Theme 1

MARINE DISASTERS AND COASTS VULNERABILITY

Wednesday 7th November
(Parallel Session - morning)

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Critical Assessment of Global and Regional Disaster Vulnerabilities Strategies for Mitigating Impacts

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Abstract

Global population expansion, technological improvements and economic growth have made the use of the world's coastal zones more necessary than before. However, the same developments and advanced industries are contributing to an increased impact from natural, terrestrial and marine disasters. The combination of social and economic factors in the development of coastal regions – without proper planning - makes a number of countries particularly vulnerable. Also, manmade disasters such as chemical, industrial, nuclear and transportation accidents and wars, are creating havoc on terrestrial and marine environments, resources and cultural sites. Slower term environmental disasters, with readily identified anthropogenic input, are creating water and climate related hazards that will have a severe impact on humanity in the future. Equally threatening are future biological disasters and epidemics. To mitigate future impacts, a more critical and comprehensive approach must be taken in assessing specific vulnerabilities of each region and in the adaptation and implementation of needed new strategies.

Introduction

In the last 30-40 years there has been tremendous population growth and significant development of coastal areas in most of the nations of the world. The population explosion will impact on the earth's limited resources and sensitive environment (Fig. 1). According to U.N. statistical reports, the human population is now more than 6.5 million and is increasing at the rate of 210,000 per day or about 76 million per year. There are speculative projections that the world population may even reach 30 billion by the end of the millennium. Given these statistics of growth, there is little doubt that the impact of natural and manmade disasters will be significantly greater in the future. Already, there appears to be an alarming increase in losses from geological and weather-related disasters. The costs of these disasters in terms of lives lost and damage to property have skyrocketed.

Geologic disasters include earthquakes, volcanic eruptions and tsunamis. Weather-related disasters include hurricanes (typhoons, cyclones) and associated surge flooding, tornadoes, heavy thunderstorms, flash flooding, floods, mud and rock slides, high winds, hail, severe winter weather, avalanches, extreme high temperatures, drought and wildfires. Longer term, environmental disasters, with considerable anthropogenic input, are already contributing to global warming, sea level rise, climate change and to more frequent and intense weather-related hazards. Manmade disasters, such as chemical, industrial, nuclear and transportation accidents, could do even more harm in the future. Biological disasters and epidemics will greatly threaten humanity as the world population continues to grow.

There is an urgent need to address trends and the means by which marine and terrestrial resources on this planet can be sustained and adverse trends reversed or mitigated. While disaster awareness and preparedness are two important parameters that can help mitigate the impact of future disasters, more comprehensive strategies must be adopted to offset increasing threats. Since different areas of the world are vulnerable to various disasters, each coastal community must assess its own vulnerability and risks and develop specific strategies. Effective disaster mitigation requires the assumption of greater responsibility by individuals, groups, organizations and government agencies.

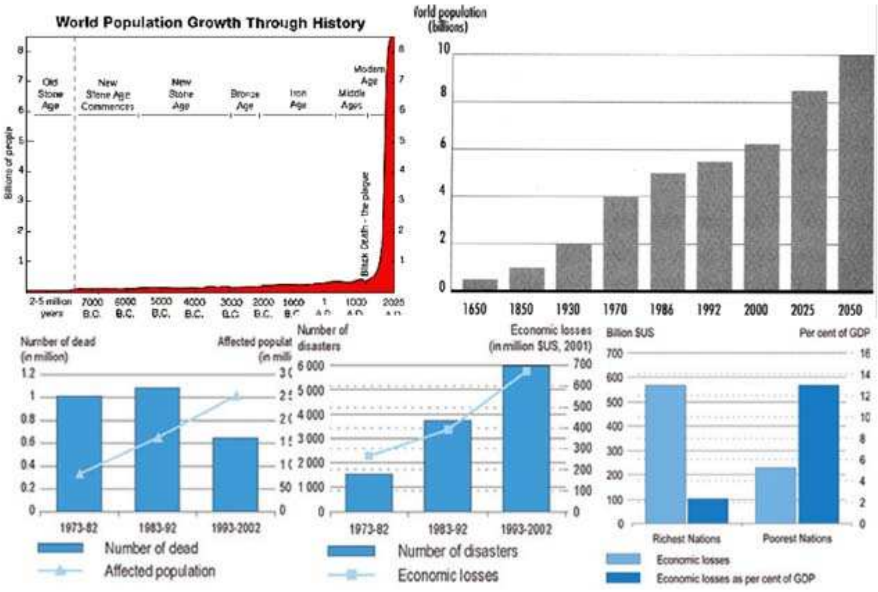

Fig. 1: Past and projected population growth – Losses of life and effect on Economic Resources (Losses do not include those of the 2004 tsunami in the Indian Ocean or the 2005 Hurricane Katrina)

Earthquake and Tsunami Disasters

The tsunami of 26 December 2004 in the Indian Ocean tsunami left irreparable losses. It affected 13 countries and was responsible for the deaths of more than 250,000 people. The earthquake of 28 March 2005, in the same general area, caused additional devastation. The great earthquake of October 8, 2005 in Northern Pakistan and Kashmir killed over 80,000 people and left over 3.3 million homeless (Pararas-Carayannis, 2004, 2005).

