NIDM

Maharashtra

National Disaster Risk Reduction Portal

Map showing the State boundary and road network (Source: http://www.mapsofindia.com/maps/maharashtra/maharashtraroads.htm)

1. STATE PROFILE [1, 2]

1.1 General

Maharashtra occupies the western and central part of the country and has a long coastline stretching nearly 720 kilometers along the Arabian Sea. The Sahyadri mountain ranges provide a physical backbone to the State on the west, while the Satpuda hills along the north and Bhamragad-Chiroli-Gaikhuri ranges on the east serve as it's natural borders. The State is surrounded by Gujarat to the north west, Madhya Pradesh to the north, Chattisgarh to the east, Andhra Pradesh to the south east, Karnataka to the south and Goa to the south west. Maharashtra State has a geographical area of 3,07,713 sq. km and is bounded by North latitude 15°40' and 22°00' and East Longitudes 72°30' and 80°30'.

The State has a population of 11.24 crore (Census 2011) which is 9.3 per cent of the total population of India. The State is highly urbanised with 45.2 per cent people residing in urban areas.

The State has 35 districts which are divided into six revenue divisions viz. Konkan, Pune, Nashik, Aurangabad, Amravati and Nagpur for administrative purposes. The State has a long

tradition of having statutory bodies for planning at the district level. For local self-governance in rural areas, there are 33 Zilla Parishads, 351 Panchayat Samitis and 27,906 Gram Panchayats. The urban areas are governed through 26 Municipal Corporations, 222 Municipal Councils, 7 Nagar Panchayats and 7 Cantonment Boards.

Mumbai, the capital of Maharashtra and the financial capital of India, houses the headquarters of most of the major corporate & financial institutions. India's main stock exchanges & capital market and commodity exchanges are located in Mumbai.

The State has 226.1 lakh hectares of land under cultivation and area under forest is 52.1 lakh hectares. Numbers of irrigation projects are being implemented to improve irrigation. A watershed mission has been launched to ensure that soil and water conservation measures are implemented speedily in the unirrigated area.

Maharashtra is the most industrialised State and has maintained leading position in the industrial sector in India. The State is pioneer in Small Scale industries. The State continues to attract industrial investments from both, domestic as well as foreign institutions. It has become a leading automobile production hub and a major IT growth centre. It boasts of the largest number of special export promotion zones.

The State has well spread road network of 2.43 lakh km. (maintained by public works Department and Zilla Parishads). All weather roads and fair weather roads connect more than 99 per cent villages. It has best surface transport facilities and connectivity with sea ports and airports has resulted into good transport system. It has highest installed capacity and generation of electricity in the country. All this has made this state the most favoured destination for investment.

State at a glance[3]

Items	Year (2010-11)
Geographical Area- (Thousand sq. km.)	308
Revenue Divisions	6
Districts	35
Tahsils/Talukas	355
Inhabited villages	43,663
Un-inhabited villages	-
Towns	535
State Capital	Mumbai
Zilla Parishads	33
Gram Panchayats	27,913
Panchayat Samitis	351
Municipal Councils	222
Municipal Corporations	23
Nagar Panchayat	7

1.2 Physiography[2, 4, 5]

Maharashtra is located in the north centre of Peninsular India. It links the north to the south and the plains of India to the southern peninsula. The state is bound on west by Arabian Sea, on north-west by Gujarat, on north by Madhya Pradesh, on southeast by Andhra Pradesh and on south by Karnataka and Goa. It is the third largest state in terms of area in the country. Dominant physical trait of the state is its plateau character. Physiographically this state may be divided into three natural divisions - the coastal strip (the Konkan), the Sahyadri or the Western Ghat and the plateau. The Konkan consists undulating low lands. North Konkan has the vast hinterlands. The Western Ghats running almost parallel to the sea coast. The average height of Sahyadri is 1,200 meters. The slopes of the Sahyadri gently descending towards the east and south-east. Tapi, Godavari, Bhima and Krishna are the main rivers of the state. Maharashtra receives its rainfall mainly from south-west monsoon. The rainfall in state varies considerably. There is heavy rainfall in the coastal region, scanty rains in rain shadow areas in the central part and moderate rains in eastern parts of the state.

Physical divisions of the State comprise of three parts based on its physical features, viz, Maharashtra Plateau, the Sahyadri Range and the Konkan Coastal Strip as explained below.

Maharashtra Plateau: The major physical characteristics of the state include many small plateaux and river valleys. In the north the plateau is flanked by Satpuda ranges, which run in the East-West direction in Maharashtra. The river Narmada flows along the north boundary of Maharashtra, and other major rivers like Krishna, Godavari, Bhima, Penganga-Wardha, and Tapi-Purna have carved the plateau in alternating broad river valleys and intervening highlands.

