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RISK ASSESSMENT AND DISASTER MANAGEMENT PLANNING FOR FISHING HARBOURS IN COASTAL INDIA

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Abstract: *Development activities in the coastal areas are generally prone to various risks which may trigger from water, climate, geology and geomorphology related calamities. The diurnal sea level changes and the volatile coastal processes make engineering interventions all the more challenging. The extent of risks may vary from region to region in which anthropogenic activities also have a considerable contribution. Climate related natural calamities can be caused from cyclone, storm, flood, tornado / hurricane, cloud bursts, thunder and lightning, heat wave as well as drought. Geology / geomorphology related calamities or hazards can be in the form of earthquake and tsunami. In addition, accident related disasters from fire, oil spills, etc, can also occur both during the construction as well as operation phases which can cause serious disruption in normal activities. It thus becomes very important to identify the type, pattern and the potential severity of the hazards which can cause loss of life, damage to property and environment. Assessment of the vulnerability and risks emanating from such activities becomes a key factor in engineering planning and designing of fishing harbour infrastructure after careful study of the local hydro-geological, geomorphological and environmental factors for ensuring creation of sustainable assets as well as for outlining an appropriate response mechanism.*

Keywords: *disaster risk reduction; vulnerability; hazards and disaster agents; UNISDR; Hyogo Framework for Action; Mitigation*

INTRODUCTION

Development activities in the coastal areas are generally prone to various risks which may trigger from water, climate, geology and geomorphology related calamities. Ports and harbours are vulnerable to natural calamities and inadequacies in design in any of the harbor components are likely to accentuate the vulnerability of the area to disasters which may result in loss of life and property, livelihoods as well as the eco systems. The extent of risks may vary from region to region in which anthropogenic activities also have a considerable contribution. The growing concern on climate change and its impact on development projects needs to be evaluated in the perspective of the project. In general climate change is a change in the statistical distribution of weather over a period of time that range from decades to million of years. With the predicted impacts of climate change viz. sea level rise leading to impacts, inter-alia, on hydrology and coastal ecosystems, the vulnerability of the coastal regions becomes undeniable. Contemporary research findings indicate that uncontrolled emission of carbon dioxide will result in increased

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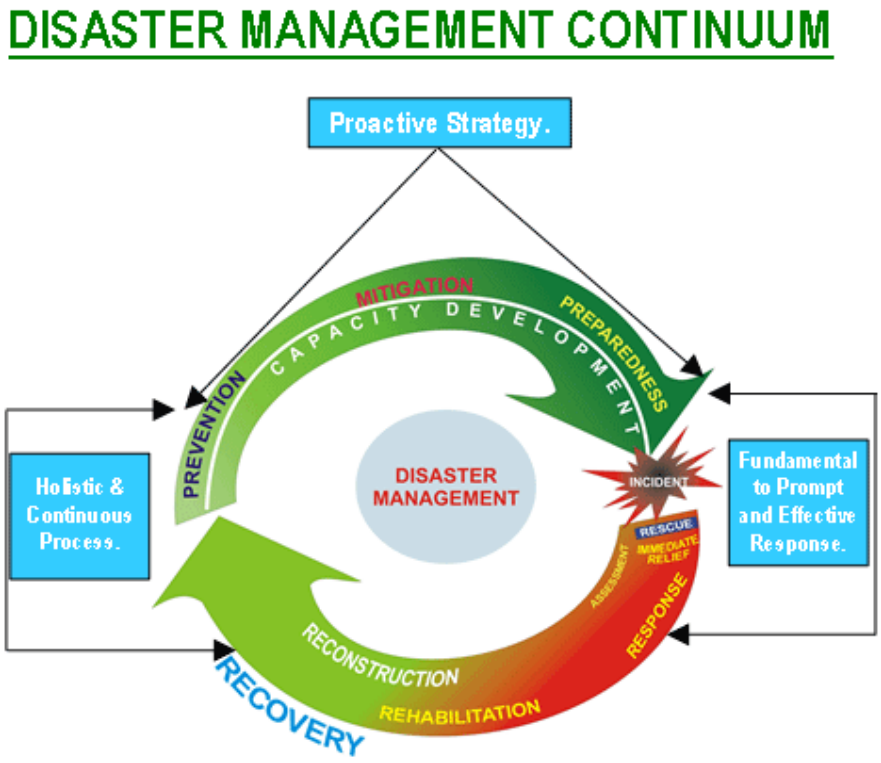
global warming the consequences of which along with the ongoing process of acidification will have severe implications for the world's oceans. The marine environment is now veritably under siege from anthropogenic interventions with no exception to the Indian coasts. The coastal regions in general are increasingly being relegated to a vulnerable matrix of socio-economic and environmental instability. The diurnal sea level changes and the volatile coastal processes make engineering interventions all the more challenging.

