami within the enclosed Sea of Marmara. It occurred along the Northern Anatolian Fault zone. Its epicentre was in the Gulf of Izmir. Official estimates indicated that about 17,000 people lost their lives and thousands more were injured.

9 OCTOBER 1963
Tsunamis can develop not only in oceans: In Italy, near the town of Longarone, the entire northern slope of Mount Toc slid into the Vaiont reservoir. The water spilled over the dam and destroyed a number of villages with a wave of 140 metres. 4000 people lost their lives.

9 JULY 1956
The best documented and most recent tsunamigenic earthquake in the Aegean Sea between Greece and Turkey is the one that occurred near the south-west coast of the island of Amorgos, killing 53 people, injuring 100 and destroying hundreds of houses. The waves were particularly high on the south coast of Amorgos and on the north coast of the island of Astypalaea. At these two places, the reported heights of the tsunami were 25 and 20 m, respectively.

28 DECEMBER 1908
Due to an earthquake and the ensuing tsunami, the city of Messina in Italy was almost completely destroyed. More than 75,000 people were killed.

1 NOVEMBER 1755
The Portuguese capital of Lisbon and its inhabitants were particularly badly hit by an earthquake that occurred in the eastern Atlantic Ocean. Two-thirds of the city were destroyed by resulting fires. The people seeking refuge from the flames on the banks of the Tejo River were surprised by huge flood waves produced by the earthquake. Some 60,000 people lost their lives. The waves were even observed in Ireland and, on the western side of the Atlantic, on the Lesser Antilles. On the coastline of the Madeira Islands the waves still had a height of 15 metres.

1672 In the Aegean Sea, the Cyclades islands, especially Santorini, were shaken by an earthquake. The island of Kos, to the east, was completely en gulfed by an ensuing tsunami.

26 SEPTEMBER 1650
A destructive earthquake was accompanied by a submarine explosion from the Colombo Volcano, whose crater lies in the sea north-east of Santorini. A devastating tsunami was observed on the island of Ios, north of Santorini, with waves of up to 16 m reported.

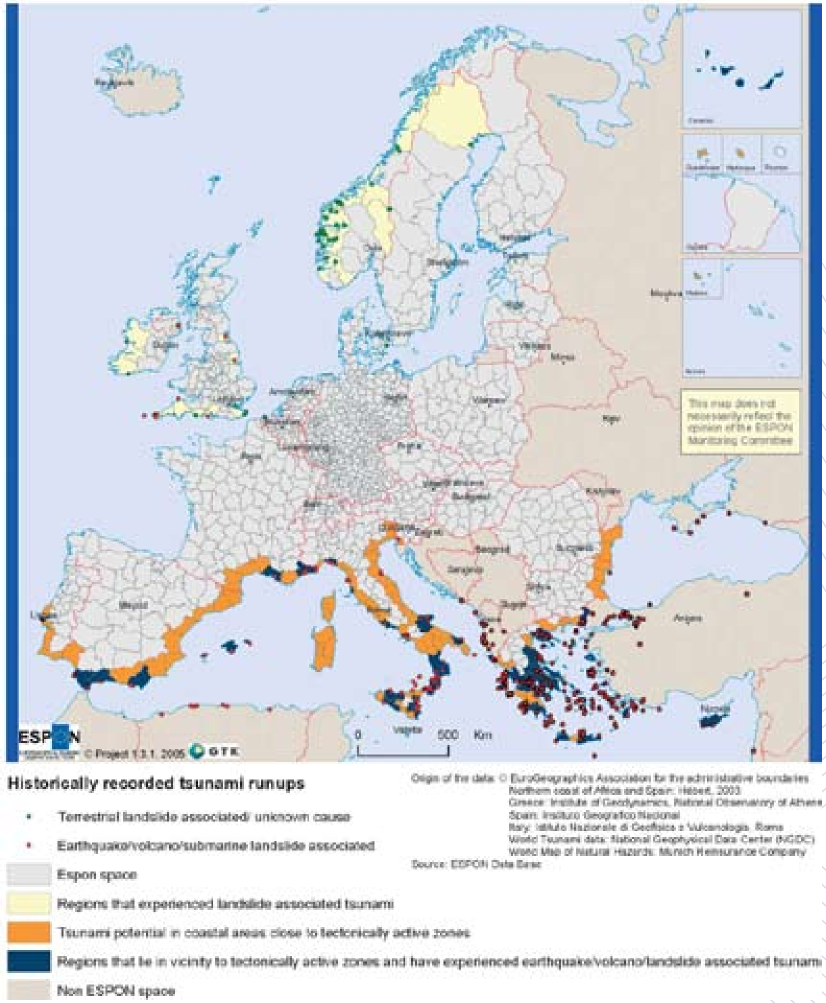
1303 AD A quake with an estimated strength of 8 destroyed the island of Rhodes and the eastern part of Crete. It caused a tsunami which reached the Egyptian coast.

365 AD A quake of 8 to 8,5 in the year 365 caused heavy destruction on the whole of Crete. The tsunami that followed the quake completely destroyed coastal regions as far as Egypt and eastern Sicily. Records indicate that 50,000 people lost their lives in Alexandria.

1628 BC The coasts of the entire eastern Mediterranean were submerged by flood waves up to 60 metres high.
The waves were caused by a volcanic eruption on Santorini and are believed to have been responsible for the destruction of the Minoan culture.

Source: http://www.tsunami-alarm-system.com/en/phenomenon-tsunami/occurrences-mediterranean.htm

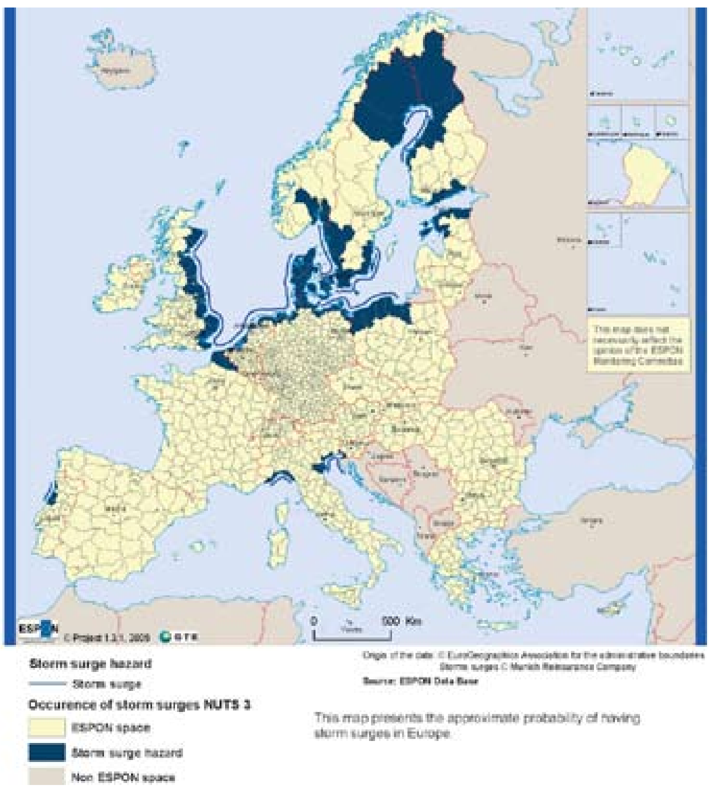
Figure 1.2.
Historically recorded tsunamis run-ups, and tsunami hazard potential in the region
Source: ESPON, 2006.



Storm surges, extreme waves and sea-level rise

Several countries are exposed to inundation due to other types of sea-level related hazard, in particular those countries with extensive low-lying coastal land: 85% of the coastal zones of Netherlands and Belgium lie below 5 m elevation, while 50% of coastal zones of Germany and Romania fall in that category. The respective figures for Poland are 30%; Denmark, 22 %; France, the United Kingdom and Estonia, 10–15% (Fig. 1.3). The likelihood of severe storm surges–surge heights with 50-year extremes of up to 3 m above the mean high tide level–make the coasts of the southern North Sea and eastern Baltic Sea very prone to flooding (UNESCO-IOC, 2009c).

Figure 1.3.
Storm surge hazard in the region
Source: ESPON, 2006.

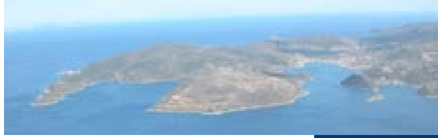


According to a recent study of climate change adaptation and natural disasters preparedness in the coastal cities of North Africa (World Bank, 2011), natural disasters have increased in frequency and intensity in that region during the last ten years. Urban flooding episodes have taken place at various times in many cities, causing huge damage and losses of life and economic activity. Furthermore, the Middle East and North Africa will be the developing region second-most affected by sea-level rise. According to recent estimates (Stern, 2006) Review, Economics of Climate Change) between 6 million and 25 million people could be exposed to coastal flooding in North Africa under a temperature increase ranging between one and three degrees Celsius. Some countries, such as Egypt and Tunisia, will be more severely impacted. With a possible 0.5-metre sea-level rise, about 3.8 million people would be affected in the Nile Delta (UNEP/GRID, undated). The region is also prone to earthquakes. The most recent have been particularly violent in Algeria and Morocco. Consequently, risk assessment and disaster preparedness have become even more relevant, and urban governments need to incorporate them in their urban and infrastructure planning, as well as in the awareness-raising of the resident populations via information campaigns and emergency response contingency plans.

Table 1.2.
Urban risks increase over time in coastal cities of North Africa
Source: World Bank, 2011, North African Coastal Cities Address Natural Disasters and Climate Change.

Urban Risks	Alexandria		Tunis		Casablanca		Bouregreg Valley	
Horizon	Current	2030	Current	2030	Current	2030	Current	2030
Seismicity/ground instability								
Tsunami/Marine submersion								
Coastal Erosion								
Flooding								
Water Scarcity								

Very High · High · Medium · Low · Very Low



1.4 Are communities of the neam region properly prepared?

Establishment of warning systems: progress achieved

The state of the art and the challenges posed by the establishment of such systems were analyzed by the Intergovernmental Coordination Group for the Tsunami Warning and Mitigation System in the NEAM region (ICG/NEAMTWS), established at the end of 2005. The IGC formulated a complete plan of action with the aim of having a fully operational system in 2011. On 10 August 2011, the communication network of the NEAMTWS was tested successfully.

According to the NEAMTWS Implementation Plan (UNESCO-IOC, 2009c), countries in the NEAM region already have the scientific and monitoring infrastructures (seismic and sea-level networks) to implement a Tsunami Early Warning and Mitigation System in the region. Some European countries also have experience and know-how gained from setting up an End-to-End Early Warning System in Indonesia and the tsunami warning system for the Indian Ocean Region (IOTWS). In the NEAM region, the infrastructure is unequally distributed, with much denser networks in European countries than in northern African and Middle East countries, where they are generally not fully real-time or based only on one communication channel. This heterogeneity reflects gaps to be filled for Early Warning purposes.

Awareness and mitigation

Hazard and risk assessments for tsunamis and other coastal hazards are key elements of any Warning System. In the NEAM region, some countries have advanced modelling and simulation systems for tsunamis (including inundation/run-up) and much of their infrastructure is adaptable to other hazards. However, there are still few examples of tsunami hazard assessment. Even less numerous are studies of vulnerability and risk; if they exist, they apply only to limited areas of special interest (e.g., urban settlements or industrial plants) with specific needs.