The global and regional vulnerabilities for large earthquake and tsunamis generated along zones of tectonic subduction are well documented (Pararas-Carayannis, 1986, 1988 1992, 2001, 2005 a, b, c, 2006a, 2007). In the Pacific Ocean, hundreds of thousands of people have been killed by tsunamis in Japan, Chile, Indonesia, Philippines, Central America and elsewhere. Since 1900, most of the tsunamis were generated in Japan, Russia, Peru, Chile, Alaska, Papua New Guinea and the Solomon Islands. The Hawaiian Islands have experienced tsunamis generated in all parts of the Pacific. Numerous other locally generated tsunamis caused extensive destruction in the Philippines, Indonesia, Colombia, Mexico, Nicaragua, Costa Rica and elsewhere in the Pacific.

In the Atlantic Ocean, the frequency of earthquakes and tsunamis has not been very high. There are no major subduction zones at the edges of plate boundaries, as in the Pacific and the Indian Ocean, to spawn destructive tsunamis. However, near the Caribbean and Scotia arcs, large earthquakes can occur and destructive tsunamis can be generated. Examples of past events would be the 1867 earthquake at Mona Pass near the Puerto Rico Trench and the 1929 Grand Banks earthquake in Nova Scotia. Also, the Azores-Gibraltar boundary of continent-continent tectonic collision, which caused the 1755 Lisbon earthquake and tsunami, is a region that is potentially dangerous (Pararas-Carayannis, 1997). A large earthquake along this boundary could be very destructive in Portugal and Morocco and could generate a tsunami that would be devastating on both sides of the Atlantic. Additionally, the Mediterranean and Caribbean Seas, both have extensive seismicity along small subduction zones, and have histories of locally destructive tsunamis.

In the Indian Ocean the frequency of tsunamis has not been as high, but the tsunami of 26 December 2004, as well as previous and subsequent events, illustrate the extreme vulnerability of this region (Pararas-Carayannis 2005 a, b, c, 2007). Continuous and active subduction of the Indo-Australian plate beneath the Eurasian plate at its east margin presents the highest danger and creates high vulnerability for Indonesia and other countries bordering the Indian Ocean.

The specific methodology for assessing earthquake and tsunami vulnerabilities has been described adequately in the scientific literature (Pararas-Carayannis, 1986,1988, 2006b). Each earthquake and each tsunamigenic region in the world has its own characteristic mechanisms that need to be evaluated independently for proper risk assessment. Analysis of the seismotectonic characteristics of each particular region of subduction can help assess the impact of future disasters, develop realistic scenarios of vulnerabilities, and adopt effective strategies for informed warnings and disaster mitigation. Such informed understanding is now lacking. Including proper evaluation of geotectonic parameters would result in a more effective decision-making process on whether to issue a local warning for a region, or whether to expand the warning to larger geographical areas. Such understanding and analysis would also result in developing better strategies for zoning risks and overall disaster mitigation.

Volcanic Disasters

Volcanic eruptions pose a serious threat to many regions of the world and have been responsible for great loss of life (Pararas-Carayannis, 2003). From 1600 to 1982 a total of 238,867 people have been killed and many more recently. Following the December 26, 2004 and the March 28, 2005 earthquakes in Indonesia, the Mt. Talang volcano became very active and required massive evacuations from the Padang region of Sumatra. Anak Krakatau in the Sunda Strait, showed signs of renewed activity. Also Merapi, Gedek and other volcanoes on Java became very active and required massive evacuations. There is a good probability that Mt. Talang and Merapi will have major destructive eruptions in the near future. Other volcanoes in Sumatra, Java, the Lesser Sunda Islands (Sumba and Sumbawa), Japan, Philippines, Alaska, the Pacific Northwest, Mexico, Central America and Colombia, could become active again.

Caribbean volcanoes pose a serious threat for several islands in the region (Pararas-Carayannis, 2006b). Mt Pelée on Martinique, La Soufrière on St Vincent, Soufrière Hills on Montserrat, and Kick'em Jenny near Grenada are the most active volcanoes in the Lesser Antilles that have caused destruction and even generated local tsunamis by their associated pyroclastic flows, flank failures and landslides (Fig. 2). They will erupt again in the future as well as volcanoes in the Mediterranean, the Red Sea and along the Great African Rift.

There have been several destructive volcanic eruptions around the globe in recent years. Contributing tectonic factors include island arc volcanism that overlies a subduction zone and which can result in the most catastrophic types of eruptions. Many additional specific factors determine the eruption style, higher explosivity, the generation of pyroclastic flows, the structural flank instabilities, the slope failures and the debris avalanches that characterize the mainly andesitic volcanoes (Pararas-Carayannis, 2006a). However, the same factors apply to all basaltic/andesitic volcanoes around the world that border tectonic boundaries.

