CHALLENGES, VULNERABILITIES AND MANAGEMENT OF COASTAL ZONE AROUND THE WORLD

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ABSTRACT
The coastal zone is the interface where the land meets the ocean, encompassing shoreline environments as well as adjacent coastal waters. The high concentration of people in coastal regions has produced many economic benefits. In view of the coastal areas, vulnerability to natural hazards particularly tsunami, storm surge, erosion, salinity intrusion, sea level rise are increasing now a days. Various protection and management measures are carried out against those natural hazards. It is important to explore all the various coastal threats so that coastal managers can take proper mitigation measures. This study is focused on the major challenges and vulnerabilities at some coasts of the world, such as Japan, Netherlands, Vietnam, Sri Lanka and Bangladesh which are greatly affected by the tsunami, storm surge, erosion, cyclone, salinity etc. Management activities to mitigate the challenges by the coastal authorities of those countries have also been investigated. Details of challenges and management of Bangladesh coastal zone have been assessed. Finally some recommendations have been made of the management of the Bangladesh coastal zone.

Keywords: Coastal zone; challenges; vulnerabilities; management

INTRODUCTION
The world coastline extends over 350,000- 1,000,000 km. Within its extent, the coastal ocean and the immediately landward region of the coastal zone displays a wide diversity of geomorphologic types and ecosystems. Overall 38% of the world's population lives within 100 km of the coast or estuaries, and 44% live within 150 km of the coast. The Japanese archipelago consists of almost 4000 islands with a combined coastline of more than 34,000 kilometers (Organization for Economic Cooperation and Development ((OECD) 2002: 136). With a coastline of 3,260 kilometers, excluding islands, Vietnam claims 12 nautical miles (22.2 km; 13.8 mi) as the limit of its territorial waters .Coastline of Sri Lanka is 1,340 km long. Bangladesh has a coastline of approximately 710 km. The objective of the study is to (i) to assess the physical characteristics, resources, challenges and management of coastal zone of Japan, Sri Lanka, Vietnam and Netherlands and Bangladesh, (ii) to recommend the management activities to be improved for Bangladesh coast in light of the study done under objective no.(i).

METHODOLOGY
This study is mainly based on secondary data and published papers the coastal management issues of Japan, Netherland, Sri Lanka, Vietnam and Bangladesh regarding. The threats, challenges and management activities of the coasts of above mentioned countries are thoroughly studied and analysis was done. Secondary data of storm surge, tsunami, sea level rise, erosion on various coasts are used for analysis. This study can help to compare and relate the threats for various coast and their mitigation measures.

Analysis and Results
Japan Coast
Japan is prone to seaborne natural disasters such as typhoon-induced flooding, high waves, tsunamis etc. In addition, Japan’s coastline is prone to erosion**.** The map of Japan is presented in Figure 1. Most of Japan is threatened by flooding and high waves during the typhoon season around September. In addition, the country’s side facing the Sea of Japan is buffeted by strong winds and rough season the

winter. Storm conditions combined with high tides can cause especially severe damage. High tides in the three major bays of Tokyo, Ise, and Osaka, as well as in the Ariake Straits, can be amplified by storm winds. The worst recorded typhoon-induced damaged was experienced in the Ise Bay Typhoon of 1959 which caused a high tide deflection of 3.4 meters and resulted in more than 5000 deaths and damage to almost one million buildings. Damage caused by flooding has diminished in recent years, but it is unclear whether this is a result of efforts to protect the coastline, or the lack of severe typhoons in recent years. The number of storm surges and its associated death are presented in Figure 6 and Figure 7. Tsunamis are also a source of severe damage and loss of life in Japan. They can hit anywhere in Japan, but they are most common on the Pacific coast. In particular, high energy tsunamis are frequently experienced in the Sanriku region in the northeast part of the main island of Honshu. A 9.0 magnitude earthquake took place on 11th March 2011at the Pacific coast of Tohoku, 231 miles northeast of Tokyo, and caused a tsunami with 30-foot waves that damage several nuclear reactors in the area. The total of confirmed deaths and missing is nearly 22,000, which includes nearly 20,000 deaths from the initial earthquake and tsunami and about 2,000 from post-disaster health conditions.