In terms of awareness and population response, these are crucial issues in the NEAM region because tsunami travel times are very short, and there is a real possibility that a tsunami could impact before the population can be properly alerted by the TWS or respond to warnings. It is important therefore that national and local emergency response plans be prepared for coastal regions, and that regular preparedness exercises and drills be undertaken in all countries of the NEAM region, starting from the coastal areas identified as the most exposed to the tsunami threat.
In terms of mitigation, historically, a large variety of coastal risk management measures has been implemented. In the periods after the coastal flood disasters in the 20th century (in particular those in 1953 and 1962 affecting the North Sea countries) measures have focused on the improvement of flood defence systems (e.g., shortening of coastlines, stronger dikes, sea walls and barriers). In recent decades, the scope of policy options is broadening to include various options related to "working with natural processes" such as beach renourishment, salt marsh/foreland management and the use of managed retreat strategies, as practiced on the East coast of the United Kingdom (Safecoast, 2008).

The EU promotes co-operation between European regions, as well as the development of common solutions for issues such as urban, rural and coastal development, economic development and environment management. There have been many initiatives and EU-funded projects related to exchanging knowledge and showing best practices on tsunami (SCHEMA, SEAHELLARC, NEAREST, TRANSFER) and coastal and flood management (COASTVIEW, CONSCIENCE, DINAS-COAST, EROGRASS, EUROSION, BEACHMED, FLOODSITE, SPICOSA, SAFECOAST, MICORE) in recent decades.

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2

COMMUNICATING AND ENHANCING AWARENESS OF RISKS

This is the process of informing the general population about the hazards affecting the country and how they can act to reduce their exposure to hazards. This is particularly important for public officials in fulfilling their responsibilities to save lives and property in the event of a disaster.
Public awareness activities aim to foster changes in behaviour leading to a national culture of prevention and mitigation. Activities include information dissemination, education, radio or television broadcasts, use of printed media, as well as the establishment of information centres and networks and community participatory activities. Regarding long-term education and planning, there are many basic measures that can be undertaken without great cost. The inclusion of hazard awareness and emergency procedures should become standard in the education of coastal communities where a high risk is acknowledged.

2.1 Information management and exchange

Increased public awareness of coastal hazard risks is typically achieved by the application at national to local scales of the following key messages:

Provide easily understandable information on tsunamis and other sea-level related risks and protection options, especially to citizens at high risk, to encourage and enable people to take action to reduce risks and build resilience. The information should incorporate relevant traditional and indigenous knowledge and culture heritage and be tailored to different target audiences, taking into account cultural and social factors.
Strengthen networks among coastal experts, managers and planners across sectors and between regions, and create or strengthen procedures for using available expertise when agencies and other important actors develop local risk reduction plans.
Promote and improve dialogue and cooperation among scientific communities and practitioners working on natural coastal risk reduction, and encourage partnerships among stakeholders, including those working on the socioeconomic dimensions of disaster risk reduction.
Promote the use, application and affordability of recent information, communication and space-based technologies and related services, as well as earth observations, to support disaster risk reduction, particularly for training and for the sharing and dissemination of information among different categories of users.
In the medium term, develop local, national, regional and international user-friendly directories, inventories and national information-sharing systems and services for the exchange of information on good practices, cost-effective and easy-to-use disaster risk reduction technologies, and lessons learned on policies, plans and measures for risk reduction.
Institutions dealing with urban development should provide information to the public on disaster reduction options prior to construction, land purchase or land sale.
Update and widely disseminate international standard terminology related to disaster risk reduction, for use in programme and institutional development, operations, research, training curricula and public information programmes.

Box 2.1

Meteoalarm - alerting Europe for extreme weather

THE INITIATIVE

In the past the Weather Services of Europe have been issuing warnings based on different parameters in very different early warning and forecast schemes. Large catastrophes like windstorms or floods were dealt with by using different warning levels in different countries, resulting in confusion for travellers and companies or institutions active in more than one country.
In the framework of EUMETNET, a network grouping the National Weather Services from 26 European countries, a program was set up to put all alert levels and/or warnings on a common web platform and to harmonize the process of issuing an alert level or a warning as much as possible. The website offers the overview and many details on the weather awareness situation within Europe. A large set of meteorological parameters including coastal events are taken into account in the program.

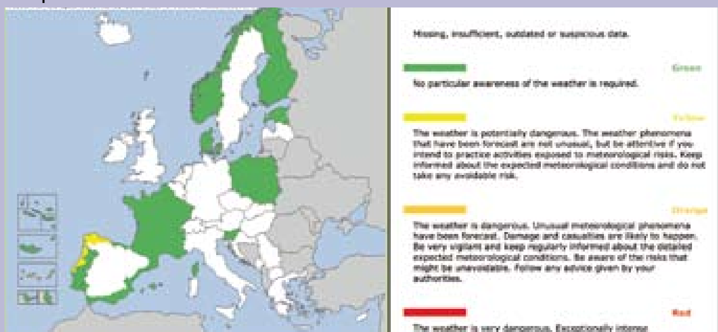
GOALS AND OBJECTIVES

The main objectives of this initiative are to:
1. Improve meteorological warnings and their impact on the behaviour of citizens and users;
2. Improve the quality of the information given to civil protection in the individual countries and on the European level; and
3. Develop and harmonize a warning system with different warning levels applicable in all parts of Europe, for 10 different warning parameters and a clear language towards the users in terms of expected weather events, their possible impact, as well as, the advice on behaviour.
The project has recommended that the alert levels be published in a unified system of four different levels with a clear relationship between the diffe-

rent meteorological features, possible damage and proposed behaviour to avoid damage. The meteorological parameters are explained with easy to understand symbols for each parameter. The colour-coded maps provide the latest warnings of expected severe weather for the next 48 hours over most of Europe. Each country is colour-coded on the map to represent four levels of warning: red to indicate exceptional risk from dangerous weather conditions, down through orange and yellow to green, indicating that severe weather is not expected. The site offers also a greyscale map for colour blind people.
The demand for such a standardized system is apparent due to a number of noticeable requests from institutions, such as WMO, UN-SPIDER and European Commission Monitoring and Information Centre (MIC), to export and promote the system in other parts of the world. Since the project was implemented in early 2007, the responses by media and the public are very high and numerous feedbacks from institutions and individuals were received.
Before the website could go online a two year preparation phase in the EUMETNET Program European Multipurpose Meteorological Awareness (EMMA) was needed. The outcome of the project, the Meteoalarm website, is frequently visited and gets up to 12 million hits per day. The warning information is provided for 250 million Europeans, the 400 million tourists in Europe who travel outside their own country, as well as users outside Europe.

THE GOOD PRACTICE

Through the warning website the project has had a direct impact on users in very diverse cultures and countries.
The website is clearly arranged, easily understandable and a large number of people can be reached. The accurate and time-relevant information is available in 27 individual languages with updates every 10 minutes. The concept is simple and straightforward, and has a good harmonized alarm capability for all involved partners based on structured promotion work. In addition, the 29 partners are constantly providing data and information to the web database. It is important to investigate the need for harmonization, the harmonization gaps and to develop corresponding data structures and information flow as well as keeping the needs of different users, different institutions and the public in mind.



Example of coastal event for Europe on 30th October 2011 at 18:02
(http://www.meteoalarm.info/)

LESSONS LEARNED

The lessons learned from this project were to start with the user's needs, to structure them well and to set up a system capable of growing in both content and partners. The mayor challenges to overcome have been the harmonization of gaps in the practice of the different partners involved and language problems. The latter could be solved by providing the static content of the website in 27 different languages and constructing a database which allows implementation in additional languages without large effort or expenditures.
The high number of requests on the website suggests enlarging www.meteoalarm.eu in a multi-hazard platform as users from institutions, the public and the media have a high level of confidence in the information provided and visit the website regularly.
The concept of Meteoalarm could be applied to other areas with existing knowledge of data handling and the harmonization process. This could be done by widening the existing warning area toward other regions or applying the same concept and strategies to other parts of the world. The high number of visitors to the website resulted in an improvement of the hardware-software infrastructure to cope with the demand. The project could be easily replicated if the user needs concerning meteorological warnings and structures of institutions which provide the information are assessed and well analyzed.

Source: UN-ISDR, 2010

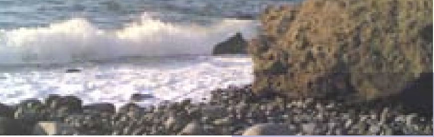
Box 2.2
Coastal inundation and the EU Floods Directive a NEAMTIC perspective

THE DIRECTIVE

The purpose of the EU Floods Directive is to establish a framework for the assessment and management of flood risks in EU Member States, aiming at the reduction of the adverse consequences for human health, the environment, cultural heritage and economic activity associated with floods in the Community. It applies to coastal areas subjected to inundation from the sea just as it does to river basins, flash- and urban flooding. The Floods Directive is also relevant to non-EU Mediterranean countries that are Contracting Parties to the Integrated Coastal Zone Management Protocol of the Barcelona Convention.

THE FLOODS DIRECTIVE IMPLEMENTATION

The European Commission DG-ENV Water Unit, together with a Member State (Ireland), is leading the Working Group-F (Floods) in the implementation of the EU Floods Directive (2007/60/EC). WG-F is one of the permanent working groups of the Common Implementation Strategy (CIS) for the Water Framework Directive (2000/60/EC).
The purpose of WG F is to provide a forum for support for the implementation of the Floods Directive, for information exchange between Member States and stakeholders on good practices with a view to reaching a common understanding on the requirements for the implementation of the Floods Directive, and for linking with other related activities in the CIS and at EU



level for support of the implementation.

The objectives of the work programme for 2010-2012 are to develop reporting formats for the different stages, as well as to provide a platform for information exchange between Member States and with other actors (including WFD groups) on themes relevant to the implementation of the Floods Directive.

The implementation of the Directive is marked by strict timelines for the completion of three stages – a Preliminary Flood Risk Assessment; Hazard and Risk Mapping; and the preparation of Flood Risk Management Plans.

LINKAGE TO NEAMTWS

The Flood Risk Management Plans being drawn up by maritime EU Member States must take account of the risk of flooding from the sea, whether by catastrophic events – tsunamis, storm surges or extreme waves – or, over the longer term, by sea-level rise. They should also take account of climate change. The dissemination of information within these plans relating to coastal inundation fits well with the objectives of NEAMTIC.

The main themes that are relevant both to the WG-F and NEAMTIC are:

Early warning
End-to-end system of warning to "the last mile"
Hazard event detection and messaging (regional/national)
Communication tests and exercises
SOPs for all parts of the warning system
- Civil Protection linkage
Evacuation Planning
Public Awareness
Education
- Risk mitigation
Structural, e.g. engineered protection
Non-structural, e.g. land-use change/planning and regulation

Russell Arthurton, United Kingdom

2.2 Education and training

Public awareness of coastal hazard risks can be enhanced by the application at national to local levels of the following key messages:

Promote the inclusion of coastal hazard and risk reduction knowledge in relevant sections of school curricula at all levels and the use of other formal and informal channels to reach and inform youth and children. Promote the implementation of local risk assessment and disaster preparedness programmes in schools and institutions of higher education. Promote the implementation of programmes and activities in schools for learning how to minimize the impacts of hazards.