HAZARDS AND DISASTER AGENTS

Coastal areas in general are prone to water, climate, geology and geomorphology related calamities. Water / climate related natural calamities in general can be in the form of cyclone, storm, flood, tornado / hurricane, cloud bursts, thunder and lightning, heat wave and drought. Geology / geomorphology related hazards can be in the form of earthquake, landslide, subsidence tsunami, etc. In addition, there can be accident related hazards viz. from fire, oil spills and chemical induced and vehicular / operational accidents. Secondary hazards like epidemics can also cause serious disruption in normal activities. The recent years have left innumerable warning signals for improved management of natural hazards and the reduction of disaster risks. The Indian Ocean tsunami of December 2004 which claimed over 2,50,000 lives with severe devastation in India, the persistent droughts in Africa, hurricanes in Central America and the United States, heat waves and fires in Europe, landslides triggered by typhoons in South East Asia as also the earthquakes in China, Pakistan, India and Indonesia all indicate the vulnerability of the coastal areas. It thus becomes imperative to identify the type and the potential hazards which can lead to disasters resulting in loss of life, damage to property and environment. Natural disasters cannot be prevented but losses / damages to life and property can be minimized / prevented through Disaster Risk Reduction (DRR) strategies. DRR aims at building safe communities through disaster prevention, mitigation and preparedness measures. Mitigation methods and preparedness contribute largely in reducing risks and related impacts. It is now recognized that disasters are intimately linked with sustainable development and that sustainable development and DRR are mutually supportive goals. Unless sustainable development practices are adopted, risks from disasters will continue and vulnerability of communities will increase. It thus becomes imperative to assess and manage the potential risks and encourage sustainable development practices along with an appropriate disaster response mechanism. The Ministry of Environment and Forests (MoEF), Government of India constituted a Committee in 2004 headed by M.S. Swaminathan to review the existing CRZ regime. The Committee's report recommended seven parameters for mapping vulnerability of the Indian coasts viz. elevation, geology, geomorphology, sea level trends, tidal ranges, horizontal shoreline displacement (erosion / accretion) and wave heights. Till recently, the approach to Disaster Management has been reactive and relief centric. A paradigm shift has now taken place at the national level from the relief centric approach to holistic and integrated approach with emphasis on prevention, mitigation and preparedness. A typical Disaster Management continuum as shown below, comprising of six elements i.e., Prevention, Mitigation and Preparedness in pre-disaster phase, and Response, Rehabilitation and Reconstruction in post-disaster phase, defines the complete approach to Disaster Management.(*Source NDMA*)



.(*Source: NDMA website*)