The Sahyadri Range: The Western Ghats of Maharashtra known as the ‘Sahyadri’ mountain ranges have an average elevation of 1000-1200 m above the MSL. The Sahyadri hills run parallel to the seacoast, with many offshoots branching eastwards from the main ranges (Satmala, Ajanta, Harishchandra, Balaghat and Mahadeo). The special features are the hills of Trimbakeshwar, Matheran and the Mahableshwar plateau. Its highest peak is Kalsubai at an altitude of 1650 m. Most of the rivers in Maharashtra originate in the Sahyadri and then divide to join the eastward and westward flowing rivers. These ranges are also characterised by a number of ghats, the important ones being Thal, Bor, Kumbharli, Amba, Phonda and Amboli.

The Konkan Coastal Strip: The narrow strip of coastal land between the Sahyadri and the Arabian Sea is called the Konkan coastal strip. It is barely 50 km in width; it is wider in the north and narrows down in the south. River creeks and branches of the Sahyadri, which reach right up to the coast, dissect this coastline. The important creeks in Konkan are Terekhol, Vijaydurg, Rajapuri, Raigad, Dabhol, Daramthar, Thane and Vasai. The rivers of Konkan rise from the cliffs of Sahyadri and have a short swift flow into the Arabian Sea. Some important rivers are Ulhas, Savitri, Vashishthi and Shastri.

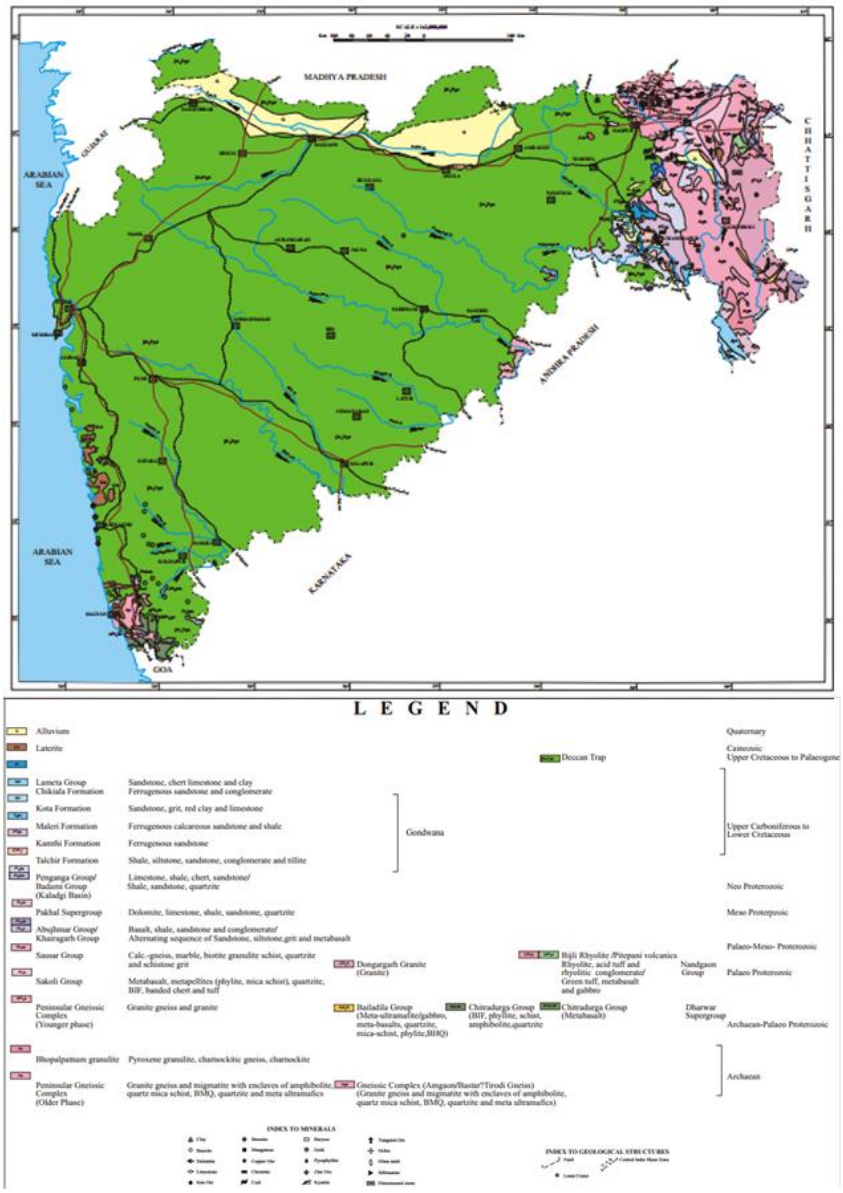
1.3 Drainage[2]

About 75% area of Maharashtra is drained by eastward flowing rivers, viz. the Godavari and Krishna, to the Bay of Bengal and the remaining 25% area is drained by westward flowing rivers like the Narmada, Tapi and Konkan coastal rivers to the Arabian Sea.