Develop training and learning programmes in disaster risk reduction targeted at specific sectors (development planners, emergency managers, local government officials, etc.).

Promote community-based training initiatives, considering the role of volunteers, as appropriate, to enhance local capacities to mitigate and cope with disasters.

Ensure equal access to appropriate training and educational opportunities for women and vulnerable constituencies; promote gender and cultural sensitivity training as integral components of education and training for disaster risk reduction.

Several successful educational activities have been undertaken worldwide, especially during the World Disaster Reduction Campaign (2006-2007) under the theme "Disaster Risk Reduction Begins at School" to make school buildings safer and have disaster risk reduction taught in school.

Box 2.3

Disaster Preparedness Education Program in Turkish Schools.

Istanbul, Turkey (2004-2005)

THE INITIATIVE

Fifty of Turkey's eighty-one provinces, and all of the most populous areas within its first and second degree Earthquake Risk Zones, needed a basic disaster awareness program for their schools. The devastating 1999 Kocaeli earthquake in Turkey had provided a wake-up call to Istanbul, which is situated in the earthquake-threatened Marmara Region. With support from the United States Agency for International Development, Office of Foreign Disaster Assistance (USAIS/OFD), Bogaziçi University, Kandilli Observatory and the Earthquake Research Institute initiated a Disaster Preparedness Education Program (DPEP). The Program developed public education materials and an instructor training curriculum that was successfully implemented in Istanbul and three surrounding provinces. Once proven, the challenge was to take this program nationwide, in cooperation with the Ministry of Education.

GeoHazards International (GHI) provided team members with an opportunity to collaborate with Turkish technical experts living in California. The bi-continental team developed a self-study, distance-learning curriculum in basic disaster awareness that could reach residents of the most remote corners of Turkey. The team also created a web-based data entry system to involve school and community-based instructors and to track the dissemination of a variety of training materials through DPEP, government agencies and non-governmental partners in each of Turkey's provinces.

LONG-TERM OUTCOMES

- The innovative Basic Disaster Awareness Self-Study Curriculum was made

available online in both Turkish and English versions.
- A corps of 100 trained instructors remains active and engaged in 30 Turkish provinces.
- Family Disaster Plan and Organizational Disaster Plan messages were drafted, which are useful in case of any natural hazards.
- Classroom activities and children's activities to reinforce disaster mitigation education were made available online.
- Courses in Non-Structural Mitigation and Structural Awareness for Seismic Safety were integrated into Turkey's national curriculum.
- Web-based infrastructure support (Web Crossing) for regional workgroups in Turkey was provided and maintained by GHI.

Young students examine models that show structural safety

Sources: http://www.geohaz.org/projects/turkishschools.html and N. Meral Özel, Ö.Necmioglu, G.Tanircan, S.Püskülcü, B.Sungay, M.Erdik

Box 2.4

Training teachers in tsunami-stricken Aceh Province, Indonesia: School-Based Disaster Preparedness, Training and Drills

THE INITIATIVE

The December 2004 Asian tsunami disaster left at least 300,000 people dead and missing in Aceh Province in western Indonesia. Such an exceptionally heavy toll was partly due to poor preparedness and mitigation among Aceh residents. To help address this issue in a sustainable manner, a culture of safety and resilience needed to be developed at all levels of society. The best entry point for such a venture is school communities. Aware of this, Aceh Partnership Foundation and the Indonesian Red Cross Society launched a pilot project called "School-Based Disaster Preparedness, Training and Drills" in four schools in the town of Sabang, Aceh Province, western Indonesia, from 11 to 23 April 2007.

OBJECTIVES

The general objective of the project was to help enhance disaster preparedness and mitigation within school communities in the tsunami-stricken Indonesian province of Aceh. Its specific objectives were: (1) to increase teachers' knowledge of possible causes of disasters such as earthquakes, tsunamis and floods;
(2) to train them in preparing a Standard Operation Procedure for disaster response in school, identifying and mapping hazards around a school, and developing an evacuation route;
(3) to put into practice the acquired knowledge by means of emergency mock exercises; and
(4) to prepare a disaster mitigation course outline that can be implemented by any organization interested.
Targeted teachers also received guidance on how to prepare disaster education courses and emergency drills for their students, which benefited the students from the four schools.
The Project was implemented by Aceh Partnership Foundation in collaboration with the Indonesian Red Cross Society and the Sabang Department of Education. Donations were received from the German Red Cross.

Source: UN-ISDR, 2010

IMPACTS AND RESULTS

A workshop was held at the end of the Project to evaluate results achieved at the four participating schools. The workshop was attended by all the teachers, school principals, NGO officers and students' representatives involved. It emerged from the workshop that the Project had:
(1) empowered the teachers and volunteers with knowledge and skills to train other people in disaster preparedness;
(2) benefited at least 35 teachers, 320 students, and nine volunteers in the four schools; and (3) achieved its objectives.
Because of its success, the Project was replicated in three sub-districts of Aceh Province.
In total, the Pilot Project and the other projects (in the three sub-districts) benefited 160 teachers and 3000 students from 23 primary schools. All the teachers, students and volunteers participated in emergency drills, and the desired disaster mitigation course outline was completed.

THE GOOD PRACTICE

The Project can be considered a good practice because:
(1) it achieved its objectives;
(2) it involved all the relevant stakeholders;
(3) it empowered teachers with the knowledge and skill necessary to train other teachers and students and replicate the Project;
(4) the trained teachers and volunteers were keen on replicating it;

(5) it was a stepping stone to further achievements through replication and the desired disaster mitigation course; and
(6) it was immediately replicated in other areas.

The Project was divided into three phases: Phase 1 - master training for facilitators; Phase 2 - training of trainers for teachers; and Phase 3 – mock exercises and drills.

Phase 1 sought to produce good facilitators. Accordingly, the participants were taught, among other things, about the natural processes behind disasters, assessment techniques, and teaching methodologies.
Phase 2 aimed to improve the teachers' knowledge of the processes behind disaster events such as tsunamis and earthquakes. The training of teachers consisted in focused group discussions with facilitators, arranging a Standard Operational Procedure (SOPs), identifying hazards, and developing an evacuation map for their own schools.
Phase 3 was about putting into practice the SOPs developed. This took place after the teachers had provided their students with basic theory on disasters, the causes of disasters, and knowledge of safety and response measures. Phase 3 was followed by the distribution of a set of equipment to each school: a simple earthquake detector, microphones, and first aid equipment.

LESSON LEARNED
A key lesson learned from the Project was the crucial importance of teachers' and students' active participation. The interest and participation of responsible stakeholders is also crucial to the sustainability of the Project. Therefore, overall coordination among organizations involved in disaster preparedness is necessary to align the Project with local government policies and avoid overlapping with other programmes.
The major challenge faced by the Pilot Project – and therefore for its subsequent replication - was how to cope with limited funding and insufficient number of facilitators. The funding problem has not been solved yet even though project proposals had been sent to potential donors to extend the Project. The insufficient number of facilitators was due to the limited attention paid to disaster preparedness and mitigation by local government authorities and NGOs operating in Aceh. The NGOs are mostly interested in rehabilitation and reconstruction. To address the issue, the Project included a "master training for facilitators" (Phase 1) to increase the number of facilitators.

Source: UN-ISDR, 2007.

2.3 Research and capacity building

Building capacity and understanding in the fields of vulnerability and risk assessment are key activities to enhance awareness, particularly when they involve the public in the assessment process. The following messages relate to this process:

Develop improved methods for predictive multi-risk assessments and socioeconomic cost–benefit analysis of risk reduction actions at all levels; incorporate these methods into decision-making processes at regional, national and local levels.
Strengthen the technical and scientific capacity to develop and apply methodologies, studies and models to assess vulnerabilities to and the impact of climate-related hazards, including the improvement of regional monitoring capacities and assessments.
Hazard awareness and education programmes that make scientifically credible information understandable and available, and that are consistent and persistent in delivery of information prove most effective.

Box 2.5

Improving Emergency Response to Ocean-based Extreme Events through Coastal Mapping Capacity Building in the Indian Ocean (COAST-MAP-IO) Project

THE INITIATIVE
In many tsunami-affected countries, one of the main impediments to accurate calculation of tsunami inundation and run-up was the lack of adequate coastal bathymetric data. For this reason, strengthened capacity to collect accurate bathymetric data is a fundamental aspect for many countries' preparedness to tsunamis and other ocean based extreme events such as storm surges.
COAST-MAP-IO is contributing to develop this capacity in the 12 following countries: Bangladesh, Comoros, Kenya, Madagascar, Maldives, Mauritius, Mozambique, Myanmar, Seychelles, Sri Lanka, Tanzania, and Thailand. Implementation began in March 2007 with assessment missions in 10 of the countries to collect information on key partners, their priorities and needs, and existing capacities and data. The countries' delegates then met in Bangkok in October 2007 to determine the project work plan.
In March, June, September and November 2008, advanced trainings on bathymetric data acquisition, processing and management, including the use of multi-beam for shallow water areas were conducted. This was followed by training on the management of bathymetric and topographical data, their use for map construction with GIS and other tools, and the development of digital elevation models and hydrodynamic models for tsunami inundation simulation.

The COAST-MAP-IO is one element in the suite of long-term response, particularly on the 2004 Indian Ocean tsunami tragedy to develop mitigating capacity to ocean-based extreme events. It further propose maximizing benefits from coastal bathymetry by transferring skills to create products for zonation decisions and rational use of coastal spaces, and therefore it is an

important factor in meeting IOC principles of Capacity-building as well as UNEP Key Principle Guiding Coastal Reconstruction.

Source: TECHAWI, 2008

Source: J. Berque and D. Travin

Bathymetric Data remain a key input for tsunami modelling and is one of the critical sources of uncertainty affecting model results. Although bathymetric surveys are expensive affairs, they must be updated continuously since changes result from both natural and man-made causes. In remote areas with no human impact, and where natural processes are largely stable, bathymetry can be updated over long timescales; some bathymetric charts from five decades ago are still largely usable. However, in coastal areas with high population densities, unplanned constructions tend to alter bathymetry rapidly with a resulting impact on the shoreline. It is these areas that have a high risk of impacting human lives. Bathymetry therefore needs to be updated continuously so that model predictions accurately reflect the onshore impacts, both in direction and intensity. Only then will it be possible to prepare robust coastal zoning and evacuation procedures that are based on sufficiently accurate estimations of risk.

The key objectives of the project were to:
- enhance available expertise to locally produce accurate bathymetric and topographic maps on either side (–200 to +50m) of the high-tide line.
- provide the capacity to model tsunami arrival, run-up and inundation in coastal areas: - transfer the necessary skills to use bathymetric and terrestrial data sets in developing targeted maps and services (e.g. flooding maps, determination of setback lines, coastal ecosystem mapping and zoning for coastal users) to national disaster management and preparedness agencies.
The project was conceived in recognition of the fact that the tsunami-affected countries have the required capacity for their reconstruction and preparedness process. It follows the core principles of co-operation and capacity development of the IOC – country driven and issue based – and meets the prerequisites for national ownership and relevance of activities. Ownership and relevance are necessary for sustainability.