DISASTER MANAGEMENT, UNISDR AND HYOGO FRAMEWORK

Disaster is defined as aserious disruption of the functioning of a community or a society causing widespread human, material, economic or environmental losses which exceed the ability of the affected community or society to cope using its own resources. A disaster isa function of the risk process. It results from the combination of hazards, conditions of vulnerability and insufficient capacity or measures to reduce the potential negative consequences of risk. *(Source: UN/ISDR Terminology).* Disaster risk reductionrefers to the conceptual framework of elements considered with the possibilities to minimize vulnerabilities and disaster risks throughout a society, to avoid (prevention) or to limit (mitigation and preparedness) the adverse impacts of hazards, within the broad context of sustainable development. *(Source: UN/ISDR Terminology).*The United Nations International Strategy for Disaster Reduction (UNISDR) Secretariat was established by General Assembly Resolution inthe year 2000. Theobjective ofthe set up is to serve as the focal point in the United Nations system for the coordination of disaster reduction and to ensure synergies among the disaster-reduction activities of theUnited Nations system and regional organizations and activities in socio-economic and humanitarian fields. With a view to making the world safer from natural hazards, 168 Governments adopted a Ten- Year Plan at the World Conference on Disaster Reduction, held in Kobe, Hyogo , Japan in January 2005. The Hyogo Framework for Action (HFA) is a global blueprin t for disaster risk reduction efforts to substantially r educe

disaster losses by 2015. Disaster losses include lives as well as social, economic, and environmental assets of communities and countries. HFA provides the guiding principles, priorities for action as well as practical means for achieving disaster resilience for vulnerable communities. As disasters undermine development achievements and impoverish people and nations the HFA indentifies disaster risk reduction as thecentral issue for development policies, in addition to being of interest to various science, humanitarian and environmental disciplines. It is considered that without serious efforts to address disaster losses, disasters will become an increasingly serious obstacle to the achievement of the Millennium Development Goals (MDG).Under the HFA natural disasters / disaster agents were categorized into three specific groups viz.

1. **Hydro-meteorological Disasters :** Includes floods and wave surges, storms, droughts and related disasters (extreme temperatures, forest/scrub fires), landslides and avalanches;
2. **Geophysical Disasters :** Includes earthquakes, tsunamis and volcanic eruptions;
3. **Biological Disasters:** Includes epidemics and insect infestations.

The HFA identifies five specific Priorities for Action viz.
1. Making disaster risk reduction a priority.
2. Improving risk information and early warning.
3. Building a culture of safety and resilience.
4. Reducing the risks in key sectors.
5.Strengthening preparedness for response.

PLANNING PERSPECTIVE FOR FISHING HARBOURS

From the planning perspective of fishing harbours in coastal India it becomes very important to identify the type, pattern and the potential severity of the hazards which can cause loss of life, damage to property and environment. Assessment of the vulnerability and risks emanating from such activities becomes a key factor in engineering planning and designing of fishing harbour infrastructure after careful study of the local hydro-geological, geomorphological and environmental factors for ensuring creation of sustainable assets as well as for outlining an appropriate response mechanism. Apart from the coastal regions in mainland India the disaster risk reduction strategy for Andaman and Nicobar (A&N) islands needs added emphasis due to its vulnerability from the seismic angle. Located at 92^{o} 94^{o} East longitude and 6^{o} 14^{o} North latitude in the south eastern Bay of Bengal, the A&N Islands comprise 572 islands, islets, reefs and exposed rocks which form a part of the broken chain of islands extending from Myanmar in the north to the Indonesian group of islands in the southeast. The coastline stretching upto 1912 km. is almost one-fourth of the entire coastline (8041 km.) of India. The Exclusive Economic Zone (EEZ) surrounding the islands cover an area of about 6.00 lakh sq. km which is about 30 per cent of the country's total EEZ. The islands are endowed with a continental shelf of about 35,000 sq. km out of the total 5,00,000 sq. km for the country.
The islands' vulnerability is greater due to the following factors.

i) Water locked, isolated and dispersed islands
ii) Vast coastline
iii) Distance from mainland.

iv) Situated on seismic zone.
v) Near eye location of cyclones
vi) Fragile ecosystems

