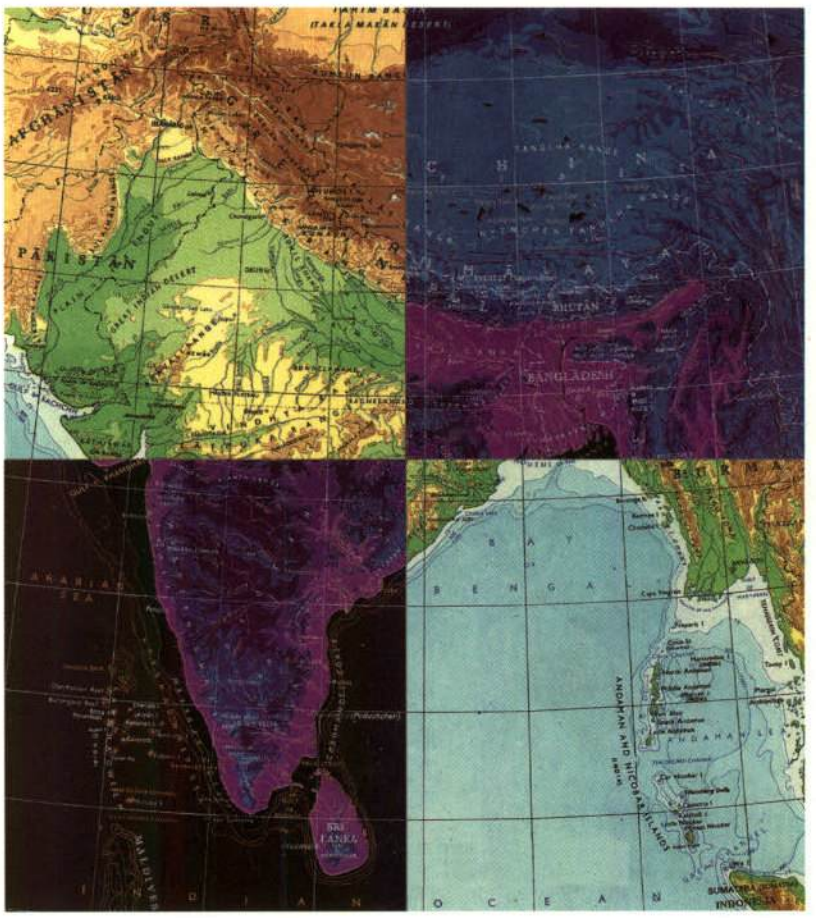
# IDNDR

# Indian Experiences and Initiatives




सत्यमेव जयते

**Ministry of Agriculture**
**Department of Agriculture and Cooperation**
**Government of India**
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## CONTENTS




**Prepared by the Sub-Group set up by the Advisory Committee on International Decade for Natural Disaster Reduction (IDNDR), Department of Agriculture & Cooperation, Ministry of Agriculture, Government of India**

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**The information compiled in this brief document may not be complete. Any information left out is not deliberate.**

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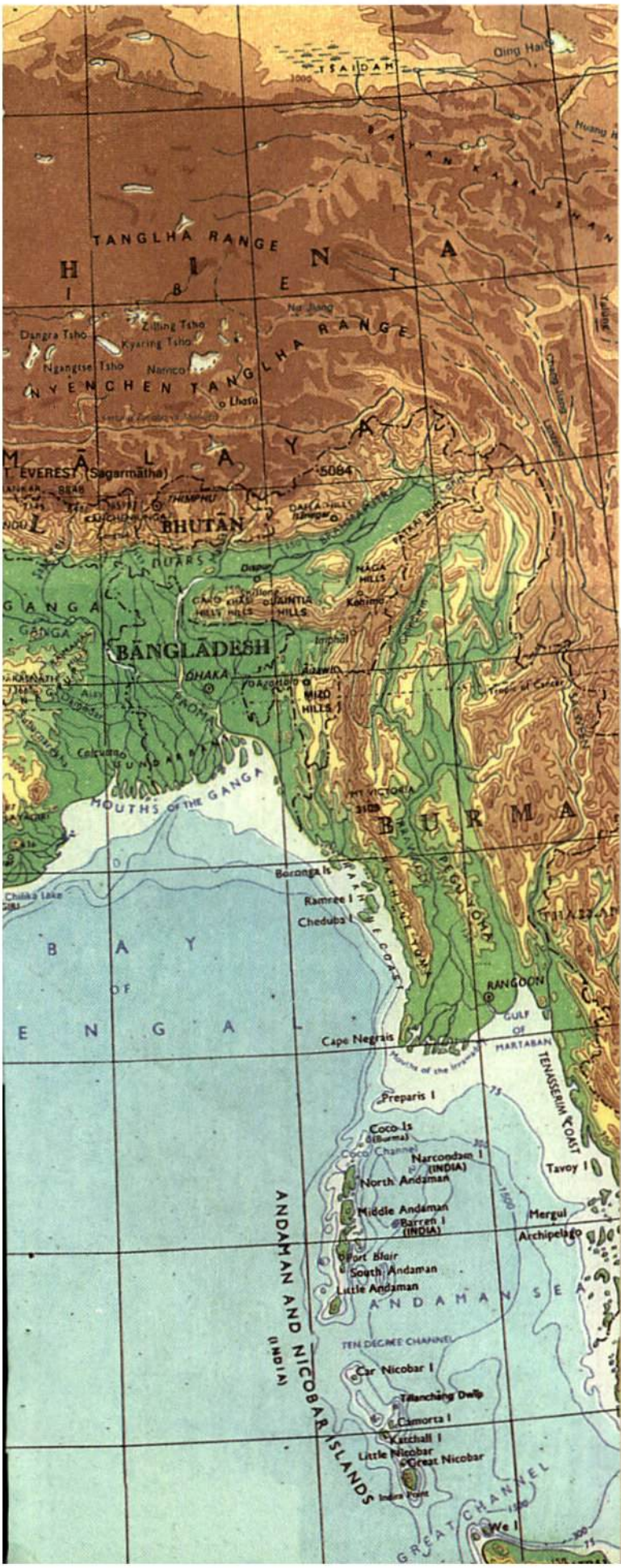



## 1. INTRODUCTION

India is a large country and has had more than its share of major natural hazards like drought, floods, earthquakes and cyclones throughout its history of civilization. Naturally, the country developed its own practices and strategies for coping with the various natural calamities. Since independence in 1947, India has developed a nationwide relief administration where a lead role of the State governments is envisaged. The ten year period of the International Decade for Natural Disaster Reduction (IDNDR), therefore, came as a good opportunity for the country to look back at what had been done in the past, take new initiatives during the Decade, and plan ahead for reducing the impact of the natural hazards on its people, settlements and economic development.

Various initiatives are being taken by the Government of India with active and ongoing collaboration of leading research institutions, autonomous bodies, universities, policy analysis agencies, non-governmental organisations, bilateral aid agencies, multilateral financial institutions, and most importantly the community based organisations.

## 1.1 The Territory of India

i. India covers an area of 32,87,263 sq.km extending from snow covered Himalayan heights in the North to the tropical rain forests of the South. In the North, the territory is bounded by the Great Himalayas and stretches southwards tapering off into the Indian ocean between the Bay of Bengal and the Arabian Sea. The main land extends between latitudes 8°4' and 37°6' North and longitudes 68°7' and 97°25' East, measuring about 3200 km from North to South and West to East. This vast land frontier of 15,200 km and coastline of 7,500 km also has groups of islands located both in the Bay of Bengal and the Arabian Sea. Hardly any other country has such a large land mass with such a diverse range of geo-agro-climatic zones.

ii. The main land of India comprises of four regions, namely, the Great Mountain Zone, Plains of the Indus, Ganges and the Brahmaputra; the Desert Region, and the Southern Peninsula. The Himalayan range comprises three almost parallel ranges interspersed with large plateaus and valleys. The mountain wall extends over a distance of 2,400 km with a varying width of 240 to 320 km. The plains about 2,400 km long, are formed by basins of three distinct river systems, viz., the Indus, the Ganges and the Brahmaputra. The desert region is clearly delineated in two parts - the Great Desert running beyond Rann of Kutch to Rajasthan - Sindh Frontier while the little desert extends between Jaisalmer and Jodhpur upto Punjab. The desert region is inhabited by local communities which have developed their own coping and recovery mechanisms. Between the two deserts is a zone of absolutely sterile region, consisting of rocky land cut up by limestone ridges.

iii. According to 1991 census, India had a population of 843.93 million with 195.02 million housing units. The literacy rate as per 1991 census was 52.2 per cent, 64 per cent for male and 39 per cent for female. To protect such a large population with low levels of education from the fury of natural hazards is not an easy task. However, local initiatives and the government's efforts combined over the years, have tried to reduce risks and build community capacity to deal with emergencies.

iv. The country is a Union of 25 States and 7 Union Territories. The Union Territories are subject to the direct rule-making powers of the National Parliament and the administrative control of the Union Government. The States have elected Legislatures and Governments, which are fully autonomous in relation to the sphere of activities entrusted to them under the Constitution. The States are further divided into Administrative Units called Districts totalling to 451 in the country. The sizes of the districts vary from small to large, the average area being 7300 sq.km and average population 1.9 million in 1991. Under the Constitution, relief and disaster management are State subjects. Now under the 73rd and 74th constitutional amendments, the village panchayat (rural local body) and the nagarpalika (urban local body) have the powers to initiate preparedness, mitigation, recovery and rehabilitation initiatives. Thus India has a decentralised administrative framework for local and community based initiatives.

## 1.2 Natural Hazards and Disasters

i. Because of the large geographical size of the country, India often faces natural hazards like floods, cyclones and drought occurring frequently in different parts of the country. At times, some areas normally subjected to drought situation have got flooded in certain years. Hazards like earthquakes, hailstorms, avalanches, landslides, etc. occur quite suddenly but they are restricted in their impact in terms of time. The extent of the impact of an earthquake depends on its Magnitude, season and time of occurence.

Natural calamities may be broadly grouped into major and minor types depending upon their potential to cause damage to human life and property. While natural

hazards like *earthquakes, droughts, floods and cyclones* could be regarded as *major*, hailstorms, avalanches, landslides, bush fires, etc., whose impact is localised and intensity of the impact on the society is much less, can be categorised as *minor* hazards. Different research institutes are doing further research in the local vagaries. So far as damage to housing and infrastructure is concerned, floods, cyclones and earthquakes turn out as the three major disasters confronting the country. However, the repeated droughts affect the water sector, thus drinking water and irrigation are adversely affected.

ii. The hazards, earthquakes, cyclones, droughts and floods are called natural since they result from natural phenomena connected with the earth's interior and the atmosphere, unaffected and uncontrolled by man. They become disasters when they impact on vulnerable habitat containing unsafe buildings and the infrastructure whose collapse or damage leads to adverse social, economic and health consequences. Certain actions of man sometimes even aggravate the disastrous impacts of natural hazards. For example, construction of buildings and structures on unstable hill slopes or loose sands with high water table which will easily liquefy under seismic vibrations, will very much enhance the disaster. Constricting or choking the water ways will result in higher flood levels. On the other hand, safer designs and constructions will reduce their vulnerability and minimise the disaster. *Thus hazards are natural but disasters are man-made.* In addition, a considerable size of population lives in poverty who are vulnerable to even slightest seasonal changes. Delayed monsoon may mean a major loss of income and assets to them.

## 1.3 Management of Disasters in India

i. The basic responsibility for management of disasters is that of the State Government concerned. The role of the National government is supportive, in terms of supplementation of physical and financial resources and complementary measures in sectors like transport, warnings and interstate movement of food grains. The national government also sets out the policy climate and draws lessons from disasters. The lessons learned are communicated to States and national initiatives are made possible. The Union Department of Agriculture & Cooperation (DAC) is the nodal Department. An Additional Secretary in the DAC is designated as the Central Relief Commissioner. He provides the focal point for interaction with the State Governments, and other Departments and agencies of the Union Government and for the implementation of the decision of the Union Government. Now, as a national initiative, the representatives of the communities and the NGOs are invited in the operational and policy processes so as to achieve greater impact of mitigation and preparedness measures. For example, CARE (India) coordinates the Government of India NGO Committee and Disaster Mitigation Institute is invited to join in dissemination of information and awareness programmes and different task forces constituted for disaster management related activities.