1.4 Geology[6, 7]

The entire area of the State forms a part of the "Peninsular Shield", which is composed of rocks commencing from the most ancient rocks of diverse origin, which have undergone considerable metamorphism. Over these ancient rocks of Precambrian era lie a few basins of Proterozoic era and of permo carboniferous periods which are covered by extensive sheets of horizontally bedded lava flows comprising the Deccan trap. More than 80% area of the State is covered by these Deccan trap, which have concealed geologically older formations. The most important economic minerals such as coal, iron ore, manganese ore, limestone, etc. are found in the geologically older formations.

Structurally, the entire area of the state forms a part of the "Peninsular Shield" of India which represents a fairly stable block of earth crust that has remained unaffected by, mountain building movements, since the advent of the Palaeozoic era. Some of the subsequent movements in the crust have been of the nature of normal and block faulting which have laid down certain portions bounded by tensional cracks of faults giving rise to basins in which sedimentary beds of the Gondwana age have been deposited. Particularly in the Vidarbha region giving rise to the the important limestone as Penganga beds and coalfields of the Pench-Kanhan valley, the Umred – Bander field the Wardha valley and Vidarbha valley. It is generally accepted that the Western coast has been formed as a result of the faulting. Along this coast from Ratnagiri to Mumbai, and further north in Thane district there exists a series of hot springs arranged almost in linear fashion which suggests that they are situated on a line of fracture. Further evidence regarding the formation of west coast by faulting is offered by the Western Ghats comprising Deccan trap lava flows, which are several hundred metres thick near the coast and which gradually thins out east wards. Near Panvel, near the west coast the Deccan traps show westerly slopes indicating designated as Panvel flexure.



Map showing geological setup of the State (Source: http://www.portal.gsi.gov.in/gsiDoc/pub/MP30_GM_Maharashtra.pdf)

1.5 Soil[5, 8]

The NBSSLP has published a map of the soils of Maharashtra, dividing the state into 356 soil-mapping units, which are broadly categorized as follows:

- Soils of Konkan coast
- Soils of Western Ghats
- Soils of Upper Maharashtra
- Soils of Lower Maharashtra

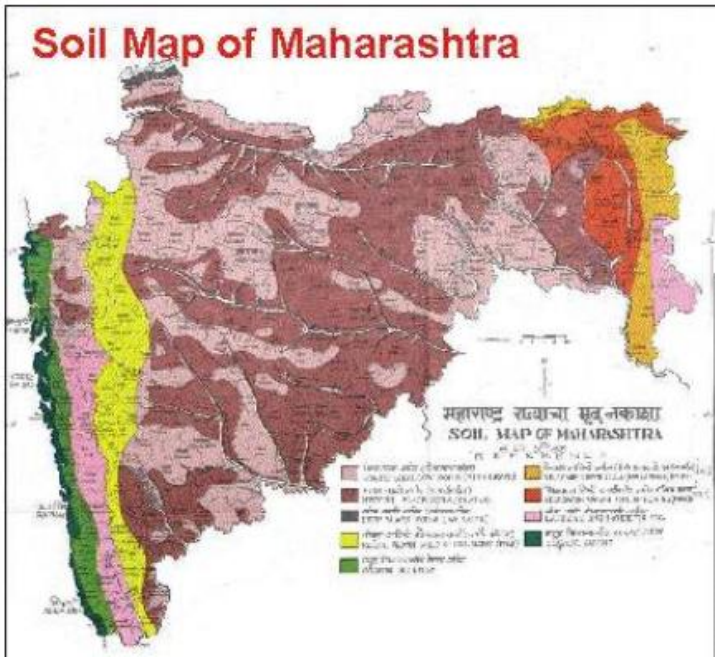
About 96.4 per cent of the states geographic area is subjected to various degrees of erosion. The soil profile reveals that the incidence of severe erosion is the highest in the Western Ghats 53.1 percent), followed by lower Maharashtra (11.5 percent).