Earthquake a potent Geo-physical Disaster

Earthquake is one of the natural disasters that gravely threatens the lives and economic well-being of affected population. The A&N islands fall under the highest Seismic Hazard Class (Zone –V) of the Seismic Zoning Map of India. Since these islands fall in between active and passive plate margins the impact of earthquake is larger and an average earthquake of above 4 numbers of Richter Scale occur once in four to five months. Further, change in the ecosystems and environmental degradation due to earthquake is a potential hazard. The impact of earthquake along the coastline is likely to increase the secondary impact of shoring tides of the sea which may cause significant damages in the form of flash floods. The history of the islands suggest that there were incidents of mega earthquake since December 1881 (NNW of the Andaman Islands, Mw 7.9). In 1941 a mega earthquake (Mw 7.7) and a tsunami occurred in the Bay of Bengal. The height of the tsunami waves was of the order of 0.75 to 1.25 m. In the recent past the earthquake of December 26$^{th.}$, 2004 with epicenter off the Sumatra coast is the largest to have occurred in the Andaman –Sumatra Subduction Zone.

Potential Impacts

Potential impacts of earthquake may be massive involving huge loss of human life and livestock, personal properties e.g. dwelling houses, personal belongings, crops and plantations, land, etc. Loss of public properties may include buildings, structures and installations, bridges, roads, power stations and transmission systems, water supply pipelines and water reservoirs, water storages, sewer lines, underground cables, communication lines and miscellaneous utilities. Damages to the environment may be caused by landslide and land subsidence, loss of vegetative cover due to soil erosion and siltation (due to flash flood owing to shoring tides), alteration in river / creek course and stream flows and natural landscape, liquefaction, etc. Socio-economic impacts of earthquakes like loss of habitation and livelihood can be very serious and long-term and can make the affected population '*environmental refugees'*. Moreover, disruption of the social structure including social order and organizations, law and order problem and psychological effects such as individual trauma and depression are also the consequential impacts of earthquake. There can also be secondary effects like fire, rains and landslides.

PLANNING APPROACH

One of the primary questions which require addressing while implementing a project is -whether the project involves creation / modification of structural / engineering assets including land reclamation or changes to existing land use plans. If yes then the costs involved in the prevention and mitigation of disasters (natural and man made) are to be internalized within the project cost. From the point of disaster risk reduction the issues for setting up a fishing harbor project are - location of the project, reasons for site selection, whether alternatives have been considered, whether the type of activities are in conformity with the relevant provisions of NDMA guidelines. The design and engineering of the structure should take into consideration the

National Building Code 2005, the appropriate BIS Codes and NDMA Guidelines. In addition other relevant sources like the Central Water Commission Manual, Central Public Health Engineering Organisation Manual, Highways and Shipping Manual, etc are to be consulted. While planning and designing, the following are to carefully addressed.

a) Identification of possible risks and analysis of the likelihood and impact from earthquakes, floods, cyclones, landslides due to location of the project as well as through secondary information.
b) Adherence to local Master / Regional plan of the area, land use directives, regulations, etc. Listing of the preventive measures mentioned in the regulations which are to be complied with.
c) Planning of mitigation measures (both structural and non structural) based on prioritization of risks. To ensure that the mitigation measures themselves do not create new hazards / risks.

Natural disasters that may have impact upon the project and the physical and regulatory measures to be taken based on design and engineering/ technology so as to prevent or mitigate the effect of such disasters including possible impacts the project may have on the local environment is required to be set as the major objective criteria. A risk assessment has to be conducted which covers the following

1. Identification of different types of risks to which the project area is vulnerable
2. Probable vulnerability of the harbour components
3. Description of the risks
4. Risk analysis based on the likelihood and consequences.
5. Evaluation of risks for prioritization

Simultaneously identification will also have to be done of the local land use planning and development guidelines, legislations, building codes and building use regulations. Risk treatment (engineering and non-engineering) based on the objective criteria will have to be identified and prioritized and included in the project cost. A check list is to be prepared which should be part of the Detailed Project Report (DPR) with indicative information as follows.

a) Siting of the Project
b) Location, detailed coordinates, elevation (above msl)
c) Earthquake Zonation
d) Flood proneness and vulnerability
e) Cyclone proneness and vulnerability
f) Landslide proneness and vulnerability
g) Tsunami proneness vulnerability
h) Existence of dams / barrages upstream