The interaction pattern which becomes operative in a huge calamity is shown in the *Fig.1*.

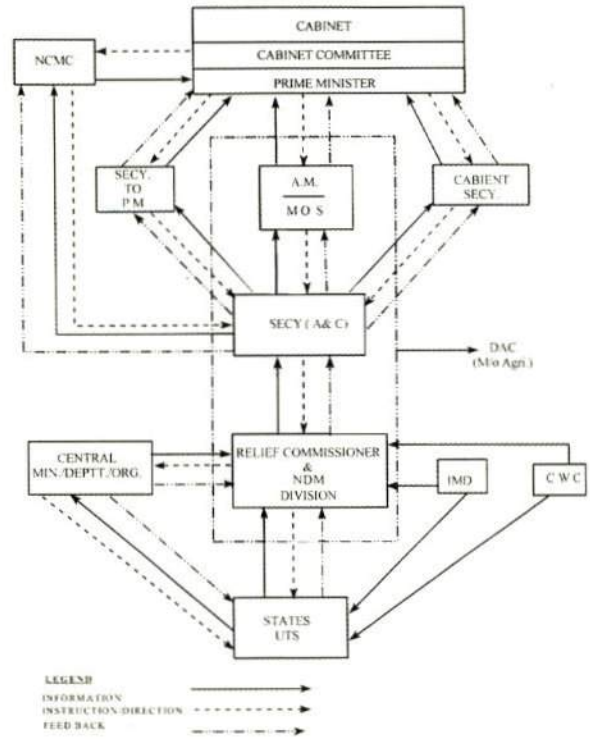



**Fig.1: Management of Disasters in India - Interaction pattern**
*Source: Report (Part-I) of Expert Group set up by Ministry of Urban Development, 1998*

ii. At the State level, the State Relief Commissioner or Secretary, Department of Revenue, directs and controls the relief operations through District Collectors or Deputy Commissioners, who are the king-pins of all relief operations, coordination, direction and control at the District level. State Governments have formulated their Relief Manuals and the Districts have their Contingency Plans which are updated from time to time based on the experience. Routinely NGOs and community are invited before the monsoon to share the contingency plan. In case of a disaster, the State Government invites NGOs and other relief organisations to join in the efforts in reaching out to the victims.

## 2. NATURAL HAZARD OCCURENCES IN INDIA

### 2.1 Earthquake Occurrences

India has a large part of its land area liable to wide range of probable maximum seismic intensities where shallow earthquakes of magnitudes of 5.0 or more on Richter scale, have been known to occur in the historical past or recorded in the last about 100 years. IMD has prepared a catalogue of all such known earthquakes which is continually updated. The largest earthquake magnitude in India has been 8.7 which had its origin in the Shillong Plateau in 1897. This and the 1950 quake of M = 8.6 in Sadiya region have been so intense that the rivers changed their courses, ground elevations got changed permanently and stones were thrown upward. A list of better known damaging earthquakes in India is given in *Table-1*.

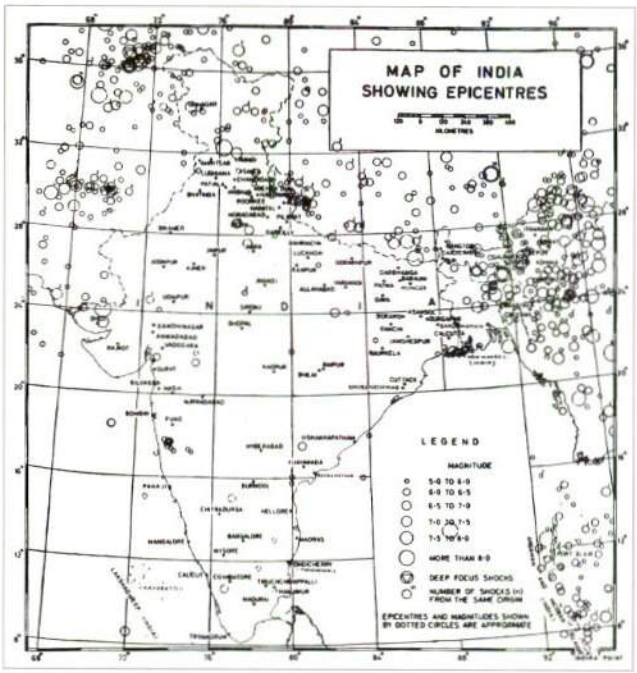



**Fig.2: Epicentral Map - India**
*Source: Report (Part-I) of Expert Group set up by Ministry of Urban Development, 1998*

**Table 1: Some better known damaging earthquakes in India**
*Source: Report (Part-I) of Expert Group set up by Ministry of Urban Development, 1998*

| Year | Area | Date | (I.S.T) Time hr:m:s | Latitude degrees North | Longitude degrees East | Magnitude M | Max. MM Int. | Deaths |
|---|---|---|---|---|---|---|---|---|
| 1819 | Gujarat (Kutch) | Jan.16 | Mid Night | - | - | 8.0 | XI | Many Thousand |
| 1833 | Bihar | Aug.26 | - | 27.5 | 86.5 | 7.7 | XI | Hundreds |
| 1897 | Assam (Shillong) | Jun.12 | 16:36:- | 25.9 | 91.0 | 8.7 | XII | 1600 |
| 1900 | Kerala (Palghat) | Feb 8 | - | 10.7 | 76.7 | 6.0 | - | |
| 1905 | Himachal Pradesh (Kangra) | Apr 4 | 06:20:- | 32.5 | 76.5 | 8.0 | XI | 20000 |
| 1930 | Assam (Dhubri) | Jul 3 | 02:33:34 | 25.8 | 90.2 | 7.1 | IX | Many* |
| 1934 | Bihar -Nepal | Jan 15 | 14:13:26 | 26.6 | 86.8 | 8.3 | XI | 14000 |
| 1941 | Andamans | Jun 26 | - | 12.4 | 92.5 | 8.0 | X | Many |
| 1943 | Assam (NE) | Oct 23 | 22:53:17 | 26.8 | 94.0 | 7.2 | X | |
| 1950 | Assam (NE) | Aug 15 | 19:39:28 | 28.7 | 96.6 | 8.6 | XII | 1500 |
| 1956 | Gujarat (Anjar) | Jul 21 | 21:02:36 | 23.3 | 70.0 | 7.0 | VIII | Hundreds |
| 1956 | Uttar Pradesh (Bullandshahar) | Oct 10 | - | 28.1 | 77.7 | 6.7 | VIII | Many |
| 1958 | Uttar Pradesh (Kapkote) | Dec 28 | - | 30.0 | 80.0 | 6.3 | VIII | Many |
| 1960 | Delhi | Aug 27 | 21:28:59 | 28.3 | 77.4 | 6.0 | VII | |
| 1963 | Kashmir (Badgam) | Sep 2 | 07:04:32 | 33.9 | 74.7 | 5.5 | VII | Hundreds |
| 1966 | Western Nepal | Jun 27 | - | 29.5 | 81.0 | 6.3 | VIII | |
| 1966 | Uttar Pradesh (Moradabad) | Aug 15 | - | 28.0 | 79.0 | 5.3 | VII | |
| 1967 | Nicobar | Jul 2 | - | 9.0 | 93.4 | 6.2 | - | |
| 1967 | Maharashtra (Koyna) | Dec 11 | 04:21:19 | 17.4 | 73.7 | 6.5 | VIII | 200 |
| 1970 | Andhra Pradesh (Bhadrachalam) | Apr 13 | - | 17.6 | 80.6 | 6.5 | VII | |
| 1970 | Gujarat (Broach) | Mar 23 | 07:23:03 | 21.7 | 72.9 | 5.7 | VII | |
| 1975 | Himachal Pradesh | Jan 19 | - | 32.5 | 78.4 | 6.5 | VIII | |
| 1988 | Bihar - Nepal | Aug 21 | 04:39:10 | 26.76 | 86.62 | 6.6 | VIII | 1003 |
| 1991 | Uttar Pradesh (Uttarkashi) | Oct 20 | 02:53:- | 30.75 | 78.86 | 6.6 | VIII | 715 |
| 1993 | Maharashtra (Killari) | Sep 30 | 03:55:47 | 18.07 | 76.62 | 6.3 | VIII | 7928 |
| 1997 | Jabalpur | May 22 | 04:22:31 | 23.1 | 80.1 | 6.0 | VII+ | 38 |

** Many will mean less than a hundred*

## 2.2 Cyclone Occurrences

Over the warm water (sea surface temperature greater than 26°C or 27°C) in the tropical ocean, little away from the equator within the belt of 30°N and 30°S, the occurrence of tropical cyclone is almost a world-wide phenomenon. However, their characteristics like frequency, intensity and coastal impact vary from region to region. But these have been the deadliest when crossing the coast bordering the north Bay of Bengal (coastal areas of Andhra Pradesh, Orissa, West Bengal and Bangladesh), mainly because of the serious storm surge problem in this area.

On an average, about 5-6 tropical cyclones form in the Bay of Bengal and the Arabian Sea every year, out of which 2 or 3 may be severe. More cyclones form in the Bay of Bengal than in the Arabian Sea. The ratio is 4:1. There are two definite seasons of tropical cyclones in the North Indian Ocean. One is from May to June and the other is from mid-September to mid-December. May, June, October and November are known for severe storms. The number of tropical cyclones during the period 1891 to 1990 is given in *Table-2*. The entire east coast is vulnerable to cyclones with varying frequency and intensity. Along the west coast, the Gujarat and Maharashtra coasts are more vulnerable compared to the southern part.

The El-Nino effect on weather is seriously being studied by Indian scientists and the outcomes of these studies will help in better communication of early warnings as well as preparedness planning.

**Table 2: Observed number of cyclonic storms crossing the Indian Coasts, 1891-1990**
*Source: Report (Part-I) of Expert Group set up by Ministry of Urban Development, 1998*

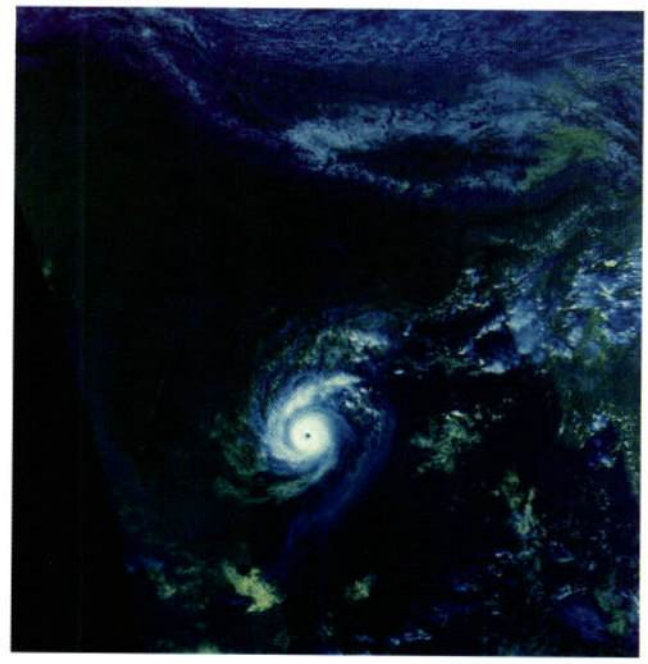
| Degree Latitude | Arabian See Coast | | Bay of Bengal Coast | |
|---|---|---|---|---|
| | All C.S | S.C.S. only | All C.S. | S.C.S. only |
| 8 - 9 | 1 | 1 | 2 | 2 |
| 9 -10 | 1 | 1 | 4 | 3 |
| 10 - 11 | 2 | 1 | 13 | 4 |
| 11 - 12 | 2 | 2 | 7 | 4 |
| 12 - 13 | - | - | 15 | 8 |
| 13 - 14 | 2 | 1 | 11 | 4 |
| 14 - 15 | - | - | 10 | 7 |
| 15 - 16 | - | - | 11 | 4 |
| 16 - 17 | - | - | 18 | 4 |
| 17 - 18 | 1 | 1 | 7 | 2 |
| 18 - 19 | 3 | 1 | 12 | 4 |
| 19 - 20 | 1 | 1 | 23 | 3 |
| 20 - 21 | 6 | 3 | 34 | 8 |
| 21 - 22 | 8 | 4 | 95* | 35* |
| 22 - 23 | 3 | 0 | X | X |
| 23 - 24 | 3 | 2 | X | X |
| **TOTAL** | **33** | **18** | **262** | **92** |

