

Disaster Management Strategies for Preparedness and Mitigation in Vulnerable Communities.

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Abstract: Disaster threatens sustainable economic development worldwide. In the past twenty years, Earthquakes, floods, tropical storms, droughts and other calamities have killed millions of People, inflicted injury, disease and caused homelessness and misery to around one billion others in the world. These have caused damage to infrastructure worth millions of rupees. Disaster destroys decades of human effort and investments, thereby, placing new demands on society for reconstruction and rehabilitation. Disaster management thus requires a multidisciplinary and proactive approach. The community, civil society organizations, media and the proverbial man on the street, everyone has to play a role in case such exigency occurs. The various prevention and mitigation measures outlined below are aimed at building up capabilities as also how to deal with disasters.

Keywords: Disaster management & strategies, Community development, Disaster resilient cities.

1. Introduction

1.1. Aim

- To Make Bharuch & Ankleshwar Disaster Resilient Cities so as to minimize human, livestock, property and environmental losses.

1.2. Objectives

- To localize a Disaster & contain its effect to the greatest extent so as to minimize its impact on life, environment and property.
- To evolve strategies for preparedness and mitigation so that risk involved invulnerable communities can be reduced
- To evolve Emergency response and recovery mechanism and financial arrangements.
- To reform financial planning for disaster management planning.
- To evolve Emergency response and recovery mechanism and financial arrangements. To reform financial planning for disaster management planning.
- Promote a culture of prevention and preparedness by ensuring that DM receives the highest priority at all levels.

1.3. Methodology

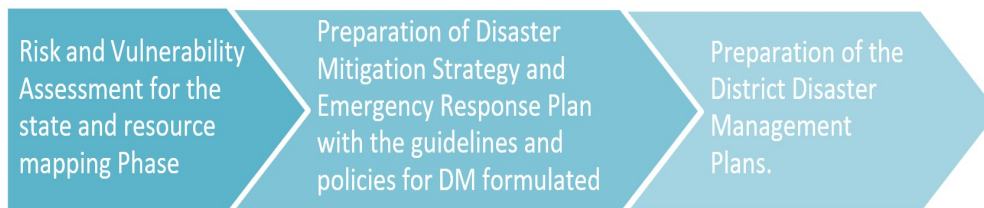


Figure 1. Methodology

1.4. Planning Process

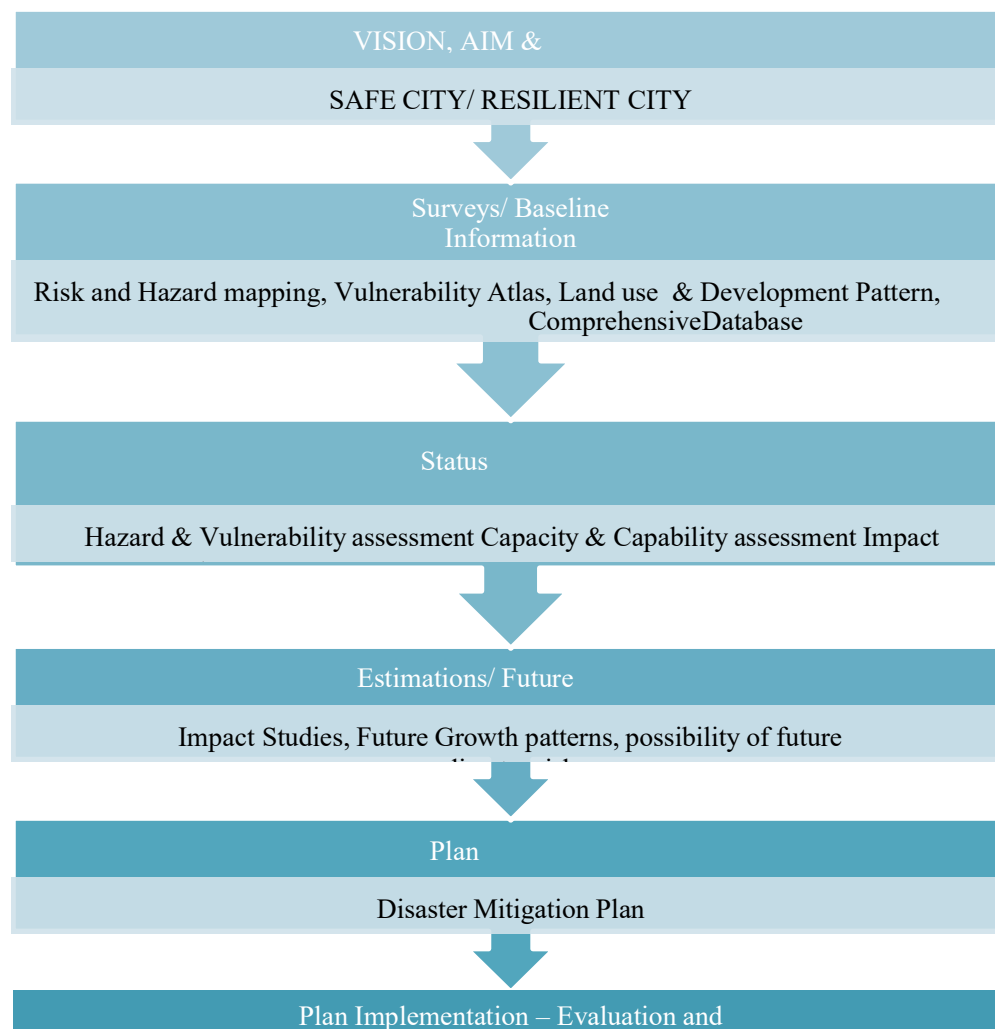


Figure 2. Planning process

1.4. Generation of comprehensive information base

Detailed Data and Information of the

- Drainage patterns of the area surrounding the river basin
- Floodplain mapping
- Catchment areas
- Low-lying areas
- Population densities therein
- Settlement patterns
- Nature and types of buildings, etc.

2. Vulnerability

The ordinary use of the word ‘vulnerability’ refers to the capacity to be wounded, i.e., the degree to which a system is likely to experience harm due to exposure to a hazard. Vulnerability Indicators

- Geological & Seismic Conditions

- Density
- Housing Conditions
- Land use Changes

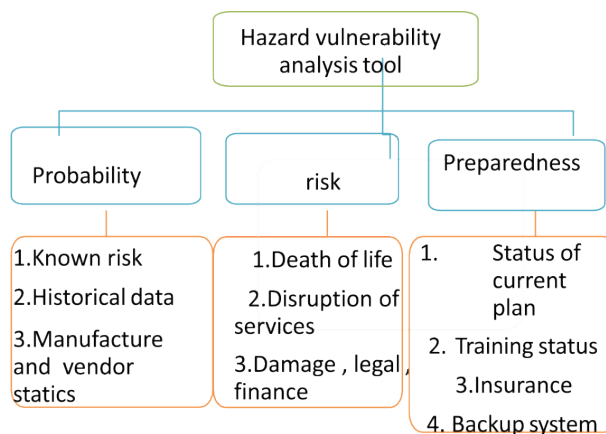


Figure 3. Hazard vulnerability analysis tool flowchart

A. Natural Calamities

- Floods
- Earthquake
- Cyclone
- Fire
- Biological Disaster

B. Manmade Calamities

- Industrial Disaster
- Radiological Disaster
- Accidents

The mode, degree and extent of response to fight out any Disaster depend upon the nature, degree and extent of Disaster, but some points are common to all kinds of situations. For example, first and foremost, appropriate and adequate steps for preventing the disaster should be undertaken. Secondly, preparedness is required to contain the damages and casualties resulting from the Disaster. Thirdly, steps for rehabilitation and restoration of community life within a reasonable time should be focused on.