The soil status of Maharashtra is residual, derived from the underlying basalts. In the semi-dry plateau, the regur (black-cotton soil) is clayey, rich in iron and moisture-retentive, though poor in nitrogen and organic matter. When re-deposited along the river valleys, the kali soils are deeper and heavier, better suited for Rabi crops. Farther away, with a better mixture of lime, the morand soils form the ideal Kharif zone. The higher plateau areas have pather soils, which contain more gravel.

In the rainy Konkan, and the Sahyadri Range, the same basalts give rise to the brick-red laterites, which are productive under a forest-cover, but readily stripped into a sterile varkas when devoid of vegetative cover. By and large, the soils of Maharashtra are shallow and of somewhat poor quality.

The soil and vegetation of Maharashtra are related to the climate and the geology. The soil in the Deccan plateau is made up of black basalt soil. This type of soil is rich in humus. The soil is commonly known as the black cotton soil because it is best suited for the cultivation of cotton.
The volcanic action which had taken place in the Deccan region has given rise to the soil texture and composition. These igneous rocks break down into the black soil which is very fertile.

The Wardha - Waliganga river valley has old crystalline rocks and saline soils which make the soil infertile. This type of soil has a natural resistance to wind and water erosion because it is rich in iron and granular in structure. A very important advantage of this type of soil is that it can retain moisture. This makes the soil very reactive to irrigation.



Map showing distribution of soil in the State (Source: http://agricoop.nic.in/Agriculture%20Contingency%20Plan/Maharastra/MH8-%20PUNE%2031.03.2011.pdf)

1.6 Climate[2, 4]

The climate of the State is tropical. The Western Ghats hill ranges run north to south separating the coastal districts of Thane, Mumbai, Raigarh, Ratnagiri and Sindhudurg from rest of the State. The average height of these ranges is about 1000 m amsl form an important climatic divide. The coastal areas receive very high monsoon rains while to the east of the Ghats rainfall drops drastically within short distance from the Ghats. Towards further east, the rainfall once again gradually increases.

The State experiences four seasons during a year. March to May is the summer season followed by rainy season from June to September. The post monsoon season is October and November. December to February is the

Maharastra has got variable climate from continental to typical maritime depending upon the location and physiography. The coastal districts of Konkan experience heavy rains but mild winter. The weather, however, is mostly humid throughout the year. The maximum and minimum temperature varies between 27°C and 40°C & 14°C and 27°C respectively. The maximum summer temperature varies between 36°C and 41°C and during winter the temperature oscillates between 10°C and 16°C. Rainfall starts in the first week of June and July is the wettest month. Rainfall in Maharashtra differs from region to region.

The State experiences extremes of rainfall ranging from 6000 mm over the Ghats to less than 500 mm in Madhya Maharashtra. The Konkan sub-division comprising of coastal districts and Western Ghats receive the heaviest rains, the Ghats receive more than 6000 mm and the plains 2500 mm.

Rainfall decreases rapidly towards eastern slopes and plateau areas where it is minimum (less than 500 mm). It again increases towards east i.e in the direction of Marathwada and Vidarbha and attains a second maximum of 1500 mm in the eastern parts of Vidarbha. Thus, the Madhya Maharashtra sub-division is the region of the lowest rainfall in the State.

The State receives its rainfall chiefly during the south west monsoon season (June to September) while Konkan receives almost 94% of the annual rainfall during the monsoon season, The other sub-divisions namely Mahdya Maharashtra, Marathwada and Vidarbha receive 83%, 83% and 87% respectively during this season.

The number of rainy days have great significance in artificial recharge to ground water. These vary from 75 to 85 in Konkan and 30 to 40 days in Madhya Maharashtra and Marathwada. The number of rainy days in Vidarbha is around 40 to 50 days during south west monsoon season.

The intensity of rainfall plays a vital role in artificial recharge to ground water. Though as such, not much data is available, the maximum rainfall recorded in 24 hrs in some selected stations have been presented in Table 2. In general, the intensity of rainfall is high in coastal and Ghat areas as compared to the other parts of the state. The intensity of rainfall varies

from storm to storm and with occurrence of depression and low-pressure areas during monsoon season.

The variability of annual rainfall over the state in general, is high. Only in the coastal areas, the variability is less than 20% otherwise the variability ranges between 20% and 35% over the state. On sub-divisional basis, the variability of annual rainfall in Konkan is the least (23%) while it is the maximum in Marathwada (31%). In Madhya Maharashtra and Vidarbha the variability is 30% and 26% respectively.