*: These are upto Long. 90°E, hence, the number crossing Indian Coast upto about 89°E will be less
X : No sea coast here
*Source : Cyclone Data 1891- 1990, IMD, G.O.I.*
C.S. = Cyclonic Storm
S.C.S. = Severe Cyclonic Storm

**Deaths in some major cyclonic storms around Bay of Bengal**
*Source: Report (Part-I) of Expert Group set up by Ministry of Urban Development, 1998*

| S.No. | Year | Country | Deaths |
|---|---|---|---|
| 1. | 1737* | Hoogly, West Bengal | 300,000 |
| 2. | 1779 | Masulipatnam | 20,000 |
| 3. | 1787 | Coringa, Andhra Pradesh | 20,000 |
| 4. | 1789 | Coringa, Andhra Pradesh | 20,000 |
| 5. | 1822 | Barisal/Backergunj | 50 000 |
| 6. | 1831 | Balasore | 22,000 |
| 7. | 1833 | Sagar Island | 30,000 |
| 8. | 1839 | Coringa, Andhra Pradesh | 20,000 |
| 9. | 1864 | Contai, West Bengal | 50 000 |
| 10. | 1864 | Masulipatnam | 30,000 |
| 11. | 1876 | Backergunj | 200,000-250,000 |
| 12. | 1885 | False Point, Orissa | 5,000 |
| 13. | 1897 | Bangladesh | 175 000 |
| 14. | 1942 | Contai, West Bengal | 15,000 |
| 15. | 1960 | Bangladesh | 5,490 |
| 16. | 1961 | Bangladesh | 11,468 |
| 17. | 1963 | Bangladesh | 11,520 |
| 18. | 1965 | Bangladesh | 19,229 |
| 19. | 1970 | Bangladesh | 200,000 |
| 20. | 1971 | Paradip, Orissa | 10,000 |
| 21. | 1977 | Chirala, Andhra Pradesh | 10,000 |

**Satellite image of 6th Nov. 1996 shows a cyclonic storm developed in Bay of Bengal and approaching the Godavri delta in Andhra Pradesh.**
*Source: Report (Part-I) of Expert Group set up by Ministry of Urban Development, 1998*



## 2.3 Flood Occurrences

The country receives an annual precipitation of 400 million-hectare meter. Of the annual rainfall, 75 per cent is received during four months of monsoon (June - September) and, as a result, almost all the rivers carry heavy discharge during this period. The problems of sediment deposition, drainage congestion and synchronization of river floods compound the flood hazard. The area liable to floods is 40 million hectares; the average area affected by floods annually is about 8 million hectares. The average annual total damage to crops, houses and public utilities during the period 1953-97 was about Rs. 972.00 Crores*, while the maximum damage was Rs.4630.00 Crores in the floods of 1988. The yearly flood losses during the years 1981-97 are shown in *Table-3*.

With increase in the population and a spurt in economic development, more and more area in the flood plains has been occupied, mainly because of numerous advantages the proximity of river offers in developmental efforts. Interference with the natural drainage by construction of roads, railways and other structures and indiscriminate occupation of flood plains have led to adverse effects of floods being felt more and more with passage of time.

As per the latest information collected by Central Water Commission (CWC), a total area of 14.37 million hectares has been reported protected in various states out of the total flood prone area of the country of about 40 million hectares as assessed by Rashtriya Barh Ayog (RBA) 1980. The protectable area has been considered to be of the order of 32 m.ha. The

**Table 3: Statement showing flood damage during 1981 to 1997**
*Source: Central Water Commission, Ministry of Water Resources, Government of India*

| S. No | Year | Area affected in Million Hectare | Population affected in Millions | Damage to Crops | | Damage of Houses | | Cattle Lost nos. | Human lives lost nos. | Damage to public utilities in Rs. Crores* | Total damages crops, houses & public utilities in Rs. Crores* (Col.6+8+11) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Area in M. Hec. | Value in Rs. Crores* | Nos. | Value in Rs. Crores* | | | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| 1 | 1981 | 6.120 | 32.490 | 3.270 | 524.560 | 912557 | 159.630 | 82248 | 1376 | 512.314 | 1196.504 |
| 2 | 1982 | 8.870 | 56.010 | 5.000 | 589.400 | 2397365 | 383.869 | 246750 | 1573 | 671.607 | 1644.876 |
| 3 | 1983 | 9.020 | 61.030 | 3.290 | 1285.850 | 2393722 | 332.327 | 153095 | 2378 | 873.429 | 2491.606 |
| 4 | 1984 | 10.710 | 54.550 | 5.190 | 906.090 | 1763603 | 181.308 | 141314 | 1661 | 818.164 | 1905.562 |
| 5 | 1985 | 8.380 | 59.590 | 4.650 | 1425.370 | 2449878 | 583.855 | 43008 | 1804 | 2050.043 | 4059.268 |
| 6 | 1986 | 8..310 | 55.500 | 4.580 | 1231.580 | 2049277 | 534.410 | 60450 | 1200 | 1982.535 | 3748.525 |
| 7 | 1987 | 8..890 | 48.340 | 4.940 | 1154.640 | 2919380 | 464.490 | 128638 | 1835 | 950.590 | 2569.720 |
| 8 | 1988 | 16.290 | 59.550 | 10.150 | 2510.640 | 2276533 | 741.600 | 150996 | 4252 | 1377.800 | 4630.040 |
| 9 | 1989 | 8.060 | 34.150 | 3.010 | 956.740 | 782340 | 149.820 | 75176 | 1718 | 1298.770 | 2405.330 |
| 10 | 1990 | 9.303 | 40.259 | 3.179 | 695.610 | 1019930 | 213.733 | 134154 | 1855 | 455.266 | 1708.920 |
| 11 | 1991 | 6.169 | 33.844 | 2.511 | 573.795 | 1125254 | 179.388 | 41065 | 1145 | 685.618 | 1438.801 |
| 12 | 1992 | 2.092 | 19.090 | 1.427 | 654.918 | 560969 | 221.884 | 76804 | 1367 | 1170.806 | 2047.608 |
| 13 | 1993 | 4.632 | 22.901 | 3.129 | 169.3 | 470951 | 124.57 | 11990 | 930 | 48.088 | 341.958 |
| 14 | 1994 | 2.752 | 21.024 | 1.896 | 888.619 | 601379 | 165.205 | 21698 | 1511 | 739.641 | 1793.465 |
| 15 | 1995 | 6.111 | 38.831 | 3.359 | 351.552 | 1195114 | 152.595 | 70371 | 2209 | 67.710 | 571.857 |
| 16 | 1996 | 7.420 | 39.393 | 3.365 | 404.287 | 406718 | 95.601 | 60215 | 1306 | 861.619 | 2204.777 |
| 17 | 1997 | 3.855 | 26.548 | 1.838 | 449.743 | 399534 | 145.578 | 27178 | 929 | 971.615 | 1566.936 |

** 1 crores = 10 million  Rupees value given are for the year concerned*

area liable to floods is the aggregate of different areas flooded in any year during the period of records, and includes the unprotected and protected areas.

The protected area is also vulnerable to floods as the flood control structures, mainly embankments, may breach during a severe flood and the protected areas may be inundated. However, because of the protective measures adopted, vulnerability of houses etc. in such areas is considered to be comparatively less in usual circumstances. The areas outside the flood prone areas are generally not vulnerable to flood. But experience shows that heavy rains in some of these areas can result in flood condition. At times, flooding in such areas may by very severe and create more acute problem than in the identified flood prone areas.

### 2.4 Drought

Due to erratic behaviour of monsoon, both low (less than 750 mm) and medium (750- 1125mm) rainfall regions, which constitute 68 per cent of the total area, are vulnerable to periodical droughts. The rare droughts of most severe intensity occurred on an average once in 32 years and almost every third year was a drought year. Local communities have devised indigenous coping mechanisms and drought-resistant farming methods in many parts of India. Due to renewed emphasis on watershed management, the impacts of droughts and floods are being minimised with community efforts. The most notable among these efforts are the National Watershed Development Programme and the Integrated Watershed Development Programme which are funded by the World Bank.

### 2.5 Landslides

The Himalayan mountains, the North-East hill ranges and the Western Ghats experience considerable landslide activities of varying intensities. The seismic activity in the Himalayan region also results in considerable landslide movement. The heavy monsoon rainfall, often in association with cyclonic disturbances, also produces considerable landslide activity on the slopes of the Western Ghats. The Government of India is collaborating with a wide range of Indian academic institutions on hill research, including International Centre for Integrated Mountain Development in Kathmandu, Nepal, which is a regional institution.

### 2.6 Avalanches

Avalanches constitute a major hazard in the higher elevations of the Himalayas. Losses of life and property have been reported due to avalanches. Parts of the Himalayas receive snowfall round the year. Severe snow avalanches are observed during and after snowfalls in the States of Jammu & Kashmir, Himachal Pradesh and the Hills of Western Uttar Pradesh.

## 3. PRE-DECADE STATUS OF DISASTER MANAGEMENT IN INDIA

**Government of India had formulated a Contingency Action Plan for dealing with contingencies arising in the wake of natural calamities, which had been periodically updated. The major emphasis in the plan was on providing relief in response to the occurrence of a major calamity due to any of the natural hazards which could not be coped by the States or Union Territories through their own resources. The preparedness for providing relief was ensured through Contingency Plans formulated for operations at the State levels as well as at the District levels. The primary relief functions of the Central Government include the following items:**

i. forecasting and operation of warning systems;
ii. maintenance of uninterrupted communication;
iii. wide publicity to warnings of impending calamity, disaster preparedness and relief measures through TV, AIR and Newspapers;
iv. transport with particular reference to evacuation and movement of essential commodities and petroleum products;
v. ensuring availability of essential commodities at reasonable prices particularly the commodities through the Public Distribution System;
vi. ensuring availability of medicines, vaccine and drugs;
vii. preservation and restoration of physical communication links;
viii. investments in infrastructure; and
ix. mobilisation of financial resources.

Schemes for financing expenditure on relief and rehabilitation in the wake of natural calamities are governed by the recommendations of Finance Commissions appointed by Government of India after every five years. In the beginning of the current decade the system of financial response underwent a change so as to reduce the time between occurrence of a calamity and the provision of relief to the victims of the calamity. Under the existing scheme, in operation for the period 1995-2000, each State has a corpus of funds called Calamity Relief Fund (CRF), administered by a State Level Committee, headed by the Chief Secretary of the State Government. The size of the corpus is determined having regard to the vulnerability of the State to different natural calamities and the magnitude of expenditure normally incurred by the State on relief operations. The corpus is built by annual contributions of the Union Government and the State Governments concerned. At present, the aggregate accretion in the States' CRF for a period of five years from 1995-2000 amounts to Rs. 63042.70

million. The States are free to draw upon this corpus for providing relief in the event of a natural calamity. In the event of a major disaster warranting intervention at the national level, a provision exists in the form of National Fund for Calamity Relief with a corpus of Rs. 7000.00 million (for 1995-2000) for the Union Government to supplement the financial resources needed for relief operations.