2.1. Hence, some necessary and common steps are as below:

1. Establishment of Central Control Rooms and capacity enhancement of Emergency Operation Centers.
2. District Disaster Management Committee to meet post early warning or immediately postdisaster occurrence.
3. A general line of action and some special duties to various officers and departments will have to be assigned, keeping in mind a timeline for finishing specific tasks.
4. Voluntary Organizations may have to be involved and their role will have to be clearly specified and coordinated.
5. Media may have to be briefed to suppress all kinds of rumors.
6. Information regarding resource inventory of Health Services, Transport Services, Evacuation & Rehabilitation Centers and Food etc. needs to be kept handy so that resources can be deployed where required.
7. Consistent follow-up of relief operations and constant reporting of pre and post

disasterwork

Broad guidelines have been given in the following pages and "Standard Procedure" has been formulated which is to be adhered to by all concerned. Once the Disaster take place and the authorities are informed of the same, they will take the necessary action with the help of the individual Disaster management plans prepared for the respective Disaster/situations.

2.2. The main objectives of various preparedness measures are:

- Minimizing the loss of human lives.
- Minimizing the loss of livestock.
- Minimizing ill effects on the health of the affected population.
- Bringing the human activities in the locality to normal soon after.

To achieve the above objectives, different tasks have to be performed by Government Departments and other agencies before, during and after the Disaster. Each Department's role and responsibilities have to be clearly identified and an action plan needs to be drawn up by each department. For close cooperation between the various Department and Agencies, close Coordination is required between the Collector at the District Headquarters and GrantOfficers (SDM) at the Sub-division or taluka level.

The responsibility to manage any type of Disaster in the district rests with the DISTRICT DIASTER MANAGEMENT COMMITTEE headed by the Collector Bharuch, who may, depending upon the gravity of the situation, seek the help of NATIONAL DIASTER MANAGEMENT AUTHORITY AND STATE DIASTER MANAGEMENT AUTHORITY. This tiered and hierarchical structure ensures that the best possible response is accorded to any disaster situation, depending upon the severity of damage. For operational expediency, the level of Disasters have been categorized and classified as under:

2.3. Level of disasters

1. **L** concept has been developed to define different levels of disasters in order to facilitate the responses and assistances to States and Districts.
2. **L0 LEVEL** denotes normal times which will be utilized for close monitoring, documentation, prevention and preparatory activities. Training on search and rescue, rehearsals, evaluation and inventory updating for response activities will be carried out during this time.
3. **L1 LEVEL** specifies disaster that can be managed at the District level, however, the State and Centre will remain in readiness to provide assistance if needed.
4. **L2 LEVEL** disaster situations are those, which require assistance and active participation of the State, mobilization of its resources for management of disasters.
5. **L3 LEVEL** disaster situation is in case of large scale disaster where the State and District Authorities have been overwhelmed and require assistance from the Central Government for Reinstating the State and District machinery as well as for rescue, relief, other response and Recovery measures. In most cases, the scale and intensity of the disaster as determined by the Concerned technical agency like IMD is sufficient for the declaration of L3 disaster

3. Bharuch and Ankleshwar Introduction

Bharuch is Located in the Southern part of Gujarat State. Its mainland extends between 21- degree - 41 min and 21 degrees - 50-min north latitude and between 72 degree 59 Min and 72 degree - 40-min longitude. It is bounded by Vadodara district in the North,

Surat district in the South, Narmada district in the east and Arabian Sea in the west. Its coastline is 286 km long and the district lies in an area of 5254 Sq.

3.1. Climate

The temperature at Bharuch District Headquarters ranges from **42.0** degree centigrade (highest) in summer and **10.2** degree centigrade (lowest) in winter. The air is humid owing to long Coastal belt.

3.2. River, Dam & Rainfall Information

The average annual rainfall is 640 mm. The soil found in the District is largely black soil, Except for the coastal areas where the soils characterized as alkaline. The District has one major river i.e. the Narmada and seasonal rivers Dhadhar & Kim. These rivers flow towards the Gulf of Khambhat in the west. The District has no Major Dam; however, it has 3 checkdams controlled by the Minor Irrigation Department.

3.3. Industries

Out of 491 Major Accident Hazards (MAH) units in the state, 88 are located in Bharuch District. Of these, GIDC Bharuch has 8, Ankleshwar has 46, Valia has 2, Vagra has 16, Hansot has 1, Jambusar has 2, Amod has 1, Jagadia has 12 MAH Unit. As is evident from the pie diagram, Ankleshwar has the maximum number of MAH units in the district. Total 71 villages falls in Industrial area. With Bharuch Estate, Palej Estate, Panoli Estate, Ankleswar Estate, Jagadia Estate, Sayakha & Vilayat Estate, PCPIR, Dahej Esta.

3.4. Hazard, vulnerability and risk assessment

BHARUCH district faces a number of hazards, which pose the threat of disaster. The threat (risk) and possible impact (vulnerability) which can be actualized from these hazards ranges from minor impacts affecting one village to events impacting larger than the state alone.

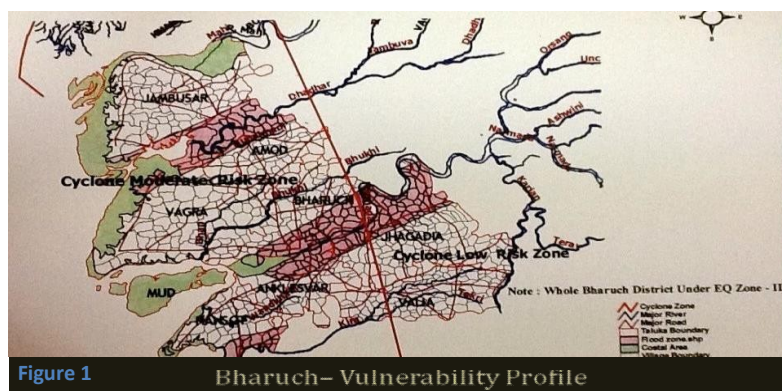


Figure 4. Bharuch – Vulnerability Profile

3.5. Flood Hazard Identification and Risk Assessment

The flooding may occur as a result of heavy monsoons or even cyclones. In the past, the areas of Bharuch and Ankleshwar have been regularly and severely affected by flooding of the Narmada River.

4. Disaster in Bharuch and Ankleshwar

DISASTER: A sudden accident or a natural catastrophe that causes great damage or loss of life

4.1. Types: Natural & Manmade disaster- Gujarat

- Gujarat state is prone to different types of disaster.
- Bharuch and Ankleshwar are located on banks of river Narmada and close to the bay of Kambath.
- In addition case area falls under area of moderate risk zone (zone-4) of seismicity.
- Apart from these, industrial hazard risk is also prominent factor in the area.
- Due to increasing number of chemical industries and exploration of natural resources.
- This makes area high risk of industrial disaster.
- The area is prone to different type of disaster
- Disasters arising out of natural calamities like floods are a real & serious threat in Bharuch & Ankleshwar.
- Geographical location of case area play an important part in the disaster vulnerability of the area