MAIN ACHIEVEMENTS

15 training courses and workshops
Number of participants by country: Bangladesh 12; Mozambique 12; Comoros 5; Myanmar 14; Kenya 12; Seychelles 3; Madagascar 15; Sri Lanka 13; Maldives 5; Tanzania 2; Mauritius 8; and Thailand 18.
10 assessment missions conducted
Provision of modern hardware and software
COAST-MAP-IO network established
National Hydrographic Committees reactivated
Awareness raised
First inundation maps prepared for several countries

"GIS Inundation Mapping", achieved an important milestone in the framework of the general objectives of COAST-MAP-IO by strengthening the capacity of participating countries to use Geographic Information Systems (GIS) for accurate risk-mapping in the coastal zones. The training included theoretical classes, practical exercises and applications for the GIS inundation mapping with a focus upon the ESRI ArcGIS software.
Source: J. Berque and D Travin in http://www.hydro-international.com/issues/articles/id1106-COASTMAPIO.html

Box 2.6

Coastal vulnerability of Saronikos Gulf to intense natural events and its relation with the Greek law for the delimitation of the seashore

BACKGROUND INFORMATION

The total coastline of Greece ~15,000 km is composed mainly (70%) of rocky coasts. The rest is characterized by sandy beaches and dunes as well as wetlands and lagoons. Coastal flooding occurs as a combination of tides, storm surges and wind waves and is triggered when offshore low-pressure atmospheric systems push ocean water inland. With regard to coastal flooding in Greece, the risk is rather limited as tidal ranges in the entire Mediterranean basin are relatively small.
Greece has not experienced any severe floods from the sea in the near past and sea level rise (SLR) is estimated to be only in the range of 0-1 mm/year. However, during December 2009-January 2010, the coastal areas of the South-eastern Aegean islands were severely flooded. The sea-level rise during these days was up to 1 m and much damage was witnessed in the coastal zone.
Concerning coastal erosion, 28.6% of the coastline is estimated to be affected by erosion (Coastal Practise Network Newsletter, Greek Newsletter No. 2, 2004). This brings the country to the fourth highest rank among the 18 coastal EU Member States, as regards the erosion rate. This high rate is due partly to the strong winds and high waves of the Aegean Sea and partly to the sandy character of a big part of the Greek coastline

THE SARONIKOS GULF

A Coastal Vulnerability Index (CVI) was calculated for the eastern coasts of Saronikos Gulf, an area with the largest population density in Greece.
The adopted technique used different ranges of vulnerability (classified

from "low" to "high") to describe the coast's susceptibility to a possible environmental change such as sea level rise. Six variables that strongly influence coastal evolution have been used:
regional coastal slope,
geological- historical shoreline change rate,
geomorphology,
relative sea-level change,
significant wave height range and mean tidal range.

Coastal vulnerability as regards sea-level related hazards is also dependent on the proper and rational delimitation of the seashore. The corresponding procedure is described by the Greek Law 2971/2001, the implications of which for relevant societal and economic issues of the coastal zone are major.
Specifically, the lack of a scientifically sound interpretation of the Law has resulted in its multifaceted interpretation and has caused delays in the delimitation process, with diverse environmental implications. A rationalization of the entire procedure for the seashore delimitation is urgently required in order to effectively contribute to coastal decision making, integrated coastal zone management and to strengthen awareness and preparedness for sea-level related hazards in Greece in the future.

Takvor Soukissian, Hellenic Center for Marine Research–HCMR, Greece

Box 2.7

Tsunami hazard mapping methodology for district level: the basics for tsunami preparedness - a pilot area in Java, Indonesia

THE INITIATIVE

Understanding the tsunami hazard and the potential impact for communities in tsunami prone areas is a prerequisite for local decision makers and other stakeholders in the preparedness stage. Despite the fact that Indonesia is located in a highly tsunami prone region the information about the tsunami hazard along many of the coasts is still very limited. No generalized adopted approach to tsunami hazard mapping at the district/community level has been developed. Due to this threat to the coastlines of Indonesia there is an urgent need for a better understanding of the tsunami hazard as a crucial step towards better preparedness. In a situation like this, tsunami hazard mapping is a task in which experts and local decision makers and planners should work hand in hand to use the available expertise and information in order to achieve maximum results.
With the objective of designing a simple, low-tech, but sufficient and adequate tsunami hazard mapping methodology, an inter-institutional team of experts conducted a tsunami hazard mapping exercise in a pilot area in Java, Indonesia. The mapping exercise was initiated by German Technical Cooperation International Services (GTZ-IS) that acts in the framework of the German Indonesian Cooperation for a Tsunami Early Warning System (GITEWS) and involves national experts from the Ministry of Marine Affairs and Fisheries, the Gajah Mada University of Yogyakarta, and the Meteorological and Geophysical Agency in Yogyakarta. The inter-institutional team of experts worked in close cooperation with representatives of local government and non-governmental organizations which belonged to working groups for the establishment of the local tsunami early warning system.
As a result, the exercise did not only produce maps but also optimized the approach and adjusted it to local capacities. Throughout the process, experiences and lessons were evaluated and fed into the final methodology.

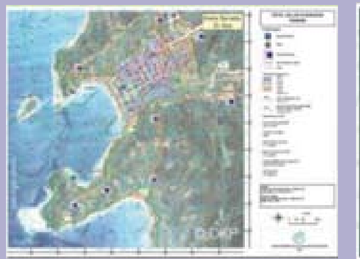
THE GOOD PRACTICE

The assessment and mapping of the tsunami hazard is an issue that requires both expertise and local knowledge. The cooperation between the advisory team and 'local experts' allows for the development of a methodology that is applicable for implementation at district level and triggers a learning process on both sides. The participatory exercise ensures that local knowledge is integrated and generates a deeper understanding about the potential threat, therefore building capacity.

BRIEF SUMMARY OF PROCESS AND METHODOLOGY:

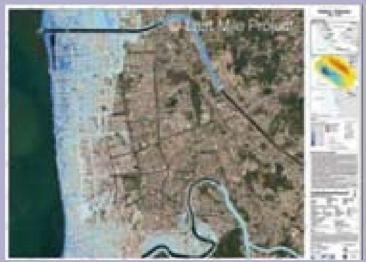
1) Getting started: after the advisory team has been formed, an introductory meeting among experts and local stakeholders confirms objectives and logistics, explains the methodology and compiles data. A field visit allows the joint group to get familiar with the area and provides the opportunity to discuss landscape features, as well as previous tsunami events and their impact.

2) Developing a base map: the tsunami hazard mapping similar to other approaches exploits three sources of information:
• Local historical data from previous tsunami events
• Modelling results for the area
• Reference data from previous tsunami events in other locations in Indonesia
3) Developing a multi-scenario tsunami hazard map: the final tsunami hazard map requires a scenario discussion. The advisory team provides input for different scenarios such as potential tsunami wave heights.



Tsunami Hazard Map for Painan

Source: UN-ISDR, 2010



Inundation Map for Padang (West Sumatra)

Source: UN-ISDR, 2010

LESSONS LEARNED

The tsunami hazard mapping has been jointly conducted with local actors who are involved in tsunami preparedness. This participatory process not only provided results regarding tsunami hazard but also created awareness about the requirements for preparedness and the scope of the threat amongst all participants. The team composition provided the opportunity to combine scientific expertise with local knowledge about the area and its characteristics.

POTENTIAL FOR REPLICATION

Since the hazard mapping exercise uses a simple approach it can be replicated in other communities in Indonesia and elsewhere. However, it requires some technical input from experts in order to use all available knowledge. The final step of the exercise involves GIS technical skills that might not be available in all communities. If the technical requirements cannot be met, the hazard maps can also be developed manually.

Source: UN-ISDR, 2010

3

PLANNING AND IMPLEMENTING THE KEY OPERATIONAL REQUIREMENTS OF AN EARLY WARNING SYSTEM

It is evident that the level of awareness of the need to establish early warning systems for tsunamis and other natural marine-related hazards has been increasing in the last years particularly since the 2004 Indian Ocean tsunami. Effective people-centred early warning systems are in great demand for several reasons. More extreme weather events are expected in future due to the expected impacts of climate change, rapidly expanding urbanization and increasing environmental degradation, all of which contribute to increase the number and scale of coastal disasters. The overall goal is to establish a global multi-hazards early warning system which consists of early warning systems at different scales that reduce risk and vulnerability at all levels.

Good practice in early warning systems also includes in having strong inter-linkages and effective communication channels between all the elements. Responsibilities need to be clearly defined and people need to be well-informed and feel a degree of ownership of the implementation process. Much depends on establishing institutional capacities to ensure that early warning systems are well integrated into governmental policy and decision-making process.

BOX 3.1

Strengthening community-based disaster preparedness in Indian Ocean countries

GOALS AND OBJECTIVES

The overall objective was to provide an integrated framework for strengthening early warning systems in the Indian Ocean region by building on the existing systems and to facilitate coordination among various specialized and technical institutions. A main goal of the project was to support the development of a tsunami early warning system by linking the available technical capacities on tsunami early warning systems with humanitarian and emergency management capacities, and quickly implement the first steps to establish effective tsunami warning capacities in the region. Specifically, it aimed to assist facilitating an interim warning capacity based on existing national and international capacities; supporting a conference to achieve technical specification and political consensus on the design of an appropriate early warning system; developing networks among practitioners and authorities concerned with all hazards; conducting regional meetings of relevant practitioners for both training and coordination aims; developing interim information materials for practitioners and community leaders; providing necessary coordination for the affected countries and developing educational support and demonstration projects.

THE INITIATIVE

The initiative successfully assisted in strengthening partnerships, linkages and synergies among the implementing agencies and donors during the process of implementing the project. The project components were identified in the two areas of warning system development and preparedness. As a cross-cutting theme, the project has promoted "people-centred early warning systems" emphasizing (i) risk knowledge, that is, prior knowledge of the risks faced by communities, (ii) monitoring and warning service, (iii) communications and dissemination of understandable warnings to those at risk, and (iv) response capability and preparedness to act by those threatened.

Seven donors financed the project with a total of US$10.5 million. UN-ISDR/PPEW coordinated the project. It was part of the larger Flash Appeal coordinated by UNOCHA, and was implemented by 16 partners including UNESCO-IOC.

The activities of the project were structured into five key components: core system implementation, integrated risk management, public awareness and education, community-level approaches and project coordination. An interim tsunami early warning system in the Indian Ocean region has been operational since April 2005 with interim tsunami advisory information issued by two institutions, the Pacific Tsunami Early Warning Center (PTWC) in Hawaii and the Japan Meteorological Agency (JMA) in Tokyo. The tsunami advisory information is received by tsunami focal points of the Indian Ocean countries designated by 25 countries to date.

The project has created an enabling environment for building partnerships necessary for the development of "end-to-end" and "people-centred" early warning systems in the Indian Ocean region. The project activities are only the first step for establishing a fully-fledged tsunami early warning system within a multi-hazard framework. Strong political commitment of the Indian Ocean countries, as well as substantial financial and technical support from the international community, are crucial to achieving this goal in the long term.

THE GOOD PRACTICE

The project assisted in strengthening coordination, partnerships, linkages and synergies among the implementing agencies and donors. Various project activities have led to new opportunities for further contributing to the development of a tsunami early warning system (TEWS) in the Indian Ocean region. In addition, the UN-ISDR secretariat and the implementing partners collaborated with a much wider group of UN agencies and national and local institutions with the common goal of establishing an effective TEWS in the region. At the global level, both humanitarian and development organizations were involved.