Disaster prevention and mitigation were not addressed as such but many of the development programmes like construction of dams and embankments, were executed with reduction of flood hazards as one of the aims. A number of actions were being taken in the country which contributed to disaster prevention and mitigation. Some of these are described herebelow:

## 3.1 Hazard Evaluation

*i. Mapping of the areas affected by each major hazard*

The three major hazards, namely earthquake, flood and cyclone, are being monitored mainly by Geological Survey of India, the India Meteorological Department and the Central Water Commission. Macro level maps have already been prepared which classify the country into the hazard zones of various intensities.

*ii. Historical and pre-historical events*

The major earthquake and cyclone hazard events which have occurred in the last about one hundred years have been recorded with appreciable precision.

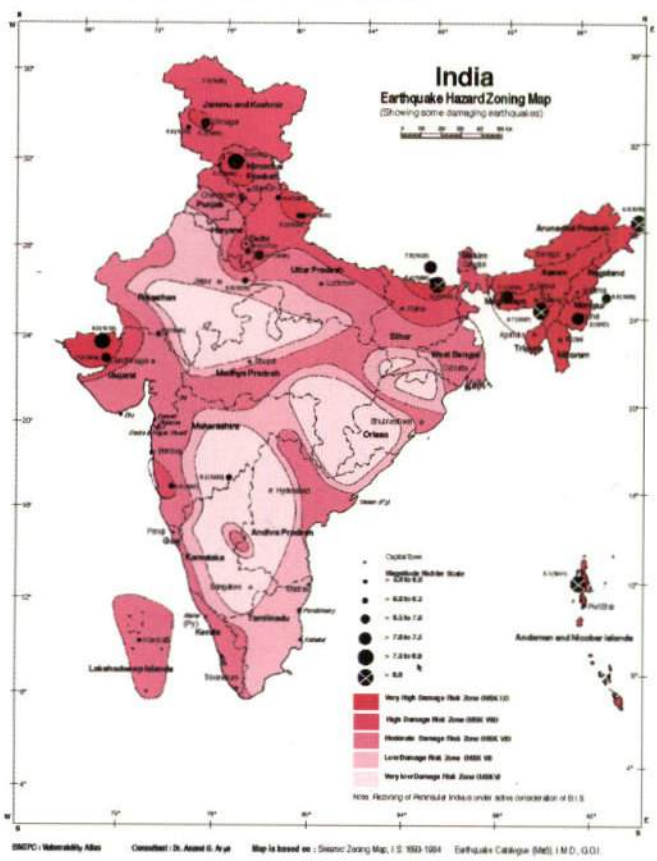
*iii. Set up of early warning systems*

Early warning systems have already been established for cyclones and floods in the country by IMD and CWC respectively and good progress has been made in terms of establishing the forecasting methodology, and accuracy in the prediction of likely events.

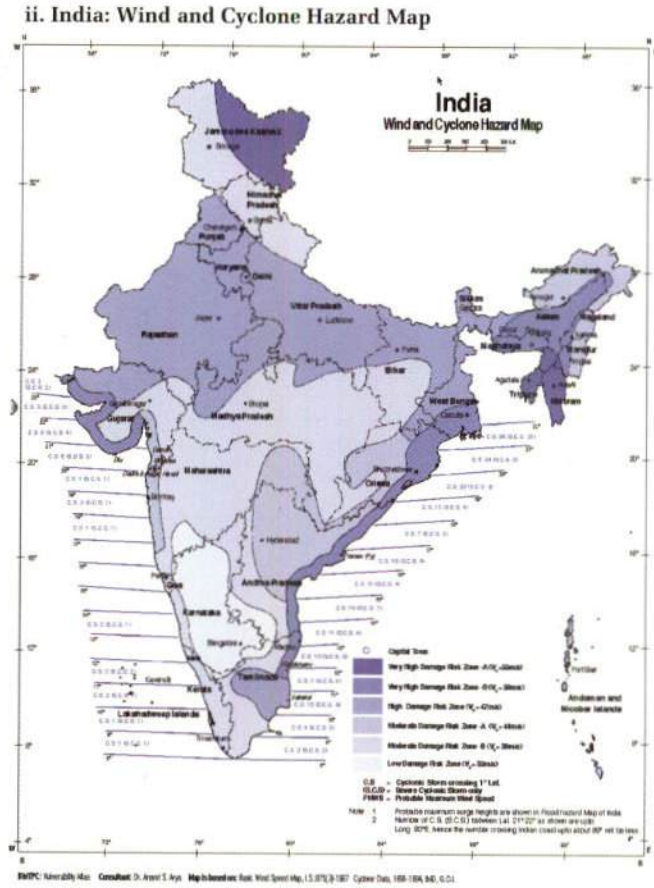
*iv. Quantification of the hazards*

For all engineering design purposes, the earthquake hazard has been quantified in terms of MM (or MSK) intensities and the cyclone hazard has been quantified in terms of the design wind speed and the probable maximum storm surge height on the sea coasts of India. So far as floods are concerned, the areas along the rivers which are prone to floods and still remain unprotected, and others, which are prone but protected by works like *bunds* have been demarcated. At local level leading NGOs are building community capacity to quantify hazards and conduct risk assessments. In this, useful work is done by ACTION in Andhra Pradesh, SEEDS in Uttar Pradesh, and Disaster Mitigation Institute in Gujarat.

**i. India: Earthquake Hazard Zoning Map**




**ii. India: Wind and Cyclone Hazard Map**



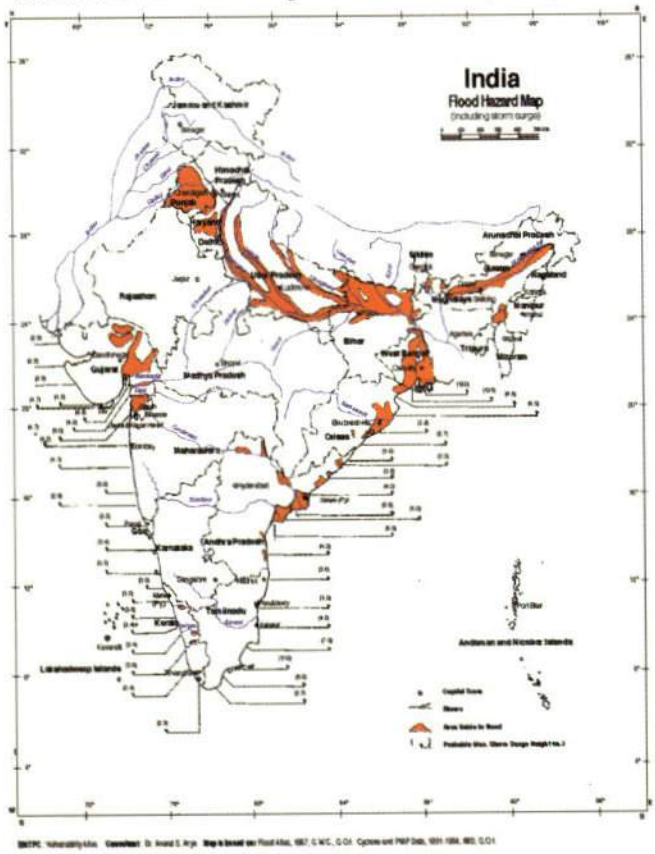
*v. Communication with emergency management authorities*

A system of rapid communication between IMD and CWC, which forecast the cyclone and flood situations respectively, and the authorities in the States and districts has already been established and functioning quite efficiently. So far as the earthquake is concerned, procedures are in place by which the district authorities of the affected area communicate with the various concerned organisations through wireless/ telephone/faxes to have rapid deployment of the needed personnel. National Computer Network is already in place and E-mail systems are getting established and expanding by which even data communication will become far easier and instantaneous. This can be further improved by dedicated systems for disaster related applications. The most crucial link in this is between the Collector Office and the community at risk, which is being recognised and local officials and NGOs such as CASA and OXFAM are developing ways to strengthen effective linkages between the community and the authorities.

*vi. Scenarios of major hazards*

Development of scenarios of likely major hazards has not been done in the routine way by disaster management agencies in India so far.

**iii. India: Flood Hazard Map** *Source: Vulnerability Atlas of India, 1997*




## 3.2 Risk Assessment

*i. Census of Population*

India has been carrying out population census every ten years and this data is readily available for the census done in the years 1971, 1981 and 1991. Besides, the data on population, its density in different areas, other indicators like the size of the family, literacy, age groups, housing data etc. are also collected and analysed. For the 1991 census, the whole information is available on computer disks and diskettes, therefore retrieval of this data has become very easy. It was indeed this housing data which has been utilised in the district wise vulnerability and risk tables included in the Vulnerability Atlas of India prepared in 1997. However, vulnerability of communities is an area Government of India is looking into more carefully since the beginning of IDNDR.

*ii. Vulnerability of buildings and structures*

The proper understanding of vulnerability of buildings and structures to various intensities of hazards has not been studied in a systematic way in the country so far. A proper way of representation of vulnerability versus hazard intensity is to develop *vulnerability functions* such as those developed for various building types under earthquake intensities. In this, attempts are being made by NGOs such as People's Science Institute (PSI) and Ahmedabad Study Action Group (ASAG).

## 3.3 Disaster Prevention

*i. Specific needs and suitable measures*

Disaster prevention by definition involves engineering intervention in buildings and structures to make them strong enough to withstand the impact of natural hazards or to impose restrictions on land use so that the exposure of the society to the disastrous situation is avoided or minimised. So far, land use restrictions are not provided in the town and country planning laws or master plan rules or the municipal bye-laws with the result that cities are expanding in all directions, occupying even hazard prone areas, and more and more developed areas are getting threatened by natural hazards.

Indian Standard Codes and Guidelines for earthquake resistant design and construction of buildings and structures were first developed in 1962 and 1967, then revised and updated every few years. Adequate standards on earthquake safety of buildings and structures are therefore available in the country. However, the implementation of the same has not been satisfactory except in the case of some Central Government Departments mainly because the standards are not mandatory and do not yet form part of the municipal bye-laws. Similar standards for cyclone safety and flood safety of buildings are, however, not yet formulated and this task has been taken up by the Bureau of Indian Standards (BIS). Also, safety of buildings under floods or storm surge has to be taken up by the BIS.

*ii. Improving resistance of essential services*

The essential services include fire stations, hospitals, water supply systems, communications, etc. The most economical and effective way of keeping such services functional in natural hazards is to design and construct the related buildings, structures and systems according to the hazard resistant principles and details. Appropriate maintenance is also necessary to keep them continuously safe at the time of the unforeseen future events. Maintenance can be ensured through a system of check list and making certain personnel responsible for the same. Unfortunately, most such systems are being established at present without due care for hazard resistance.

The reinforced concrete cyclone shelters built after 1977 cyclone were found in damaged state on account of corrosion of reinforcement due to coastal saline environment. It is therefore extremely important that cyclone shelters meant for accommodating the people in distress are well designed, constructed with utmost care, and maintained properly so that they serve the purpose for which they are intended. It is also important that access to these is kept clean of any obstructions.

## 3.4 Emergency Planning

As stated earlier, the emergency planning and implementation fall in the domain of the State governments. The various States have contingent plans for emergencies related to hydrological hazards, namely, drought and flood situations. Considerable experience has been gained in managing such disasters on account of their recurrence year after year. However, in the case of the rapid onslaught disasters like earthquakes, which occur without any prior warning, the State and District administrations are found in a state of unpreparedness. Fortunately, the cyclonic storms do now permit reasonable prior forecast and warning, so that evacuative actions are being taken to save the people.

## 3.5 Public Information and Awareness

There are four steps to be taken:

i. to prepare and distribute suitable information materials such as simple maps, illustrated brochures, video and T.V. programmes, etc.
ii. to hold specific training for the community under high risk,
iii. to hold public simulation exercises, and
iv. to analyse the results and improve the plan.