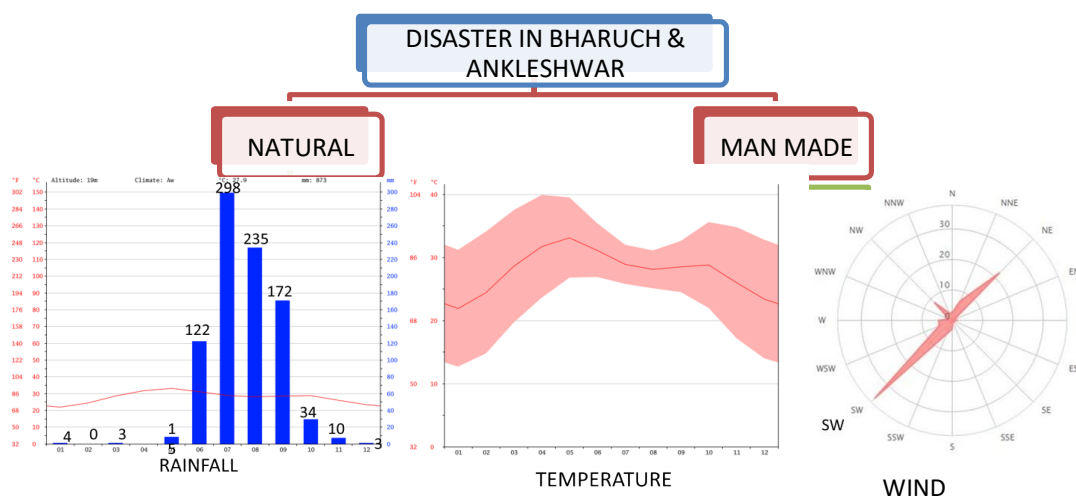


Figure 5. Climate charts

4.2. Depth of water level

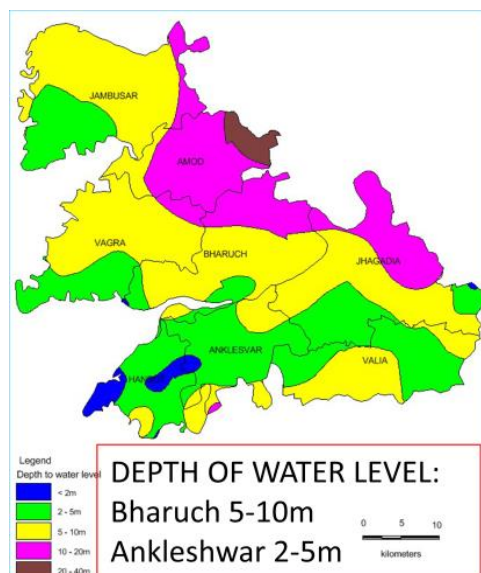


Figure 5. Depth of Water level

4.3. Disaster scenario in Bharuch & Ankleshwar in Gujarat

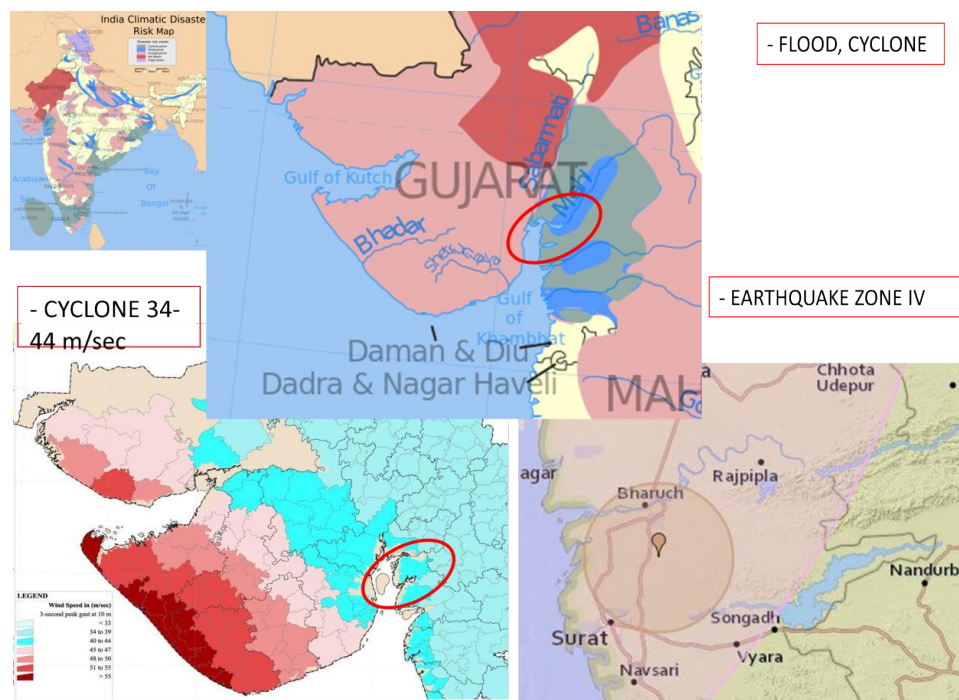


Figure 6. Disaster Scenario

4.3.1. Flood

- WHY: Bharuch is located on flat lowlands of lower Narmada basins are prone to flooding.
- The flooding may occur as a result of heavy monsoons or even cyclones.
- Due to sudden rise in the level of water in Narmada River.
- During high tide in Gulf of Kambath water table in Narmada increases.
- After construction of Sardar Sarovar dam risk of damage due to flood is reduced, now flooding mainly occurs due to the high rainfall in upper catchment of Narmada during rainy season.
- The storm water from the entire town drains into the river.

4.3.2. Earthquake

- Both city area falls under moderate risk zone (**Zone IV**) of Seismicity.
- The city needs certain building by-laws which will follow building code in such region
- Need to identify old & debilitated buildings.

4.3.3. Cyclone

- It is categorized as a Moderate damage risk zone-A of about 44 m/s wind velocity.
- So far 3 cyclones have hit Bharuch costal line but none has recorded as severe.

Table 1. Rainfall data of last 50 years

RAINFALL DATA OF AST 50 YEARS

Sr. No	YEAR	DANGER LEVEL CROSS FLOOD DETAILS IN METER	Sr. No	YEAR	DANGER LEVEL CROSS FLOOD DETAILS IN METER	Sr. No	YEAR	DANGER LEVEL CROSS FLOOD DETAILS IN METER
1	1970	12.65	18	1987	5.35	35	2004	6.95
2	1971	7.92	19	1988	8.23	36	2005	6.1
3	1972	9.75	20	1989	7.2	37	2006	9.7
4	1973	11.3	21	1990	11.28	38	2007	7.95
5	1974	9.15	22	1991	8.6	39	2008	8.45
6	1975	8.69	23	1992	6.1	40	2009	7.5
7	1976	8	24	1993	9.1	41	2010	8.55
8	1977	8.23	25	1994	12.05	42	2007	6.1
9	1978	8.69	26	1995	7.8	43	2008	4.419
10	1979	9.6	27	1996	10.05	44	2009	6.628
11	1980	9.38	28	1997	9.1	45	2010	6.628
12	1981	9.45	29	1998	10.45	46	2011	7.5
13	1982	7.62	30	1999	9.85			7.085
14	1983	-	31	2000	5.486	48	2012	9.2
15	1984	10.66	32	2001	5.409	49	03/08/2013	9.83
		6.86	33		8.75	23-		
16	1985		34	2002		50	25/08/2013	11.13
17	1986	9.67		2003	6.019			