For building and managing the regional early warning system and disaster management, the project also addressed the need for developing and promoting national and regional human and institutional capacity, transfer of know-how, technology and scientific knowledge through international cooperation and partnership.

Some success stories have been reported by the partners to the UN-ISDR/PPEW. The interim warning system established under the project has proven to be effective not only for tsunamis but also for other hazards:

1 The UNESCO/IOC and WMO reported that the Global Telecommunications System (GTS) demonstrated its effectiveness for the July 2006 tsunami in Java. Interim tsunami advisory information was issued from the PTWC and JMA. Several national warning centres in the Indian Ocean region, including the one in Jakarta, Indonesia, received the interim tsunami advisory information from PTWC and JMA soon after the earthquake took place.

2 The UNDP Sri Lanka office reported that the enhanced capacity for early warning and dissemination as well as the in-country partnership among relevant institutions saved some vulnerable communities in Sri Lanka on the occasion of the landslide in January 2007. The initiative in Sri Lanka aimed at addressing environmental factors relating to tsunami risk through building national capacity to integrate environmental assessment and management with national and regional early warning systems and disaster risk reduction efforts. Due to the implementation of flood and landslide monitoring systems and an early warning dissemination mechanism, valuable time for evacuations is gained. During a landslide in the Nuwara Eliya District in 2007, 56 families were evacuated in time, which resulted in no casualties. The landslide could be predicted with the help of the GPS instruments and hazard zoning maps by the National Building and Research Organization (NBRO) officials after villagers observed cracks in the ground, knowing its meaning because of awareness sessions conducted in the communities. Additionally the new technology also proves useful for determining safe areas for resettlement. The key success factors in this case include the development of standard operating procedures (SOPs) for which communities were trained. Disaster awareness sessions were also held. Beyond that an early warning mechanism was implemented and local authorities were trained to recognize disasters, and determine safe areas for resettlement in post-disaster scenarios and for the formulation of land usage plans for the unaffected areas. An early warning monitoring system was installed and a national agency was trained on its usage.

3 The UNESCO Jakarta office reported that the SOPs developed under the project in cooperation with KOGAMI, a local NGO, were effectively applied by the disaster control authority in Padang, Indonesia when the earthquake hit West Sumatra in March 2007. The specific objectives for the project were to identify and assess critical factors and issues related to community-based disaster preparedness for disaster prone or high-risk areas at the local level. The support of initiatives on community-based disaster preparedness at different levels and contexts in pilot sites was a follow-up action to the Community Based Disaster Preparedness (CBDP) assessment. It supported the development of coherent in-country strategies and a vision regarding CBDP, with emphasis on the effective interface between TEWS and CBDP.

The comprehensive assessment comprised two components, i.e. a general assessment on preparedness in three pilot sites in Sumatra (Padang, Bengkulu and Aceh Besar districts) and an assessment on the use of traditional knowledge in disaster preparedness. Based on assessment results and in line with the recommendations put forward by the expert team, a range of follow up activities were organized in the pilot sites including training, workshops and public awareness activities.

The activities have helped to put disaster preparedness on the agenda for key-stakeholders in the pilot sites, as well as generate a great interest in the broader public. Knowledge, attitude and behavior surveys showed improved awareness amongst key stakeholders. When a 6.4 magnitude earthquake hit the Indonesian island of Sumatra on 06 March 2007, at least 70 people were killed and hundreds of buildings were destroyed. Thanks to education and drill simulation, the resistance of the people had been high in the pilot areas supported by the Flash Appeal. There had been no casualties in Padang, "only" nine people received injuries.

All outputs and publications of the Indian Ocean project have been disseminated to a wider audience by the UN-ISDR secretariat and each implementing partner to further enhance awareness on tsunami early warning and disaster risk reduction and to facilitate the Indian Ocean countries to exchange experiences and replicate good practices.

LESSONS LEARNED

The project faced some administrative challenges arising from the multi-partner and multi-donor nature of the project.

The project was implemented as a single integrated project with each donor having specific requirements and administrative procedures for written agreements, transfer of funds, reporting, monitoring and evaluation. Additional challenges included difficulties in monitoring the progress of all of the project activities that were implemented by respective partners and in obtaining substantive progress reports in a timely manner.

However, within the limited scope of the project activities, these difficulties were largely overcome by the coordinated support of all Indian Ocean countries.

Substantial parts of the capacity building and community preparedness were undertaken towards the end of 2005 and in 2006. It was a challenge for the project to provide rapid assistance to the countries when requested, and to assist in longer-term enhancements of national and local capacities. This latter task requires considerable time for preparation and consultation with a much wider range of stakeholders including disaster management authorities and development planning agencies.

UNISDR will use the experience thus gained to feed into the Regional TEWS and to disseminate the lessons learned to inform other community-based preparedness and EWS in other countries of the Indian Ocean region.

Source: UN-ISDR, 2010

Box 3.2

Actions made by the National Institute of Geophysics in Morocco towards the establishment of a tsunami early warning system

CONTEXT AND OBJECTIVES

Like the countries of the Iberian Peninsula (Spain and Portugal), Morocco is exposed to tsunami. This risk is clearly demonstrated by both historical data and numerical modelling studies. The high level of exposure and vulnerability along coasts, given the concentration of the population, industrial and tourism infrastructure, would result in a devastating tsunami impact. Proximity to the tsunamigenic sources of the Gulf of Cadiz on the Spanish Atlantic coast would leave little time for an early warning. For an effective evacuation of the population, this imposes the necessity of establishing an early warning system that could give an alert in less than twenty minutes.

THE INITIATIVE

The Moroccan National Institute of Geophysics (ING), as an institution responsible for the National Seismic Monitoring and Alerting, initiated some efforts in recent years on tsunami risk evaluation and in the accomplishment of some actions towards the implementation of an effective tsunami early warning system (TEWS). The tsunami risk assessment was made in collaboration with the University of Lisbon. First steps towards the establishment of the TEWS were initiated in the framework of the Euro-Mediterranean NEAREST project in collaboration with neighbouring countries, Portugal and Spain, mainly the sharing between the three countries of seismic data in real-time. ING has also deployed in the Atlantic littoral a digital tide gauge transmitting data in real-time for monitoring sea level. This facility will be extended to three other gauges in the next two years and in a configuration minimizing the time of warning. Like the seismic data, data from the tide-gauge network will be also shared in real-time with Portugal and Spain for regional sea level monitoring.

PERSPECTIVES OF TEWS DEVELOPMENT

1. Extension of the number of shared real-time seismic stations between Morocco, Spain and Portugal (End 2011)
2. Installation of two other digital real-time tide gauges on the Moroccan Atlantic coast (2012)
3. Installation of a fourth digital real-time tide gauge on the Mediterranean coast (2013)
4. Integration and real-time sharing of tide-gauge data between Morocco, Spain and Portugal (starting 2012)
5. Continuation of development within a framework of international cooperation procedures for tsunami detecting and warning triggering (starting 2012)
6. Working for the establishment in the medium term of a regional cooperation of a Deep-ocean Assessment and Reporting of Tsunamis (DART).

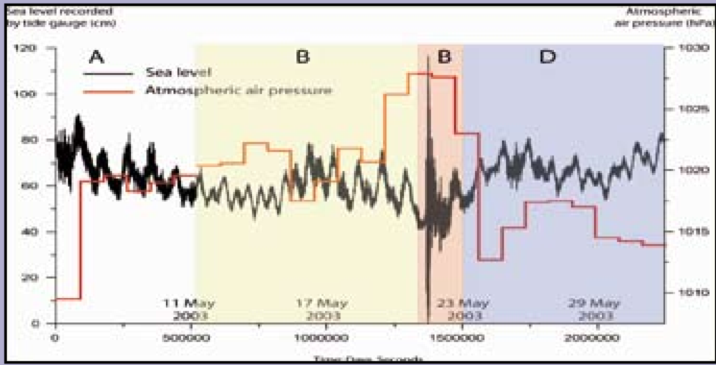
Abdelwahed Birouk, ING/CNRST, Rabat, Morocco

Box 3.3

Setting up the Algerian sea-level monitoring infrastructure

BACKGROUND INFORMATION

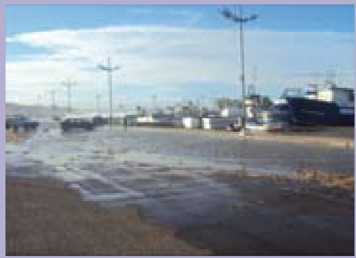
The Algerian coastline is about 1600 km long, most of which is exposed to natural hazards such as tsunami, meteotsunami and seiches (harbour oscillations), storm surges, etc. Since 1365, few tsunamis have been reported by contemporaneous witnesses in Algeria. However, two important earthquake-induced tsunamis with significant damage affected the Algerian coast in 1365 and 1956 near Algiers and in the city of Jijel, respectively (Hemdane and Garcia, 2006). Recently, after the 2003 Zemmouri earthquake (Mw 6.9, Algeria), a strong tsunami with sea disturbances affected the western Mediterranean. It was observed along the Algerian coast, and had significant damage mainly in the Balearic islands' harbours.

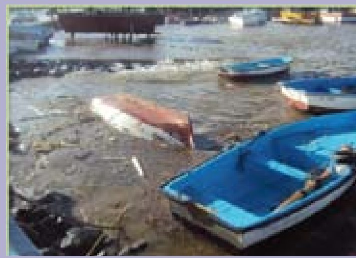


Spectral and temporal wave-by-wave analysis of tsunami waves measured in the near-shore zone of Palma de Majorca and Sant Antoni (Spain) caused by the 2003 Zemmouri (Boumerdès) earthquake (Mw=6.9), Algeria.

Source: Hemdane and Garcia, 2006.

During the atmospheric disturbance event of November 2010, the coast of Algiers was suddenly submerged by a sea level rise of about 2 metres due to a potential seiche. At the same time (11th September, 2010), the IOC tide gauge network recorded no tidal sea-level oscillations at Almeria (Spain). During this event, the sudden sea-level rise and consequent damage were observed only at El Djamila harbour. This phenomenon could be due to the inadequate harbour size and shape. However, the absence of tide gauges with high frequency sampling does not allow us to know what really happened during this event.





Inundation and damage caused by the 2m rise in sea-level at El Djamila harbour, 11th September 2010

Source: Envoyés spéciaux Algériens http://www.facebook.com/media/set/?set=a.156221931076730.13456.133674969998093

PROJECT DESCRIPTION

Because of the high exposure of the Algerian coast to different sea-level related natural hazards, and in order to detect such hazards and be able to protect people and the coastal structures from flooding, the implementation of a sea-level monitoring system is urgently required.
In its first step, the project will take Algiers Bay as an experimental area in order to define a work method which will be extended along Algerian coast using first a WLR 7 Aanderaa high frequency automatic tide gauge which will record high frequency sea-level oscillations (< 0.016 Hz; > 1 mn). The project will then deploy seven WLR 7 Aanderaa high frequency tide gauges among which six require calibration.
In the near future, the project foresees the need to set up a national tide gauge network through a national real-time communication system and integrate a regional real-time tide-gauge communication system through bilateral or multi-lateral cooperation.