This is an area of work where contributions have been made in India by a number of organisations including the Central Government Relief Office, State Government Relief Offices, Central Government Ministries such as Ministry of Urban Affairs and Employment, Disaster Management Institutions and Voluntary Organisations. Such activities, however, have been limited mostly to the time of few weeks in the aftermath of the occurrence of a major natural disaster, whether it is a earthquake, a cyclone or major flooding of urban and rural areas. As yet, however, there is no concerted and well planned and sustained effort to create appropriate awareness at various levels of the society from policy makers and administrators to the common people.

The Red Cross, CARE (India) and partners of Oxfam (India) Trust have taken active part in community awareness raising in the states of Maharasthra, Andhra Pradesh, Uttar Pradesh and Gujarat. Publications in regional languages and with suitable visual material are being developed.

## 3.6 Seismological Network in India

The first seismological observatory in India was setup in Calcutta (Alipur) on 1 September 1898. Bombay and Kodaikanal observatories were started in 1898 and 1899 with Milne seismographs. The Shimla observatory setup immediately after the 1905 Kangra earthquake was later shifted to Agra in 1929, then to Delhi in 1944. The number of stations rose to 8 in 1950 and to 15 in 1960. More sensitive instruments like Benioff, Springnether and Wood-Anderson were deployed. At present the national network has 37 seismological observatories mostly of analog type. During 1962-64 the stations at Delhi, Poona, Kodaikanal and Shillong were converted into WWSSN observatories. In 1967 similar equipments were installed at the Hyderabad observatory. At about the same time Gauribidanur array was established by Bhaba Atomic Research Centre.

**Network of Seismological Stations**

*Source: Earthquake Research in India, Earth System Science Division, Department of Science and Technology, Government of India, 1999*

At present the national network of seismological observatories are maintained by the Indian Meteorology Department. Though this network is capable of locating earthquake in the magnitude range of 4 and above, the inter station spacing prohibits accurate location for hazard assessment. Other organisations like BARC, NGRI, RRL (Jorhat), WIHG, GSI, University of Roorkee, Kurukshetra University, Kumanon University, MERI and GERI operate local microseismic and strong motion networks in different parts of the country. These observational networks are relatively dense in some parts of Northwest Himalaya, Northeast Himalaya, and Koyna region of Maharashtra.

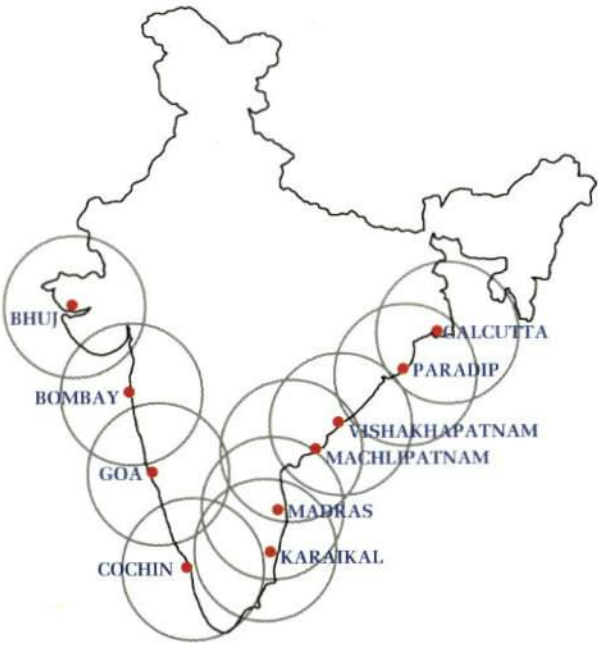
## 3.7 Cyclone Monitoring Forecasting and Warning System in India

The India Meteorological Department (IMD) has a well established organizational set-up for observing, detecting, tracking and forecasting cyclones and issuing cyclone warnings whenever a cyclonic storm develops in the Bay of Bengal and the Arabian Sea. It is tracked with the help of INSAT satellite, powerful cyclone detection radars with a range of 400 km, installed at Calcutta, Paradip, Visakhapatnam, Manchilipatnam, Madras, Karaikal on the east coast; and Goa, Cochin, Bombay and Bhuj along the west coast. The present cyclone surveillance system in the country is such that no cyclone in the region can escape detection any time in its life cycle.

Cyclone warnings are provided through six cyclone warning centres located at Calcutta, Bhubaneswar, Visakhapatnam, Madras, Bombay and Ahmedabad. These centres have distinct responsibilities areawise covering both the east and west coasts of India and the oceanic areas of the Bay of Bengal and the Arabian sea, including Andaman & Nicobar Islands and Lakshadweep. The cyclone warning bulletins are issued to All India Radio and Doordarshan for broadcasting/telecasting them in different languages, on all India basis. The Cyclone Warning Division at Headquarter office, New Delhi also provides warning information to the Control Room and Crisis Management Group set up in the Ministry of Agriculture, Government of India which is finally responsible for coordination with various Central Government agencies. Cyclone Warning Division at New Delhi also caters to the needs of international responsibilities such as issue of cyclone advisories to the neighbouring countries.

**Cyclone Detection Radars**

*Source: Report (Part-I) of Expert Group set up by Ministry of Urban Development, 1998*



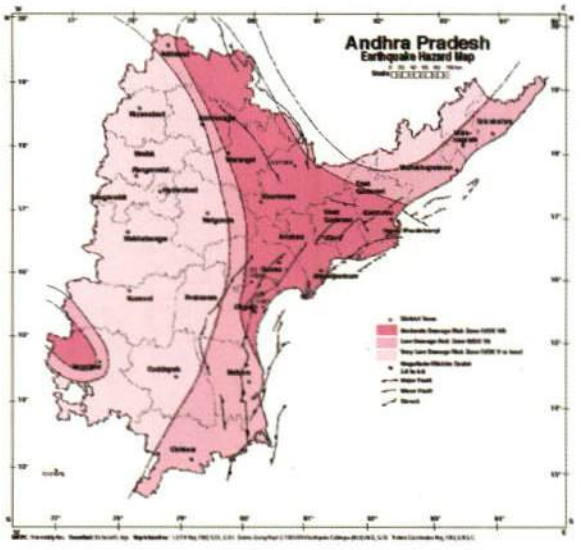

## 3.8 Flood Forecasting and Warning System

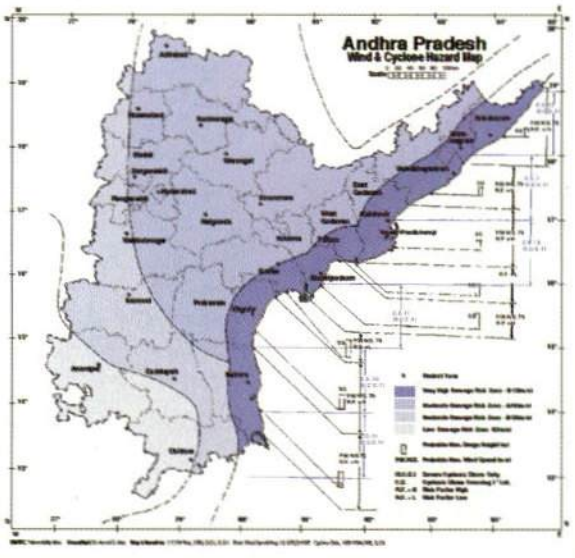
Flood forecasting and flood warning system in a scientific way was commenced in the year 1958 by Central Water Commission (CWC). At present the flood forecasting and warning network of CWC covers 62 major interstate river sub catchments which includes 132 water level forecasting stations and 25 inflow forecasting stations for important reservoirs. Hydrological and hydrometeorlogical data from nearly 700 stations in these rivers are being collected and analysed, and flood forecasts and warning messages are issued, generally 24 hours to 48 hours in advance. In case of very large incoming floods, advisory forecasts 72 hours in advance or more are also issued which predicts the incoming floods at the downstream locations.

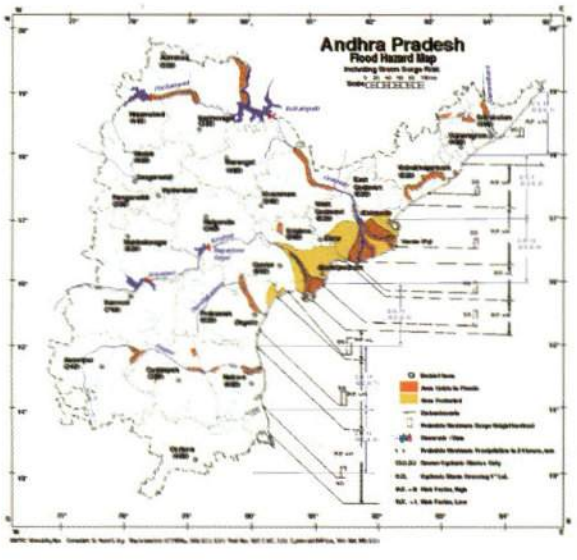
Coordination between neighbouring districts, states, and countries is being promoted to reduce loss of livelihood and life.

## 3.9 Research & Development, Education & Training

Research, education and training in earthquake engineering were started by University of Roorkee (UoR) through School of Research and Training in Earthquake Engineering in 1960. Through this initiative, national capacity has been built for design and construction of earthquake resistant structures from small to tall buildings, all types of bridges and dams, conventional to atomic power plants and petro-chemical industrial structures etc. Indian Standard codes of practice on earthquake safe design and construction were initially developed in the sixties, later revised and updated from time to time. A master of earthquake engineering degree program exists since 1965 and hundreds of short training programs were organised for engineering teachers and professional. This type of activity has expanded in several institutions, such as IITs, Universities and research institutions to cover floods, cyclones as well as landslides. Sophisticated testing, measuring and computing facilities including shake-tables and wind tunnels are available in a number of institutions.




## 4. INITIATIVES TAKEN DURING THE DECADE

The Yokohama message emanating from the IDNDR mid-term review Conference held at Yokohama in May 1994 underlined the need for an emphatic shift in the strategy for disaster mitigation.

"Disaster prevention, mitigation, preparedness and relief are four elements which contribute to and gain from the implementation of sustainable development policies. These elements, alongwith environmental protection and sustainable development, are closely interrelated. Therefore, nations should incorporate them in their development plans and ensure efficient follow-up measures at the community, national, subregional, regional and international levels."

"*Disaster prevention, mitigation and preparedness are better than disaster response in achieving the goals and objectives of the Decade. Disaster response alone is not sufficient, as it yields only temporary results at a very high cost.* We have followed this limited approach for too long. This has been further demonstrated by the recent focus on response to complex emergencies which, although compelling should not divert from pursuing a comprehensive approach. *Prevention contributes to lasting improvement in safety and is essential to integrated disaster management.*"

In the light of this message and to meet the objectives stated in the IDNDR, a number of important initiatives were taken by Government as well as Non-Government Organisations. The initiatives taken and also the activities following the initiatives and the results achieved thereby are summarized in the following paragraphs:

### 4.1 Hazard Mapping and Vulnerability Assessment of Buildings

Under the initiative of the Ministry of Urban Development, a Vulnerability Atlas of India has been prepared during the period 1994-1997 in which the earthquake, cyclone and flood hazard maps for every State and Union Territory of India have been prepared to a scale of 1:2.5 million. In these maps the boundaries of the districts are clearly shown so that the areas of the districts prone to the various intensities of the hazards are clearly visible. Also the vulnerability of the buildings, as per the Census of Housing 1991, has been brought out in tabular form in one sheet for each District. This information clearly highlights the risk to the buildings of various types in every District when subjected to the different intensities of the three hazards. As an extension, State-wise Vulnerability Atlases also have been prepared including an Action Plan that the State may adopt for achieving disaster reduction.

At local level in Gujarat, the community has been involved through innovative methods including NGOs such as Ahmedabad Study Action Group, Peoples Science Institute and EFFICOR have played a leading role.