While typhoon-induced floods and tsunamis cause enormous damage in a short period of time, the most serious damage to coastal areas has been wrought by slow coastal erosion over a long period of time. A wide variety of structures have been built in Japan with the express purpose of preserving coastal areas against the above-discussed problems of typhoon-flooding, tsunamis, and slow coastal erosion. The total length of the coastline in Japan is 34,536 km. Approximately one-half of this total (15,932 km) requires protection again coastal erosion. Structures have been built along about two-thirds (9382) km of this portion. In the 30-year period from 1962 to 1992 protective structures were built on about 4,248 km of coast. While it can be said that the coastline has been protected, it can also be said that the coastline is no longer natural. It is an artificial coastline. Of the protective structures, banks and seawalls were built primarily in the first 10 years of this 30-year period. In the next 10 years, construction of seawalls together with off-shore barriers dominated. In the last 10 years, the focus was primarily on off-shore barriers. This shift in emphasis was due to the fact that banks and seawalls were limited in their ability to stop the effects of rough seas. Off-shore barriers were found to be more effective in controlling rough sea sand coastal beach currents. Japan's first formal coastal zone management scheme was embodied in the Coastal Act of 1953. Its objective was the prevention of disasters. Japan has a nationwide tsunami warning system. The system usually issues the warning minutes after an Earthquake Early Warning (EEW) is issued, should there be expected waves.[5][6] The tsunami warning was issued within 3 minutes with the most serious rating on its warning scale during the 2011 Tohoku earthquake and tsunami. There is a good number of Tsunami shelter along the coastal zone of all over Japan.

Netherlands Coast

55% of the Netherland's area is situated below mean sea level with the deepest points at almost 7 m (Fig 2). Nevertheless, the country is considered safe from flooding by storm surges, coastal erosion and sea level rise. The number of storm surge is presented in Figure 8. In the northern part of the Holland coast (the Province of Noord -Holland) the erosion in the near shore zone is around 0.7×10^6 m^3/yr and in deep water 0.3×10^6 m^3/yr. At northern coastal sections sedimentation occurs around 0.9×10^6 m^3 /yr. In deep water of the southern part of the Holland coast (the Province of Zuid-Holland) erosion occurs 0.6×10^6 m^3/yr, while the near shore zone is gaining sediment 0.2×10^6 m^3/yr. Coastal erosion was estimated to occur over 134 km, spread along half of the Dutch coast. In the past, the sea level in the Netherlands rose about 20 centimeters within 100 years, also caused by the subduction of the delta systems. The rising sea level caused and causes local coastal erosion and sediment deposits in mudflats of the North Sea. Recent studies expect the sea level to rise by 20-110 centimeters by 2100, on average by 60 centimeters. The coastline of The Netherlands is 350 km long of which 290 km consists of dunes and

Fig. 1: Map of Japan

Fig. 2: Map of Netherlands

Fig. 3: Map of Sri Lanka

beach flats, while the remaining 60 km is protected by dikes, dams and storm surge barriers. The beaches and shore-face, in fact the foundation of the Dutch coastal zone, almost completely consist of sand. More than half of the coastline is subject to coastal erosion. The remaining part is stable or advancing .The Dutch coast can be divided into three sections, which can be called Delta coast, Holland coast and Wadden coast (Ruig and Hillen 1997). In the Delta area in the Southwest, the coastal zone is dominated by dams, storm surge barriers and drainage sluices, closing off the tidal inlets (technical constructions resulting from the 'Delta plan'). Behind the central part of the coastline, comprising the uninterrupted coastline of the provinces South Netherlands .The sea defense measures guarantee that a storm surge level can be withstood which has a probability of only 1/10000 a year (Ruig and Joost, 1998). Until 1990 coastal defense was directed towards maintaining the defensive structure of the coastline against the sea, and solving only the most acute erosion problems. Dunes and dikes protect parts of the Netherlands which are situated below sea-level.

Sri Lanka coast

Main coastal problem in Sri Lanka (Fig 3) are soil erosion, storm surge and tsunami. The number of storm surges and its associated death are presented in Figure 9 and Figure 10.The impacts of coastal erosion are most severe along the west and southwest coasts. It has been estimated that along the western coastal segment, extending about 685 kilometers from Kalpitiya to the Yale National Park Bay, about 175000 to 285000 square meters of coastal land are lost each year (CCD 11990). Erosion rates vary greatly between different locations, and maximum local retreat rates of around 12 meters/year have been observed in some areas between Mahaoya and Lansigama. The master plan of coastal erosion management is prepared. Structural measures such as beach nourishment, offshore break water and groins are used to minimize erosion and storm surge. Shorelines have had to be protected by the construction of revetments and in some places by groins. Tsunami shelters are built. Numerical modeling is used for warning system.

