IMPROVING THE COASTAL HAZARD MANAGEMENT IN INDONESIA: LESSON LEARNED FROM OTHER COUNTRIES

A. Y. W. Widayati \textsuperscript{1} and K. H. Kim \textsuperscript{1}

ABSTRACT: The management of coastal development in hazard areas has now become a serious issue due to increasing trend for people to live at the coast, including Indonesia. Unfortunately, coastal hazards often go unaddressed until they happened and brought severe damage the coastal areas. Therefore, the development of appropriate advance setbacks based on the need to avoid or reduce risk and acceptance of the uncertainties can be established and translated into planning system and management actions in a pragmatic and effective way. Also to be able to transfer the knowledges, technologies and expertise also to be able to share of research findings, lessons learned and best practices to enhance the capability of arranging an optimal coastal hazard management. Such successful experience and knowledge about hazard mitigation action should be shared by taking consideration of local conditions in Indonesia. Also, the preparations for community, such as education and awareness when planning for coastal protection and development, are really important to be considered carefully.

Keywords: Coastal, hazard, management, climate change, sea level.

INTRODUCTION

Coastal areas become more vulnerable to a wide range of natural hazards including hurricanes, tropical storms, tsunamis, floods, and other coastal hazards. The increase in vulnerability is partly due to the rapid population growth in high-risk coastal areas, unprecedented urban development, the prospects of global climate change, and sea-level rise. It is also an area of high economic significance, which is often subject to rapid economic development, large population migrations and urban development. The coastal areas are affected, through the coastal hydrodynamics, by the actions of the sea (e.g., storms, coastal erosion and accretion, flood ing, tsunami, etc).

Main component in the formulation of a comprehensive approach to hazard mitigation is to develop, adopt, and update as needed a local hazard mitigation plan. A hazard mitigation plan establishes the broad community vision and guiding principles for reducing hazard risk, and further proposes specific mitigation actions to eliminate or reduce identified vulnerabilities.

RESEARCH METHODS

Qualitative Research

The data analysis process is based on the qualitative data analysis process as described by Powell and Renner (2003). It consists of five steps. After examining the data collected, the second step of the analysis focused on how all actors responded to each question within each topic. The third step of the analysis involved categorizing the information. This involved identifying or grouping themes or patterns and organizing them in coherent categories. As the categorization progressed, new themes were identified and were treated as sub-categories. The fourth step included identifying patterns, connections, and relationships between categories and importance. The last part of the analysis involved pulling together all the analysis for final interpretation of the data and proposing new concepts and ideas.

Case Study

The case study discusses and provides a detailed account of the selection procedures for the research cases and presents analysis and interpretation. In the conventional view, qualitative methods produce information only on the particular cases studied, and any more general conclusions are only propositions. The first step in case study research is to establish a firm research focus to which the researcher can refer over the course of study of a complex phenomenon or object. The researcher establishes the focus of the study by forming questions about the situation or problem to be studied and determining a purpose for the study.

\textsuperscript{1} Civil and Environmental Engineering, Kwandong University, 24 579bungil Bumil-load, Gangneung, SOUTH KOREA
Comparative Research

Comparison is inherent in all science, where comparative research has historically played a significant role in their development as scientific disciplines. Lijphart (1971:682) situated the comparative method as a basic method in its own right, alongside the experimental, statistical and case study methods.

One of the most prominent issues discussed in comparative methodology texts is the question of how many cases (where cases refer mostly to countries) should be studied. Generally, a study of a single country can be very intensive and conducted in considerable detail, but the more countries there are, the less intensively each one will be studied. This is illustrated in Fig. 1, in which Landman (2008:26) categories is used for the number of countries dealt with.

LESSON LEARNED FROM OTHER COUNTRIES

Management Performance on Coastal Hazard Mitigation Tools and Techniques

Decision makers need answers to a variety of hazard-related questions and they are urgently needed to factor the risks of coastal hazards into daily decisions. Although some of this information is available, our increasing vulnerability to hazards, suggests a need for more and better information. Some of this new information can be generated at relatively low cost, but much of it will require that we collect new field data, acquire and interpret remotely sensed data, and present the information in formats that are useful to decision makers. Some hazards information will be needed for long-range planning, whereas some is more appropriate to site specific decisions. Whatever the case is, natural hazards maps and reports need to be more consistent in content and of higher quality than they now are.