1.7 Agro-climatic zones[9]

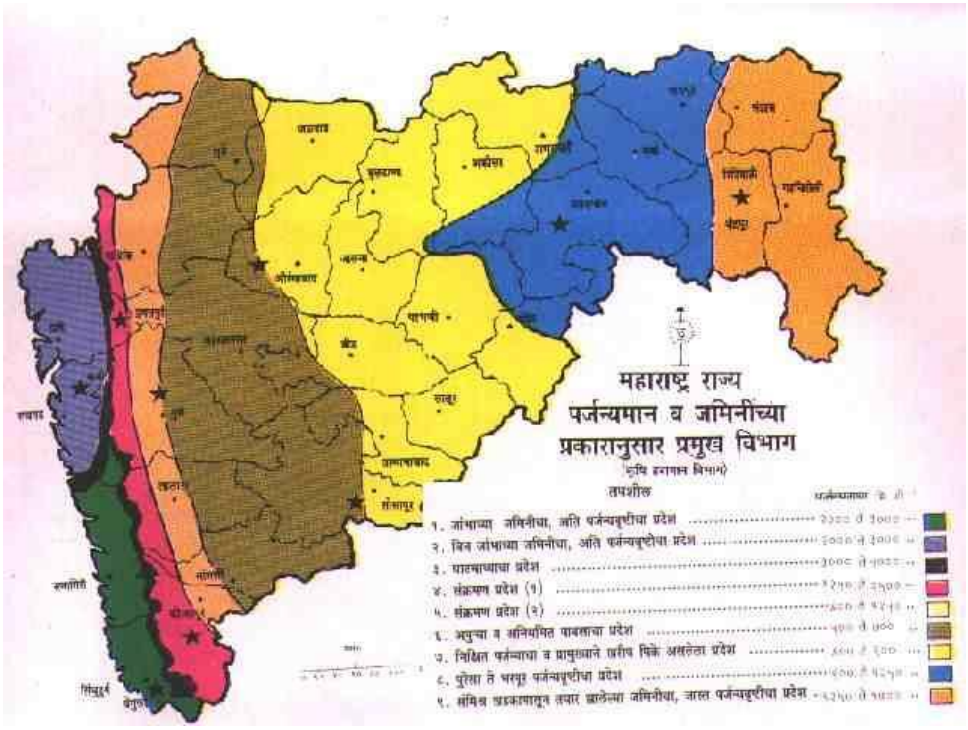
Major portion of the state is semi arid with three distinct season of which rainy season comprises of July to September. There are large variations in the quantity of rainfall within different parts of the state. Ghat and coastal districts receive an annual rainfall of 2000 mm but most part of the state lies in the rain shadow belt of the ghat with an average of 600 to 700 mm.

The state has been divided into 9 agro-climatic zones based on rainfall, soil type and the vegetation as mentioned below.

Sl No	**Agro-climatic zones in Maharashtra**	**Name of the Zone**	**Climatic condition**	**Avg. Annual rainfall**	**Soil Type**
1	South Kokan Coastal Zone	Veryhigh rainfall zone with laterite soils	Daily temp. Above 20^0C. Throughout the year.	3105 mm in 101 days	Laterite. PH-5.5-6.5 acidic, poor in phosphorous rich in nitrogen and Potasscium
2	North Kokan Coastal Zone	Very high rainfall zone with non lateritic soils	Avg.daily temp 22 to 30C.Mini. temp17 to 27 C. Humidity 98%in rainy season & winter-60%	2607 mm in 87 days.	Coarse &shallow. PH5.5to 6.5, acidic Rich in nitrogen, poor in phosphorus & potash.
3	Western Ghat	Western Ghat Zone/Ghat zone	Maximum temp. ranges from 29-39 C. Minimum temp ranges from 13-20 C.	3000 to 6000 mm. Rainfall recorded in different places of the zone viz Igatpuri, Lonawala, Maha baleshwar, & Radhanagari.	'Warkas' i.e. light laterite & reddish brown. Distinctly acidic, poor fertility low phosphorous & potash content.
4	Transition	Sub Montane	Average	700-2500	Soils are reddish