Vietnam coast

The development of industrial activities, tourism as well as urban expansion in Vietnam (Fig 4) has generally been concentrated in the coastal zone. Urbanization is likely to increase in the coastal zone in the future due to unchecked population growth and human activities (Nagothu, 2005). Main coastal problem in Vietnam are soil erosion, storm surge, tsunami and tropical cyclone. In last fifty years more than 800 storm surges hit in Vietnam. The number of storm surges and its associated death are presented in Figure 11 and Figure 12. Vietnam coast consists of approximately 5,000 km of river dykes and approximately 3,000 km of sea dykes which protect the coast from strong storm surge. The recently built dikes with a reinforced surface provide protection against most waves. These dikes are built with higher crest elevation and are less erosion prone than dikes covered with grass.

Bangladesh coast

Bangladesh has a 710 km coastline connected to Bay of Bengal (Fig 5). Coastal zone is delineated based on the tidal fluctuation, salinity and storm surge risk. Around one-third of country's total

Fig. 4: Map of Vietnam

Fig. 5 Map of Bangladesh

land area belongs to the coastal zone. Major coastal problems in Bangladesh are salinity intrusion, storm surge, erosion, drainage congestion etc. In the last fifty years more than 50 coastal cyclones hit in Bangladesh and more than 800000 people are died. Of the 508 cyclones that have originated in the Bay of Bengal in the last 100 years, 17 percent have hit Bangladesh, amounting to a severe cyclone almost once every three years (Ahamed et al, 2012). Of these, nearly 53 percent have claimed more than five thousand lives. The number of storm surges and its associated death are presented in Figure 13 and Figure 14. Bangladesh would be one of the most victim countries in the world due to global climate change induced sea level rise. A total of 123 flood control polders involving 5,107 km of embankment have been constructed covering approximating 1.5 million ha of the coastal area under the Coastal Embankment Project (CEP). The objective of the polders is to prevent inundation of floodplain agricultural land by saline water during high tide. Cyclone shelters are constructed to provide refuge to the exposed population during storm floods and also intended for multi-purpose use as school and community center. The National Water Management Plan (NWMP) proposes 775 multi-purpose shelters for 1.72 million people and 1,369 killas (raised earth mounds) for livestock over the next 15 years. The Cyclone Preparedness Programme (CPP) is a collaborative effort of the Ministry of Food and Disaster Management and the Bangladesh Red Crescent Society. It is one of the most successful initiatives in early warning in the South-East Asian region, internationally recognized as a “standard of excellence” with a dedicated team of community volunteers living in coastal and offshore island villages. The CPP covers 11 districts in the coastal areas. Volunteers have been trained to play a crucial role in the dissemination of cyclone warnings, evacuation, rescue, first aid, emergency relief and in the usage of radio communication equipment. CPP’s 27,600 male and 5,520 female volunteers are the first line of an early warning system to the members of their communities. As an operational wing of the government’s disaster management bureau, the CPP provides scheduled daily weather reports via an extensive high frequency (HF) radio transmitting system operated by volunteers throughout the coastal region of Bangladesh. In addition, government has constructed about 2,400 cyclone and flood shelters along its coastal belt. There is still a requirement to construct a further 1,500 shelters to serve 3.56 million people residing in the high risk coasts. Government has also initiated a complimentary disaster preparedness programme to promote community participation in the construction and maintenance of cyclone shelters. Presently, Bangladesh is working on developing a Tsunami Preparedness Programme as an extension to the Cyclone Preparedness Programme.