**Andhra Pradesh: Hazard Zoning Maps**
*Source: Vulnerability Atlas of India, 1997*

## 4.2 Techno-Legal Regime for the Country

The Town and Country Planning Acts governing the planning of settlements and preparation of Master Plans were studied and found deficient in regard to planning from the natural disasters' view point. So also the present Building Bye-laws do not address the problem of safety from natural hazards. A complete techno-legal regime has been proposed for amending the Acts and Bye-laws to include the safety aspects from natural hazards point of view.

In addition several states have taken up review of relief manuals and scarcity preparedness guidelines to suit local needs and geo-climatic conditions.

## 4.3 Guidelines for Disaster Resistant Construction

Realising that majority of constructions in India are of the non-engineered type, appropriate guidelines have been developed to cover the aspects of (a) land-use zoning, (b) earthquake resistant building construction, (c) cyclone resistant building construction, and (d) flood resistant building construction. Transfer of better construction technologies is being affected through HUDCO-BMTPC Building Centres.

This has not only influenced safer building practices but also generated local housing market and construction labour market.

**Risk Table - East Godavari, Andhra Pradesh**
*Source: Vulnerability Atlas of India, 1997*

**Distribution of Houses by Predominant Materials of Roof and Wall* and Level of Damage Risk**

**Table No. : AP.05** **ANDHRA PRADESH** **EAST GODAVARI**

| Wall and Roof Combination | | Census Houses | | Level of Risk under | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | No. of Houses | % | EQ Intensity MSK | | | | Wind Velocity m/s | | | | Flood | | |
| | | | | > IX | VIII | VII | ≤ VI | 55 & 50 | 47 | 44 & 39 | 33 | Prone | Protected ** | Outside *** |
| | | | | Area in % | | | | Area in % | | | | Area in % | | |
| | | | | | | 60.2 | 39.8 | 65.1 | | 34.9 | | 18.3 | 15.3 | 66.4 |
| **CATEGORY - A** | | | | | | | | | | | | | | |
| ***A1. Mud Wall*** | | | | | | | | | | | | | | |
| All roofs sloping | Urban | 37,930 | 3.07 | | | | | | | | | | | |
| | Rural | 190,900 | 16.71 | | | | | | | | | | | |
| | Total | 248,830 | 21.79 | | | M | L | VII | | M | | VII | M | L |
| ***A2 Unburned Brick Wall*** | | | | | | | | | | | | | | |
| a) Sloping roof | Urban | 4,930 | 0.43 | | | | | | | | | | | |
| | Rural | 60,390 | 5.29 | | | | | | | | | | | |
| | Total | 65,320 | 5.72 | | | M | L | VII | | M | | VII | M | L |
| b) Flat roof | Urban | 285 | 0.02 | | | | | | | | | | | |
| | Rural | 275 | 0.02 | | | | | | | | | | | |
| | Total | 560 | 0.05 | | | M | L | VII | | M | | VII | M | L |
| ***A3. Stone Wall*** | | | | | | | | | | | | | | |
| a) Sloping roof | Urban | 960 | 0.08 | | | | | | | | | | | |
| | Rural | 5,825 | 0.51 | | | | | | | | | | | |
| | Total | 6,785 | 0.59 | | | M | L | VII | | M | | VII | M | L |
| b) Flat roof | Urban | 390 | 0.03 | | | | | | | | | | | |
| | Rural | 925 | 0.08 | | | | | | | | | | | |
| | Total | 1,305 | 0.11 | | | M | L | H | | L | | VII | M | L |
| **Total - Category - A** | | **322,600** | **28.26** | | | | | | | | | | | |
| **CATEGORY - B** | | | | | | | | | | | | | | |
| ***B. Burned Brick Wall*** | | | | | | | | | | | | | | |
| a) Sloping roof | Urban | 84,995 | 7.44 | | | | | | | | | | | |
| | Rural | 344,645 | 30.17 | | | | | | | | | | | |
| | Total | 429,640 | 37.62 | | | L | VL | H | | M | | H | L | VL |
| b) Flat roof | Urban | 61,095 | 5.35 | | | | | | | | | | | |
| | Rural | 30,105 | 2.64 | | | | | | | | | | | |
| | Total | 91,200 | 7.99 | | | L | VL | M | | L | | H | L | VL |
| **Total - Category - B** | | **520,870** | **45.60** | | | | | | | | | | | |
| **CATEGORY - C** | | | | | | | | | | | | | | |
| ***C1. Concrete Wall*** | | | | | | | | | | | | | | |
| a) Sloping roof | Urban | 3,510 | 0.31 | | | | | | | | | | | |
| | Rural | 13,500 | 1.18 | | | | | | | | | | | |
| | Total | 17,010 | 1.49 | | | VL | NIL | H | | M | | L | VL | VL |
| b) Flat roof | Urban | 9,545 | 0.84 | | | | | | | | | | | |
| | Rural | 7,620 | 0.67 | | | | | | | | | | | |
| | Total | 17,165 | 1.50 | | | VL | NIL | L | | VL | | L | VL | VL |
| ***C2. Wood Wall*** | Urban | 3,595 | 0.31 | | | | | | | | | | | |
| (all roofs) | Rural | 17,890 | 1.57 | | | | | | | | | | | |
| | Total | 21,485 | 1.87 | | | VL | NIL | VH | | M | | H | M | VL |
| ***C3 Mud Wall*** | Urban | 61 | 0.01 | | | | | | | | | | | |
| (all roofs) | Rural | 115 | 0.01 | | | | | | | | | | | |
| | Total | 176 | 0.02 | | | VL | NIL | VH | | M | | H | M | VL |
| **Total - Category - C** | | **58,735** | **4.88** | | | | | | | | | | | |
| **CATEGORY - X** | | | | | | | | | | | | | | |
| ***X1 - GI and other Metal Sheets*** | Urban | 245 | 0.02 | | | | | | | | | | | |
| | Rural | 500 | 0.04 | | | | | | | | | | | |
| (all roofs) | Total | 745 | 0.07 | | | NIL | NIL | VH | | M | | H | M | VL |
| ***X2 Bamboo, Thatch*** | Urban | 33,335 | 2.92 | | | | | | | | | | | |
| ***Grass, Leaves etc.*** | Rural | 208,695 | 18.27 | | | | | | | | | | | |
| (all roofs) | Total | 242,030 | 21.19 | | | NIL | NIL | VH | | H | | VH | M | L |
| **Total - Category - X** | | **242,775** | **21.26** | | | | | | | | | | | |
| **GRAND TOTAL** | | **1,142,180** | **100** | | | | | | | | | | | |

**Building Category**
**Category - A** : Buildings in field-stone, rural structures, unburnt brick houses, clay houses
**Category - B** : Ordinary brick building; buildings of the large block and prefabricated type; half-timbered structures, building in natural hewn stone
**Category - C** : Reinforced building, well built wooden structures
**Category - X** : Other types not covered in A,B,C. These are generally light.

**Probable Maximum Precipitation in 24 hrs (mm) is 520**

**Notes :**
* Source : Census of Housing, GOI, 1991
** With probability of more severe damage under failure of protection works
*** The local damage may be more severe under heavy rains

**Building Materials & Technology Promotion Council** **Expert Group, MOUARE, GOI.**

## 4.4 Strengthening of Information Technologies

Ministry of Agriculture which is the nodal Ministry for disaster management in India, laid great emphasis on using the various state-of-the-art technologies, namely, Remote Sensing, Geographical Information System (GIS), Global Positioning System (GPS), Computer Modelling and Expert Systems, and Electronic Information Management System (collection, storage, retrieval and dissemination fo information) in managing the situation caused by natural disasters. State profiles on disaster management have been taken in hand accordingly.

Active and ongoing efforts are being made for modernising the control rooms so as to make them more effective and community friendly in several States. In addition databases are being complied to keep track of past events and benefit from the experience.

## 4.5 Monitoring and Impact Assessment of Natural Hazards (Drought, Flood, Cyclone - using Space Technologies)

India is one of the very few countries in the world which uses space technology, for near-real-time impact assessment of drought, flood and cyclone as a national programme. In the wake of severe drought in recent memory during 1987, which affected the entire population due to shortage of food grain production, water scarcity and economic severity, followed by large scale devastating floods in major flood-prone river basins in the country in 1988, significant technological programmes had been launched by the Department of Space, Government of India using space technology as information support for monitoring and quick assessment of drought, flood and cyclone impact wherever these occurred in the country.

The activities undertaken during the Decade include, national agricultural drought assessment and monitoring, and flood incidence monitoring and inundation area assessment.

Impact on local natural resources and community are of great concern to India and efforts are being made to make these concerns central to the impact assessment activities.

## 4.6 Human Resource Development

The Department of Agriculture and Cooperation, MOA, initiated a Central Sector Scheme in 1993 including human resource development, research, consultant services and documentation of various natural disasters. Under the scheme a National Centre for Disaster Management (NCDM)

was established at the Indian Institute of Public Administration (IIPA) at New Delhi and 15 States of India set up Faculties in disaster management in different institutions of the States.

A National Advisory Group is initiated by leading organisations to establish the agenda for measuring and managing vulnerability and taking up policy issues. The output may be integrated into curriculum of the ATIs.

In addition investments are being made to build capacity of NGOs and CBOs for working with the community as well as with the government.

The research and development work, education and training in the institutes of higher learning like Earthquake Engg., Earth Sciences, Hydrology Deptt. of University of Roorkee, the Central Building Research Institute, Jadavpur University, IITs at Kanpur and Bombay and SERC, Chennai, have been further expanded and developed and good number of M.E. and Ph.D thesis written during the Decade on the topics related to earthquakes, floods and cyclone disasters. The research work also continued at CBRI, CRRI and University of Roorkee on landslide hazard zoning and mapping etc.

## 4.7 Upgrading and strengthening of seismological instrumentation network

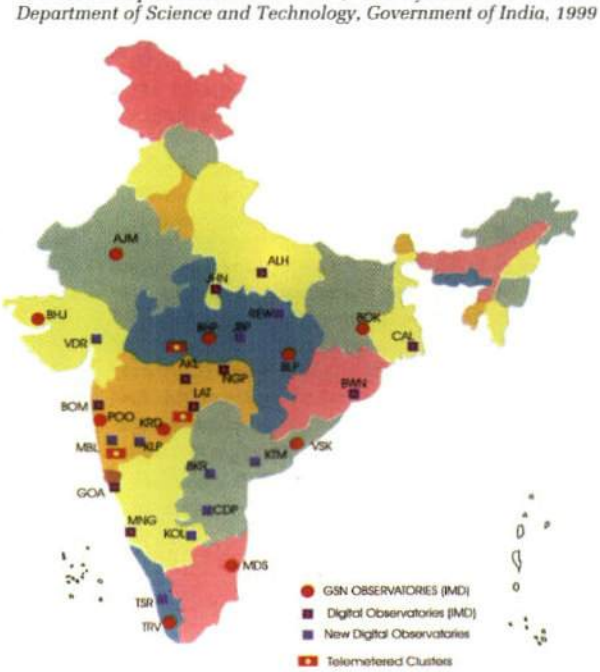
The Department of Science and Technology, Government of India coordinated a World bank assisted project through which the seismological observatories in the peninsular shield region have been strengthened. Under this programme 20 existing observatories of IMD in full operation (10 GSN Stations, 10 stand-alone Broad Band Digital Stations) have been strengthened and 10 new observatories have been built. These will provide a state-of-the-art station network. Besides, Telemeter clusters at Koyna, Khandwa and Latur have been installed which will provide information from three important locations in the shield region. The on-going Strong Motion Accelerograph arrays and network program through DEQ-UOR has been expanded and strengthened.

DST has also launched a nationally coordinated project on the study of seismicity and seismotectonic in the Himalayan region involving several research organisations. The strong motion data collection programme is being expanded and a number of tall buildings and other structures are being instrumented to study their behaviour during future earthquakes including soil structure interaction effects. GPS aided geodetic studies are being initiated with DST support and a national GPS programme has been evolved and planned for monitoring the seismotectonic provinces in the country. DST has initiated a number of projects in various parts of the country involving paleoseismology as a tool to date pre-historic earthquakes.