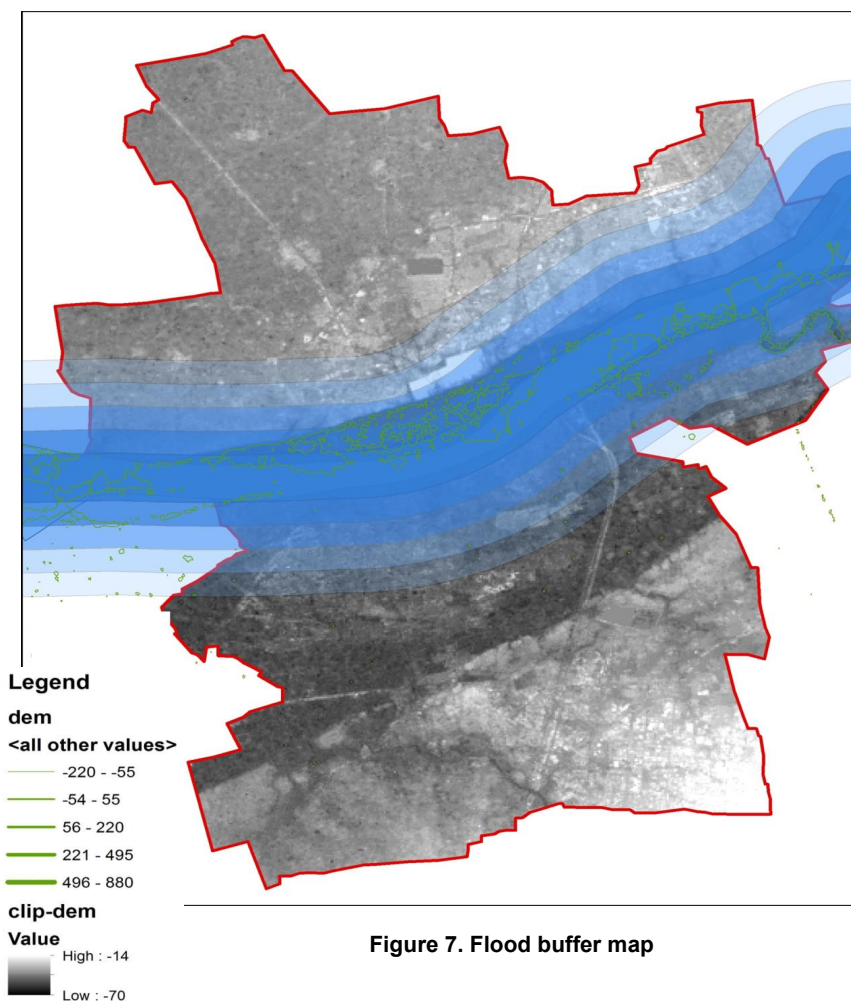


Figure 7. Flood buffer map

Table 2. Flood water level data

INSTRUCTION	FOOT	METER
Alert	22	6.71
Ready for Evacuation	23	7.01
Immediate Evacuation	24	7.31

4.4. Bharuch flood map

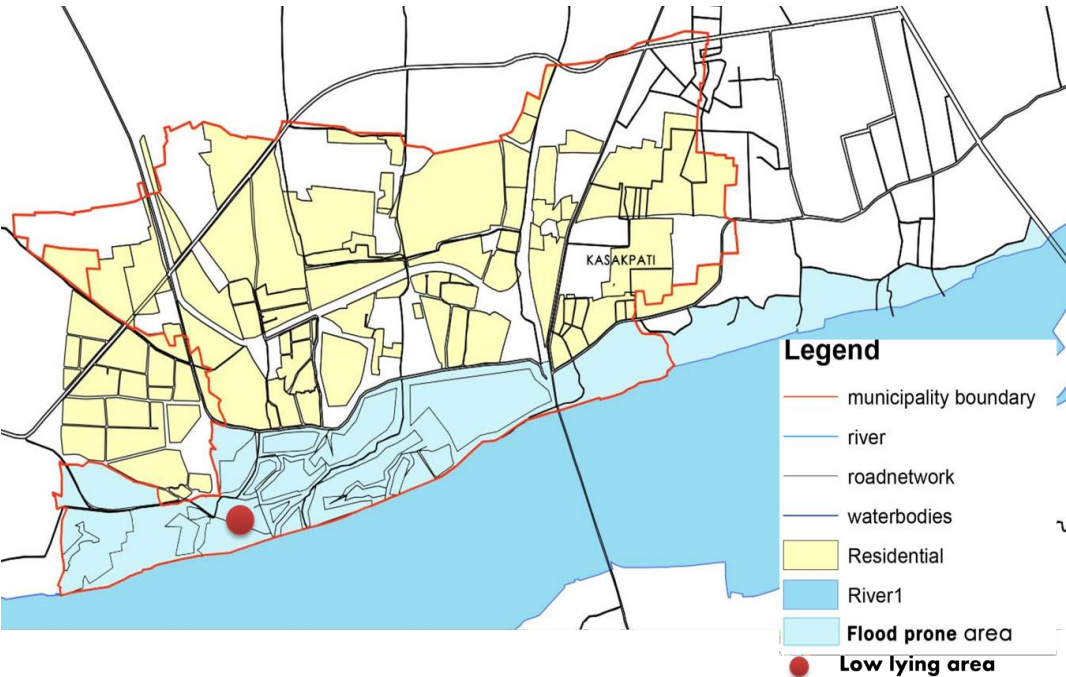


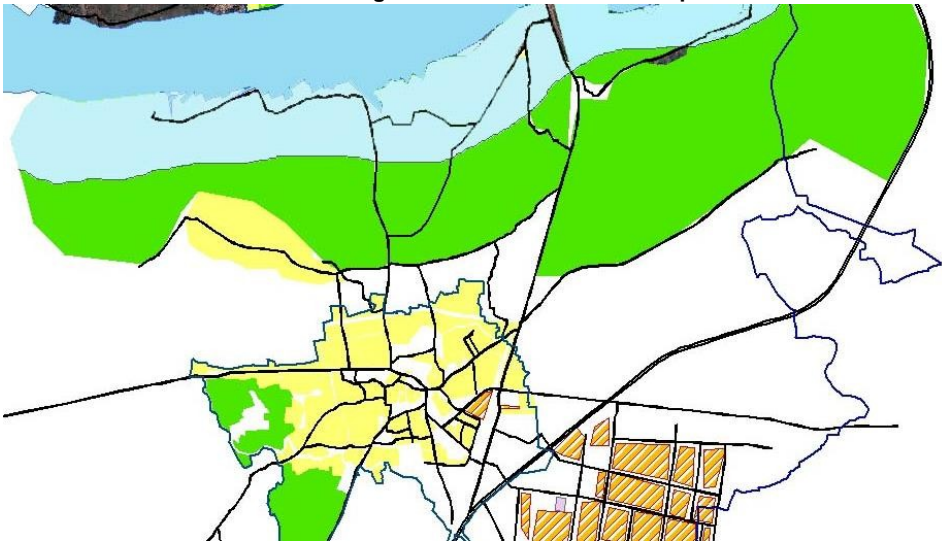
Figure 8. Bharuch Flood map

- Built-up area is there along Narmada River
- Total Bharuch stretch is 12km (appx) along river

4.4. Ankleshwar flood map

- Agriculture land is there along Narmada river
- Total Ankleshwar stretch is 12km (appx) along river

Figure 9. Ankleshwar flood map



TOTAL POPULATION	TOTAL FEMALE POPULATION	TOTAL CHILDREN BELOW 14 YEARS	OLD AGE GROUP AFTER 60 YEARS	ROAD WIDTH	STROM WATER DRIANS	INSURANCE(% PEOPLE INSURANCED)	HOUSE TYPOLOG Y	AGE OF STRUCTURE	HEIGHT OF STRUCTURE	HISTORY OF REPITATION OF EVENT	FACILITIES AVAILABLE LIKE RESCUE TEAMS, NGOS, OTHER EQUIPMENT	TOTAL
	% of population 1. high 2. medium 3. low	% of population 1. high 2. medium 3. low	% of population 1. high 2. medium 3. low	IN FEET 1. RW>20, 2. RW/20 TO30) 3. RW/30 AND ABOVE)	1. NOTAVAILABLE, 2. ONLY ONE SIDE OF ROAD, 3. BOTH SIDE ALONG ROAD	1. < 35% 2. 35% TO 55% 3. 55% AND ABOVE	1. KUTCHA, 2. SEMI Pucca, 3. Pucca	1. ABOVE 35 YEARS, 2. 34 TO 20 YEARS, 3. 20 AND BELOW	1. ABOVE G+2, 2. G+1, 3. GROUND	1. ONCE IN 5 YEARS, 2. ONCE IN 5 TO 10 YEARS, 3. ONCE IN 10 TO 20 YEARS	1. UN AVAILABLE, 2. AVAILABLE BUT MAY NOT BE SUFFICIENT , 3. SUFFICIENT	
7421	3	3	3	3	1	2	3	2	1	1	2	24
12180	1	1	1	3	1	2	3	2	1	1	2	18
10383	2	2	2	1	1	1	1	1	2	1	2	16