Volcanic eruptions are often associated with numerous other collateral disasters, which may have an immediate impact or a long-term environmental effect on climate and weather-related hazards. For example, tsunamis can be generated by volcanic caldera and lava dome collapses by vertical, lateral or channelized explosive activity and by associated atmospheric pressure perturbations, pyroclastic flows, lahars, debris avalanches or massive volcanic edifice failures. Whether a volcano will have effusive eruptive activity or explosive type of bursts will depend primarily on geochemical factors. The build up of pressure of volatile gases within the magmatic chambers determines a volcano's eruption style, explosivity and flank instability. The mechanisms and explosivity factors have been thoroughly analyzed and presented in the scientific literature (Pararas-Carayannis 2006 a, b).

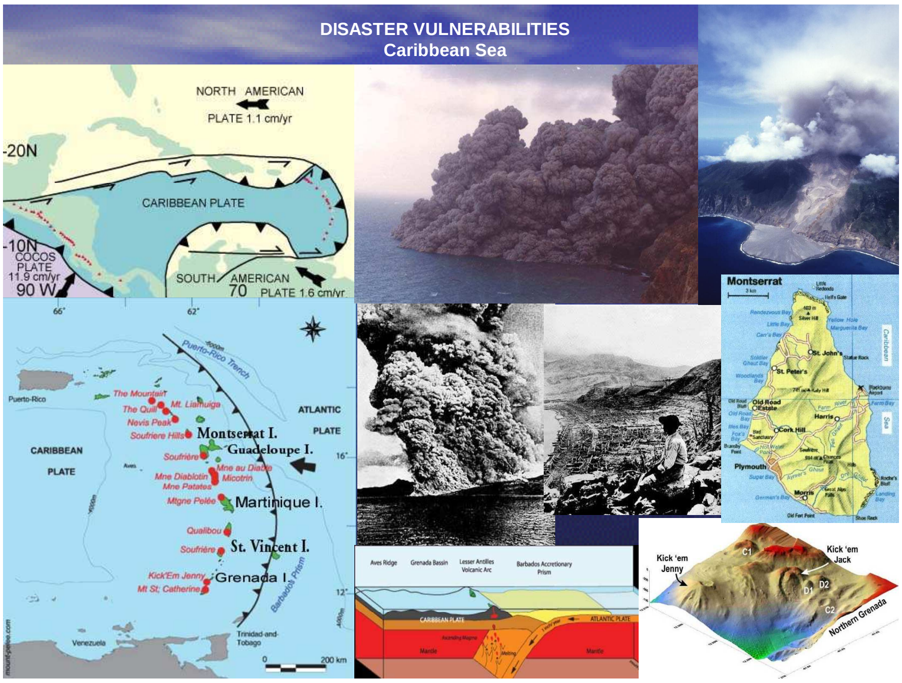

Fig. 2: Composite diagram of volcanic and tsunami hazards in the Caribbean Sea; Active volcanoes and eruptions (1902 Mont Pelée Eruption on Martinique; 2003 eruption of Soufrière Hills on Montserrat; Pending eruption of Kick'em Jenny Submarine Volcano; Debris avalanches and pyroclastic (lava) flows associated with the 1999 eruption of the Soufrière Hills volcano on Montserrat (Photos of Soufrière Hills pyroclastic flows: Montserrat Volcanic Observatory)

Each region of the world that faces the prospect of volcanic disasters should prepare so that loss of life and damage to property can be minimized. Strategies for mitigating future impact of volcanic disasters should include the monitoring of precursory eruptive processes. Additionally, strategies must include studies of geomorphologies and flank instabilities of each individual volcano and the mapping of risk areas that can contribute to massive volcanic edifice failures - with or without a volcanic triggering event. The threat of mega-tsunami generation from massive flank failures of island volcanoes has been greatly overstated, but should not be overlooked. Locally catastrophic collapses will occur along unstable volcanic flanks. The best strategy for the mitigation of this type of disaster is to properly monitor unstable flanks of volcanoes and mountains and to legislate for appropriate landuse that would not allow development in such risk areas.

Weather Related Disasters

Hurricanes (typhoons, cyclones) are severe tropical storms that form in the southern Atlantic Ocean, Caribbean Sea, Gulf of Mexico, in the eastern and western Pacific Ocean and in the Indian Ocean. The disastrous effects of their winds and of the flooding surges are well known. Their paths and vulnerable regions of the world are well established. Intense weather-related disasters have resulted recently in an increase of the human death toll. Global warming appears to be a contributing factor. According to the World Disasters Report, weather-related disasters in 1998 resulted in the deaths of thousands. Hurricane Mich killed 10,000 in Central America. Indonesia experienced the worst drought in 50 years. Floods in China affected 180 million people. Fires, droughts and floods - blamed on the El Nino weather phenomenon - claimed a total of 21,000 lives and caused more than $90 billion in damages.