## 4.8 Disaster warning system (DWS)

Department of Telecommunications' (DoT) telecommunication systems such as telegram, telex and telephones are often among the first casualty during a cyclone situation and warning messages get delayed. To overcome this difficulty, a very dependable and unique communication system known as

**Upgraded seismological instrumentation network in the peninsular shield region**
*Source: Earthquake Research in India, Earth System Science Division, Department of Science and Technology, Government of India, 1999*




**Proposed permanent GPS stations**
*Source: Earthquake Research in India, Earth System Science Division, Department of Science and Technology, Government of India, 1999*

Disaster Warning System (DWS) has been developed in India. Through this system, rapid and direct dissemination of cyclone warnings are made through INSAT satellite to designated addresses at isolated places in local languages. The Disaster Warning System is working along the coastal areas where 250 DWS sets have been installed in small administrative units like Block Development Offices and Police Stations. Disaster warning sets are also located in the State and District level headquarters in the above areas. The DWS has been successfully operated on occasions of cyclone during the past few years and has been found to be very effective.

Recently increased involvement of the vulnerable communities in disaster warning system is being worked out in India where rural groups will increasingly play a key role in early warning dissemination and execution.

### 4.9 Role of Voluntary Sector

The Decade has been of great stimulation to the Voluntary sector and NGOs in India. A number of NGOs and private industrial houses has initiated various activities. Some of the leading NGOs like OXFAM (India) Trust, CASA, CARE- India, Ramakrishna Mission, DMI, Dasholi Gram Swarajya Mandal etc. have been active in responding to almost every disaster with timely and effective relief operations.

CARE-India, CASA, DMI etc. have developed an extensive network of the community amateurs for disaster preparedness programmes. DMI is promoting building food, water, shelter and work security with the local community through action planning and participatory methods. The OXFAM (India) Trust with its partners have initiated activities of relief that can be achieved by the agencies over the years. Dasholi Gram Swarajya Mandal has integrated the natural forest resource management with disaster mitigation in the hill areas of U.P. The JAC has organised eight annual conventions on Disaster Management in different parts of the country. JAC was also instrumental in the development of Global Forum for NGOs. CAPART has started playing an important role in supporting the NGO activities in post-disaster rehabilitation activities.

### 4.10 Conferences, Symposia and Workshops

A large number of national and international conferences, symposia and workshops were organised and proceedings published by number of institutions and learned societies and organisations on various subjects related with disaster mitigation, prevention and management. Some of the important proceedings brought out are listed at *Annexure*.

Indian Society for Wind Engineering established in 1993 had the distinction of hosting the 9th International Conference on Wind Engineering in New Delhi in Jan. 1995. It has also sponsored several conferences on the subject in India and the Pacific region.

## 5. MAJOR ACHIEVEMENTS DURING THE DECADE

### 5.1 Through Space Technology application:

i. Agricultural Drought Monitoring has been carried out on fortnightly basis to provide near-real-time information on agricultural condition at District and Sub-District level during the paddy season. Eleven States of India have been covered.

ii. Based on the improved relationship obtained between vegetation index and major crop yield from August month onwards, the early warning on relative yield assessment is provided at District level.

iii. District-wise flood affected area statistics were generated during 1998 floods and information furnished to the Relief Commissioners of the States of Assam, UP and Bihar.

iv. Cyclone impact assessment was conducted successfully in recent past in Gujarat using multi-satellite data and ground verification.

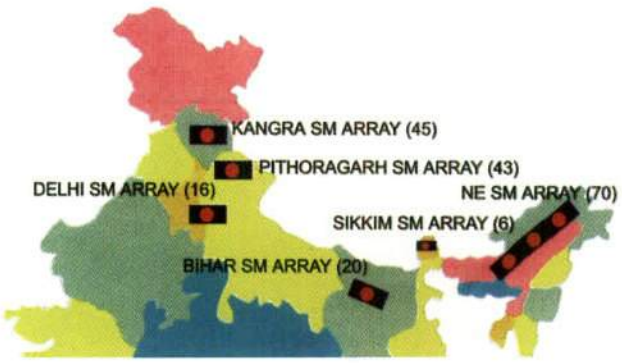
### 5.2 Through the NCDM

The NCDM and State Faculties at ATIs have already conducted numerous research documentation and other activities and training of personnel both from government and non-government sectors resulting in better situation in assisting the Central and State Relief Commissioners in the management of natural disasters.

The NCDM is also taking up collaborative action planning projects on Urban Risk Reduction and Capacity Building with organisations such as SEEDS and Disaster Mitigation Institute.

### 5.3 Through DST initiated projects:

- Induction of broadband digital stations with state-of-the-art communication links.
- 20 observatories of IMD in the shield region upgraded. Ten stand-alone digital observatories added.
- National Seismological Data Centre (NSDC) at IMD established
- Project databases at RRL, Jorhat and WIHG, Dehradun.
- Deep drilling at Latur has revealed sub-surface fault characteristics in the zone of the 1993 Maharashtra earthquake.
- Seismic tomography has brought out the velocity structure at Koyna.
- Precursory studies on Radon and Helium have shown correspondence with local seismicity in the Himalaya.
- Additional information generated on historical earthquake in northern India covering medieval period.
- Data generated from the strong motion accelerograph network are used for engineering applications.




**Strong motion accelerograph arrays**
*Source: Earthquake Research in India, Earth System Science Division, Department of Science and Technology, Government of India, 1999*

- Strong motion instruments and digital accelerographs developed and field deployed.
- 160 scientists trained in seismic instrumentation, data acquisition and processing.
- Five special publications brought out.

## 5.4 Disaster Related Standardisation

A number of building codes and guidelines were developed through the Bureau of Indian Standards, BMTPC and SERC as stated below:

- ***Earthquake Resistant construction***

i IS 1893:1894 'Criteria for Earthquake Resistant Design of Structures'.

ii IS 4326:1993 'Earthquake Resistant Design and Construction of Buildings' - Code of Practice.

iii IS 13827:1993 'Improving Earthquake Resistance of Earthquake Building - Guidelines'.

iv. IS 13828: 1993 'Improving Earthquake Resistance of Low Strength Masonry Buildings - Guidelines'

v. IS 13920: 1993 'Ductile Detailing of Reinforced Concrete Structures subjected to Seismic Forces - Code of Practice'

- ***Flood Damages***

i. IS 13739 : 1993 'Guidelines for estimation of flood damages'.

- ***Hill Area Development***

i. IS 14496:1998 'Guidelines for preparation of landslide - Hazard zonation maps in mountainous terrain.

ii IS 14458:1998 'Guidelines for Retaining Wall for Hill Area : Part 1 Selection of type of wall; Part 2 Design of retaining/breast walls; Part 3 Construction.

iii Guidelines for Design and Selection of Building Materials for Residential Buildings in Hilly Areas of Seismic Zone V (under preparation).

- ***Guidelines for Improving Hazard Resistant Construction of Buildings and Land Use Zoning***

i Land use zoning in hazard prone areas - Guidelines (BMTPC).

ii Improving flood resistance of housing - Guidelines (BMTPC).

iii Improving wind/cyclone resistance of buildings - Guidelines (BMTPC).

iv Improving earthquake resistance of buildings - Guidelines (BMTPC).

v. Guidelines for Design and Construction of Buildings and Structures in Cyclone Prone Areas (SERC, Chennai).

## 5.5 Flood Forecasting

CWC had established 145 flood monitoring and forecasting stations in different reverain systems covering major parts of the country before 1990. During the Decade 12 more such stations have been established. The forecasting accuracy is increasing as will be seen from the following table:

| S.No | Year | No. of Forecasts issued | Accuracy of Forecasts | |
|---|---|---|---|---|
| | | | No. of forecasts within ±15 cm | % of Accurate Forecasts |
| 1 | 1991 | 5234 | 4890 | 93.4 |
| 2 | 1992 | 3588 | 3418 | 95.3 |
| 3 | 1993 | 5226 | 5066 | 96.9 |
| 4 | 1994 | 5472 | 5159 | 94.3 |
| 5 | 1995 | 5394 | 5203 | 96.5 |
| 6 | 1996 | 4983 | 4826 | 96.8 |

## 5.6 Hazard Assessment & Mapping

- Seismic hazard map of India and adjoining regions giving contours of expected values of acceleration having 10% probability of exceedance in 50 yr. has been prepared. This is available with GSHAP website (NGRI).
- Data on cyclone tracks over the last 100 years have been digitized, and using a knowledge based computer software developed in-house, the probability of cyclone crossings along the coastal regions for a given origin of a future cyclone can be determined (SERC).
- Analytical modelling for carrying out risk and vulnerability analysis for structural systems, and regions exposed to cyclone damage based on knowledge based expert systems and neural network methodologies have been developed (SERC).
- Risk analysis of cyclonic wind speeds has been carried out and a cyclonic wind speed map developed for the coastal regions of the country (SERC).

## 5.7 Awareness and Information Dissemination

A number of brochures and fliers with regard to earthquakes and cyclones have been printed and distributed to the lower level technical personnel as well as the disaster affected people on a large scale such as the following:

**a. Posters**

(in English, Hindi, Tamil and Telugu languages) on Improvements in Building Layouts; Improvements to Roofs and Walls of Buildings; Improvements for Thatched Roofs and Mud Walls and Improvements to Tiled/A.C. Sheet Roofs to reduce damage due to cyclones.

**b. Brochures on the following:**

i. Guidelines for Mitigating Damage to Dwellings (in English, Hindi, Tamil, Telugu, Oriya and Bengali).
ii. Guideline on House Construction in Chamoli Earthquake affected areas (in Hindi by HUDCO, BMTPC).
iii. Guideline 1 - Earthquake Resistant construction of houses in Chamoli earthquake affected area (in Hindi by HUDCO, BMTPC)
iv. Guideline 2 - Repair and Retrofitting of damaged houses in Chamoli earthquake affected area (in Hindi by HUDCO, BMTPC)
v. Retrofitting of stone houses in Marathwada Area of Maharasthra, March 1994 (BMTPC).
vi. Earthquake and Building, A guidebook to understand the relationship between the two (Arya, Revi, Jain) 1994.
vii. Build Your Home with Earthquake Protection (BMTPC).

Similar brochures were made for Jabalpur earthquake affected area.

**c. Preparation of Bibliographies**

Annotated Bibliographies were compiled as follows:

i. Earthquake Effects on and Earthquake Resistant Design and Construction of Non-Engineered Buildings (BMTPC).
ii. Cyclone Effects on and Cyclone Resistant Design and Construction of Non-Engineered Buildings (BMTPC).

**d. Preparation of Video Films**

Training Films were prepared in VHS format in English and Hindi on retrofitting of stone houses as follows:

i. A Stitch in Time - An introduction to Seismic Retrofitting of Stone Houses (English 15 minutes, BMTPC).
ii. Seismic Retrofitting in 4 parts (Hindi, 45 Minutes, BMTPC)
   - Installation of headers
   - Reduction of weight on the roof
   - Installation of knee braces
   - Installation of seismic bands.
iii. Video film on 'Tackling Landslides by ES and AVRC-University of Roorkee
iv. 'Build a Safer Tomorrow' by BMTPC.

**e. Post Disaster Damage Assessments**

i. Andhra Cyclone Identification Mission – an independent appraisal Nov 1996 (Taru Research and Information Network).
ii. Post-earthquake guidelines for damage assessment, repair and retrofitting of houses and reconstruction and new construction of houses in the earthquake affected areas of Jabalpur and Chamoli have been prepared in bilingual form using Hindi and English for training of the technical staff (BMTPC, TARU, Arya).

## 5.8 Cyclone Warning and Management

Saving of human lives in the severe cyclone of 1990 at Andhra Pradesh and 1999 in Gujarat through reliable cyclone warnings issued and the evacuation carried out by Government of Andhra Pradesh and Gujarat respectively saved thousand of precious lives as compared with huge loss of lives that had occurred in earlier cyclones in 1977 and 1998 in the same areas.