Information also needs to be more accessible to decision makers. Although improvements in natural hazards information will require significant public investment, the cost of inaction could be much greater. Therefore, coastal hazard management is need to be implemented and execute to ensure that all data and information are collected, to guarantee that all monitoring program are well-executed to observe coastal problems due to the failure of hazard mitigation plan, etc.

Analysis Result

Fig. 2 below describes the comparison of management performance on coastal hazard mitigation tools and techniques between The United States, Japan, South Korea, and Indonesia. These comparisons are based on paper-based data collection, literature review, and previous research studies.

![Fig. 2 Graphs of management performance comparison on coastal hazard mitigation tools and techniques between United States, Japan, South Korea, and Indonesia.](image)

From figure above, it showed that in matters of structures constructions, United States and Japan have more experience compared with South Korea and Indonesia. Followed are the detailed analysis of each tools and techniques on coastal hazard mitigation from each country.
Shore Perpendicular Structures
The United States
Shore perpendicular protection structures are designed to either reduce the rate of transport of sand along a specific reach of shoreline or to completely block the alongshore movement of sand beyond a certain point. Groins are often constructed in series (called a groin field) forcing the sand to fill in to a specified level on one beach before allowing sand to be transported to the next beach in the field. Terminal groins and jetties are impervious shore perpendicular structures constructed to keep sand from moving into an undesirable area including navigational inlets, harbors and submarine canyons.

Japan
Groin has been developed to reduce the longshore sediment transport into sheltered area in the southwest. The groin has control about 60% of the sediment transport to the south of the area. Another groin is built near the estuary of Tabaru River located at northeast side of the bay. The groin is build to protect sediment accumulated in the river mouth especially strong waves.

South Korea
A comprehensive approach used to mitigate beach erosion that occurred after the construction of a coastal road with a seawall along Namae Beach in Korea (Widayati et al., 2009). The construction of a short jetty and two submerged reef mounds was proposed to reduce the wave-induced current and resulting beach erosion. After the jetty construction from May to August, 2008, the shoreline advanced offshore continuously in the zone affected by the jetty.

Indonesia
Coastal erosion is prevalent throughout many provinces (Bird and Ongkosongo, 1980; Syamsudin et al., 2000; Tjardana, 1995). US$79.667 million was provided by the Indonesian Government to combat coastal erosion from 1996 to 2004 in Bali to protect the valuable coastal tourism base. A combination of hard structures and engineering approaches of different shapes that fused functional design and aesthetic values, and soft structures and engineering approaches (beach nourishment) was used. They succeeded in stopping coastal erosion on Sanur, Nusa Dua and Tanjung Benoa beaches, but were neither cost effective nor efficient, because during low tide all of the coastal area was exposed up to 300 meters offshore; thus, these huge structures were revealed and became eyesores.

Shore Parallel Structures
The United States
Shore parallel protection structures are built both onshore and offshore of the coast. Viewed as the last line of defense against coastal storms, onshore structures, limit the landward extent of erosion or retain land behind the structure. Offshore structures, or breakwaters, are designed to limit the magnitude of wave energy in their lee. Breakwaters can be built either above or below the water’s surface depending on the desired level of wave protection.

Japan
Shoreline response to submerged structures: emergent coastal structures, such as groynes, detached offshore breakwaters and sea walls have been successfully adopted as coastal protection measures for many decades (Dean and Dalrymple, 2001). This type of breakwaters is common in the US and Europe (Dean and Dalrymple, 2001) and even more so in Japan, where Seiji et al. (1987) reported the completion of over 4000 emergent breakwaters by the mid-1980s.

South Korea
Many offshore breakwater, seawalls and revetments have been constructed along the east coasts without hesitation and have served as expedient protectors of certain coastal sectors. The basic design of the seawall is based on the use of tetrapods (TTPs), which are armour units normally used in Korea, for protection of the seawall against strong waves during typhoons.

Indonesia
Many beaches in Indonesia are facing problems due to coastal hazards. Many coastal protections also have been installed to solve the coastal problems. However, due to financial problems and the fact that many beach areas need to be addressed, problems that occur in many coastal areas in Indonesia have not been handled well. Many shore parallel structures that already constructed are not well maintained and monitored.

Non-traditional Shore Protection Structures
The United States
As research and experimentation continue, new techniques for shoreline stabilization will be proposed and developed (Herrington et al., 1998). In many instances, these approaches "work with nature" rather than simply constructing a barrier as a solution to erosion or wave attacks. Increasingly, a shoreline stabilization structure can be hidden in the natural environment and only exposed, if at all, during severe storm events.
Japan
Prototypical pumping systems have successfully lowered the water table level and have resulted in morphological responses ranging from no change to stabilization to accretion. A dewatering system installed at Kashiwabaru Beach in Kagoshima, Japan was used to experiment with drainage pipe placement. Despite the multiple pipe locations and the use of direct and continuous pumping, no definitive differences between the dewatered beach and control beaches were found.