	Zone-1	Zone/ Transition Zone 1	maximum temperature is between 28-35 C and minimum 14-19 C	mm.Rains received mostly from S-W monsoon.	brown to black tending to lateritic. PH 6-7.Well supplied in nitrogen but low in phosphorous & potash
5	Transition Zone-2	Western Maharashtra Plain Zone /Transition-2	Water availability ranges from 120-150 days. Maximum temperature 40 C & minimum 5 C.	Well distributed rainfall 700 to 1200 mm.	Topography is plain. Soils greyish black .Moderately alkaline 7.4- 8.4, lowest layer is 'Murum' strata. Fair in NPK content. Well drained & good for irrigation.
6	Scarcity Zone	Western Maharashtra Scarcity Zone/ Scarcity Zone	Suffers from very low rainfall with uncertainty & ill-distribution. Maximum temperature 41 C minimum - 14-15 C	Less than 750mm in 45 days. Two peaks of rainfall. 1) June/ July2) september. Bimodal pattern of rainfall.	General topography is having slope between 1-2%. Infiltration rate is 6-7 mm/hr.The soils are vertisol. Soils have Montmorilonite clay. Poor in nitrogen, low to medium in phosphate & well supplied in potash.
7	Assured Rainfall Zone	Central Maha rashtra Plateau Zone /Assured Rainfall Zone	Maximum temp erature 41 CMinimum temp erature 21 C	700 to 900 mm 75 % rains received in all districts of the zone.	Soil colour ranges from black to red. Type- 1) vertisols 2) entisols & 3) inceptisols PH 7-7.5
8	Moderate Rainfall Zone	Central Vidarbha Zone /Zone of Moderate Rainfall	Maximum temperature 33-38 C Minimum temperature 16-26 CAverage daily humidity 72 % in rainy season, 53 % in winter & 35% in summer.	1130 mm.	Black soils derived from basalt rock. Medium to heavy in texture alkaline in reaction. Low lying areas are rich and fertile.
9	Eastern Vidarbha Zone	Eastern Vidharbha Zone/ High Rainfall	Mean Maximum temperature varies from 32	950 to 1250 mm on western side. 1700 mm on	Soils derive from parent rock granite, gneisses, and schists. Brown to

		Zone with Soils derived from parent material of different crops. There are four subzone based on climate, soilsand crop pattern	to 37 C. Minimum temperature 15 to 24 C. Daily humdity 73% for rainy season 62 winter & 35 summer	extreme east side No of rainy days 59.	Red in colour. PH 6 to 7



Map showing agri-climatic zonation in the State (Source: http://www.mahaagri.gov.in/CropWeather/AgroClimaticZone.html#map)

1.8 Socio-economic conditions[4]

Although Maharashtra is a highly industrialised state of India, agriculture continues to be the main occupation of the people. About 61% of the people directly or indirectly depend on agriculture and allied activities for their livelihood. Principal crops of the state are rice, jowar, bajra, wheat, tur, mung, urad, gram and other pulses. Maharashtra is a major producer of oilseeds like groundnut, sunflower, soyabean etc. Major cash crops of the state are cotton, sugarcane, turmeric and vegetables. Horticulture has a very important place in this state. Varieties of fruits like mango, orange, banana, grape, cashew nut etc. are produced in this

state. The Nagpur oranges and Alphonso mangoes are very famous. There were about 10.91 lakh hectares of land under horticulture. Fishing is an important activity of this state.

Socio economic profile at a glance[3]

Items	Year (2010-11)
Total Population (In thousands)	1,12,373
Male Population (In thousands)	58,361
Female Population (In thousands)	54,012
Rural Population (In thousands)	61,545
Urban Population (In thousands)	50,828
Density of population (per sq. km.)	365
Literacy rate (percentage)	82.9
Sex ratio (Females per thousand males)	925
Percentage of urban population	45.2
Percentage of rural population	54.8
Birth Rate	16.7
Death Rate	6.5
Infant mortality rate	25
Decadal growth (per cent)	16.0
Net area sown (in '000 ha.)	17,406

2. DISASTER RISK PROFILE[5]

2.1 Vulnerability of the State[5]

Maharashtra is prone to various disasters such as drought, floods, cyclones, earthquake and accidents. While low rainfall areas of the state are under the constant risk of droughts, high rainfall zones of eastern and western Maharashtra are prone to flash floods and landslides. The Koyna reservoir and surroundings fall under the high risk of earthquake hazards. Similarly, Industrial belt of Pune, Mumbai and Nashik are prone to the risk of accident and industrial hazards. Other disasters like fire and road accidents occur in congested areas lacking proper infrastructure. The state has suffered huge losses, both direct and indirect, caused by various disasters. For example, the infamous Latur earthquake of 1993, resulted in the loss of several thousands of human and animal lives. In addition, it caused damage to entire infrastructure such as buildings, roads, railways, pipelines, and electricity network, etc. In order to avoid such losses due to disasters, the GoM has established a mechanism for disaster preparedness and mitigation by integrating science and technology with communication network facilitates.

