CHAPTER 5

STRUCTURAL AND NON STRUCTURAL MITIGATION FOR CYCLONES

STRUCTURAL MEASURES

5.1. Introduction

5.1.1 Having studied the two major cyclones in Odisha in 1999 and 2013, it has been seen that a good early warning system and preparedness is very important to reduce the loss to life and property. Every disaster takes the nation and the region in particular a step backwards in progress. Severe cyclones not only wreak colossal damage to temporary structures such as thatched roofs, tiled houses, mud wall houses etc., but also cause heavy damage to semi-engineered buildings such as schools, workshops and factory buildings, etc., and well-engineered structures including communications, transmission and windmill towers. An important aspect of cyclone risk reduction is to ensure availability of adequate numbers of shelters, community centers/school buildings, places of worship, etc., which can be utilised for moving people from vulnerable areas to safety. Besides this, the structural safety of various lifeline infrastructure such as roads/culverts/bridges, communication and transmission towers, power houses, water towers and hospitals will be ensured, so that the communication system at all levels remains useable, the electricity and water supply systems do not break down and adequate medical attention is possible. Care taken in strengthening various structures during construction and also effort to strengthen existing structures can be very effective in reducing the damage. The Mitigation Strategies could be:-

(a) Proper infrastructure development for providing accurate and prompt cyclone warning.

(b) Design and construction of robust buildings, roads, bridges and other infrastructure besides "Cyclone proof" shelters, which have storage and sleeping areas high off the ground and use water-resistant materials. (c) Measures to control the hazard in advance, such as, seawalls, diversion drains, coastal shelterbelts, protection and promotion of natural sea side vegetation (mangrove) etc.

(c) Land use planning, which "builds in" a distance between the hazard and the community.

(d) Management of Delta Zones.

(e) Contingency Plans at all levels (community, government and civil society), which include disaster mitigation strategies.

(f) Awareness and Educational campaigns that provide advice to the community on cyclone preparedness as well as mitigations measures.

(g) Develop healthy partnerships between stakeholders at all levels -especially government, private sector and the community to achieve sustainable mitigation strategies.[29]

5.1.2 National Disaster Management Guidelines for Cyclones (2008), states safe shelters help protect human life at the time of cyclones. Many cyclone shelters constructed earlier were not connected by all-weather roads with nearby habitats from where affected people need to be shifted during emergency evacuation. The distance a person has to travel to reach a shelter should not be much. Existing road network and provide at least one link road, in all weather conditions, for each village, that is accessible during cyclone or flooding periods as well. Failure of well-engineered structures such as communication and transmission towers during past cyclones brings the importance of the care to be taken while designing such structures. Indian Codes and Standards, such as

[29] http://www.answers.com/Q/What_are_mitigation_strategies_for_cyclones

IS:875-1987 (part.-3), IS:456- 2000, IS800-1984, the National Building Code, among others, which detail out the requirement for the design and construction of structures, taking into account wind loads as well. Indian Road Congress (IRC) specifications which cover roads/culverts/bridges can become guidelines for designing roads.

5.2 Cyclone Shelter

5.2.1 To achieve the motto of minimum loss of life, it is important to have an adequate number of safe shelters which can withstand the fury of cyclones, including wind, rain and storm surge. Circular cyclone shelters were initially constructed but they deteriorated very soon due to lack of proper usage and maintenance. While most of them have been dismantled, others that remained are in a dilapidated condition, unfit for use. Now the concept of multi-purpose cyclone shelters has come into vogue. Schools, places of worship, community halls, etc can be used as a shelter as was seen in cyclone Phailin where PM School, Ganjam was used as a cyclone shelter. A list of all such available buildings is generally maintained by the district administration. However, with more multi-purpose cyclone shelters being constructed, the relief operations can get streamlined.

5.2.2 An assessment of the total requirement of cyclone shelters has to be made by all the states/UTs. Existing shelters need to be factored in. The factors that need to be considered are:-

(a) Vulnerability of the area.

(b) Percentage of the total number of people in a habitation/village that would have to be evacuated after taking into consideration the

available and planned buildings like schools, places of worship, community halls, etc.

(c) Communication requirements.

(d) Identification of sites Coastal villages/habitations prone to frequent cyclone impact that do not have any suitable safe shelters will identify and reserve a suitable place to construct cyclone shelters, even if the actual construction is taken up at a later stage.

5.2.3 Design Considerations of Structures

Buildings, shelters and lifeline structures will be designed on the basis of existing codes and standards. The material and design specifications and their criteria will be such that minimum maintenance is needed and the structures can withstand adverse weather conditions.

5.2.3.1 Design considerations for Buildings

(a) The design to be carried out for 1.3 times the basic wind speed as recommended in the IS 875 - 1987 part 3.

(b) The design will also be able to withstand seismic forces in regions which are additionally vulnerable to earthquake hazard.

(c) Urban Local Bodies (ULBs) and Panchayati Raj Institutions (PRIs) will be asked to ensure houses which will be cyclone resistant.

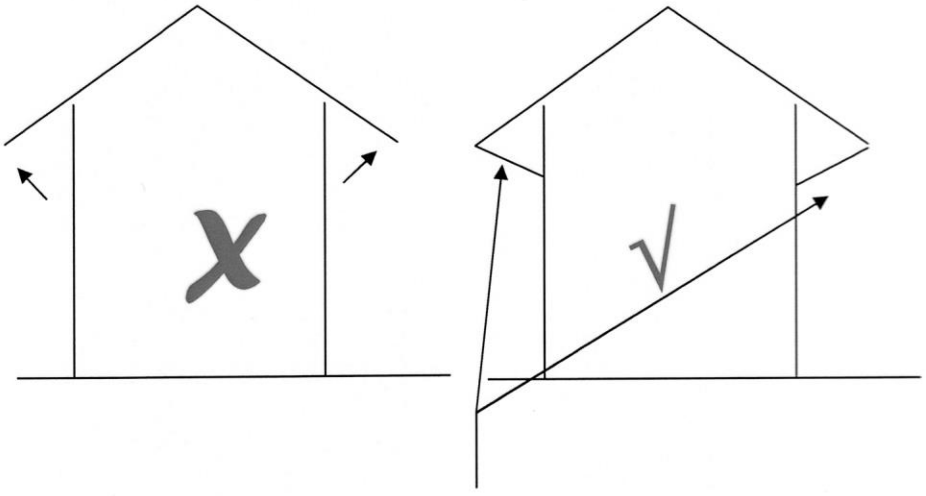
(d) Sloping RCC roofs (say 1 in 5 or 6 slope) will be used to provide quick rain water drainage and avoid any seepage or leakage.