South Korea
Geotube is a type of coastal structure which can be used as coastal protection. Basically geotube is a geosynthetic type of material which is stitched to form a tube when filled with sand or cement material. The geotube solution was adopted because it was more economical and satisfied the client’s technical requirements and construction time constraints. A total of more than 14 km of geotubes ranging from diameters of 3m to 5m were used as reclamation dike units to form a 1.6 km long artificial island strip that rose about 7m to 9m above the sloping seabed in the city of Incheon, South Korea.

Indonesia
The use of non-traditional shore protection structures are still rarely applied in Indonesia, although some studies have been conducted. The result indicated that the agreement between the theoretical solution and the experiment was encouraging. The analytical solution may be utilized to predict underwater pipe stability under wave attack with certain degree of accuracy.

Beach Nourishment
The United States
In the United States, beach nourishment has grown in acceptance as major shore protection and beach restoration measure for more than fifty years. Beach nourishment is extremely important to all aspects of coastal maintenance and will become the fundamental component of future coastal management and habitat restoration efforts. Newly placed sand protects property and infrastructure from wave attack, inundation, undermining, and increased vulnerability due to long-term shoreline erosion/recession.

Japan
In Japan, "hard" structures are also commonly used but after a new coastal law was approved in April 2000, beach nourishment as a legal shore protection work was accepted. However, at present, beach nourishment is not yet widely used as shore protection method in Japan.

South Korea
Beach nourishment has been implemented as a preferred alternative for shoreline stabilization at Songdo Beach, Busan, South Korea that suffers a deficit of sand due to either natural or man-made causes (Yoo et al., 2005) Methods for beach nourishment are still developing, and considerable guidance for the performance of new projects is derived from the observed performance of previous projects.

Indonesia
The main issue of coastal area is erosion problem caused by wave attack and human activities such as the construction of beach structures. One of beach protection methods that considered as environmental friendly is artificial beach nourishment. It has been increasingly applied in Indonesia as a coastal protection technique. However, the standard guide to design a sand beach profile that corresponds to the condition in Indonesia is not yet available.

Natural Resource Restoration
The United States
Most coastal landscapes are composed of two types of geologic features; loose granular soils and eroding headlands. This composition allows the land to rapidly adjust to varying amounts of wave and wind energy and reach equilibrium between the amount of incident energy and the amount of energy dissipated along the coast. In addition to the physical forces in the environment, saltwater flooding and salt spray creates an extremely harsh environment for plants and animals. As communities work toward mitigating hazards along the coast, careful consideration should be given to restoring the natural features of the coastal environment.

Japan
The coastal sea area at Cape Erimo and its surroundings falls on a junction where warm currents from the west and cold currents from the east converge, making it one of the best fishing areas in Japan. Although the yield of fish and shellfish once fell dramatically due to the flowing of sand and dirt as a result of the above-mentioned desertification of the continental land, a recovery has been observed in recent years owing to the regeneration of forests and grasslands.

South Korea
Since the first occurrence of reef degradation (ie whitening phenomenon) off the coasts of Korea in 1970, the damage has rapidly spread to the eastern coast, southern coast and Jeju Island. Disappearing algae has lead to the reduction of fish, abalone and sea cucumber.
The seawater's self-purification capability has declined, further threatening the ocean's ecology as well as fish productivity. Joining the efforts of the Korean government and the National Institute to restore the marine environment, POSCO explored the idea of using iron and steel-making slag to promote marine forestation in damaged areas. Steel slag is an environmentally safe by-product of steel-making and has been widely used in construction, civil engineering and soil fertilization.

Indonesia

This program of Wetlands International, WWF, IUCN and Both ENDS has been active in Aceh since July 2005, to rehabilitate livelihoods of the tsunami affected communities by restoring coastal ecosystems (coastal forest and marine resources). Per March 2007, this resulted in 60 community led restoration projects, benefitting 43,000 people and a total 600 hectares of coast successfully reforested with mangroves and other coastal vegetation.