Many regions of the world remain extremely vulnerable. When Typhoon Whipa slammed recently into China's heavily populated east coast with winds of up to 100 kilometers per hour, close to 2 million people had to be evacuated and ships and ferries had to leave the ports. The threat of Whipa created chaos in Shanghai, one of the country's most significant economic centers. The most recent example of extreme hurricane and hurricane surge vulnerability is that of the city of New Orleans and of adjacent areas in the Gulf of Texas. Other coastal regions in Florida, Mexico, Central America and the Caribbean region are equally vulnerable. When Hurricane Katrina made landfall on August 29, 2005, it was only a Category 3 storm, yet its impact on the city of New Orleans was catastrophic. This impact should not have been a surprise. It was only a question of time before a storm of such magnitude or greater would strike the city. Numerous hurricanes have made landfall near the city of New Orleans in the past. (Pararas-Carayannis, 1975). What really made the impact of Hurricane Katrina so severe was lack of planning and preparedness. Social, economic and political forces played key roles in setting the stage for the hurricane's severe impact on the communities. A clustering of vulnerability factors and unequal exposure to risk - coupled with unequal access to resources – is what contributed to the devastation.

Strategies for mitigating the impact of weather-related disasters must be based on good understanding of what happened in the past. Thus, proper assessment of potential risks is the first essential step in the planning process and in designating susceptible areas. Building shelters in safe areas can help mitigate the impact of storm disasters in low-lying coastal regions such as Bangladesh or New Orleans. Also, planning for quick post-disaster recovery is essential in keeping the death toll low. Imposing higher building standards and adopting better landuse policies are an effective strategy in mitigating the impact of a similar disaster. Finally, strategies for hurricane disaster mitigation must include reliable early warning systems that use remote sensing, satellite photography and other types of imaging techniques that can successfully estimate storm tracks, wind velocities, landfalls and mathematical modeling of hurricane surges (Pararas-Carayannis, 1975, 1993, 2004).

Global Warming Climate Change and Rising Sea Level

The ongoing climate change and the accelerated global warming that our planet has been experiencing for the last few decades, represent the greatest long-term disasters that threaten present and future generations (Pararas-Carayannis, 2003). Unfortunately, these slow, global changes cannot be easily quantified or mitigated. It will be very difficult to reverse the damage that has been done already to our planet. Mitigating the long-term effects of global warming and associated hazards will require more than firm commitments or simple adherence to international treaties for greenhouse emission standards. It will require responsible decisions and many sacrifices.

Existing technologies and forward-thinking policies and strategies offer practical and affordable solutions to reduce our dependence on the fossil fuels that currently dominate the world's electricity production systems. In the way they operate presently, these systems threaten the health of our communities by polluting the air and contributing to global warming. If left unchecked, heat-trapping emissions, such as carbon dioxide (CO_2), are expected to cause irreversible damage. Whether sustainability can be achieved will not be known for a long time. Already many regions of the world – particularly low lying coastal areas and islands - face the direct and indirect threats of multiple disasters associated with climate change, due to global warming and rising sea level. Unfortunately there are no easy solutions to mitigate effectively the impact of such long-term disasters.

In brief, decisions about climate change must be made in spite of considerable uncertainties as those related to sea level rise. In spite of uncertainties, governments must urgently initiate mitigation actions, for both short- and long-term threats. Policies will need to be adaptive on climate change and sea level rise as new data is collected. Mitigation and adaptation policies should occur in parallel and in a synchronous manner. There is no time for political games or delays. Indeed the planet is already in great danger.

Application of Disaster Information in Mitigating Future Losses - A Summation

The methodology for assessing the potential risks that threaten each region of the world requires adequate understanding of the physics of each type of disaster, a good and expeditious collection of historical data of past events, and an accurate interpretation of this data as to what the future impact will be. An effective disaster mitigation strategy must promote the application of appropriate scientific tools for planning and management that raises public awareness of the potential hazards and promotes public participation in mitigating their impact.

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Coastal Disasters: When marine hazards meet terrestrial vulnerabilities – risks, reasons and remedies

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Abstract

In recent years the number of extreme events affecting coastal plains and settlements increased considerably. Hurricane Katrina alone caused a monetary damage twice as much as the hitherto aggregated average annual disaster losses worldwide. Through increasing and chaotic urbanisation, first and foremost in developing countries more and more people migrated to the coastal zone. Even in continents with a fairly settled "settlement landscape" like Europe, almost half of the EU's population inhabits a mere 13% of the land surface along the long shoreline (185,000 km). It is fair to say that most of this people (even the long-term coastal residents) are less than well informed about the potential hazards they face. The December 2004 Indian Ocean Tsunami revealed a frightening degree of ignorance about hazards of marine origin, which may seriously affect the land-based population and its infrastructure. Even less known is that the Mediterranean is more threatened by tsunamis than the Indian Ocean perimeter.

The consequences – at least in the two abovementioned extreme events - were devastating. The casualty statistics were distinctly different, having much more women and children than men as victims of the tsunami, while hurricane Katrina claimed the life of mainly elderly people. Marine hazards did not only kill, they permanently displaced survivors. Among other "permanent" damages an estimated 200,000 people did not return to New Orleans. In Sri Lanka the post-tsunami resettlement areas are frequently located several kms away from the sea. Due to lack of access to employment, poverty in the resettlement areas exceed by a large margin the pre-tsunami level in the original coastal communities.