(e) Quality of the basic materials and quality assurance of the construction is to be ensured.

(f) The walls and all the RCC work will be plastered with cement mortar of 1:4. The outside plaster should be in two coats. Inside wall also should have plaster coating.

(g) The doors and windows will be of heavy gauge quality aluminium with anodized fixtures.

(h) **Fig 15** below shows how an overhang roof which may be lifted up by high speed winds. By providing ties this can be prevented. The blowing off of thatched roofs will be prevented by tying the roof with rope, wire or metal straps and by anchoring it to the ground.



Overhang Ties

Figure15: Safe Construction for overhang roof

Source: http://www.houzz.com/photos/overhanging-roof-/p/8

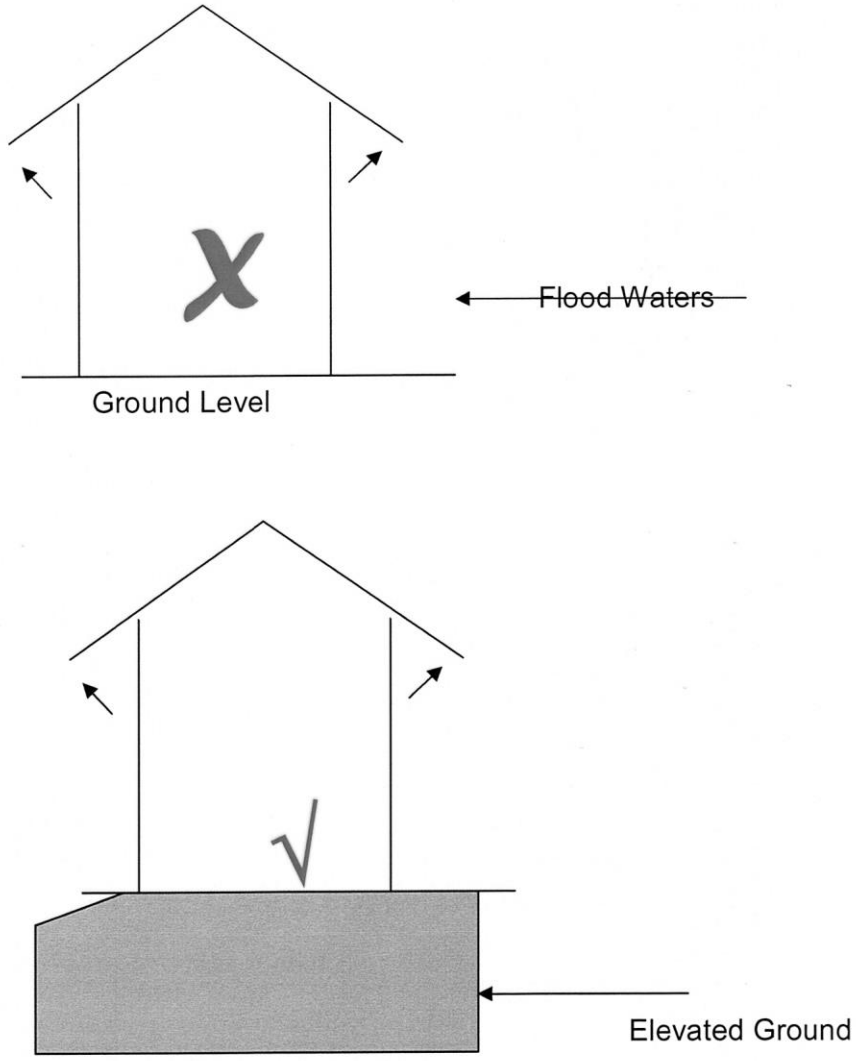


Fig 16 : Construction on stilts or on artificially raised earth mounds.

Source: http://www.houzz.com/photos/overhanging-roof-/p/8

(i) **Fig 16** above, shows Construction at ground level which has an inherent risk of inundation. If natural elevation is not available, construction on stilts or on artificially raised earth mounds needs to be undertaken.

5.2.4 Design Issues for Multipurpose Cyclone Shelters (MPCS)

(a) The cyclone shelter is primarily designed to shelter people and sometimes even cattle, during cyclones. However, it will be utilised as a multipurpose community facility all through the year so as to avoid deterioration of the building by not using it during non-cyclone periods. Therefore, the design consideration will keep in mind its use for multiple purposes such as school, ration shop, community centre, teaching centre, temporary godown or a public utility building. Constant use of the building for various purposes ensures that it is well maintained at all times and, consequently, it becomes available during a cyclone, which is its main purpose. It also generates income for its maintenance.

(b) Cyclone shelters will be located preferably about 1.5 km away from the coast.

(c) The plinth height of 1.5 m will be used for stilt with the height varying from 2.5 m to 4.5 m if the storm surge level is more than 1.5 m and less than 4.5 m.

(d) A sloped ramp will be provided in case the surge level is likely to exceed 1.5 m.

(e) The shelter will have a rectangular or polygonal plan depending on the functional aspect, with curved corners for better aerodynamic features and the non-erosion of walls.

(f) The shelter will have a rectangular or polygonal plan depending on the functional aspect, with curved corners for better aerodynamic features and the non-erosion of walls.

(g) Solar panels to be used for heating water and supply of electricity.

5.2.5 **Construction of New Building Structures.** Construction of new buildings will follow the standard code of GoI. The selection of sites will be based on a study of 100-year return period TC, New cyclone shelters will be planned for multi-purpose use. Further Regarding the construction of private houses, the local community will be encouraged to construct houses which would be cyclone resistant.

5.2.6 **Maintenance of Cyclone Shelters**

The following measures will be envisaged for proper and effective maintenance of MPCSs and other safe shelters:-

(a) Ensure multi-purpose use of the shelters.

(b) Collect a suitable maintenance fee from the users by lending them for use for social functions; use the money thus collected, to set up a corpus fund. Besides, budgetary allocations may be made for the maintenance of these shelters. A corpus fund may be set up with the budget provision as seed money for a corpus fund that could be set up and maintained by the village panchayat and subject to Local Fund audit.

(c) Schools, community halls and places of worship that are used as safe shelters at the time of cyclones will be maintained by the local communities.