Many areas of the State have faced droughts for consecutive years, which damaged agriculture and caused water shortage in more than 20,000 villages. The disaster vulnerability and district-wise vulnerability of the state is given in the following tables

Table showing the hazards and its impacts in the State[5]

Hazards	Impacts
Floods	The rivers, which cause flood in the state, are the Tapi, Wardha and occasionally the Pen- Ganga. The eastern parts of the state are prone to floods. The 1996 flood in the state destroyed 2,899 lakh hectares of land, killing 198 people and 38 cattle.
Droughts	The Deccan plateau constitutes 50 percent of the drought-prone areas of the state. 12 percent of the population lives in drought-prone areas. Once in 5 years, deficient rainfall is reported. Severe drought conditions occur once every 8-9 years. The 1996 drought affected 7 districts and 266.75 lakh people. The 1997 drought affected 17 districts.
Earthquakes	Latur in Maharashtra experienced a number of shocks between August and October 1992. An earthquake measuring 6.4 on the Richter scale shook Latur on September 30, 1993. Extensive damage was caused to life and property in the districts of Latur and Dharashiv. The earthquake killed 7,938 people, injured 16,000, and left 15,847 livestock dead. 52 villages were razed to the ground and around 27,000 houses were totally damaged. The Koyna dam is situated in one of the most active seismic zones of Maharashtra and in 35 years this region has witnessed more than one lakh tremors. A severe quake occurred in Koyna on December 11, 1967. The quake was the strongest earthquake on Maharashtra Konkan coast in the 20th century. The magnitude ranged between 6.5 and 7.5 on the Richter scale and was felt all over western Maharashtra, Goa and Karnataka; the epicentre was near the Koyna Dam. Over 200 people died and hundreds more were injured. An earthquake measuring 3.7 on the Richter scale hit Maharashtra Koyna region as recently as March 2001.

Table showing the district wise vulnerability of the State[5]

Districts	Flood	Earthquake	Cyclone	Drought
Ahmednagar	3% of the population lives in flood prone areas	83 % of human settlements are in areas with non-specific building codes	Yes	Yes
Akola	Patur taluka has the largest flood-prone area (57%), followed by Barsi Takli (48%), Akot (45%), Balapur (40%) etc	Yes	No	Yes
Amravati	Flood-prone along the Wardha river; eight floods in the last 15 years	Yes	No	Yes

Beed	Flood-prone: almost 26 % of the population lives in flood-prone areas	Yes	No	Yes
Bhandara	Flood-prone along the Vainganga river	Yes	No	Yes
Chandrapur	Flood-prone; 12 major floods in last 30 years causing 47 deaths and loss of Rs 3400 lakhs	Minor seismic activity	No	Yes
Dhule	170 villages identified as flood-prone every year	Yes	No	Yes
Gadchiroli	Three major floods in the last 10 years; 9.89 % of the population lives in flood-prone areas	Probability increased after the Jabalpur earthquake	No	Yes
Jalna	7 floods in the last 30 years; 196 villages flood prone	Weak zone possibility after the Marathwada earthquake of 1993	No	Yes
Kolhapur	Severe floods in 1989 and 1994; 188 riverside villages are prone to flood	Earthquakes with epicentres in the adjoining districts affected villages in 1967-68 and 1993-94 Indicated in zone IV: very high probability; massive earthquake in 1993	No	Yes
Mumbai	Yes	Yes	Yes	No
Nagpur	Flood-prone during monsoons. Seven major floods in the last 30 years. 13 % of the population lives in flood-prone areas.	Vainganga and Wardha river basins are earthquake-prone. Total population at risk: 3,66,631. Recorded tremors of 4.2 on the Richter scale during the Jabalpur earthquake	No	Yes
Nanded	History of frequent floods due to heavy rainfall and release of water from irrigation projects	Yes	Likelihood of cyclones because of proximity to Andhra Pradesh	Yes

