

Section E2

Coastal Engineering: Reconstruction – Management and Mitigation



Objectives

- To familiarize the assessor with the process that should be followed in organizing any reconstruction efforts.
- To emphasize the importance of accessing a proper database during the reconstruction process, and of using appropriate design criteria.
- To outline the necessity for post construction efforts, which should include proper monitoring and maintenance.
- To reduce vulnerability of the affected country or area.



Introduction

In developing reconstruction strategies for coastal type infrastructure, it is beneficial to go through a system of steps, which aid the collection and analysis of data that may be critical to the development of the reconstruction efforts. This section outlines a number of Management Requirements that recommend a process to be followed in preparing reconstruction strategies for coastal infrastructure.

In addition, a number of Mitigation Strategies are suggested, which address the areas of monitoring and mitigation. These are areas that have been traditionally neglected in the development of infrastructure, in general, and coastal infrastructure in particular. This aspect of the design cycle is of particular importance for coastal infrastructure, since it is a typically harsh environment, and one that is subject to wear and tear on an ongoing basis.

Following are the recommended strategies for management of disaster impacts and for mitigation of future impacts.

Management Requirement 1 **[Understanding the cause of the disaster]**

In the design of reconstruction works for coastal infrastructure, it is first necessary to understand the cause of the disaster. To aid the development of such understanding, the following steps/procedures are recommended:

- The National Hurricane Centre maintains a database of storms, which dates back to 1876. This database may be accessed at their website, <http://www.nhc.noaa.gov/>. The records are more reliable for the latter half of the past century (i.e. since 1950) as data collection techniques have improved since that time. More recently, with the ability for “hurricane hunters” to fly into the eye of the storm, and with the advent of satellite technology, records have become even more accurate and detailed.
- The collection of rainfall records. These should ideally cover as long a period as possible and, if available, records from an extreme event should be collected, as these may likely act as the design event.



- Proper hindcasting of hurricane waves should then be carried out using information from the hurricane wind field and applying this data to a wave hindcast program.
- The transformation of the hurricane wave climate from deep water to the nearshore zones is the next step in the process, as it is the nearshore waves that are most frequently used in the reconstruction design process.
- Finally, extremal analysis of the hindcast wave climate or rainfall records should be carried out, so that design conditions can be extracted. [What return period should be used for design? 50 year or 100 year, and what part does climate change play in the development of a design criterion?]

Management Requirement 2 **[What can be affected by the disaster]**

This step requires proper mapping of the coastal/river infrastructure, which in turn calls for knowledge of the following:

- Locations, physical extents and condition of coastal and river infrastructure;
- Extent of coastal communities, population, location of critical infrastructure, degree of vulnerability of these communities. Note that assessment of vulnerability should take into account the ability of the community to mobilize during an emergency situation, which will rely to some extent on the presence of an appropriate road network;
- Representation of this data on digital mapping is desirable, or at the very least, on 1:2500 scale mapping;
- Definition of coastal infrastructure such as roads, bridges, housing, etc., should be documented.

Following the completion of this step, a good knowledge of the characteristics of the vulnerable areas can be obtained. This documentation can go in tandem with the data collection exercises from other sector investigations.



Management Requirement 3 **[How damages are effected]**

Proper understanding of how a disaster is manifested within a community requires a sound knowledge of the processes that can result in damage to coastal shorelines or to river infrastructure. Some of the items that must be considered include:

- Beach characteristics (presence of sand dunes, backshore vegetation, slope of beach face); seabed bathymetry (slope of nearshore areas, presence of offshore bars).
- Knowledge of benthic substrates in the relevant nearshore areas (seagrass beds, coral reefs).
- Nearshore wave climates for design (i.e. from hurricane events) and perhaps also day-to-day conditions (Trade Wind generated sea and also swell from extra-tropical events).
- Knowledge of tidal fluctuations, global sea level rise and storm surge estimates.
- Effect of existing and proposed sea defences on shoreline processes.
- River hydrology and hydraulics.