5.2.7 **Amenities** Cyclone shelters will be provided with amenities for large gatherings for a few days during the disaster. Separate storage tanks are proposed for drinking and general purpose usage, to be placed on the roofs of the kitchen and toilets. Rain water harvesting will also be planned.

5.2.8 **Cattle Mounds** Efforts will be made to have cattle mounds adjacent to cyclone shelters. Selection of sites for cattle mounds will be made immediately along with the site for the MPCS. Efforts will be made to raise the level of the site selected for the cattle mounds to the final extent required, keeping in view the maximum storm surge, by using debris or earth from sites which have been excavated.

5.3 **Road Links, Culverts and Bridges** Many coastal villages do not have all-weather approach roads. The objective will be to ensure all weather access roads are provided to all habitations/villages falling within this area in all the 84 coastal districts of the country. This will prove to be an essential preparedness measure. The design considerations for roads, culvert and bridges are as follows:-

(a) Efforts will be made to provide at least one link road for each village that is accessible even during the cyclone and flood inundation periods.

(b) The link road and the culverts on the road will be with requisite hazard resistant structural design specifications and planning.

(c) Each link road to the village and to the shelter will be identified and marked for mandatory maintenance as per the requirement.

(d) The link road and culverts will be designed and laid with road level 0.5 m above the possible flood level.

(e) Embankment of the road will be well protected, preferably by revetment.

(f) The sub-grade and the main course of the road will have the same specification as that of a national road so as to be durable under hazard conditions. It will be at least a single lane of about 4m width with adequate camber (preferably a gradient of 1 in 15) for allowing quick drainage.

(g) The link road that leads to a shelter will have to be laid in M30 grade concrete.

(h) Bridges and culverts will be designed with RC slabs as per IRC recommendations. The minimum width of the culvert will be for two lane traffic even if the road is of one lane.

5.4 **Canals, Drains, Surface Water Tanks** Canals and drains get choked by weeds, silting, sand and encroachments. These remain unattended for decades together, sometimes for over a century. The main drains and canals are fed by primary and tertiary canals. Authorities need to take up their maintenance in totality. Their condition has to be assessed periodically, particularly in the pre-disaster and post-disaster seasons. It may be necessary to widen drains or even have diversion canals, wherever required, to cope with flooding due to heavy rains associated with cyclones and storm surges. It may be noted that surface water tanks also serve to lower the impact of cyclones and storm surges. But poor maintenance of these tanks lowers their storage capacity due to silting. Therefore, it is essential that desilting of surface water tanks is regularly undertaken.

5.5 **Saline Embankments** Cyclone related rainfall and storm surges are mainly responsible for such coastal inundation that at times cause enormous loss of life and property. Construction of 'saline embankments' is one of the structural mitigation measures to protect habitation, agriculture crop and important installations along the coast.

5.6 **Communication Towers and Power Transmission Networks** The coastal areas are generally endowed with a large network of communication and power transmission lines in keeping with the comparatively higher population density. Communications and power transmission towers will be designed on the basis of 100-year return period wind velocity of cyclone design of a communication and transmission line tower, including its foundation, is checked by a competent authority. Further, through regular inspection for assessing the conditions of the sub-assemblages such as cables and other fixtures in case of transmission line towers and antennas in case of lattice communication towers, the development of fatigue cracks can be checked and monitored.

NON STRUCTURAL MEASURES

5.7 Introduction

5.7.1 National Disaster Management Guidelines for Cyclones (2008), notes, in the face of increasing menace of cyclonic hazards, mitigation would remain the key and the most effective strategy to reduce the risks of cyclone. Every country and community has to decide its own mitigation strategy according to its own risks, resources and capabilities. Broadly such strategies would be twofold: structural and non-structural. As seen above structural mitigation measures generally refer to capital investment on physical constructions or other development works, which include engineering measures and construction of hazard resistant and protective structures and other protective infrastructure. **Non-structural measures** refer to awareness and education, policies techno-legal systems and practices, training, capacity development etc.

5.7.2 One third of India's population lies in the coastal area. Coastal areas are endowed with a wide range of coastal eco-systems. Coastal areas are also places that are prone to natural hazards like floods, cyclones and tsunamis. Even though good EWS and preparedness has reduced the number of human life's lost. it is not humanly possible to prevent or even control the phenomena. holistic approach to Coastal Zone Management (CZM), including precautionary measures like proper planning of the coastal areas for locating communities and infrastructure in safer areas, protecting and restoring natural bio-shields like mangroves and casuarinas trees etc., can minimise loss of life and damage to property to a considerable extent. This has been the motto of all authorities; that is to reduce the number of deaths or human life's. Such measures have to be truthfully addressed with the participation of all stakeholders. Non structural measures for mitigation include the following steps:-

(a) Coastal Regulation Zone (CRZ).

(b) National Coastal Zone Management Policy.

(c) Land Use Zoning with CRZ.

(d) Natural Bio Shields.

(e) Shelter Belt Plantations.

(f) Maintaining Natural Sand Dunes.

(g) Coastal Vulnerability Index.

(h) National Cyclone Risk Management Programme.

5.8 Coastal Protection

5.8.1 Coastal protection[30] is of paramount necessity if good zonal management is to be achieved. A setback line needs to be demarcated on the beachfront. **Setback** is the distance which a building or other structure is set back from a street or road, a river or other stream, a shore or flood plain, or any other place which is deemed to need protection. The setback requirement that protects beachfront structures from erosion and storm waves can also preserve turtle-nesting sites on the back beach. Similarly, restriction on clearing of mangrove swamps will not only conserve an economically valuable resource, but

[30] www.world bank.org/en/news/feature/2012/2011/protecting_India's_coastline.

also maintain a physical defence against storm tides. Conservation of Coastal Wetlands. Vegetated and non-vegetated wetlands (freshwater, coastal marshes, swamps, mangroves, waterlogged areas) are converted for aquaculture, saltpans, agriculture and even for housing/tourism/industry, etc. Non-vegetated wetlands can help in the expansion of bio-shield belts that can also meet the requirements of local communities in terms of fuel wood and timber, following its regeneration cycle. Plantation of mangroves can be initiated in the inter-tidal areas after considering their suitability and adaptability to the species to be planted. Some of the non-vegetated wetlands include past degenerated mangrove zones as well. Backwater reclamation is a serious problem in coastal Kerala and a plan was prepared to conserve these backwaters. The scenic coastal sand dunes and sandy beaches can be well stabilised by adopting suitable afforestation programmes. Cashew and casuarinas are found to be promising shelterbelt plantations on the shoreline. The citizens of Paradip had pointed out immediately after the Odisha Super cyclone that cutting of casuarinas trees on the beach has resulted in the increase in wind speed and resultant damage. The trees were cut during construction of the port.