Yacine Hemdane, ENSMAL. Algiers, Algeria

Box 3.4
Vulnerability of the Tunisian coastline to the accelerated sea-Level Rise

BACKGROUND INFORMATION

The Tunisian coastal zone represents 79% of the country's economic activities and 90% of the total housing capacity for tourists. Furthermore, approximately 70% of the country's total population lives near the coasts with one of the highest urban concentration rates (more than 1,000 inhabitants/km^2 in Tunis and Sfax, while the national average is 57 inhabitants/km^2). It also contains most of the major cities of the country in low-lying land and thus very vulnerable to accelerated sea-level rise. For example, in Tunis and Sfax, 68% of the urban districts and 96% of the residential areas lie between 0 and 2m above sea level.

Coastal urbanization in Salambo

PROJECT DESCRIPTION

The Costal Observatory of the Coastal Protection and Planning Agency is exploring methodologies to map in 3D the impacts of the sea-level rise on the Tunisian coastal landscape over time. The project, which is in its first phase, seeks to introduce long-term planning tools to manage climate hazards and risks, including Geographical Information System (GIS) and Digital Elevation Model (DEM). These tools will help decision makers to understand, identify, and assess the vulnerability of the coastal areas to sea-level rise (SLR). This project is indeed part of the efforts undertaken by the Ministry of Agriculture and Environment in order to find measures to protect the most vulnerable coastal areas to the sea-level rise.

The proposed methodology will consist in three steps. (1) Classification of the coastal topography; (2) Ranking of vulnerable areas and (3) Simulation of the vulnerability.
These steps will require the following analysis:
Bibliographic data analysis (including data and information on the adaptation of the coast, agriculture, health and tourism to the effects of climate change) and identification of vulnerability indicators of the Tunisian coast to sea-level rise.
Analysis of the morphology and mobility trends of the shoreline. Identification of the different natural units constituting the Tunisian coast and assessment of their exposure to sea-level rise.
Evaluation and importance of the anthropogenic factors in the evolution of the coastline.
Conception and development of the geographic database.
Identification of the vulnerability of the Tunisian coast to SLR based on analysis of the thematic spatial GIS layers, and from the DEM maps.
Definition of a ranking of sites based on their threat, sensitivity and vulnerability indices. This classification must take account, in addition to geomorphological factors, the socio-economic and environmental dimensions in a climate change context.
Elaboration of scenarios taking into account SLR with and without human occupation. These scenarios should take into account the management policies that are currently developed for the coast as well as those planned.
Development of a 3D simulation model of the impacts of SLR on the Tunisian coastline. This model will be based on scientific hypotheses that show, for different time slots and different scenarios, the impact of SLR on the coastal ecosystems, archaeological sites, tourist areas and other sectors (industrial, agricultural, urban,...). The operation should be seen in normal or critical times (exceptional events, storm surges…).
Definition of forecasting tools and anticipating impacts (for numerical models that allow characterizing the morphological changes of the coastline).
Creation of an operational impact prediction system, based on extensive hydrodynamic predictions (for the short term) and scenarios of sea-level variations in the medium- and long terms.

Adel Abdouli, APAL, Tunis, Tunisia

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4

PROMOTING COMMUNITY-BASED DISASTER RISK MANAGEMENT

Community-based disaster risk management (CBDRM) is an overarching strategy comprising structural and non-structural measures to avoid (prevention) or to limit (mitigation and preparedness) adverse effects of natural hazards. Communities engage in a systematic process of administrative decisions, apply organizational and operational skills, and implement policies and strategies to enhance their capacities to cope with the impacts of hazards and related disasters. With an increased frequency of storms and climate variability due to global climate change, local-level preparedness is increasingly important as a key adaptive capacity and an essential component to community resilience.

CBDRM is practiced and applied worldwide, especially following the recent deadly disasters (2011 Japan Tsunami, 2004 Indian Ocean Tsunami and the U.S. Hurricane Katrina). Furthermore, by incorporating local knowledge, communities are far more likely to be engaged and participate actively in the risk management process. In some success stories, communities' use of indigenous knowledge to reduce risk, and cope and survive natural disasters provides many lessons for practitioners and policy makers on the value of indigenous knowledge for disaster risk reduction.

Box 4.1

Community-based tsunami early warning system in Peraliya, Sri Lanka

The Community Tsunami Early Warning Centre (CTEC) initiative in Sri Lanka is a purely community-based initiative, in the beginning focusing only on tsunamis and later expanding to multiple hazards. The case study illustrates the responsibilities and structures between the national and local levels which need to be clearly defined.

The initiative

To ensure that the warnings reach the population, community-based early warning systems need to be created in order to close the gap between the national and local levels. Community-based systems need to receive the information from the National Early Warning Centre and to disseminate the appropriate information and early warning alarms to the communities. One of the community-based systems that exist in Sri Lanka is the Community Tsunami Early Warning Centre (CTEC) at Peraliya, on the south-west coast of the island.

Source: www.communitytsunamiwarning.com

Peraliya was one of the areas most devastated by the December 2004 tsunami. The village drew media attention in the aftermath of the tsunami, because of the train that was toppled over by the giant waves, claiming over 2000 deaths including many villagers.

Source: www.communitytsunamiwarning.com

CTEC currently covers about five villages directly through its public address system. In addition, it has extended its services to the whole of the Galle District through its Community Focal Point (CFP) network. It conducts community awareness and educational programmes to equip the public with knowledge and skills regarding emergency preparedness. Training programmes and training material have been developed for these community awareness programmes. CTEC has established volunteer teams in line with its CFP. The volunteers of these teams have been trained with regard to the action to be taken in an emergency situation. CTEC has Information and Communications Technology facilities to link with both national and international warning agencies and media. It is open 24 hours 7 days a week. Institutional operational procedures have been developed that are to be followed in an emergency. Though initially established to prepare the community against tsunamis, the CTEC activities have been expanded to cover a broader range of disasters. CTEC focuses on the needs of vulnerable groups in the society such as children, the elderly, women and handicapped individuals.

During the 2007 tsunami alert, the CTEC played a major role in informing people using its loud speaker and mobile speaker (siren) system to direct people towards evacuation places. The CTEC system has a community database. This is updated daily and is displayed to the community. It has the following components:
- Seismic activity recording: Every 15 minutes, the duty officer looks at websites and records in the Centre logbook the earthquakes with a magnitude more than 5 on the Richter scale. All earthquakes that occur in the Indian Ocean Region are extracted every 24 hours and are displayed on the CTEC notice board.
- Weather Information: The daily weather report issued by the Meteorology Department is read and recorded by the Duty officer. It is displayed on the CTEC notice board so that anybody interested can obtain the weather information.
- Disaster Information: Inquiries made by community members are recorded in the incoming call book. Date, time, name of the person who calls, location, contact telephone number, and the inquiry are recorded, as well as the action taken afterwards.

Source: www.communitytsunamiwarning.com

THE GOOD PRACTICE

The CTEC initiative is intended to support and facilitate the government's efforts in Disaster Risk Management at the grass-root level. CTEC provides the technological and human communication network needed to disseminate warnings issued by the government to the communities. Based on the criteria developed for good practices in Community Based Disaster Risk Management (CBDRM) guidelines by the Asian Disaster Preparedness Center

(ADPC), a community early warning system has been established with the specific aim of contributing to a safer community.

1. The CTEC initiative is a purely community-based initiative, founded after the 2004 tsunami, that later extended its relationship to the local government. At first, the focus of CTEC was only on tsunamis, as a national early warning system for tsunamis did not yet exist, and was later extended to multiple hazards.
2. The initiative is based on community knowledge about hazards. It is an opportunity to make people aware of other hazards, which can be done with community participation and through disseminating information via participatory tools.
3. CTEC has been carrying out awareness programmes to make people understand tsunami early warning messages through the community focal points of CTEC in Peraliya.
4. CTEC made different channels available for the Peraliya community to receive tsunami early warning. An evaluation study disclosed that 80% of the people of the three communities covered under the CTEC system know about CTEC and benefited from its service in the past.

Source: www.communitytsunamiwarning.com

LESSONS LEARNED

The link between the district disaster management focal centre and the national level early warning authority is still missing. It should be established for the better operation of the last mile hazard early warning. Standard systems and procedures should be developed to make the message consistent from all directions.

In order to do this, the government focal point for the tsunami early warning should develop standard operating procedures in disseminating early warning messages for all disseminators in a consistent manner, so that confusion over the early warning message from different sources (e.g., radio, TV, mobile SMSs) can be avoided.

2. Community-based early warning centres should be given authority to disseminate early warnings to a broader geographical area. To date only CTEC disseminates tsunami early warnings to the Peraliya community.
3. There are several concerns and questions on how to make these community-driven initiatives sustainable in order to be replicated to other parts of the country. Relevant key questions are, for example: Is it necessary to observe the seismic activities at the community level through this type of centre?; Despite the fact that the news channels broadcast the weather information obtained from the meteorology department several times a day, do people use CTEC to obtain this information? Besides these specific questions, there are other general concerns about this setup. Is the system sustainable? What is the community coverage of this system, if we make it a community-based early warning initiative with a multi-hazard approach? How to keep the trained volunteers to do the job continuously?
4. The costs for well-functioning early warning systems are lower than disaster response and rehabilitation costs. To ensure the cost efficiency and sustainability for less frequent high impact disasters, multi-hazard systems need to be designed.

In the case of CTEC, different possible options were explored, recognizing the need for a community-based system: multi-hazard approach; use of existing entities for early warning purposes such as community centres and schools; integrating the system in daily life by, e.g., using loudspeakers for religious sermons on a daily basis in order to ensure their functionality.

RECOMMENDATIONS AND POTENTIAL FOR REPLICATION

The following recommendations can be drawn for any community-based tsunami early warning system in other coastal areas of the country in the future:

a) Using the existing systems: The existing system should be utilized in order to guarantee cost-effectiveness and sustainability. Proper operation in times of an emergency is also of great importance. To achieve this, the partnership of all stakeholders should be coordinated by the relevant government authority at a national level. The government in this case provides the legal authority; the private sector can contribute with resources and infrastructure, whereas civil society can help to maintain grass-root linkages to provide a social infrastructure and motivation.

b) Using schools as community-based early warning centres: The system can be best carried out using schools involving teachers and children in community-based early warning initiatives. The government introduced disaster management as a subject to advanced vocational training for teachers and to the school curriculum after the 2004 tsunami at all the schools starting from the first grade. However, the operation of an early warning centre needs to be 24 hours 7 days a week. All the proposed activities should be coordinated by the district disaster management centre.

c) Multi-hazard early warning: Multi-hazard early warning systems are the best option for community-based initiatives in terms of sustainability, utility and cost effectiveness of the community-based early warning systems. The Disaster Management Centre should register all the community-based systems through its district disaster management centres. This registration will help to keep track of community-based initiatives, thus provide a legal authority to disseminate tsunami warnings within the geographical area of their coverage. It will also help to avoid overlapping of initiative by different stakeholders.

Source: UN-ISDR, 2010 www.communitytsunamiwarning.com

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5 ENHANCING THE RESILIENCE OF COASTAL COMMUNITIES TO HAZARDS

The concept of "coastal resilience" is a new way of thinking about how to better protect coastal communities from sea-level related hazards. Proponents of this concept suggest that planning for resilience can proactively reduce hazard risk and vulnerability. Indeed, resilient communities understand the hazards they face, take specific and coordinated actions to reduce their vulnerability, and develop response and recovery plans to facilitate a quick response and effective long-term recovery should a disaster occur. It is now being actively promoted as a management strategy by several organizations and agencies.