Terrestrial vulnerability is not only exposed to marine hazards when the "sea visits the land" through coastal inundations due to storm surges, hurricanes or tsunamis. In recent years thousands of landlocked countries, especially in Western Africa experienced land degradation, drought and outright desertification. The number of migrants is increasing with medium term trends all indicating that the exodus is likely to get worse. Due to the lack of recognition and adequate assistance, many of these migrants end up in the network of traffickers. Capsized boats and uncounted people drowned mark the reverse exposure to marine hazards, when terrestrial vulnerability was brought to the sea.

No doubt that the lack of awareness is one of the key factors causing otherwise avoidable casualties. Well-conceived and people-oriented early warning could further mitigate, if not material losses but at least casualties. Both professionals and policymakers must learn to prepare for and to cope with low frequency extreme magnitude events. As far as the unsafe (frequently illegal) naval passage of migrants are concerned, a profound reconsideration of humanitarian, security and cooperation concepts are needed. Different categories of migrants are to be defined, empowerment of specialised support agencies, legal framework and efficient administrations are needed next to a strong change of mentality towards migrants out of despair, driven by their respective vulnerabilities to attempt ill-defined and risky coping strategies.

Results of the post-tsunami studies of the United Nations University Institute for Environment and Human Security (UNU-EHS) and its concepts addressing the environmentally forced migration issue will illustrate the above outlined problems.

Introduction

"Which lessons did we learn from the massive Tsunami of 26 December 2004?"

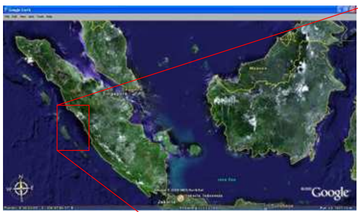
Risk can be interpreted as the "product" of hazard, a possible and even probable natural event of extreme proportions and vulnerability, the pre-disposition of society to be hurt. We may consider several different hazard events, while vulnerability also has multiple dimensions including the institutional one, which was particularly exposed in new Orleans in 2005 by Hurricane Katrina.

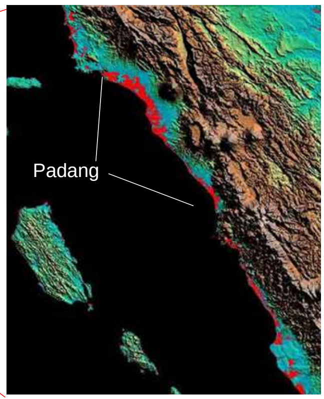
The Sunda Arch of the Indonesian shores is one of the most earthquake-prone areas of the world. Major earthquakes preceded along Sumatra and Java the big quake of 26 December 2004, triggering an unprecedented, at least as human remembrance is concerned, tsunami of global proportions. While the Northern part of the subduction of the continental shelf - through a more than 1000km long rupture and several metres of vertical displacement - has considerably been relieved from its internal stresses, the expectation of the experts concentrates on the possible catastrophes along the Southern part of the arch.

The destructive tsunami wave of 26 December 2004 had not only a substantial impact on important soil and water resources, but also caused great damage of ecologically important ecosystems such as coral reefs, sea grass and beach forests. The victims that had survived this calamity were confronted with psychosocial stresses as a consequence of the brutal loss of their beloved ones, being suddenly unsheltered and the anxiety of a successive tsunami. The degradation of the coastal ecosystems is due also to the tsunami which had left a major "scar" on livelihoods, coastal resources, human settlements, the natural environment and the psychosocial state of the coastal inhabitants.

Recent earthquakes off Central Sumatra and a medium size local tsunami off Southern Java are the recurring mementos As a result and lesson learnt of the 2004 upheaval, it became clear that the countries must improve and further develop their disaster management strategies by implementing mitigation and preparedness options as to strengthen the country's resilience to natural hazards such as tsunamis. Therefore, the establishment of an effective end-to-end, human-centred tsunami (and other marine hazards) early warning system in the Indian Ocean is not only the compelling legacy of a quarter of a million victims of the 2004 tsunami, but a well-founded precautionary measure for the threatened people in the city of Padang (refer to images No. 1 & 2 below).

EO-Data and forecasts, vulnerability assessment and evacuation planning





Tsunami-prone coastal stretch in West-Sumatra near city of Padang

(3rd largest city of Sumatra, approx. 1 mio. inhabitants, area 650 km², built 350 km² flat coastal areas, net of urban waterways Major Tsunamis: 1797: 9m and 1833: 6m)

Fig. 1

Fig. 2: Elements of a state-of-the-art early warning system, combining the observation, warning and potential response elements

Risk and vulnerability assessment are the most essential steps to identify the most endangered locations, to assess potential rescue (evacuation) routes and potential need and sort of assistance. Without these assessments even a potentially available rescue / intervention capacity could prove to be inefficient.