5.8.2 **Coastal Wet Land Conservation.** Natural or organised bio-shield plantation efforts need to be given priority in coastal wetlands. The basis for conservation of wetlands has been established in two important studies carried out by SAC, Ahmedabad, and the National Remote Sensing Agency (NRSA), Hyderabad, through firming up of methodologies for zoning dominant varieties of mangroves using satellite data. While the SAC study is found to be useful in getting information on dominant mangrove community zones, the NRSA study made it possible to delineate the areas up to 50-100 ha, along with biodiversity characterisation at landscape level over the eastern coast only, at 1:50,000 scale.

5.8.3 The airborne LIDAR[31] system is mounted in an airplane looking downward. sensor oscillates back and forth scanning the terrain to produce millions of 3-D. Lidar is popularly used as a technology to make high-resolution maps, with applications in geomatics, archaeology, geography, geology, geomorphology, seismology, forestry, remote sensing, atmospheric physics, airborne laser swath mapping (ALSM), laser altimetry, and contour mapping. The ability of coastal environment to buffer human induced/natural impacts (hazards and climate change) is crucial for the sustainability of the biodiversity and productivity of coastal zones through a holistic and trans-sectoral management approach. The need of the hour is to facilitate the preparation of well-coordinated land-use project plans, vulnerability zoning and site development plans through multidisciplinary teams.

5.9 National Coastal Zone Management Policy.

5.9.1 Swaminathan committee report[32], consisting of various committee reports, brings out the findings of Sukthankar committee which was the first to look into the National Coastal Zone Management Policy issues. The objectives of coastal zone management policy are to protect coastal communities, conserve coastal resources by ensuring functional integrity of the various coastal systems and maintain a balance between development and environmental protection. Coastal areas were classified into four zones as given below:-

(a) Ecologically and Geo morphologically Important Areas (EGIA)

(b) Areas of Particular Concern (APC[1])

(c) High Hazard Zone (HHZ): a preservation zone which includes coastal seas, bays, gulfs, their beds, adjoining beaches, inland

[31] LIDAR can be expanded as Light Detection and Ranging.
[32] http://envfor.nic.in/mef/crz_report.pdf

water bodies and land area up to 50 year setback line, except EGIS and APC

(d) Low Hazard Zone (LHZ): conservation zone.

5.9.2 **Coastal Zone Management Plan.** To have a Coastal Zone Management Plan within the regulatory framework the recommendations of Prof MS Swaminathan committee was accepted by MoEF. The recommendations are:-

(a) Implementation of the ICZM Plan instead of an uniform regulatory approach.

(b) Allow development along the coastal stretches based on the vulnerability/setback line.

(c) Inclusion of the ocean zone in the CRZ.

(d) Setting up of a National Institute for sustainable coastal zone management to address policy and legal issues.

(e) Address coastal water pollution in a time bound manner.

(f) Identify, map and protect the coastal eco sensitive areas such as mangroves, corals, turtle breeding areas, etc.

(g) Develop bio-shields along the coastal stretches.

5.9.3 The Swaminathan Committee also gave the following recommendations to ensure the coastal zone, as well as life and property of the people along the

coastal areas needed protection from natural hazards. The recommendations are as below:-

(a) Mangrove wetlands will be regenerated.

(b) Coral reefs, grass beds and coastal forests will be preserved and conserved for both short-term and long-term ecological and livelihood benefits.

(c) Coastal plantations like casuarinas, saliconia, palm, bamboo, etc., will be raised which will act as an effective bio-shield.

(d) Geomorphologic features like sand dunes, beaches, coastal cliffs will be protected.

(e) Impact of natural hazards in the coastal and marine areas will be taken into account while formulating coastal area management schemes.

5.9.4 **Land Use Zoning and Siting Plan of Infrastructure.**

Average coastal population density is 432 persons per sq. km as against 256 persons for the entire country. Apart from protecting the community and resources, there is a need for providing necessary infrastructural facilities for the communities to maintain a better standard of living and ensure their economic development. Development of infrastructure such as electricity, water, gas, roads, bridges, etc., are designed to serve multiple uses and is usually planned and provided by the government, but they may not be fully addressing the issues associated with protection of natural geomorphic barriers and sustainable natural resource management based on holistic CZM plans. The following needs to be kept in mind when taking up developmental plans in coastal area:-

(a) Regional plans depending upon the potential of development based on the CZM (covering assessment of coastal multi-hazard risk and vulnerability) will be evolved as per the town and country planning techno-legal framework of the concerned state/UT.

(b) Regulation codes for construction and building activities will be implemented for the sustainability of coastal ecosystems.

While expansion of the waterfront may be necessary for the coastal cities, it may jeopardize coastal resources. Expansion of townships and cities has put certain eco-systems such as mangroves, salt marshes, and mudflats, under pressure. However, the settlements of local communities have to be protected against natural calamities.

5.10 **The Coastal Aquaculture Authority.** The aqua culture authority promotes sustainable development of coastal shrimp farming activities based on 'Precautionary Principle' and 'Polluter Pays Principle' as its primary function. Planned utilization of land and resources can help in sustainable development, at the same time preservation of the ecology. Salient facts that need to be kept in mind are:-

(a) Saline and degraded lands not suitable for other purposes will be identified for coastal aquaculture activities.

(b) It is critical to ensure good quality of water source. However, groundwater will not be permitted to be drawn.

(c) Such identified areas/zones will also find a place in the Integrated coastal Zone Management (ICZM) plan of the coastal states/UTs to ensure optimal utilisation of scarce coastal land resources.

(d) In such areas, facilities, on the lines of software parks and industrial estates, will be provided to enable shrimp farming to be taken up in a scientific and environmentally sustainable manner with appropriate management practices, common waste water treatment plants.

(e) Large tracts of agricultural land was converted for shrimp farming thus degrading them completely and rendering them unsustainable for agricultural activities. Immediate efforts will be made to enumerate them and evolve suitable regeneration strategies.