Figure 10. Detailed flood analysis - Bharuch

4.5. Flood analysis – Bharuch

Table 3. Ward population data - Bharuch

WARD	POPULATION	SCORE
7	7421	3
9	9302	3
11	10335	3
10	10383	2
3	11951	2
6	12072	2
8	12180	1
5	12361	1
4	12456	1
1	16886	1
2	20332	1

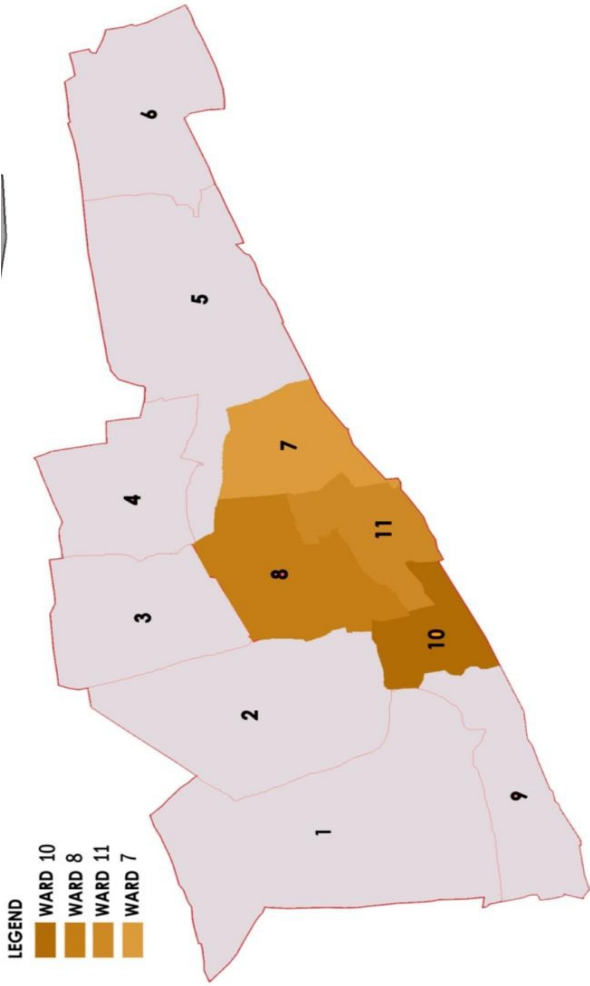


Figure 11. Zone map - Bharuch

EVENT	WARD NO	TOTAL POPULATION	TOTAL FEMALE POPULATION	TOTAL CHILDREN BELOW 14 YEARS	OLD AGE GROUP AFTER 60 YEARS	ROAD WIDTH	INSURANCE (% PEOPLE INSURANCE D)	HOUSE TYPOLOGY	AGE OF STRUCTURE	HEIGHT OF STRUCTURE	HISTORY OF REPUTATION OF EVENT	FACILITIES AVAILABLE LIKE RESCUE TEAMS, NGOS, OTHER EQUIPMENT	TOTAL
	SCORE		% of population 1. high 2.medium 3. low	% of population 1. high 2.medium 3. low	% of population 1. high 2.medium 3. low	IN FEET 1. RW>20, 2. RW(20 TO30) ,3. RW(30 AND ABOVE)	1. < 35% 2. 35% TO 55% 3. 55% AND ABOVE	1. KUTCHA, 2. SEMI PUCCA, 3. PUCCA	1. ABOVE 35 YEARS, 2. 34 TO 20 YEARS, 3. 20 AND BELOW	1. ABOVE G+2, 2. G+1, 3. GROUND	1. ONCE IN 5 YEARS, 2. ONCE IN 5 TO 10 YEARS, 3. ONCE IN 10 TO 20 YEARS	1. UN AVAILABLE , 2. AVAILABLE BUT MAY NOT BE SUFFICIENT , 3. SUFFICIENT	
EARTH QUAKE	B1	16886	1	1	1	2	1	3	1	1	3	2	17
EARTH QUAKE	B2	20332	1	1	1	2	1	3	1	1	3	2	17
EARTH QUAKE	B3	11951	2	2	2	2	1	3	3	1	3	2	22
EARTH QUAKE	B4	12456	1	1	1	2	1	3	3	1	3	2	19
EARTH QUAKE	B5	12361	1	1	1	3	2	3	2	1	3	2	21
EARTH QUAKE	B6	12072	2	2	2	2	1	3	3	1	3	2	22
EARTH QUAKE	B7	7421	3	3	3	3	2	3	2	1	3	2	26
EARTH QUAKE	B8	12180	1	1	1	3	2	3	2	1	3	2	20
EARTH QUAKE	B9	9302	3	3	3	1	2	1	1	2	3	2	22
EARTH QUAKE	B10	10383	2	2	2	1	1	1	1	2	3	2	18
EARTH QUAKE	B11	10335	2	2	2	2	2	3	1	2	3	2	23

Figure 12. Detailed flood analysis – Ankleshwar

4.6. Earthquake analysis Ankleshwar

Table 4. Ward population data - Ankleshwar

WARD	POPULATION	SCORE
7	7421	3
9	9302	3
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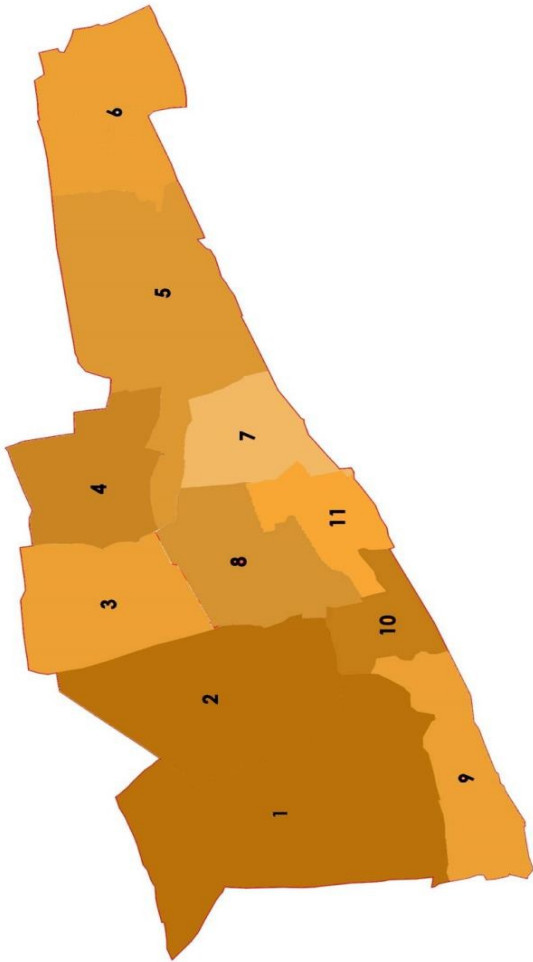


Figure 13. Zone map - Ankleshwar

5. Industrial & roads/accidents disaster

5.1. Introduction

- Bharuch is one of the fastest developing, highly industrialized districts in the country with over 11,500 units of small and medium industries from sectors such as chemicals and petrochemicals, engineering, and textiles.
- The district is sub-divided into eight Talukas: Amod, Bharuch, Jambusar, Jhagadia, Vagra, Valia, Hansot, and Ankleshwar.
- Each Taluka has a Major Accident Hazard (MAH) unit. Ankleshwar has the maximum concentration of MAH industries with 81 units.
- The district has the highest preponderance of hazardous chemical industries and is rated in the AA Category making Bharuch a 'Highly Hazardous' district in the State SCG Response Plan (2008).
- The figure below shows the location of MAH, Type A and Type B units in Bharuch District.