Mitigation Strategy and Data Requirements **[Implementing protection against disasters]**

One of the first steps in mitigating against future disasters, which should be used in the reconstruction efforts, will be the design and construction of coastal defence or river training works. The data requirements and steps for this include:

- Topographic and bathymetric surveys (typically, these may be obtained from admiralty charts, or a surveying team may have to be commissioned);
- Preliminary engineering design of shore protection or river training works (steps here should include concept development, site understanding, and recommended options);



- Preliminary costing of the developed works should then be carried out (examples of construction costs from similar works either in the affected country or in the adjacent region, may be used to aid the costing process). Where a number of alternatives have been developed, a benefit and cost analysis should be carried out to indicate the most cost effective way of achieving the desired mitigation strategies;
- An EIA for the proposed works should then be carried out. This EIA may be done on the preliminary designs, so that the Final Design benefits from the EIA process (it is recommended that the designer/EIA expert develop terms of reference, which should be approved by the appropriate regulatory agencies);
- Selection of the preferred option can then be carried out in consultation with the relevant stakeholders;
- Final designs of the works are then implemented (these must be designed to withstand anticipated impacts).

Protection against disasters may also take the form of building setbacks, emergency relief planning initiatives, improvements to the building code, or preparation of a Coastal Zone Management Plan (CZMP). This process, however, requires:

- A sound knowledge of the areas that are most at risk. This information may be obtained from the collected socio-economic data;
- Some knowledge of the population and infrastructure within the risk area. This may be obtained through the undertaking of a vulnerability assessment;
- The identification of safe shelters (emergency response planning requires that shelters be in safe locations, and should be sited such that access to and egress from these shelters is assured even for example in a Category IV or V hurricane);
- That a proper evacuation plan be developed for areas or communities that have been identified as being at risk (this is a function that is best handled at the level of disaster management planning);
- Improvements to the building codes (the code that is used throughout the region is CUBIC, the Caribbean Unified Building Code. In addition, other codes from the USA or UK may be referred to as deemed to be appropriate);
- Development of a CZMP should be carried out. This is a very useful tool that can be successfully employed in the reduction of vulnerability. Essentially, a CZMP can be used to identify the areas most at risk, and through this, the appropriate response strategies.



Mitigation Strategies: Ensuring longevity of sea defense investments

Ensuring that the reconstruction works are properly maintained over the anticipated life of the structure will require proper maintenance of coastal or river defence works. Issues that must be considered here include:

- Monitoring of any shoreline movement or change on a regular basis (this may be achieved through a programme of beach profile monitoring that should be carried out on a regular basis, such as quarterly);
- Evaluation of the effectiveness of sea defence or river training works;
- Estimation of the residual life left in the structure or works; and of the need to do repairs to those works;
- Evaluation of the long-term impacts, if any, on the adjacent shoreline, and the need to modify the works so as to minimize any identified impacts.
- The need to incorporate post-event monitoring of the reconstruction works, or of any implemented mitigation strategies.

Actions at the National and Community Levels

Several actions may be carried out at the national and community levels that can assist the reconstruction and mitigation process. These include:

- The development of proper mapping of coastal resources within a GIS type of database.
- Use of the hazard and vulnerability data to develop an informed emergency management plan.
- Use of hazard and vulnerability data to inform the physical planning process, for example to restrict development in zones that have been identified as being at risk.
- Use of a community network to inform the most effective mitigation and/or reconstruction approaches.



Example

Following a hurricane event, a section of coastal road has been damaged to the point where reconstruction of this road is now required. As the expert responsible for the implementation of this infrastructure, describe how you would carry out the following tasks.

1. What are the studies and/or data requirements that you would call for at the start of the reconstruction process.
2. What steps should be followed in implementing the process.
3. What post-construction monitoring and/or evaluation should be carried out.
4. What steps would you take to ensure the longevity of the reconstructed works.

Self Assessment

By this stage you should be able to evaluate the necessary steps required to evaluate, design, implement and monitor the reconstruction works that would be needed following a disaster.