5.11 Coastal Regulation Zone (CRZ)

5.11.1 Coastal Regulation Zone, MOEF (2011), notified in the draft notification[33] the first focused initiative towards the protection of coastal zones in India was taken up in 1981 by the then Prime Minister Smt. Indira Gandhi. She wrote to the Chief Ministers of all the coastal states, directing them to avoid all activities up to 500 meters from the maximum high tide line along the coast. Central Government, with a view to ensure livelihood security to the fishermen communities and other local communities, to conserve and protect coastal stretches, its unique environment and its marine area and to promote development through sustainable manner based on scientific principles taking into account the dangers of natural hazards in the coastal areas, sea level rise due to global warming, does hereby, declare the coastal stretches of the country and the water area upto its territorial water limit, excluding the islands of Andaman and Nicobar and Lakshadweep and the marine areas surrounding these islands upto its territorial limit, as Coastal Regulation Zone (hereinafter referred to as the CRZ) and restricts the setting up and expansion of any industry, operations or processes and manufacture or handling or storage or

[33] http://www.moef.nic.in/downloads/public-information/CRZ-Notification-2011.pdf

disposal of hazardous substances as specified in the Hazardous Substances (Handling, Management and Transboundary Movement) Rules, 2009 in the aforesaid CRZ.; and In exercise of powers also conferred by clause (d) and sub rule (3) of rule 5 of Environment (Protection) Act, 1986 and in supersession of the notification of the Government of India in the Ministry of Environment and Forests, number S.O.114(E), dated the 19th February, 1991 except as respects things done or omitted to be done before such supercession, the Central Government hereby declares the following areas as CRZ and imposes with effect from the date of the notification the following restrictions on the setting up and expansion of industries, operations or processes and the like in the CRZ:-

(a) "The land area from High Tide Line (hereinafter referred to as the HTL) to 500mts on the landward side along the sea front".

(b) "CRZ shall apply to the land area between HTL to 100 mts or width of the creek whichever is less on the landward side along the tidal influenced water bodies that are connected to the sea and the distance upto which development along such tidal influenced water bodies is to be regulated shall be governed by the distance up to which the tidal effects are experienced which shall be determined based on salinity concentration of 5 parts per thousand (ppt) measured during the driest period of the year and distance up to which tidal effects are experienced shall be clearly identified and demarcated accordingly in the Coastal Zone Management Plans (hereinafter referred to as the CZMPs). Explanation.-For the purposes of this sub-paragraph the expression tidal influenced water bodies means the water bodies influenced by tidal effects from sea, in the bays, estuaries, rivers, creeks, backwaters, lagoons, ponds connected to the sea or creeks and the like".

(c) "The land area falling between the hazard line and 500mts from HTL on the landward side, in case of seafront and between the

hazard line and 100mts line in case of tidal influenced water body the word 'hazard line' denotes the line demarcated by Ministry of Environment and Forests (hereinafter referred to as the MoEF) through the Survey of India (hereinafter referred to as the SoI) taking into account tides, waves, sea level rise and shoreline changes".

(d) "Land area between HTL and Low Tide Line (hereinafter referred to as the LTL) which will be termed as the intertidal zone".

(e) "The water and the bed area between the LTL to the territorial water limit (12 Nm) in case of sea and the water and the bed area between LTL at the bank to the LTL on the opposite side of the bank, of tidal influenced water bodies".

5.11.2 The following are declared as prohibited activities within the CRZ:-

(a) "Setting up of new industries and expansion of existing industries except:-

(i) Those directly related to waterfront or directly needing foreshore facilities; eg: Port, pipelines, lighthouse, Jetty etc.

(ii) Facilities for generating power by non-conventional energy sources and setting up of desalination plants in the areas not classified as CRZ-I(i) based on an impact assessment study including social impacts.

(iii) Development of green field Airport already permitted only at Navi Mumbai.

(iv) Reconstruction, repair works of dwelling units of local communities including fishers in accordance with local town and country planning regulations.

(b) Manufacture or handling oil storage or disposal of hazardous substance as specified in the notification of Ministry of Environment and Forests, No. S.O.594 (E), dated the 28th July 1989, S.O.No.966(E), dated the 27th November, 1989 and GSR 1037 (E), dated 5th December 1989 except:-

(i) Transfer of hazardous substances from ships to ports, terminals and refineries and vice versa.

(ii) Facilities for receipt and storage of petroleum products and liquefied natural gas (LNG) subject to implementation of safety regulations including guidelines issued by the Oil Industry Safety Directorate in the Ministry of Petroleum and Natural Gas and guidelines issued by MoEF and subject to further terms and conditions for implementation of ameliorative and restorative measures in relation to environment as may be stipulated by in MoEF. Provided that facilities for receipt and storage of fertilizers and raw materials required for manufacture of fertilizers like ammonia, phosphoric acid, sulphur, sulphuric acid, nitric acid and the like, shall be permitted within the said zone in the areas not classified as CRZ-I(i).

(c) Setting up and expansion of fish processing units including warehousing except hatchery and natural fish drying in permitted areas.

(d) Land reclamation, bunding or disturbing the natural course of seawater except those:-

(i) Required for setting up, construction or modernisation or expansion of foreshore facilities like ports, harbours, jetties, wharves, quays, slipways, bridges, sea link, road on stilts, and such as meant for defence and security purpose and for other facilities that are essential for activities permissible under the notification.

(ii) Measures for control of erosion, based on scientific including Environmental Impact Assessment (hereinafter referred to as the EIA) studies.

(iii) Maintenance or clearing of waterways, channels and ports, based on EIA studies.

(iv) Measures to prevent sand bars, installation of tidal regulators, laying of storm water drains or for structures for prevention of salinity ingress and freshwater recharge based on carried out by any agency to be specified by MoEF.

(v) Setting up and expansion of units or mechanism for disposal of wastes and effluents except facilities required for:-

(vi) Discharging treated effluents into the water course with approval under the Water (Prevention and Control of Pollution) Act, 1974 (6 of 1974).

(vii) Storm water drains and ancillary structures for pumping.

(viii) Treatment of waste and effluents arising from hotels, beach resorts and human settlements located in CRZ areas other than CRZ-I and disposal of treated wastes and effluents.

(e) Discharge of untreated waste and effluents from industries, cities or towns and other human settlements. The concerned authorities shall implement schemes for phasing out existing discharge of this nature, if any, within a time period not exceeding two years from the date of issue of this notification.