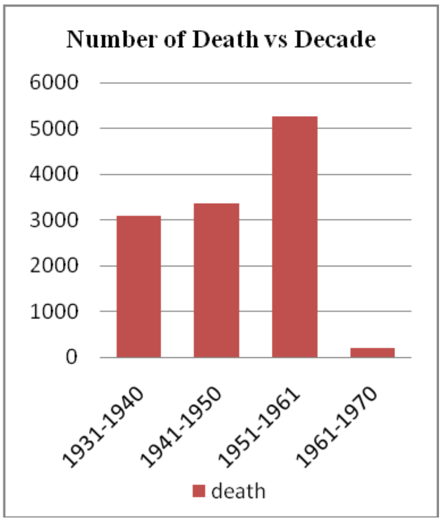

Fig. 6: No. of death due to Strom in Japan

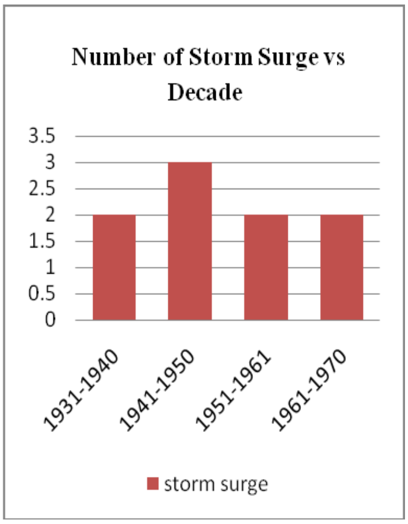

Fig. 7: No. of storm surges in Japan

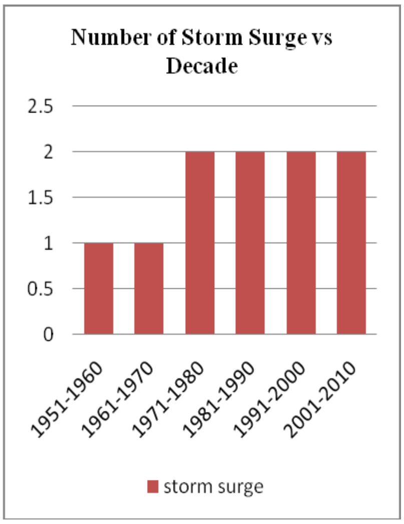

Fig. 8: No. of storm surges in Netherlands

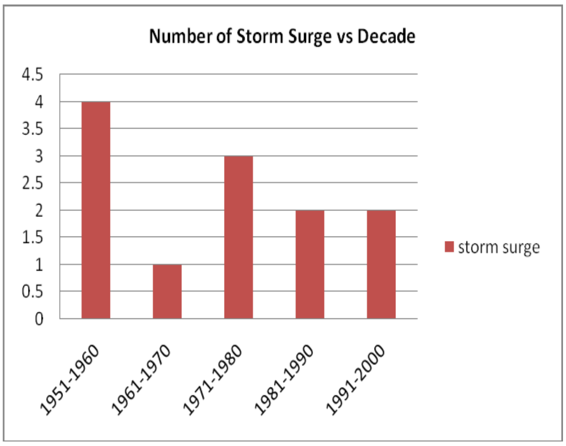

Fig. 9: Number of Storm Surges in Srilanka

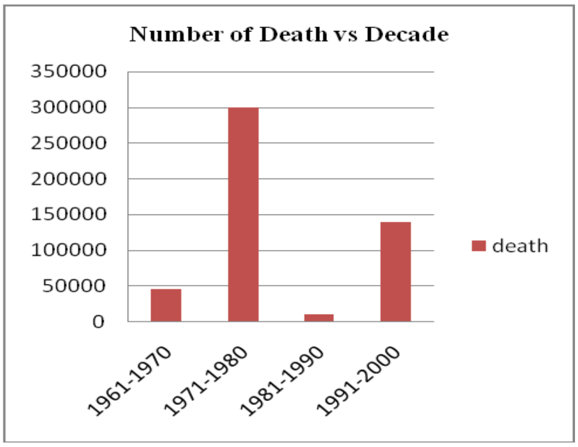

Fig. 10: Number of death due to Storm Surges

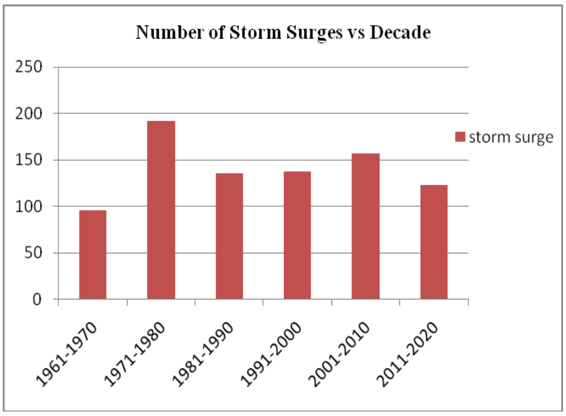

Fig. 11: Number of storm surge in Vietnam

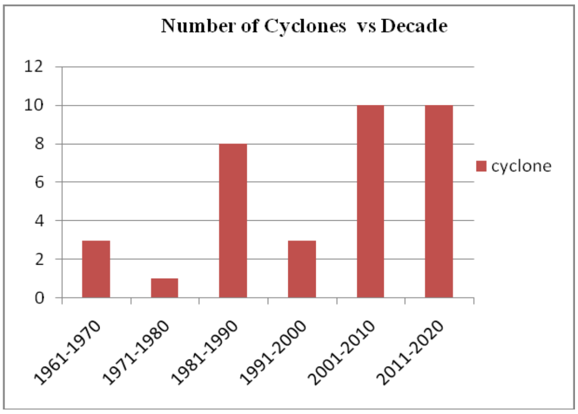

Fig. 12: Number of cyclones in Vietnam

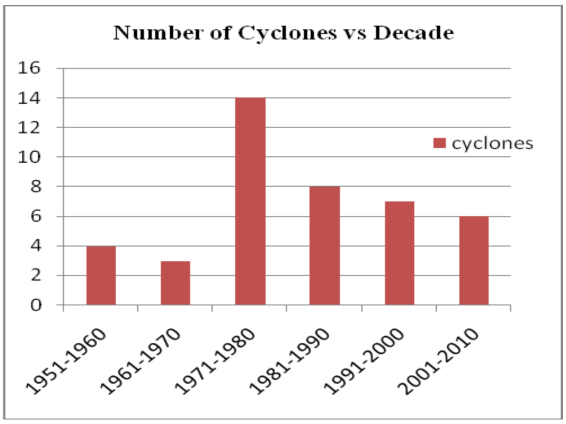

Fig. 13: Number of cyclones in Bangladesh

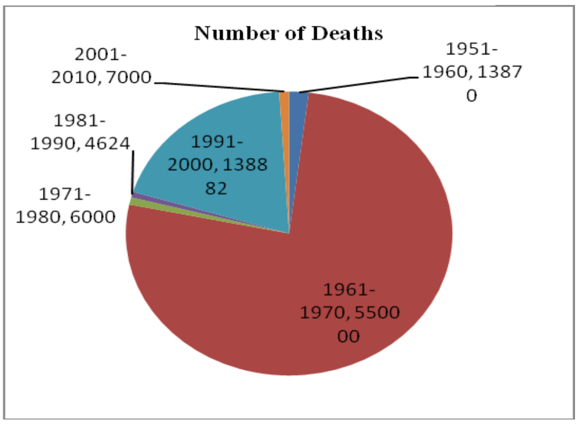

Fig. 14: No. of death due to cyclones in Bangladesh

CONCLUSIONS

Cyclone induced storm surge, tsunami, erosion, sea level rise and salinity intrusion are the major threats along the coastal zone all over the world. Countries like Japan, Netherlands, Vietnam and Sri Lanka are managing the coastal problems through both structural and non-structural measures. Structural measures include hard protection like coastal revetment, sea wall, tsunami wall, breakwater, beach nourishment etc. While non-structural measures include storm surge/tsunami warning system, storm surge/tsunami shelters, evacuation of the people at risk during disaster etc. Integrated Coastal Zone Management (ICZM) plan is being implemented in managing the coastal challenges. The coastal zone of Bangladesh is vulnerable to coastal flooding, salinity intrusion, storm surge, coastal erosion and sea level rise. Over one hundred polders consists of more than five thousand km long embankment have been constructed to obstruct the saline water intrusion during high tides. It also saves the poldered area during the low height storm surges. Storm surge warning system has been developed and cyclone shelters have been constructed along the coastal belt of Bangladesh. A project is now being conducted to study the strengthening the embankment and increasing their height named CEIP (Coastal Embankment Improvement Project). ICZMP has been prepared and some of implementation has been started. However, salinity intrusion and drainage congestion and erosion are major challenges for the managing authorities.

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