This assessment has been carried out for the city of Padang within the framework of the German-Indonesian Tsunami Early Warning System (GITEWS) project and the Numerical "Last Mile" Tsunami Early Warning and Evacuation Information System projects, both being funded by the Federal Ministry of Science and Education of Germany. As Padang is Sumatra's third largest city, with one million citizens located directly on the coast and partially sited beneath the sea level, it is thus exposed to an area of severe risk caused by intense earthquakes and by the uncertainty of triggered tsunamis. The preliminary assessment of the tsunami hazard of Padang city revealed for a hypothetical 5m high tsunami wave that 80km of roads, 34 government offices, 2410 houses, and 13 hospital and clinics would be affected (refer to image No. 3 below).

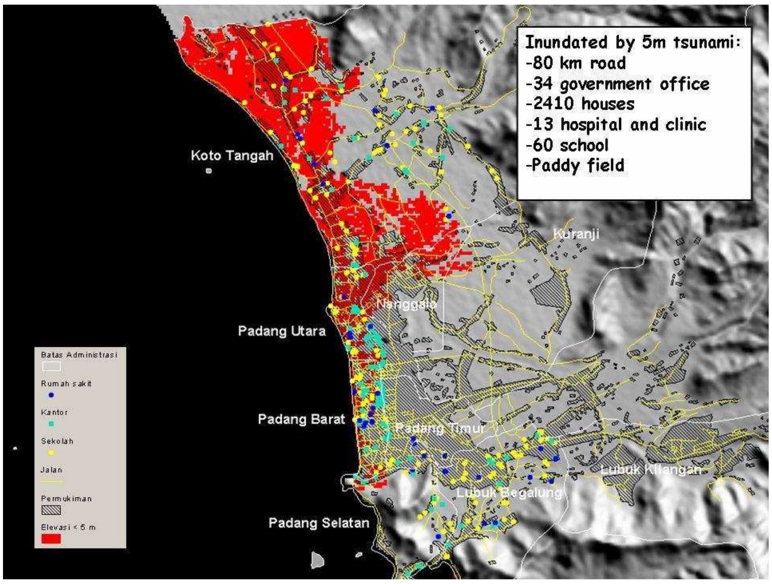


Fig. 3: impacts and consequences of a hypothetical 5m tsunami wave

Lessons for the City of Padang

Inundation modeling and the numerical simulation of the propagation of the wave front have shown not only substantial penetration of seawater into the city, but also revealed that the most rapid movement of the tsunami wave would be along the six major canals and watercourses flowing through the city (refer to image No. 4 below).

Fig. 4: Rivers as tsunami wave propagation routes

These proofs have been obtained fortunately in right time. The city of Padang became commendably proactive and assigned evacuation routes and marked them to assist the population to flee should a tsunami (early) warning be received. Ironically, however, these routes were assigned along the watercourses, instead of seeking higher grounds as soon as possible. Guiding the people to the canals and rivers would expose a large number of people to the most ferocious onslaught of the Tsunami.

The "discovery" of the fallacy of the well-intended, however, even dangerous evacuation plan of the city of Padang is a strong reminder that scientifically sound forecasts and early warning should serve as the basis for local preparedness and response activities. As far as the city of Padang and the potential propagation of likely tsunami waves are concerned, high resolution topographical and bathymetric data are needed to achieve the necessary accuracy in modeling the entrance of tsunami wave(s) between the islands in front of Padang and the sum up of the wave once it hits the shore. No doubt, that even with the help of these refined data decisions, warning (or refraining from the issuance of an (early) warning) will still remain to be associated with uncertainty. Type, strength and location of tsunami triggering earthquakes are unknown.

In addition, the extreme events with strong destructive potential are (fortunately) still rare events. Due to the lack of observations and data homogeneity, it is not more than an educated guess to claim that the recurrence period of devastating tsunamis like the 2004 one could be between once in three-to five hundred years. By acknowledging this uncertainty, the real challenge will be obvious: next to improved data and observations, refined technical means and institutional structures of an early warning chain, we need also a sustainable risk culture to become piece and parcel of the social fabric. Public awareness, disaster and evacuation drills are not meant to nurture fear, but rather to shape the awareness, ability and trust of the people that they would be able to cope should such extreme events (re)occur. The risk culture also implies compliance with building codes, security prescriptions, leaving evacuation routes marked and free, the restraints of city developers to spread over unsafe areas. Hotspots of vulnerability have to be identified and focus needs to be placed on those areas which will require special assistance in case of an evacuation potentially caused by a natural hazard.

Closing remarks

The 2004 Tsunami and the 2005 Katrina were striking examples of extraordinary magnitude of marine hazards exposing terrestrial (social, institutional) vulnerabilities. Humanity may have the chance not to experience these type of extremes for long. History, however, teaches us that seventeen out of twenty of the most disastrous natural hazards since 1950 have taken place during the last decade. It is apparent that extreme environmental events swell in frequency and magnitude. The number of human losses and the economic damage resulting from such hazards is alarming. Yet, unless we are able to build up and keep alive awareness and a precautionary risk culture for centuries, future extreme events might prove to be even more devastating than those recent ones.