(f) Dumping of city or town wastes including construction debris, industrial solid wastes, fly ash for the purpose of land filling and the like and the concerned authority shall implement schemes for phasing out any existing practice, if any, shall be phased out within a period of one year from date of commencement of this notification. Note:-The MoEF will issue a separate instruction to the State Governments and Union territory Administration in respect of preparation of Action Plans and their implementation as also monitoring including the time schedule thereof, in respect of paras (v), (vi) and (vii).

(g) Port and harbour projects in high eroding stretches of the coast, except those projects classified as strategic and defence related in terms of EIA notification, 2006 identified by MoEF based on scientific studies and in consultation with the State Government or the Union territory Administration.

(h) Reclamation for commercial purposes such as shopping and housing complexes, hotels and entertainment activities.

(i) Mining of sand, rocks and other sub-strata materials except:-

(i) Those rare minerals not available outside the CRZ area.

(ii) Exploration and exploitation of Oil and Natural Gas.

(j) Drawal of groundwater and construction related thereto, within 200mts of HTL; except the following:-

(i) In the areas which are inhabited by the local communities and only for their use.

(ii) In the area between 200mts-500mts zone the drawal of groundwater shall be permitted only when done manually through ordinary wells for drinking, horticulture, agriculture and fisheries and where no other source of water is available.

(k) Construction activities in CRZ-I except those specified in para 8 of this notification.

(l) Dressing or altering the sand dunes, hills, natural features including landscape changes for beautification, recreation and other such purpose.

(m) Facilities required for patrolling and vigilance activities of marine/coastal police stations".

5.11.3 Important Observations made after the tsunami disaster of December 2004 along the Indian coast:-

(a) The maximum damage had occurred in low lying areas near the coast.

(b) High causalities were found in thickly populated areas.

(c) Mangroves, forests, sand dunes and coastal cliffs provided the best natural barriers against the tsunami.

(d) Heavy damage was reported in areas where sand dunes were heavily mined (e.g., Nagapatinam and Kolachal) and where coastal vegetation was less.

5.11.4 The buffer provided in the coastal zone and our approaches for conservation of mangroves/sand dunes/coral reefs/coastal forests were all put to test during this event and were found to be reasonably effective even in calamities of this magnitude. This leads us to the necessity for an effective mechanism to correct our approach and to incorporate coastal zone vulnerability indices in management practices.

5.12 **Natural BioShields** Coastal communities have a Natural protection from coastal storms, tidal waves and Tsunamis due to biological mechanisms like Mangrove forests[34]. Non mangrove bio-shields along the coastal zone are popularly known as shelterbelts. Shelterbelts are strips of vegetation composed of trees and shrubs grown along the coasts to protect coastal areas from high

[34] **Mangroves** are various large and extensive types of trees up to medium height and shrubs that grow in saline coastal sediment habitats in the tropics and subtropics

velocity winds. The forest departments in India have mastered the technique of raising shelterbelts since 1970, in which casuarinas was the main species. Along with casuarinas, other ecologically and economically important species can also be grown taking into account the biophysical condition and available breadth and width of the area selected for raising shelterbelts Mangrove cover has been classified into dense and open mangrove areas. The areas of mangrove cover so assessed have been merged in the respective figures of dense and open forest cover. The Sundarbans in West Bengal alone accounts for about little less than half of the total area under mangroves in the country, followed by Gujarat and the Andaman and Nicobar Islands. The Sundarbans in West Bengal alone accounts for about little less than half of the total area under mangroves in the country, followed by Gujarat and the Andaman and Nicobar Islands.

5.13 **Shelterbelts** Wikipedia, defines, **windbreak** or **shelterbelt** as a plantation usually made up of one or more rows of trees or shrubs planted in such a manner as to provide shelter from the wind and to protect soil from erosion. They are commonly planted around the edges of fields on farms. If designed properly, windbreaks around a home can reduce the cost of heating and cooling and save energy. Windbreaks are also planted to help keep snow from drifting onto roadways and even yards. Other benefits include providing habitat for wildlife and in some regions the trees are harvested for wood products. Raising of shelterbelts all along the coastline needs a sound strategy. raising of shelterbelts to fight cyclonic winds requires an appropriate strategy which is free from problem of land being under intensive cultivation, villages being densely populated. and has practical applicability. Under the Shelterbelt Plantation Programmes along the coast, a width of 5 km from the shores has been considered since 1977. This 5 km width has been differentiated in to the first 500 m zone or main zone and 500-5000 m zone as the support zone.

(a) **Main Zone (Upto 500m)** We need to adopt block planting for main zone. This zone could be characterised by salinity, poor soils with high pH, low nutrition, poor moisture retention capacity, inadequate irrigation facilities, subjection to high speed and salt laden winds, etc. Stock maps are to be prepared the entire main zone of 500 m along the coast indicating all types of areas, soils, crops, plantations, etc. After completion of preparation of the stock map, the method of treatment to be adopted on a
particular piece of land may be decided.

(a) **Support zone (500-5000 m)** In the support zone tree crops are planted around households, public offices and all along the road margins and field bunds without leaving any gaps, including the difficult areas, with suitable species in the area between 500-5000 m. Islands offer unique ecosystems and coastal planning and regulation in their case will take into account features such as their geological nature, settlement patterns, volcanic or coral nature of the island, size of habitations, unique cultures, livelihood patterns, etc., along with adequate environmental safeguards.

5.14 **Maintaining Natural Sand Dunes** Coastal sand dunes fringe thousands of Kilometers of coastline around the world. They are made up of continuous hills of sand that are held together by specially adapted sand dune vegetation. These plants have adaptations that allow them to survive in sand, a moving substrate which covers and uncovers its roots, adaptation to desiccation, to strong winds carrying salt and sand and to wildly changing temperatures. Coastal sand dunes formed during a time of low sea level where sand and sediments on the foreshore became exposed and in conjunction with sufficient winds, this sand was transported up the beach face via a process known as siltation. Once sufficient wind (>15 km/hr) mobilises sand particles they become

trapped in vegetation or drift wood at the back of the beach, sand then continues to accumulate among the vegetation and over time slowly builds up the dunes we see today. Sand dunes serve an important purpose by protecting inland areas from coastal water intrusion. They are able to absorb the impact and protect inland areas from high energy storms and act as a resilient barrier to the destructive forces of wind and waves, Wikipedia.