Andhra Pradesh presents success story of disaster management through Cyclone Emergency Reconstruction Project carried out from 1990-94 under which besides DWS, cyclone shelters were constructed in cyclone prone areas. This programme is further expanded thereafter through the Decade.

# 6. LOOKING AHEAD IN THE NEXT DECADE

**6.1** Based on the experience of the last Decade in dealing with natural disasters of drought, flood and cyclone in India, a National Mission named "Natural Disaster Management Information Services Through Space Technologies" is in the process of being launched in India on an operational scale during 1999-2003 for the entire country.

**6.2** Population pressure, environmental degradation, irrigation and unplanned urbanisation are some of the major factors contributing to increased vulnerability in the country. As such need has been felt to accelerate the pace of disaster mitigation efforts in the country. It is planned to lay more emphasis on the following areas:

- linkage of disaster mitigation with development plans;
- effective communication system;
- use of latest information technology;
- insurance in all relevant sectors;
- extensive public awareness and education campaigns particularly in the rural areas;
- legal and legislative support;
- greater involvement of NGOs/private sector.

**6.3** The natural disasters like floods, earthquake and cyclones cause havoc in more than one country simultaneously. It underlines the necessity for coordinated regional action in order to strengthen all aspects of disaster management wherever possible by learning from one another and by sharing experiences. Regional co-operation for effective disaster management system is needed broadly hazard and vulnerability analysis, and human resource development.

### 6.4 Hazards reduction programme in Andhra Pradesh

Based on the outcome of the activities during the Decade the State has planned to undertake the following work:

- Revision of the policy for long term hazard reduction.
- Planning and development of control measures to reduce future hazards relating to economic activities, siting and construction of new infrastructure.
- Planning and development of control framework for coastal, delta region, and watershed will be evolved.
- Community participation to undertake Hazard Mitigation activities in future.

### 6.5 Preparation of Seismotectonic Atlas of India

The Geological Survey of India has included the preparation of Seismotectonic Atlas of India in its programme of work which will consist of 43 sheets of maps covering 3° longitude x 4° latitude in each sheet to scale of 1:1 m. The Maps will be of derived nature than a multi element data base, and intended to include earthquake data, gravity data, magnetic data, stress field data, geothermal data, geological faults, medium and major lineaments and geodetic data. Seismotectonic maps so generated could be used for the seismic hazard risk assessment and preparation of reliable seismic zoning map of India.

### 6.6 Suggestions for the Next Decade

For rapid progress towards appreciable reduction in the disastrous impact of natural hazards, the policy of the governments may include the following:

- To invest on Global Observations and Early Warning Systems, and to give a boost to the science of observation and measurement on which the real progress will depend.
- To enhance the scientific content of prediction methodologies and reliability of Forecasts.
- To map the Hazards on a large scale, and link the maps intimately with the process of Development Planning.
- To foster, closer partnerships with financial and legal institutions, insurance companies, community based organisations and industry.
- To create an all India Institutional Network, to involve in Disaster Preparedness, Mitigation Management and Prevention.
- To invest more on public awareness, education, training and human resource development in the area of Disaster Mitigation.

## 7. REGIONAL & INTERNATIONAL COOPERATION

**7.1** India being a big country and having experience of managing different types of natural disasters almost every year, intends to play a vital role in the regional and global activities for natural disaster reduction. India has accepted the membership of the Asian Disaster Reduction Centre which has been established by the Government of Japan as a part of regional cooperation. Regular interaction is being maintained with the Asian Disaster Preparedness Centre in Bangkok.

**7.2** A number of learned societies, institutions and organisations in India are already having fruitful exchange and data sharing programs with sister international organisations and bodies in various subjects including disaster related activities. India encourages such initiatives through bilateral and multi-lateral protocols and exchange programs.

As a founding member of WMO, IMD has been playing significant role in the following activities:

i. It is recognised as the Regional Meterological Training Centre by WMO and imparts professional training in meteorology to the candidates of foreign origin. Candidates from South-east Asian, African and Middle-east countries have availed the training facilities.

ii. Cyclone Warning Division of IMD functions as Regional Meterological Specialised Centre for tropical cyclones and implements the regional cyclone operational plan of WMO/ESCAP panel. It issues daily tropical weather outlook and cyclone warnings in the regions.

**7.3** India is committed to continue making efforts at national, regional and international levels to achieve the goals, set by the IDNDR, beyond the Decade. The areas of regional and international cooperation can be considered broadly in the sectors of hazard and vulnerability analysis, human resource development, exchange of information through internet, disaster management network and networking of different institutions.

**7.4** In most Asian countries there is a lack of appropriate implementation mechanism, effective regulatory frame work and legal instruments. Whereas developing countries

prone to disasters would continue to depend on the international financial institutions, a change from the current state of affairs is essential. NCDM instituted during the Decade should serve as a regional centre for SAARC as well as the Asia region for various activities in the field of natural disaster reduction especially human resource development, creation of data base, networking of the institutions, public participation and community awareness, disaster relief and rehabilitation mechanism, preparation of relief manuals/codes.



## CONFERENCES AND SYMPOSIA

1. Symposium on Preparedness Mitigation and Management of Natural Disasters, organised by Central Water Commission, New Delhi, August 2-4, 1989.
2. 9th Symposium on Earthquake Engineering, organised by DEQ-UOR and ISET, November, 1990.
3. National Policy Analysis - Workshop on Natural Disaster Reduction, organised by Administrative Staff College of India, Hyderabad, December 16-20, 1991.
4. Workshop on Uttarkashi Earthquake, organised by DEQ-UOR, December, 1991.
5. World Congress on Natural Hazard Reduction, organised by The Institution of Engineers (India), New Delhi, January 10-14, 1992.
6. 4th Session of the Scientific and Technical Committee of IDNDR, organised by Ministry of Agriculture, Govt. of India, February 1-5, 1993, New Delhi.
7. National Seminar on Hydrological Hazards - Prevention and Mitigation, organised by DH-UOR, March, 1993.
8. Workshop on Natural Disaster Reduction in the South Asia Region, New Delhi, March 30- April 2, 1994.
9. 10th Symposium of Earthquake Engineering, organised by DEQ-UOR and ISET, November 1994.
10. Seminar on Comprehensive Flood Loss Prevention and Management organised by ESCAP hosted by Govt. of India, 28-29 September, 1994, New Delhi.
11. International Conference on Wind Engineering, organised by Indian Society for Wing Engineering, Roorkee, at New Delhi, January 9-13, 1995.
12. IDNDR-Day celebrations on given theme on regular basis since 1995, on Second Wednesday of October every year, organised by NCDM
13 Workshop on Himalayan Eco-development and Natural Disaster Reduction, organised by NCDM, New Delhi, November, 1995.
14. International Seminar on Mathematical Modelling of Atmospheric and Oceanic Processes, organised by Department of Mathematics, Berhampur University, Berhampur, December 18-21, 1995.
15. International Conference on Disasters and Mitigation, organised by Anna University, Chennai, January 19-22, 1996.
16. Workshop on Safety from Forest Fire : Courses and Remedies, organised by Uttar Pradesh Academy of Administration, Nainital and Forest Panchayat Training Institute, April 16-17, 1996.
17. PIARC G2 Group Seminar, Natural Disaster Reduction for Roads, organised by Central Road Research Institute, New Delhi, January 29-31, 1997.
18. International Seminar on Coping with Natural Disasters : Aspects of Risks, Crisis and Development, organised by Natural Disasters Management Cell, Agro-Economic Research Centre, Visva Bharati, Shantiniketan, February 28-March 2, 1997.
19. Workshop on Earthquake Disaster Mitigation, organised by DEQ-UOR, October, 1997.
20. Seminar on Natural Hazards in Urban Habitat, organised by Central Building Research Institute, Roorkee at New Delhi, November 10-11, 1997.
21 International Symposium on Asian Monsoon and Pollution over the Monsoon Environment, organised by Indian Meteorological Society, New Delhi, December 2-5, 1997.
22. Third Annual Convention of Indian Building Congress on Built Environment & Natural Hazards, New Delhi, February 7-8, 1998.
23. International Conference on Disaster Management, organised by Tezpur University, Guwahati, Assam, April 23-26, 1998.
24. Workshop on Geohazard & Related Societal Issues, organised by Indian Society of Engineering Geology, Lucknow, November 26, 1998.
25. 11th Symposium on Earthquake Engineering, organised by DEQ-UOR and ISET, December, 1998.
26. Policy Forum on Future of Mitigation of South Asian Disasters, organised by Disaster Management Institute and Duryog Nivaran, New Delhi, February 5-6, 1999.
27. National Symposium on Tropical Meteorology, organised by Indian Meteorological Society, Regional Meteorological Centre, Chennai, February 16-19, 1999
28. National Advisory Group Meeting on Managing and Measuring the Vulnerability, organised by Disaster Management Institute, New Delhi, June 12, 1999.

## SOME RESOURCE PUBLICATIONS


1. Uttarkashi Earthquake, October 20, 1991, *Special Publication No. 30, Geological Survey of India, 1992*
2. Disaster Management, V.K. Sharma, NCDM, New Delhi, 1993.
3. Impact of Natural Disasters on the Environment and Development : Examples from Himalaya and Eastern and Western Ghats, 1994, *Chandi Prasad Bhatt, Himalayan Research Centre, Dehradun.*
4. Applicability of Long Range Forecast of South-west Monsoon Rainfall in Different parts of India with Special Reference to Andhra Pradesh, 1994, *B.V.Ramana Rao et.al., Central Research Institute for Dryland Agriculture, Santoshnagar, Hyderabad.*
5. Killari Earthquake, September 30, 1993, *Special Publication No. 37, Geological Survey of India, 1996*
6. Curren Science, Volume 62, Number 1&2, Special Issue: Seismology in India - An Overview
7. Current Science, Volume 67, Number 5, Special Issue: Strong Ground Motions and Engineering Specifications.

## ABBREVIATIONS

| | |
|---|---|
| **AIR** | All India Radio |
| **ATI** | Administrative Training Institute |
| **AVRC** | Audio Visual Resource Centre |
| **BARC** | Bhaba Atomic Research Centre |
| **BIS** | Bureau of Indian Standards |
| **BMTPC** | Building Materials and Technology Promotion Council |
| **CWC** | Central Water Commission |
| **CBRI** | Central Building Research Institute |
| **CRF** | Calamity Relief Fund |
| **CRRI** | Central Road Research Institute |
| **CSIR** | Council for Scientific and Industrial Research |
| **CAPART** | Council for Advancement of Peoples Action & Technology |
| **DMI** | Disaster Mitigation Institute |
| **DST** | Department of Science and Technology |
| **DEQ-UOR** | Department of Earthquake Engineering, University of Roorkee |
| **DES-UOR** | Department of Earth Science, University of Roorkee |
| **DH-UOR** | Department of Hydrology, University of Roorkee |
| **DGSM** | Dasholi Gram Swarajya Mandal |
| **DWS** | Disaster Warning Systems |
| **GIS** | Geographic Information System |
| **GPS** | Global Positioning System |
| **GSI** | Geological Survey of India |
| **HUDCO** | Housing and Urban Development Corporation |
| **IMD** | Indian Meteorological Department |
| **ISET** | Indian Society of Earthquake Technology |
| **IDNDR** | International Decade for Natural Disaster Reduction |
| **IITs** | Indian Institutes of Technology |
| **JAC** | Joint Assistance Centre |
| **MOA** | Ministry of Agriculture |
| **NCDM** | National Centre for Disaster Management |
| **NDM** | Natural Disaster Management |
| **NFCR** | National Fund for Calamity Relief |
| **NGRI** | National Geophysical Research Institute |
| **NRSA** | National Remote Sensing Agency |
| **NGO** | Non Government Organisation |
| **RRL** | Regional Research Laboratory |
| **SERC** | Structural Engineering Research Centre, Chennai |
| **WIHG** | Wadia Institute of Himalayan Geology |
| **WMO** | World Meteorological Organisation |