Risk Factors for the 17 July 2006 Java Tsunami which killed 802 people

Yuichi Ono

United Nations International Strategy for Disaster Reducation

Abstract

The field survey was conducted by the National Disaster Management Office (BAKORNAS) of Indonesia, the Asian Disaster Reduction Center (ADRC), and the United Nations International Strategy for Disaster Reduction (UN/ISDR) to investigate the risk factors accounting for 802 deaths caused by the 17 July 2006 Java Tsunami in Indonesia. Physical field surveys and interviews to affected people were conducted in one of the most severely affected areas in Pangandaran and Cilacap in the southern Java during 27-30 July 2006. Through the interviews, information on 269 persons directly affected by the tsunami was collected. This includes information on the 28 deaths. The main risk factors that emerged were: 1) no warning was issued and delivered to the communities; 2) the tsunami-caused earthquake was so weak that most people did not feel it in time to take action; 3) weak building structures; 4) no structural measures or designated safe places to shelter lives from the tsunami; and 5) physical and social vulnerabilities of infants, women, and the poor.

Risk Factors for the 17 July 2006 Java Tsunami which killed 802 people

As soon as ISDR received the news of tsunami damages in Java, the staff members started to collect information through media and partner agencies. However, this fact-finding process resulted in some contradicting information (on e.g. the arrival time of the tsunami, the strength of the earthquake, damages, etc.). In addition, it was not clear why no tsunami warning had been issued in Indonesia, how people despite the lack of official warning reacted to the tsunami, and why, in the inundated area, some people survived and others did not. One week after the event, the ISDR Platform for Promotion of Early Warning (PPEW) organized a field survey mission to the most seriously affected areas together with the Asian Disaster Reduction Center, and assisted by the National Coordinating Agency for Disaster Relief and Refugees of Indonesia (Bakornas PBP). The objective was to find answers to the abovementioned questions and to provide recommendations for a strengthened early warning system. According to the survey, an earthquake with the magnitude of 7.7 occurred in the Indian Ocean at 15:19 (local time), around 355 km south of Jakarta and 200 km south of Java, Indonesia, triggering a local tsunami that hit a 300 km stretch of coast along southern Java, causing more than 500 fatalities.

It was the first real test of the regional Indian Ocean Tsunami Warning System (IOTWS). The technical component of this interim tsunami watch information system in the Indian Ocean, established by the IOC/UNESCO, functioned well. The Indonesian Center for Meteorology and Geophysics (BMG) received the interim tsunami watch information from the Pacific Tsunami Warning Center (PTWC) at 15:27, followed by the Japan Meteorological Agency (JMA) several minutes after. The magnitude estimate was 7.2 and both had indicated the risk of the local tsunami. The Chief of the BMG, Dr. Prih Harjadi advised that, based on their initial estimates of 6.8, no warning should be issued. Nevertheless, concerted efforts were made to contact senior local government officials in the coastal provinces by telephone, facsimile, and SMS messages, unfortunately without success due to saturation of communication lines and unavailability of key people. In the end, local people did not receive any official tsunami warning. According to the survey, the Java tsunami reached the city of Pangandaran 46 minutes after the earthquake and Cilacap 71 minutes after. In Pangandaran, the inundated distance from the coast was up to 500-600 meters in the western side of the peninsula and up to 100 meters in the eastern side. The maximum tsunami height was 7 meters, according to the BMG survey, while the PPEW team was only able to identify up to 4 meters. The team interviewed 35 residents and thereby managed to identify the response and destiny of 269 people, including their family members, friends, and neighbors.

None of the interviewed people received official warning. Thus, no one could take any action until the tsunami approached the coast. Many people became aware of the approaching tsunami by noticing the roaring sound and/or seeing the approaching waves. The survey estimates that if the tsunami had ccurred in the evening hours, the number of deaths would have been significantly higher. While a number of people were warned by others who had detected the tsunami, many people did not become aware of the destructive waves until they were caught by the water. Another finding is that due to the TV images of the December 2004 Sumatra tsunami most people knew about tsunamis, which helped people to understand their observations and to take quick action. Such understanding is a crucial factor for quick response and should not be underestimated for saving lives. At the same time, because of such knowledge, many people were so scared that they evacuated very far inland and stayed for about 3 to 10 days. In addition to a large gender difference in terms of the number of deaths, the age and the tsunami height were important factors. People with instantaneous physical ability to swim and run survived. The degree of physical damage suggests that buildings situated at the coastline received most significant damages, especially non-concrete buildings such as bamboo-made structures. Yet, the team recognised that the buildings even one street away from the coast received much less damages. There seemed to be a significant correlation between the survival rates and the tsunami height or distance from the sea.