A key aspect of resilience to climate-related hazards lies in the way the governance of risk is undertaken at the national and local level through well-planned policies and projects. Effective land-use management and well designed structures allow communities to recover more quickly after a disaster event. In addition, the existence of land-use plans and policies that address critical vulnerabilities identified through hazard risk assessments can expedite recovery.

Improved coordination between coastal managers and disaster managers is needed to develop contingency plans and implement preparedness and mitigation activities for different types of coastal hazards. Integration of plans that addresses basic needs, environmental management, economic alternatives, and disaster preparedness will automatically sustain resilience efforts.

Box 5.1

Coastal resilience assessment using near-real-time mapping of coastal morphodynamic state indicators

BACKGROUND INFORMATION

Coastal systems are inherently dynamic and adaptive. As all environmental systems, coasts tend towards entropy and this is frequently confronted by human intervention which does not allow for readjustment in the natural temporal and spatial scales. Most times human intervention aggravates the destabilization of the system and the definitive instability of the coastal system. Never is this more problematic than when high-energy events occur and decision makers lack a full characterization of the system's reaction. Likewise, sometimes the lack of timely intervention is due to a limited understanding of the natural or altered state of the coastal system. In those instances it is paramount to detect the potential reaction of a morpho-sedimentary system to high-energy events since most processes are non-linear, cyclic or predictable in time and space using simplistic extrapolation of modal conditions in climate and sea level.

Coastal morphodynamics state provides the study of dynamic forcing and morphological adaptation in coastal lands and waters, and determines the potential ease of the system to remain or change. Thus, the capacity to estimate beach and nearshore morphodynamics on a near-real-time basis becomes a significant tool to address potential reactions for decision making in emergency situations.

Global change is providing a framework for new approaches in coastal science and the use of more complex concepts to the characterization of the coast, such as resilience. In the context of coastal morphodynamics, a highly resilient state of the system may be defined by the adaptability to great energy variations whilst maintaining the structural functioning of the circulation of littoral cells and sedimentary systems. A non-resilient system, even in low-energy conditions, would not be capable of adapting, and thus a quick reaction and an understanding that more damage can take place if some thresholds are exceeded would be necessary.

METHODOLOGY AND OUTCOMES

The methodology presented develops a mapping system which provides results on a web-based viewer through a stepwise procedure including (i) reading wave data from offshore wave buoys, with potential real-time application, (ii) simulated wave conditions from propagation of waves upon the coastal shelf estimating energy conditions when waves reach the shoreline, (iii) prediction of focal points for potential damage due to high energy concentration spots. To do this, a spatial database infrastructure provides OGC services to feed the bathymetric/altimetry digital elevation model, which then receives climatic and hydrodynamic services combined to map energy levels on the coast. The mapped results are instantaneously fed to the SDI as WMS and thus can be integrated in a coastal resilience viewer in which all relevant OGC services (such as cadastral info, etc.) could be combined into a complex vulnerability index.

The morphodynamic resilience is calculated instantaneously by combining wave energy data with information of nearshore and shoreface geometry and the transformation of morphodynamic beach states (from dissipative to reflective) using a fuzzy logic approach which characterizes on the mapped shoreline a resilience factor from 1 to 5, with 5 being the most resilient and hence potentially least vulnerable scenario. The combined index may use a Gornitz type solution as in the figure below.

Malvarez, G., Guisado, E. and Navas, F., Universidad Pablo de Olavide, Spain

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6 MAINTAINING PREPAREDNESS OVER THE LONG TERM

Even after learning about tsunami preparedness and taking steps to prepare, people, governments and other groups need to be continually reminded to keep their preparedness efforts ongoing and up-to-date. Families should update their evacuation plans based on changes in where they work, live or go to school. Governments need to update their plans to accommodate changes in the community's growth.

Many communities use a large, initial tsunami preparedness campaign to build a base of awareness about tsunamis and support for preparedness activities. Then, annual events, such as a week with extensive tsunami media coverage and community outreach, keep the subject current and part of the public dialogue on an ongoing basis.

Some approaches that communities use to keep disaster preparedness activities ongoing include:

- *Creating an organization to focus on coastal disaster preparedness issues.*
- *Integrating tsunami preparedness into government programmes. Government officials can incorporate activities such as distributing evacuation maps, testing warning systems, or making sure their ongoing development is tsunami-resistant.*
- *Integrating tsunami preparedness into programmes of other institutions, such as schools and businesses.*

Box 6.1

Integration of climate variability and change into national strategies to implement the ICZM Protocol in the Mediterranean PAP/RAC activities

In the framework of the MedPartnership project, PAP/RAC is preparing a set of activities aiming to raise awareness of policy makers on climate variability and change in order to assist the integration of these aspects into national strategies and plans to be prepared according to the requirements of the ICZM (Integrated Coastal Zone Management) Protocol of the Barcelona Convention (UNEP/MAP/PAP, 2008).

The first group of activities within the project is focused on the assessment of the socio-economic and environmental impacts as well as of the adaptation options. The aim is to agree on the methodology for estimating economic costs of climate variability and change, and to apply it in selected critical areas. The methodology will build upon the existing models, like DIVA, upgrading it for the climate variability, taking into account the latest works on the adaptation deficit and scaling it down. It is expected that the development of this methodology will contribute to a more precise analysis of the adaptation deficit in the coastal zones. It is expected that the results expressed in monetary terms will be more relevant to the policy makers, in particular since the emphasis will be placed on the possible costs of the extreme events.

In parallel with scientific modelling, a series of workshops involving stakeholders will be conveyed by the Blue Plan, applying for the first time the IMAGINE methodology (UNEP/MAP/Plan Bleu, 2005) on the climate variability and change issues. The two methodologies will be combined in order to extend the assessment with the stakeholders' ideas and local knowledge, as well as to provide stakeholders with the relevant scientific input for the generation of future scenarios.

Another group of activities will be oriented towards the insurance and banking industries. An assessment of the climate variability and change impact on the global insurance and banking sectors will be performed, in particular analyzing the insurance of the weather-related risks and availability of loans for real-estate in the close proximity of the sea. The results of the assessment will be disseminated during the Coast Day campaign (http://www.coastday.org/). Namely, the climate variability and change is proposed as a central theme for the Coast Day 2013 on the occasion of which the Ambassador for the coast with specific focus on the climate threats for the coastal zone is to be appointed.

Daria Povh Škugor, PAP/RAC, Split, Croatia

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7

SELECTING THE STRATEGIC APPROACHES TO RISK REDUCTION

Options to respond to hazards include reducing susceptibility to inundation and primarily reducing vulnerability of coastal communities. The first can be achieved by hard and soft engineering solutions and regulating human activities that exacerbate susceptibility. The second can be achieved by preparedness, better communication links at the global and local levels, and mobilizing contingency resources. Vulnerability can be reduced through strategic measures: introducing strategic planning, adapting to a changing physical environment, recognizing vulnerability of expanding urban areas, and weighing livelihood opportunities against vulnerability.

Most coastal hazard problems have been caused by coastal development being located too close to the existing shoreline to accommodate natural changes and trends in shoreline movements. Subsequent management of the hazard has been dominated by reactive and engineering-based approaches that, over time, often lead to the level of risk increasing and the wider consequences becoming more complex to manage.

Challenges of the strategic risk mitigation include:

overcoming short-term views and concerns to develop a longer term perspective;

avoiding over-focus on adaptation for single sectors rather than an ICAM approach which considers all coastal activities and their trade-offs;

considering all the potential options when retreat is often seen in negative terms by coastal residents, at least initially;

assessing full cost (direct and external such as socio-economic and environmental impacts, etc.) of the management options in order to select a suite of options that would have the maximum benefit for the minimum cost; and

assigning management responsibilities and assuring adequate funding.

Examples of alternatives to standard engineering approaches, which in many cases may be deployed alongside existing flood and coastal erosion risk management, include:

Increasing levels of awareness of flood and coastal erosion risks among individuals, businesses, and communities.

Increasing individual and community preparedness for flood and coastal erosion events.

Supporting individuals, communities and businesses to build their resilience to flood events. Speeding up the recovery process by incorporating greater resilience measures into the design of new buildings, and retro-fitting at risk properties, including historic buildings, with flood resilience measures.

Planning and development control to reduce the impact of new developments on flood and coastal erosion risk.

Utilizing the environment, such as management of the land to reduce runoff, harnessing peat lands and wetlands to store water, restoring and expanding salt marshes, or sustaining beaches and shingle ridges to dissipate wave energy and reduce risks to communities.

Identifying areas suitable for inundation and water storage to reduce the risk of flooding elsewhere.

Planning to roll back development in coastal areas to avoid damage from flooding or coastal erosion.

Better warning systems for flooding events and high tides/stormy seas.

Ensuring effective emergency plans are in place for flood emergencies.

Improving the response to flooding by local emergency responders, as well as individuals and businesses.

Ensuring effective recovery arrangements are in place.

Box 7.1

Liguria coastal planning as a contribution to natural hazard damage prevention

BACKGROUND INFORMATION

Liguria, as a geographic and administrative region, is completely dependent on its coast. Almost all the inhabitants and economic activities, as well as the transport infrastructures, are located in a narrow strip not more than 2 km wide along 350 km of coast. Close to the wealthiest part of northern Italy, an additional pressure is represented by the tourism coming from this area, with a high demand for second homes and facilities such as marinas and golf courses. Therefore the pressure on the coastal land exploitation is very strong. Urbanization, having occupied the scarce coastal plains, is extending to the hills facing the sea with additional problems of soil erosion and landslide hazards.

In 2000, Liguria Region was one of the first in the Mediterranean to approve a Coastal Territorial Plan inspired by the ICZM principles and aimed at managing some of these problems. The Plan tries to fill the void existing at the national level about coastal issues, dealing with urbanization with special attention to coastal erosion and seabed protection.

In 2010, the Region adopted a new important tool, the Plan for the protection of the marine and coastal environment (PTAMC), which is developed for each sedimentary cell. The Plan is aimed to foster the natural coastal processes both for sediment dynamics and habitat conservation.

These plans, based on a routinely updated Coastal Geographic Information System, can contribute to the prevention of some of the man-made damage to the coastal area.
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Box 7.2

Coastal zone management approaches of Alexandria (Egypt) for sea-level related hazards

The coastal zone of Egypt on the Mediterranean extends over 1200 km from El-Sallum in the west to El-Arish in the east. Alexandria is the largest Egyptian city on the Mediterranean (more than 4 million inhabitants). It is the main summer resort of Egypt along the Mediterranean coast. 40% of the nations' industry surrounds the city from the southern and western borders. Alexandria region includes Abu Qir Bay, the Rosetta branch of the Nile River, Lake Edku and El-Max Bay.
For the Alexandria Governorate, two main economic areas appear most vulnerable; Alexandria lowlands and Alexandria beaches. The Alexandria lowlands, on which the city of Alexandria originally developed, are vulnerable to inundation, water-logging, increased flooding and salinization under accelerated sea-level rise. Some of the Alexandria beaches will be lost even with a 0.5 m rise in sea level.