5.2. Industrial disasters handling agencies:

- Industrial disasters in case are limits are handled by DISASTER PREVENTION AND MITIGATION CENTRE, ANKALESHWAR.
- It was set up by Ankleshwar industrial association with help of Gujarat industrial development association.
- DPMC set up in 1995 but full fledged came into force by 2003.
- DPMC, Ankleshwar has been working efficiently to tackle various industrial emergencies and disaster like fire, explosion and gas leakage, toxic releases etc.
- Purpose of setting up DPMC is firefighting personnel's were facing difficulty in handling industrial and chemical emergencies due to insufficient knowledge and experience about chemical and industrial hazards.

5.3. DD plan Ankleshwar estate

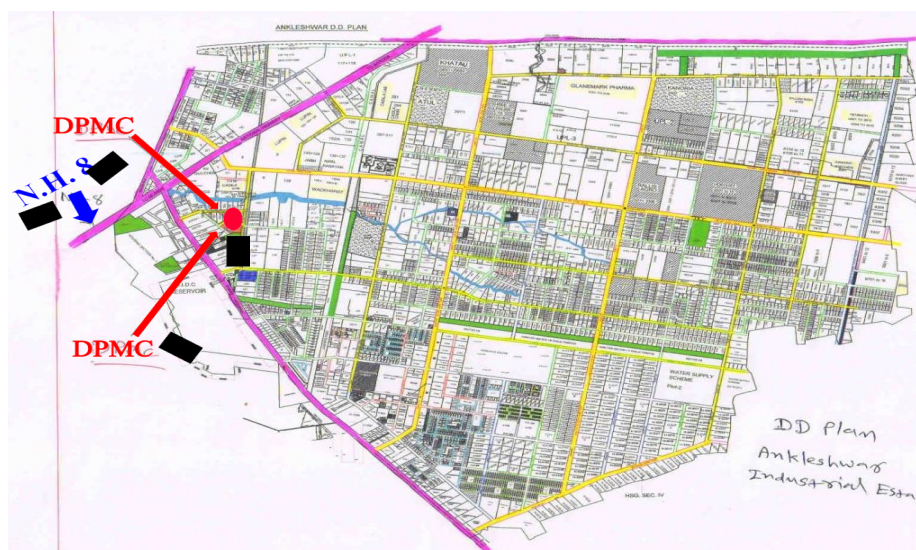


Figure 14. DD plan Ankleshwar estate

5.4. Major activities of DPM, Ankleshwar

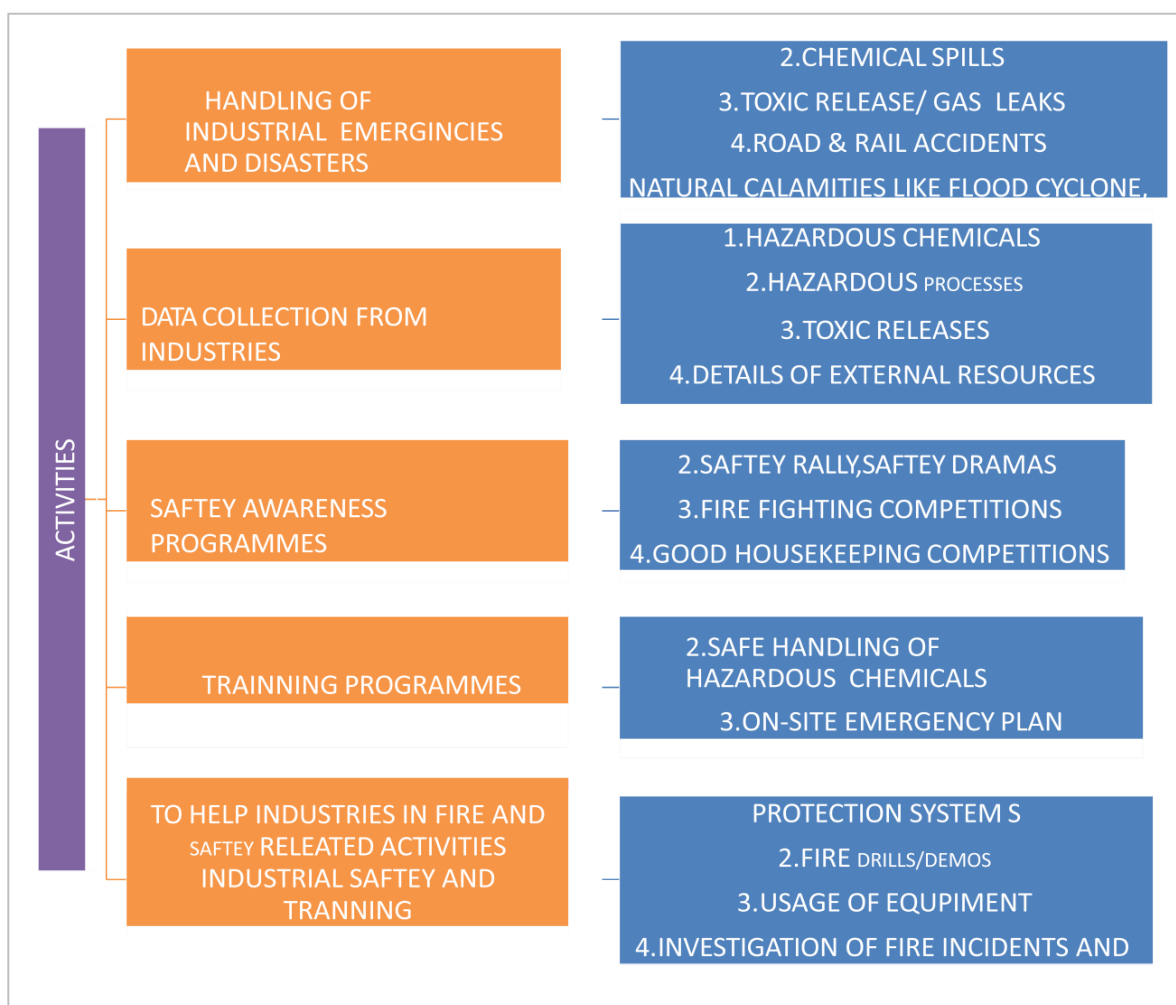


Figure 15. Flow chart of major activities of DPM, Ankleshwar

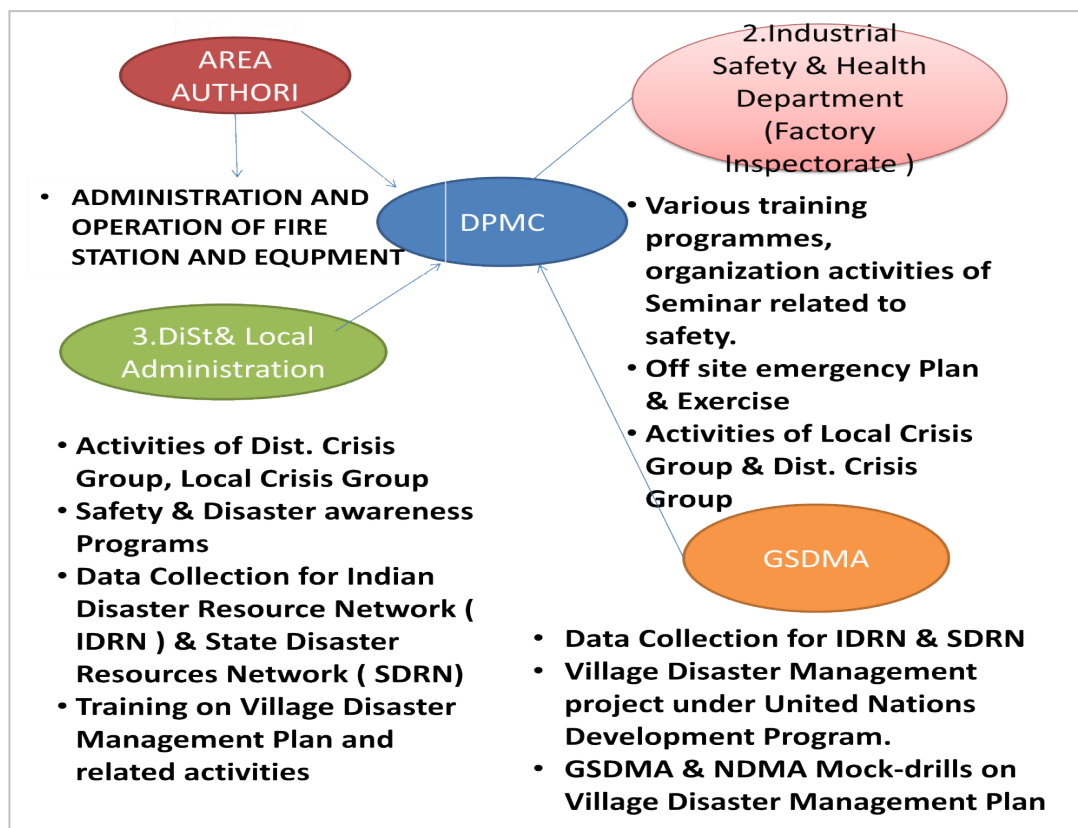


Figure 16. Disaster management center, old building in 1995

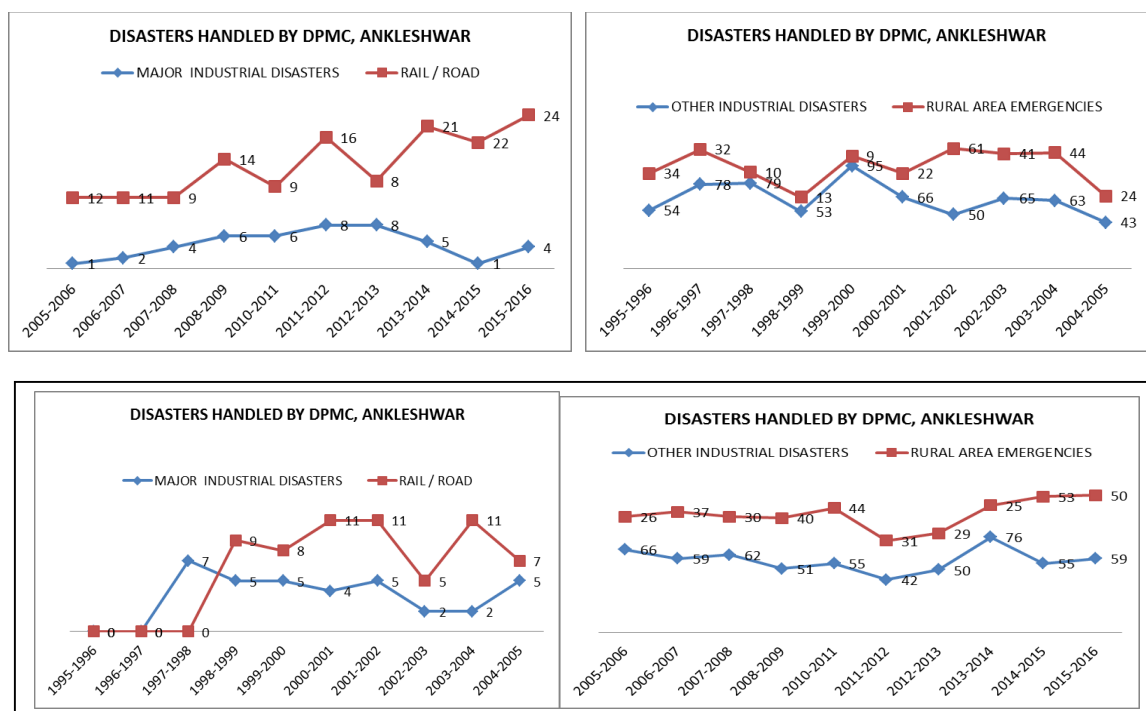


Figure 17. Accommodated in full-fledged new building in December – 2003

5.5.DPMC with other agencies



5.6. Various disaster handled by DPM



6. Strategies for flood prone areas

6.1. Identification of flood prone areas:

- Other areas can be flooded, mainly because of ;
- Heavy Intensity Rains,
- Inundation on Depression,
- Back flow in Drains,
- Inadequate Drainage,
- Failure of protection Works.

6.2. Land Use Restructuring & Zoning in the Flood plain

- The Land use and the activity pattern of the flood prone area is extremely crucial in the effectiveness of the flood mitigation measures.
- Creation of buffer zone all along the river and strong regulatory measures to prevent any encroachments.
- Only recreational activities like parks, gardens, play areas may be allowed within the buffer zone. This will also add to the green cover of the city.
- Construction of strong, high, steep sloped embankment walls along the river would control the overflowing river during monsoons. This would also create a barrier to halt the encroachments on the river banks