5.15 Coastal Vulnerability Index (CVI)

5.15.1 CVI[35] is an index that expresses the relative vulnerability of the coast to physical changes due to future sea-level rise. It highlights areas where the various effects of sea-level rise may be the greatest. Once each section of coastline is assigned a vulnerability value for each specific data variable, the coastal vulnerability index (CVI) is calculated as the square root of the product of the ranked variables divided by the total number of variables;

$$CVI = \sqrt{(a^2b^2c^2d^{2f})}/6.$$

Where,

a = geomorphology

b = shoreline erosion/accretion rate

c = coastal slope

d =relative sea-level rise rate

e = mean wave height

f = mean tide range.

[35] http://www.gktoday.in/coastal-vulnerability-index/

The calculated CVI value is expressed in quartile ranges to highlight different vulnerabilities within the area of interest. A high Index specifies increased vulnerability.

Vulnerability Scale

Sl No	CVI value	Vulnerability
1	2.1-4.75	Low Vulnearbility
2	4.75-9.5	Medium Vulnerabilty
3	>9.5	HighVulnearbility

Table 7: Vulnerability Values for Orissa State

Source: http://www.indiaenvironmentportal.org.in/files/Coast%20Orissa.pdf

2.1-4.75: Low vulnerability

4.75-9.5: Medium Vulnerability

>9.5 Highly Vulnerable

In first half of 2012, the comprehensive 'Coastal Vulnerability Index' (CVI) Atlas has been brought out by the Indian National Centre for Ocean Information Services (INCOIS). Data from satellites, simulated models, tide gauges and Shuttle Radar Topography Mission (SRTM) of the United States, INCOIS prepared this Atlas, which determines the relative risk to coastline due to future sea-level rise. This was for the first time; such an Atlas has been prepared at the national level. Based on seven physical and geological parameters, the Atlas has classified the areas along the coastline in terms of very high risk, high risk, medium and low risk to future sea-level rise. The seven parameters used are: -

(a) Tidal range.

(b) Wave height.

(c) Coastal slope.

(d) Coastal elevation.

(e) Shoreline change.

(f) Geomorphology.

(g) Historical rate of sea-level change.

5.15.2 The **CVI** value along the study area of Orissa coastline varied from 2.1 to 19. The 25th and 50th percentiles of CVI value are 4.75 and 9.5, respectively. Those parts of the coastline having CVI values ranging from 2.1 to 4.75 are considered to be low vulnerable, those ranging from 4.75 to 9.5 are considered to be medium vulnerable, and the remaining parts having CVI values of more than 9.5 are high vulnerable. **Fig 17** shows expanded map of Odisha showing vulnerability based on CVI Accordingly:-

(a) About 76 km of the coastal stretch of Orissa state, covering parts of Ganjam, Chilka, southern Puri, and Kendraparha, is low vulnerable.

(b) About 297 km of the coastal stretch of Orissa state, covering northern Ganjam, Chilika, central Puri, Jagatsinghpur, Kendraparha, southern Bhadrak, and northern Balasore, is medium vulnerable.

(c) About 107 km of the coastal stretch of Orissa state, covering northern Puri, parts of Jagatsinghpur, Kendraparha, northern and southern Bhadrak and southern Balasore, is high vulnerable

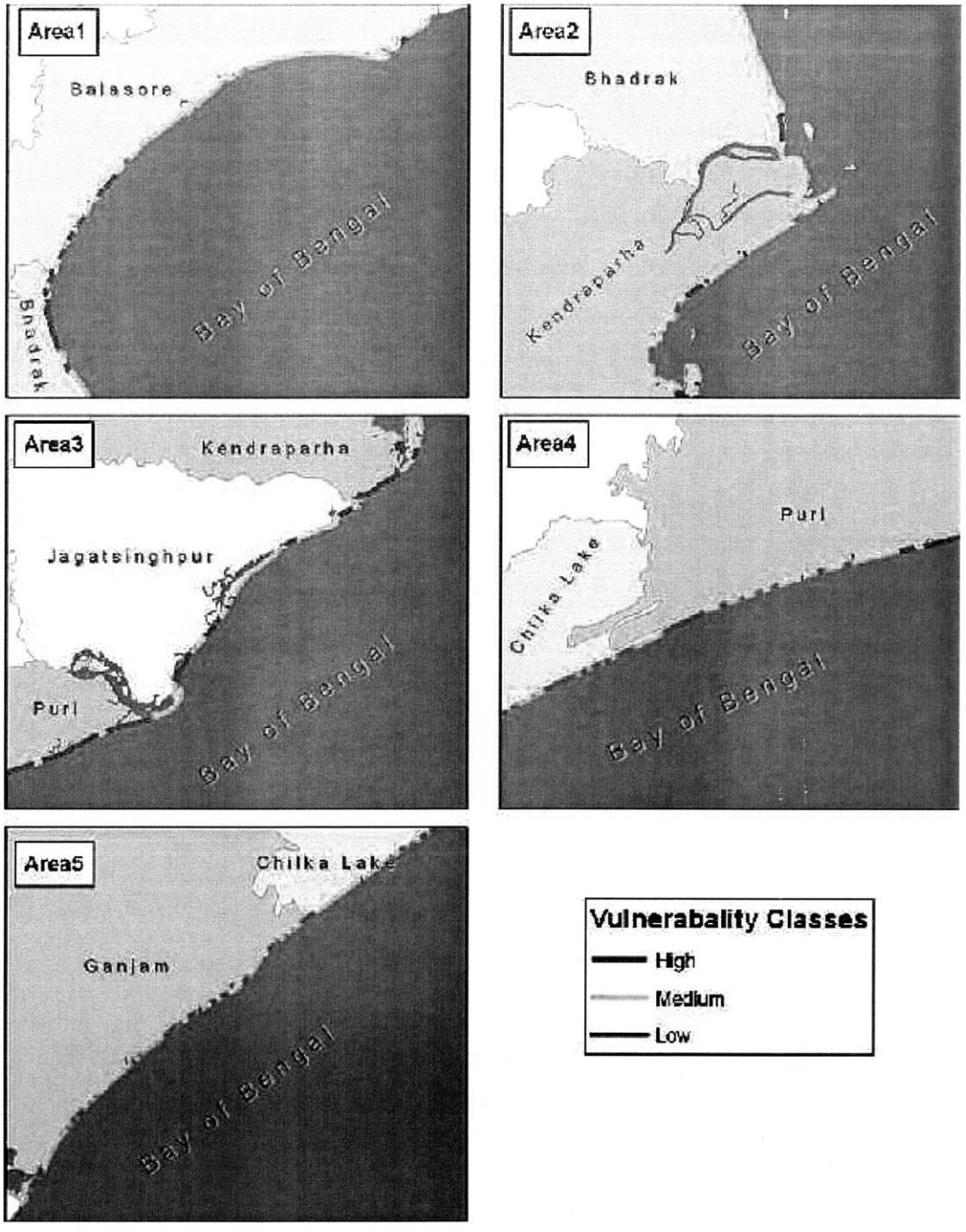


Figure 17: Enlarged portion of Orissa sectors showing vulnerability.