The following hazards / risks to the project are required to be evaluated

1. Probability of occurrence of flood, earthquake, tsunami, cyclone, land slide, mud flows, etc
2. Probable maximum seismicity at site
3. Site dependent seismic design parameters
4. Probable maximum storm surge
5. Probable maximum wind speed
6. Probable maximum rainfall
7. Probable maximum flood discharge and level
8. Soil liquefaction proneness under probable earthquake intensity

MITIGATION AND RISK REDUCTION

The following indicative codes / guidelines for safety of buildings and structures from natural hazards are relevant for consideration while planning for a fishing harbor in coastal India.

i) For general structural safety
ii) Protection from cyclones / wind storms
iii) Protection from earthquake
iv) Flood Management
v) Landslide Hazard
vi) Protection of saline embankments and coastal canals

Finally, during the construction and operation phases it has to be seen whether the safeguards have been adopted as well as the impacts of the project on the local population and environment studied and appropriate mitigation measures adopted.

INTEGRATING DRR INTO PROJECT MANAGEMENT

Assessment of the vulnerability and risks lead to integrating DRR into the planning and designing of fishing harbours after careful study of the local hydro-geological, geo morphological and environmental factors for ensuring creation of sustainable assets as well as for outlining an appropriate response mechanism. A generic set of recommendations which are to be adopted as part of the DRR in fishing harbours in coastal India are summarised below.

- Provision of Tsunami Rescue tower (as per guidelines of National Disaster Management Division under the Ministry of Home Affairs, New Delhi)
  - It is a proven means of preparedness as vulnerable people can be evacuated immediately after tsunami/ cyclone warning
  - It is a livable structure (3.5 m high) on 4.5 m high stilts
  - For evacuation of 600 people 1850 sq ft of floor area may be provided (3 sq ft per person)
  - For better upkeep and maintenance multiple use capability is provided. A school of 200 students (7 sq ft / student) may be run in the centre.
- Provision of Communication and Alert Room
  - To facilitate shore-to-boat and boat-to-shore communication to guide emergency assistance in case of distress call from fishing boats in far off sea

- VHF and other instruments are housed in theroom to provide round the clock service and two way communication to fishing boats
- Fishing boats are to be equipped with VHF sets and GPS
- Advising boat operators not to venture into sea during inclement weather

- Navigational Aids
  - Lighted tower easily distinguishable at night provided in harbor for safe navigability of fishing boats approaching the harbor
  - Harbour channels tobe provided with lighted buoys / beacons for safe entry/ exit to / from the habour
  - Entrance as well as the nose of the break waters (wherever applicable) to be provided with lighted buoys/ beacons
- Fire Fighting Equipments

  Required fire fighting inst ruments and fire hose to be located at strategic locations inside the harbour premises
- Alertness during construction particularly of heavy structures like breakwaters and diaphragm walls
- Design considerations as perlatest codal provisions regarding grade of concrete and stability in consideration to seismic and wind factors
- Proper model studies for alignment and design of quays, breakwaters and tranquility conditions inside the harbor basin.
- Emphasis on regular aw areness campaigns and com munity / stakeholder participation.
- Area Hazard Map to be displayed at prominent locations in and around the fishing harbor and fishing villages
- Setting up of a Disaster Management Com mittee / Task Force from am ong the stakeholders with specified role functions
- Close coordination with Dist rict Disaster Management Authority / Block office / Tehsildar / Patwari, as the case may be.

CONCLUSION

In a broader way, coastal environment constitutes near shore, terrestrial, inter-tidal, benthic and pelagic components. Coastal ecos ystems assume unique characteristics as the reg ions are the interface of land and water which create distinct structure, diversity and flow of energy and are closely linked with social system s. The area provides a large num ber of resources e.g food, fodder, fuel, medicine, etc for sustenance of the local population which are collectively known as ecosystem services. Un derstanding the ecosystem services thus forms an im portant factor in development activities in coastal zones and integrating DRR into project management constitutes the bedrock for sustainable development. Stakeholder participation and community based DRR approach constitute the spokes in the overall development planning.