6.3. Regulations for land use zoning for natural hazard prone areas

- Providing regulations for development in particular area to serve desired purpose efficiently & to preserve its character.
- Providing a legal tool for guiding the use of land & protection of public health, welfare safety.

6.4. Restriction of development on high hazard prone areas:

Anthropogenic activities on unsuitable lands exacerbate disaster putting the built-up and population at high risk. This could be made possible by strategies such as:

- Scientific vulnerability assessment and micro zoning of disasters.
- Discourage construction on high hazard zones.
- Preparation and enforcement of planning tools that integrates risk and vulnerability assessment.

6.4.1. Urban green area to be conserved

- Green areas should be used as ground water recharge points & as buffers Protection of major connectivity route and critical infrastructure
- Protection and strengthening critical public facilities and physical infrastructure, through proper design for adequate resilience to hazards.

6.4.2. Awareness raising

- "Concept of community participation" in areas of disaster risk reduction and management by:
- Adopting specific policies, attribution of roles and responsibilities and the delegation of provision of the necessary authority and resources at grass root level.
- Training & Technical support Learning & experience sharing Flood control measure–
 - *Structural measures include reservoirs, embankments, channel improvement.*
 - *Non-structural measures include flood plain zoning, watershed management, flood forecasting and flood warning.*

6.4.3. Buildings

- High plinths; No basements allowed
- All buildings to be at least G+1 structures
- Mechanisms to prevent collapse, buckling and cave-ins of buildings during and after floods
- Minimum use of timber in construction (rails, posts, door frames) as it tends to rot.
- Emergency shutdown and evacuation mechanisms in every building (especially for lifts/escalators)
- All community facilities/centers/halls to be on high plinth or on upper floors (with open staircases) so that they can serve as emergency shelters during floods.