Changes in sea level at Alexandria are analyzed for a study period of 32 years (1974-2006). The observations gave a minimum water level of less than 20 cm in spring months and a maximum level of more than 80 cm in August.
The annual variations of mean sea level increased by 9.95 cm over the study period, giving a sea level rise of 3 mm/year. The computed probable maximum expected abnormal water level condition will reach 165 cm in 100 years and 181 cm in 500 years.
For presenting the risks of extreme water levels, the relationship between the design lifetime and risk of the 80 cm level was calculated. The results indicated that, the high extreme level of 80 cm has a return period of 100 years and design risk of 0.64. The design risk of 0.99 was expected for the design lifetime of 500 years.

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COASTAL MANAGMENT APPROACHES
FOR SEA LEVEL RELATED HAZARDS
Case studies and Good Practices

8 RECOMMENDATIONS

8.1
AWARENESS

Four main steps were identified by the working group on awareness as follows:

FIRST STEP

Identifying stakeholders and stakeholder analysis, in order to take into account the gender and age issues; health issues and education levels, and to define perceptions to risk.
The identified stakeholder groups are:

- Decision-makers (at National, Regional and Local levels)
- Coastal managers; planners
- Civil Protection agencies
- National and municipal safety inspectors
- Industry
- Media
- Public institutions (authorities, schools, universities, kindergartens)
- Public spaces (e.g., theatres, museums, stadiums, shopping malls)
- Hotels and travel agencies; tourists
- Aquaculture industry; fishermen
- Harbours (commercial, passengers); marinas
- Hospitals
- Cultural site managers
- Religious entities
- Coastal zone transportation
- Telecommunications operators
- NGOs
- Disabled people (associations of)
- Insurance companies
- Others

SECOND STEP

Developing a communication strategy

- Tailoring the message according to the group's perception to risk
- Identifying education needs – check list
- Identifying best channels for transmitting the message
- Identifying the needed information and data
- Assessing the available maps, models, simulations

THIRD STEP

Preparing educational materials

FOURTH STEP

Communicating, discussing, informing, workshops

The development of these steps raised four main questions during the discussion:

Question 1

How to provide education and outreach to Member States and localities on coastal risks and available tools to reduce them?

Recommendations and education packages following the main findings are categorized for different target groups related to policy makers and managers and the various coastal communities.

Decision makers, including civil protection agencies and national safety inspectors

- Signing agreements with the Ministry of Education, Ministry of Industry….
- Inviting cooperation in obtaining data
- Priority to the hot-spots
- Importance of risk transfer
- Assessment of the catastrophy insurance pool (Turkish experience)
- E-learning – possibilities for international curriculum

Media, tourism industry, travel journals, NGOs, others

- Education packages to be provided on the Internet
- Invitations to visit the web site (add photo library, social networks...)
- Possibilities of labelling schemes for readiness for sea-level related hazards

Sea-related people (managers of big harbours, marinas, artisanal fishermen...)

- To be involved through workshops
- To secure simulation models for harbours (kindly to be provided by Greek partners)
- To be informed on the risk transfer possibilities

Question 2

How to increase awareness of stakeholders about coastal risk management, planning objectives and existing trade-offs (e.g., related to economic development, flood risk and nature conservation)?

- General public
- Availability of hazard, risk and vulnerability maps
- Importance of clearly communicated messages
- International signage
- Products like information cartoons, theatre plays, festivals, quizzes in schools, web site
- Tsunami code
- Specific messages for selected stakeholders (e.g., hospitals)
- Planners
- Communication/workshops
- Availability of maps and precise information
- Focus on vulnerable priority areas

- Legal grounds (ICZM Protocol, other related conventions and laws)
- Good examples of Cost-Benefit Analysis; information on possible economic costs
- Good practices - safe architecture
- Reactions from the insurance industry
- SEA and EIA – to steer this kind of risk
- Coastal plans and strategies, spatial plans

Question 3

How to increase the participation of local communities and authorities in coastal risk planning and management?

- Through Media: short promotional messages, advertisements on radio/TV
- Encourage people to participate in EIA, SEA processes, in preparation of coastal plans, strategies, spatial plans...
- Clear definition of responsibilities among different authorities
- Organising events, photo exhibitions, school activities, etc.
- Labelling schemes applied through safety inspection
- Guidelines and definition of criteria – UNESCO expert group
- I-phone applications

Question 4

How to test and implement emergency plans with the local coastal communities?

- Exercises for local communities
- Use existing experiences from Greece (University of Crete), Morocco (transboundary), Turkey (earthquake), Italy, France (RAMOGE)
- Present these experiences on the NEAMTIC web site
- Preparation is long and extremely important
- Need for maps, modelling, simulations, scientific data
- Encourage transboundary exercises, also to stimulate data sharing

8.2 PREPAREDNESS

The main issues discussed by the working group on preparedness were addressed as responses to the following four questions:

Question 1

Which actions should be promoted to achieve a more integrated approach to coastal risk management?

Knowing the risks:

- Use an established framework for coastal flood risk analysis, e.g., EU Floods Directive implementation.
- Ensure that information systems are suitable for integration (via use of Open Geospatial Consortium Services: OGC) exploited through dedicated viewer. Promote altimetry/bathymetry integration.
- Use standard assessment procedures (including modelling) by scientists and other stakeholders for each hazard.
- Apply standard assessment procedures for all dimensions of coastal resilience and vulnerability (both environmental and social-economic) for each hazard.
- Integrate tsunami and/or hazard modelling with other information (for assessing value and risk for ecosystems, property, etc). Standard risk as sessments for each hazard.
- Optimise the configuration of the seismic and sea-level networks and detection capabilities.

Strategic land-use planning approaches:

- Integrated in strategic land-use/marine spatial planning processes. This should be in line with current ICZM Protocol since setback measures and risk assessments are mandatory (a number of examples exist, e.g., Saronikos Gulf in Greece).
- There is a lack of integration between tsunami research and spatial/ marine planning (example of the current sub-regional spatial plans of Andalucia).
- Mapping and accounting of natural capital (such as landscapes, cultural features, heritage, ecosystems).
- An issue for strategic land-use/marine spatial planning is zoning: river basins should be taken into account, including damming (the case of Morocco, as a typical southern Mediterranean case, is proposed).

Emergency response measures:

- Detailed SOPs should be developed at the national level for response to catastrophic hazard emergencies. National Tsunami Warning Centres (NTWC) to add value applying their knowledge of their own coastal con figurations.
- NTWCs should liaise closely with Civil Protection (CP) to inform the delimitation of evacuation zones and constraints, etc.
  Exercises and drills for emergency situations should become standard practice for high risk coastal areas.

Question 2

Which measures are most appropriate to reduce coastal risks?

Knowing the risks:

- Local knowledge should be taken into account in the risk assessment process. High resolution mapping is needed to address local inundation threats.
- Recurrent assessments of resilience and vulnerability are needed to address the adaptive nature of hazard management, taking account of socio-economic changes over time.

Strategic land-use planning approaches:

- For strategic planning, more focused planning measures should include construction/adaptation codes (location, land/sea use, building specification, etc).
- Set-back policies should be specific to coastal type (rocky, sandy shores, etc) taking the indicators from the Protocol and improving those on a local level.

Emergency response measures:

- Engage into all aspects of NEAMTWS including NEAMTIC.
- Awareness and education required at all levels.
- Voluntary groups to be included in the process.
- Exercises in drills for evacuation and emergency for local and visiting communities (tourists and locals).

Question 3

What (preparedness measures) are the knowledge gaps on coastal risks?

Knowing the risks:

- There is a need for countries to establish risks at the local level. This may involve developing a capability in tsunami inundation modelling.
- More work is required in the field of community resilience assessment.
- Estimates are needed on how risks (from catastrophic- as well as creeping hazards) are likely to change with time.

Strategic land-use planning approaches:

- Countries need to improve their understanding of the impacts of structural and non-structural mitigation measures, including their financial implications and the trade-offs associated with the approaches considered. Such activities need to be carried out with wide stakeholder consultation.

Emergency response measures:

- Efforts should be made to improve the clarity of messages and the understanding of terminology between National Warning Centres and Civil Protection agencies.
- Identification of standards (precise) for responding to local inundation effects is needed. This includes the cartographic representation of inundated areas as well as evacuation routes and safe locations.

Question 4

Which characteristics should an early warning system include?

Knowing the risks:

- The risks for each type of hazard should be known. The configuration of the seismic and sea-level networks and detection capabilities should be in place.
- Improving knowledge in the local community through, for instance, NEAMTIC should be a key activity.

Strategic land-use planning approaches:

- Mitigation approaches, addressed in a strategic ICAM view, must have tried and tested action plans, including a consideration of trade-offs (winners and losers).

Emergency response measures:

- The EWS should be tried and tested complying with the Strategic Environmental Assessment Directive. To have spatial scenario databases (pre-run simulations) to immediately determine the likely coastal impact.
- It is important to develop communication means that are not land-based.
- Stakeholders should understand their roles and responsibilities and, particularly, their interactions in the event of an emergency.

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ACRONYMS

ADPC	Asian Disaster Preparedness Center
CBDP	Community Based Disaster Preparedness
CBDRM	Community-based Disaster Risk Management
CCRU	Cambridge Coastal Research Unit
CFP	Community Focal Point
COAST-MAP-IO	Coastal Mapping Capacity Building in the Indian Ocean
CP	Contracting Parties
CTEC	Community Tsunami Early Warning Centre
EMMA	European Multipurpose Meteorological Awareness
EU	European Union
EUMETNET	Network of the European National Weather Services
EWS	Early Warning System
GIS	Geographical Information System
GITEWS	German-Indonesian Tsunami Early Warning System
GPS	Global Positioning System
GTS	Global Telecommunications System
GTZ-IS	German Cooperation International Services
ICAM	Integrated Coastal Area Management
ICG	Intergovernmental Coordination Group
ICZM	Integrated Coastal Zone Management
IOC	Intergovernmental Oceanographic Commission
IOTWS	Indian Ocean Tsunami Warning and Mitigation System
ISDR	United Nations International Strategy for Disaster Relief
MIC	Monitoring and Information Centre (European Commission)
MICORE	Morphological Impacts and COastal Risks induced by Extreme storm events
NBRO	National Building and Research Organization
NEAM	North-eastern Atlantic, the Mediterranean and Connected Seas region
NEAMTIC	Tsunami Information Centre for NEAMTWS
NEAMTWS	Tsunami Early Warning and Mitigation System in the North-eastern Atlantic, the Mediterranean and Connected Seas
NGO	Non-Governmental Organisation
NOAA	National Oceanic and Atmospheric Administration (United States Government)
NTWC	National Tsunami Warning Centre
OGC	Open Geospatial Consortium
PAP/RACUNEP	Priority Action Programme, Regional Activity Centre, Split
PPEW	Platform for the Promotion of Early Warning
PTWC	Pacific Tsunami Warning Center
PTWS	Pacific Tsunami Warning and Mitigation System
SOP	Standard Operating Procedures
TIC	Tsunami Information Centre
TWS	Tsunami Warning and Mitigation System
UN/ISDR	see ISDR
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNOCHA	United Nations Office for the Coordination of Humanitarian Affairs
UN-SPIDER	United Nations Platform for Space-based Information for Disaster Management and Emergency Response
WMO	World Meteorological Organization

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