Source: http://www.indiaenvironmentportal.org.in/files/Coast%20Orissa.pdf

5.16 National Cyclone Risk Management Programme(NCRMP)

5.16.1 The National Cyclone Risk Mitigation Project (NCRMP) (2006)[36] has been drawn up with a view to address the cyclone risks in the country, with World Bank assistance. The main objectives of the project are to minimize risk and vulnerabilities to cyclones, to strengthen the structural and non-structural cyclone mitigation efforts and to build capabilities and capacities of people for cyclone risk mitigation in harmony with the conservation of coastal ecosystems in coastal cyclone hazard prone States and Union Territories. The project will be funded by the World Bank as an **Adaptable Programme Loan** (APL) with an International Development Association (IDA) credit amounting to Rs. 1198.44 crore. The remaining amount of Rs. 298.27 crore will be contributed by Governments of Andhra Pradesh and Orissa (Under Component B only). Other components will be funded 100% by the Central Government. Planning Commission has given in principle approval for the project. Other states were to be taken up after seeing the experience of activity in Odisha and Andhra Pradesh.

5.16.2 **Mission Statement** "The National Cyclone Risk Mitigation Project seeks to minimize vulnerability in the cyclone hazard prone states and Union Territories of India and make people and infrastructure disaster resilient, in harmony with conservation of coastal ecosystems".

5.16.3 **Key Objectives** "The Project aims to fulfill its Mission by undertaking following structural and non structural measures:-

(a) Early warning and communication system by improving the Last Mile connectivity.

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[36] http://ncrmp.gov.in/ncrmp/components.html

(b) Construction and sustainable maintenance of Multi-purpose Cyclone Shelters (MPCSs), Improved access and evacuation to these and already exiting MPCSs and habituations through construction of roads and bridges, and construction of coastal embankments in selected places for protection against storms, flooding and storm surge in high risk areas.

(c) Enhanced capacity and capability of local communities to respond to disasters.

(d) Strengthening Disaster Risk Mitigation (DRM) capacity at Central, State and Local levels in order to enable mainstreaming of risk mitigation measures into the overall development agenda."

5.16.4 **Components of NCRMP.** The NCRMP Phase I have four principal components as elaborated below:-

(a) Early warning and dissemination system (EWDS) and capacity building of coastal communities (Rs 72.75 crores)

"Main task is to reduce existing gap in dissemination of warning to communities. This will be done in the States of A.P. and Orissa. Installation and operation of early warning communication and dissemination system by allowing the state and or district or sub-district level control centre to send communication directly to the villages including strengthening emergency operation centers to communicate the warnings through multiple modes of communication including satphones and new radio based wireless communication technology in one block in each state. This will ensure coastal communities of A.P. and Orissa to maintain and operate the EWDS and carry out emergency mobilization

(i) In operating, maintaining and regular use of EWDS equipment by officials and village representatives.

(ii) Of communities in disaster preparedness and response by preparing disaster management plans and arranging mock drills etc."

(b) **Cyclone Risk Mitigation Infrastructure (Rs 1164 crores)** "The purpose of this component is to improve the access to emergency shelters, evacuation and protection against cyclones and other hydro meteorological hazards in high risk areas of A.P. and Orissa. This will be done through investment in multipurpose cyclone shelters, up-gradation of existing roads to all weather roads, helping in connecting the habituations and Cyclone shelters, construction of bridges suitable for evacuation, drainage improvement measures and repair and up-gradation of existing embankments."

(c) **Technical Assistance for Cyclone Hazard Risk Mitigation, Capacity Building and Knowledge Creation (Rs 29.10 crores)** "The activities under this component will be in assisting thirteen vulnerable coastal states and UTs to improve their understanding of natural disaster risks and vulnerabilities, and strengthen their institutional capacity to address such risks and vulnerabilities. The component will also support pilot activities to be implemented by NDMA, NIDM, A.P. and Odisha."

(d) **Project Management and Implementation Support (Rs 95.06 crores)** "This component provides for support for Project management and implementation by financing incremental operating costs for PMU, PIUs, Nodal units in line departments and NIDM. The office

equipment, training and exposure visits and consulting services for specialist activities will be under taken under it.

Unallocated and contingency @ 10% of overall cost (Rs. 135.80 crore).

Components A, C and D will be fully financed by the Central Government through World Bank assistance. The component-B will be financed by Central and State Governments in the ratio of 75:25.

5.16.7 **Conclusion** A good early warning system and preparedness is very important to reduce the loss to life and property. Reduction in loss to human life was main motto of UNDP. From 9800 or more deaths in Odisha Super Cyclone, the loss has been brought down to 44 in Cyclone Phailin respectively. However the loss due to damage to property, livestock and crop etc has not been brought down. Loss to property has been due to temporary structures like thatched roof, tiled roof, mud wall house etc. Strengthening and constructing houses according to IS codes will help reduce the loss considerably. Building house on stilts will help protect these structures from flood water that follows a cyclone. Building Multipurpose shelters is the requirement of the hour. These shelters should be accessible at all times, connected by weather roads. They should be stocked with food, medicines and fodder for cattle. Cattle mounds need to be planned close to the shelters. Non structural measures are equally important. As the first step a risk map needs to be prepared to ascertain weak links. CVI is one of the biggest tools available to decide on the sectors where mitigation measures need to be concentrated. Measures like mangrove and planting of casuarinas trees etc will help reduce the destruction. Power and communication towers are the first victims and take longest to restore. Material and skilled resources need to be stocked to repair the towers and restore power. It was noticed that 33/11 Kv power lines were damaged in Phailin cyclone. Thus

it can be safely assumed that we can stock material required to repair 33/11 Kv lines. Adopting the structural and non structural measures will definitely help reduce destruction and loss of lives and properties.