6.4.4. Infrastructure

- Water Supply and sewage lines to be laid with minimum bends and joints
- Waterproof, leak proof casing for the pipelines, especially at the joints and bends

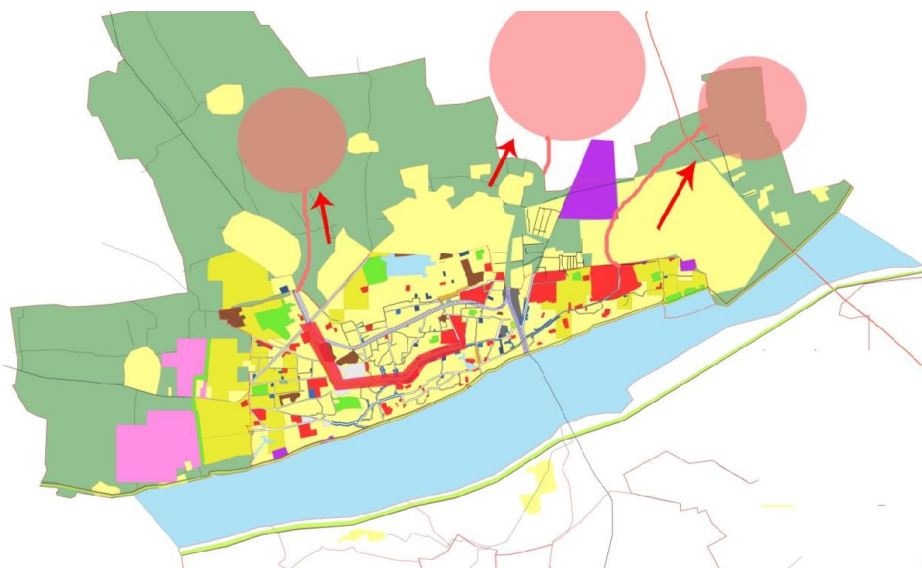
6.4.5. Power supply (Most dangerous in case of floods)

- Electrical supply mains, wires, etc. to be strictly overhead.
- High voltage installations strictly not allowed in the flood prone zone
- Electrical installations, transformers, etc., to be strictly placed at safe levels (mounted on poles or on high plinths).
- Planning and management of power supply networks

6.4.6. Drainage and solid waste

- Detailed analysis of the drainage patterns and measures to keep them effectively working
- All the manholes/inspection chambers to be of larger dimensions than those in other normal areas
- Solid waste dumping is main cause for water clogging and flooding in most of the cases. A detailed survey is essential to locate such critical areas and measures taken to prevent dumping
- Effective solid waste management systems to be set in place

6.4.7. Evacuation map



6.4.8. Flood management guidelines in India disaster management act 2005

The NDMA has the responsibility of laying down the policies, plans and guidelines for effective Disaster Management emphasize:-

1. Importance of non-structural measures which are very effective in reducing loss of life and property and can be implemented in a short time.
2. Proposed to set up establishment of River Basin Organizations as a mechanism for interstate coordination.
3. Proposed to set up a National Institute of Flood Management for taking up training, research and development activities related to floods and their management.
4. The guidelines envisage that the states will enact and enforce the flood plain zoning regulations on the lines of model bill circulated by the ministry of water.(KASPOTI BAZAR)



Figure 18. Kaspoti Bazar

7. Conclusion - Safe city proposals

7.1. Construction of levees



LEVEE

Wide embankment built along river-banks – made from clay, sand, or soil; sometimes topped with sandbags

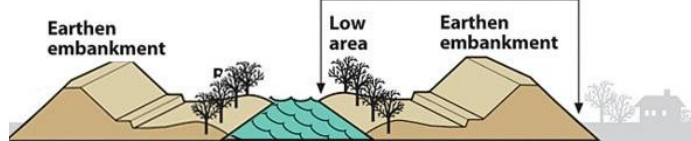
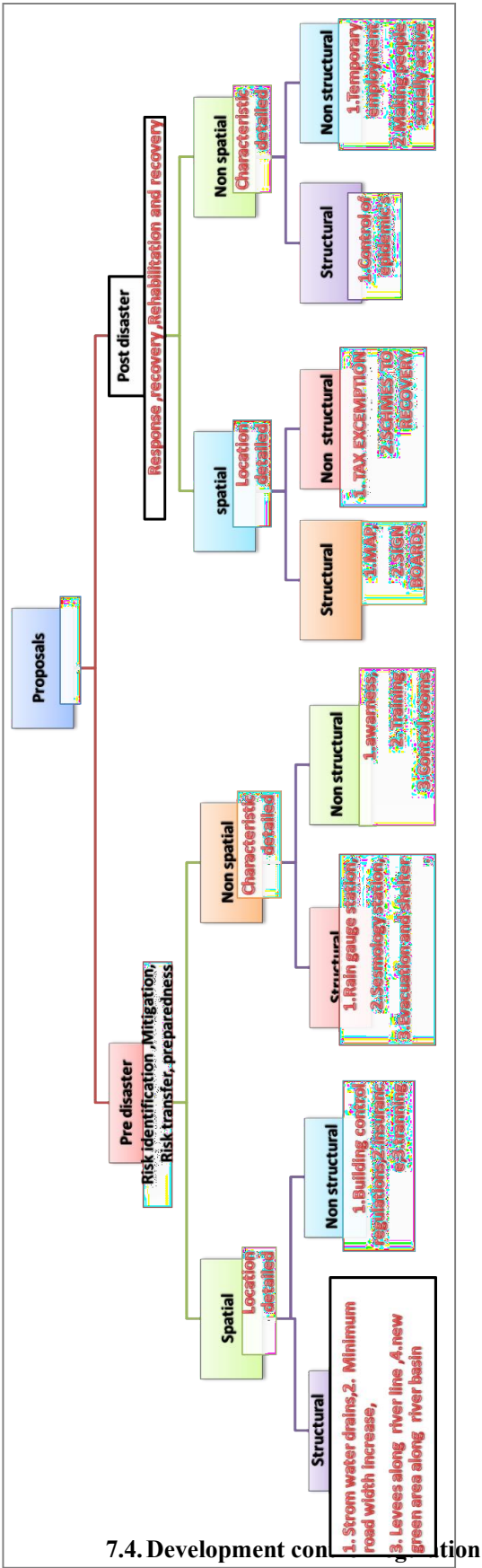


Figure 19. Construction of levees and cross section of a levee

LENGTH: 14KM (approximately) along river on both sides

HEIGHT: 17M, as maximum danger level crossed is 12.65mm



7.2. Construction of storm water drains



Figure 19. Construction of storm water drains

- As storm water drains are only 4% in Bharuch
- Proposing new storm water drains
- Maintenance and operation sewage and stormwater drains

7.3. Road widening



Figure 20. Road widening image



- Excavation routes for any disaster
- It also related to sewage and drainage's
- It can only done on wards no other

- Controlled increase in flood prone areas like ward 7,8,10,11 Bharuch
- Proposing Narmada water board
- Golden bridge engineer
- Rain gauge station & Seismology station comes under MOEF, MOES
- Evacuation & temporary arrangement of shelter
- Map showing evacuation route
- Sign Boards showing routes

7.5. Control of epidemics:

- Marking of health care center
- Providing basic medication

7.6. Temporary Employment

- Construction Contractor in recovery process

7.7. Making people socially active

- Telling them not to get hyper
- Awareness about diseases

7.8. Land Use

- Hazardous activities should be shifted away from the high density areas and ecologically sensitive areas.

7.9. Inadequacy in Infrastructure provisions

- Provide adequate Municipal infrastructure in slums and other areas.
- Provision of fire hydrants at strategic locations
- Solid Waste Management to be improved
- Organize cleaning Nallah

7.10. Local Area Level

- Sewerage network for slum pockets should be improved; Dumping of solid waste directly in the river should be restricted with involvement of the community.
- Involvement of stakeholders and community based organization at each level, for overall development of the slum pockets with adequate infrastructural facilities

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