Building Techniques

The Unites States

Over the latter half of the 20th century, great strides have been made in the design and construction of residential buildings to withstand the extreme forces that occasionally occur in the coastal zone. Many best management practices have been derived from the analysis of structural failures during coastal storms. As a result, homeowners and builders now have a variety of low-cost building materials, building techniques, and design options to mitigate potential storm damage.

Japan

In Japan, where earthquakes are far more common than they are in the United States, the building codes have long been much more stringent on specific matters like how much a building may sway during a quake. After the Kobe earthquake in 1995, which killed about 6,000 people and injured 26,000, Japan also put enormous resources into new research on protecting structures, as well as retrofitting the country’s older and more vulnerable structures. Japan has spent billions of dollars developing the most advanced technology against earthquakes and tsunamis.

South Korea

South Korea is one of the countries around the world that concern about develop the building techniques so it could be more environmental friendly and save the energy. Specify efficient building equipment, office equipment, motors, lighting, appliances, etc have been carefully measured.

Indonesia

Since Indonesia is one of disaster prone country, the building techniques need to be carefully calculated and planned. The building setting requirements include the responsibility of local governments, function and classification of the building, landing requirements building on disaster mitigation, directives setting buildings on emergency response and post-disaster, building management information systems, empowerment, and also guidance and supervision. Due to the fact that Indonesia consist of many islands, until now it is still difficult to monitor and manage the building techniques in all coastal areas. Therefore, good management is needed so the quality and strength of buildings can be guaranteed.

Community Maintenance and Preparedness

The United States

Every coastal community has its hazard hotspot, and yet government still has failed miserably in keeping development out of these highly vulnerable areas. Community based approach is needed to bring together partners in coastal hazards to share recent advances in their hazard related activities to develop efficient and effective ways to enhance coastal hazard planning, preparedness, mitigation, response, and restoration. To serve the needs of coastal communities, it is essential to speed up the transfer of research results to application towards the goal of building a more resilient and sustainable coastal (both built and natural) environment throughout the U.S.

Japan

Japan’s hazard readiness has developed as a result of the lessons learned from the past. The coastal areas that have suffered much of the damage have been the most active in promoting preparedness, local authorities nation-wide have begun a review of readiness policies and emergency planning. Even with the sophisticated technology of today it remains difficult to predict where and when a tsunami will occur. When a tsunami is generated, the height and arrival time of the tsunami vary according to coastal configurations and the resulting types of damage complicate safety planning. Furthermore, because Japan’s historical tsunamis have yet to strike hit densely populated areas, readiness planning for coastal areas with large concentrations of people is essential task for planners.

South Korea

Korean Ministry of Education, Science and Technology introduced the national policies of Korea about education for natural disasters. Education always
plays a significant role in natural disaster prevention, reduction and response. The Korean government has put great efforts to educate its people through a systematic approach.

Indonesia

In relation to the effort of managing disaster in Indonesia, the school has a tangible role in building community resilience. The school as an education institution has the responsibility to deliver education. The school still gains trust as an effective institution to build the culture of disaster preparedness in societies, particularly among students, teachers, education practitioners, and other stakeholder as well as to the public.

Future studies and improvements are needed to be carried out especially in Indonesia, based on these comparison results to improving the performance of coastal hazard management. The coastal hazard management should be able to offer a systematic approach by combining the coastal sciences and engineering with other aspects, such as economics and public policy, to achieve a more holistic design and optimal protection for coastal area. Coastal hazard management also should be able to address new problems and concerns that coastal area in Indonesia will face, such as sea level rise and changing dynamics of coastal processes. This will involve the development of long-range planning approaches that can be combined with short-term emergency tools.

CONCLUSION

The main actors for successful management in Indonesia and other countries are policy and planning staffs, engineers, and communities. Coastal hazard management should provide regional and territorial authorities with information on the key effects of climate change on coastal hazards, also should provide a decision-making framework to assess the associated risks, and provide criteria to appraise and decide on appropriate responses to the risks.

Long-term monitoring of the effects of coastal hazards should be undertaken to improve the understanding and ensure that response options are effective and sustainable. Monitoring techniques need not be expensive but in high-risk situations, robust monitoring programs that will provide useful information for future assessment of coastal hazards and response options should be considered.

It is recommended that an effort to improve and enhance coastal hazard management is needed so that it can be used as a means to cope with coastal hazard problems optimally. It is also essential to learn from the experience of other countries in dealing with coastal hazard to get good inputs and feedbacks so the best practices of coastal hazard management could be implemented in Indonesia.

ACKNOWLEDGEMENTS

This work was partly supported by the RIC program of MOCIE.

REFERENCES