In conclusion, it was not technically easy to issue a tsunami warning for this particular earthquake. However, both PTWC and JMA indicated the risk of local tsunami to the BMG only 8 minutes after the earthquake. In this respect, the survey concludes that BMG should have been able to respond to this vital information quickly. In order to improve future dissemination of warnings, the Government of Indonesia needs to build a fast and dependable tsunami warning system, including the dissemination of warning to designated agencies and people at risk. This cannot be completed by the BMG. The communication agencies as well as media, police, military, local governments, NGOs, and all related agencies need to support such efforts. In the aftermath of this disaster, the BMG changed its threshold for when to issue a tsunami warning. They now issue a local tsunami warning for any sea earthquake with a magnitude that is equal or larger than 6.3. This is considered as a temporal solution until the existing monitoring system has been sufficiently strengthened. The National Disaster Management Agency (BAKORNAS) has the national responsibility to raise tsunami awareness among the Indonesian communities in close collaboration with relevant local, national and international agencies. PPEW strongly encourages all related actors to support these efforts of strengthening local capacities through awareness raising events, disaster education and drills.

Fig.1: Many houses were destroyed by the 17 July Tsunami at the coast of Java. (Source: ISDR, Yuichi Ono)

Fig. 2: The team interviewed many people living in the affected area.
(Source: ISDR, Yuichi Ono)

Fig. 3:The sign board was erected after the 17 July Tsunami at the coast of Pangandaran to inform the people what to do if another tsunami occurs. (Source: ISDR, Yuichi Ono)

DisasterAWARE: A Comprehensive Decision Support System for the Emergency Manager

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Abstract

PDC developed DisasterAWARE for the National Disaster Warning Center (NDWC)–Thailand as an enhancement of the NDWC's early warning capabilities in response to the tragedy of the Indian Ocean Tsunami. DisasterAWARE incorporates disaster management-related best practices and procedures, augments the underlying early warning system infrastructure to support multi-hazard analysis, and extends disaster warning notification processes.

During 2005-2006, in concert with its technical and funding partners and the NDWC-Thailand, the Pacific Disaster Center (PDC), Hawaii, USA, developed and implemented an in-place, decision support system for multi-hazard early warning for Thailand. In May 2005, Thailand's NDWC formally announced its operational warning/response capability for tsunami and earthquake hazards. The PDC's solution began automation of the national disaster management information flow and emergency response by linking sensor data collection systems, Geographic Information Systems (GIS) mapping, scenario modeling, and emergency notification. PDC project partners developed an integrated architecture for a disaster warning and decision support platform to support the NDWC's operations. The platform includes a user friendly, web-accessible GIS map viewer, hazard event tracking and collaboration tools, and basic hazard modeling systems that are all needed to support disaster management and decision making.

DisasterAWARE ingests complex input from numerous sources, and facilitates transmission of complete, useful and effective warning messages to designated recipients. The result is an enhanced and automated analytical capability for "decision support" that is integrated within the NDWC's Concept of Operations. The NDWC decision support system can be "scaled-up" to include multiple hazards in the future.

DisasterAWARE increases the capacity of disaster managers to synthesize multiple data streams for critical early warning and quick decision support. The system integrates data from a variety of sources into an enterprise geospatial application for collaboration and analysis*.*

The African ocean and marine environment span twenty-two countries in the South and Central Eastern Atlantic Ocean and nine countries in the Indian Ocean. According to the World Bank, the population of Africa is approximately 650 million and is projected to grow at a rate of no less than 3% per year. With this growth rate, the population in the coastal urban area is expected to double within the next 30 years, and by the year 2025 the urban coastal population will increase from a mean of 200 inhabitants/km^2 to 500 inhabitants/km^2.

The African ocean and marine environment is richly blessed with a wide variety of living and nonliving resources. Rapid industrial growth and the search for a source of livelihood in the coastal cities have resulted in high pressures on the coastal and marine area including the adjoining coastal ocean. According to a Global Environmental facility report, the three greatest threats to the African ocean and marine areas are pollution from land-based activities, overexploitation of living resources, alteration and destruction of marine habitats including coastal erosion and flooding. Global climate change and associated impacts like sea-level rise and flooding have been documented to have negative impacts on the socioeconomic activities in both West and East African regions. While several national and international coastal and marine programmes are presently being implemented, many areas and communities are still adversely impacted by these problems. Coordinated national and regional mitigation programmes with built-in local and community participatory programmes could enhance efforts to mitigate these coastal and marine hazards. Such local and community based programmes should involve enlightenment, education, and poverty alleviation programmes for youth, women and other coastal stakeholders.

Addressing Coastal Ocean and Marine Area Hazards in Africa through Coordinated National and Local Participation

Larry Awosika

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Abstract

The African ocean and marine environment span twenty-two countries in the South and Central Eastern Atlantic Ocean and nine countries in the Indian Ocean. According to the World Bank, the population of Africa is approximately 650 million and is projected to grow at a rate of no less than 3% per year. With this growth rate, the population in the coastal urban area is expected to double within the next 30 years, and by the year 2025 the urban coastal population will increase from a mean of 200 inhabitants/km2 to 500 inhabitants/km2.

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