Nashik	Three major flood-prone areas: Chandori, Saikheda, Niphad; 38.33 % of the population lives in flood-prone areas	Two earthquakes on the same day in 1993 (5.2 and 4.5 on the Richter scale); frequent tremors around Kalwan taluka from 1995 onwards	No	Yes
Parbhani	Yes	Yes	No	Yes
Pune	Yes	Tremors felt during all major earthquakes that affected western and Marathwada regions of the state and also during the Gujarat earthquake	No	Yes
Raigad	Yes	Yes	Yes	Yes
Ratnagiri	Possibility of river floods in the monsoon	The Koynagar earthquake of 1967 affected Chiplun and Sangameshwar talukas killing three people. Chances of future earthquakes are rare.	167 km coastline could attract cyclones. No major cyclones in the past.	No
Sangli	Flood-prone. 15 floods in the last 30 years	Vulnerable to earthquake. Severe earthquake in 1967 (6 on the Richter scale); in 1993 (5.5 on the Richter scale)	No	Yes
Satara	Possible monsoon floods	Strong possibility of earthquake. Also reservoir-induced seismicity	No	Yes
Sindhudurg	Prone to floods due to high rainfall and rush of seawater during high tide	Yes	No	Yes
Solapur	Possibility of floods. Major flood on the Bhima river in 1996	Tremors felt during the 1967 Koyna earthquake. 11 dead during the 1993 Latur earthquake. Included as seismic zone II	No	Common
Thane	Yes	Yes	No	Yes
Wardha	Great threat of floods. Major flood in 1994	Yes	No	Yes
Yavatmal	Heavy floods in 1994	Yes	No	Yes

In Maharashtra, floods mainly result from damage to the dam embankments, release of excessive water from dams, improper storm-water drainage systems and unplanned urbanisation. Increased migration and rising population due to urbanisation exerts tremendous pressure on the existing storm-water drains in the cities.

2.2 Flood[5]

More than two lakh hectares of land in Maharashtra is prone to floods and Patur taluka in Akola district has the largest flood prone area in the State. Nanded and Nashik are frequently affected by floods in the monsoons.

The eastern parts of the state are more prone to floods. The Tapi, Wardha and occasionally the Pen Ganga are the rivers causing floods in the State. The 1996 floods in the state destroyed 2,899 lakh hectares of land, killing 198 people and 38 cattle. In some cities like Mumbai land reclamation over the years has disturbed the natural drainage system. Therefore, city's low-lying areas are under the threats of floods even if there are minor rains. In Mumbai, there are 111 places in the city, 26 in Mumbai city district, and 73 in the eastern suburbs and 12 in the western suburbs that were identified in 1993 as flood prone areas. On July 26, Mumbai's suburbs were hit by 949 millimeters (37 inches) of rainfall, the heaviest downpour in a century. This resulted in heavy floods killing at least 900 people and huge damage to property.

2.3 Drought[5]

About 50 percent of the drought prone areas of Maharashtra are in the Deccan Plateau. About 90 per cent of the land in the state has basaltic rock, which is non- porous and prevents rainwater percolation into the ground and thus makes the area drought prone.

2.4 Earthquake[5]

Earthquakes in Maharashtra are showing major alignment along the west coast and Western Ghats region. Seismic activity can be seen near Ratnagiri, along the western coast, Koyna Nagar, Batas and Surry areas of Thane district. In north Maharashtra, the seismic activities near Dhule, Akola, Jalgaon and Amravati could be due to movements on the faults present in the area associated with the complex system of Narmada, Tapi and Purna. In north-east corner of Maharashtra, the earthquake activities in Nagpur and Bhandara districts may be associated with Deolapar thrust or sheared and faulted zones of Ramtek and Sakoli Basins.

2.5 Landslide[5]

Landslides occur, mainly due to vertical cutting of hills, for construction of houses, roads, railway lines, etc. In absence of proper embankment material, heavy rains lead to falling of earth matter and debris. Most cases of landslides occur during heavy rains associated with high velocity winds. Many regions in the state face the risk of landslides due to increased

pressure on land. For example, in Greater Mumbai region, many vacant sites on hill slopes or bottoms of hills have turned into inhabited area and thereby become vulnerable to landslides. Landslides sometimes result in loss of human lives and damage to structures such as houses and roadways.

2.6 Cyclones [5]

However, the coastal districts, especially the 167 km long coastlines along Ratnagiri can be hit by cyclones. In the Arabian Sea, during the period 1890-1995, around 207 depressions, mild cyclonic storms or severe cyclonic storms have been recorded. However, most of them have moved away from Maharashtra as out of 207 disturbances, only 19 have affected Maharashtra-Goa coast. Out of these 19, six were major ones causing 70 deaths, with 150 boats and 160 crew missing and extensive damage to trees and ships. Thus, in spite of having a long coastal region, Maharashtra has experienced only 6 cyclones in last 50 years, though there have been numerous threats. Thus, climatologically, the state is having low risk of cyclone.

2.7 Manmade Disasters[5]

Unnatural and manmade disasters such as road accidents, industrial accidents, fires, accidents in quarries and mines, drowning, explosion etc. may occur due to some technical blunders or man made changes in the environment.

2.8 Road accidents[5]

Road accidents are common on National highways that have about 107 accident prone spots (107) with maximum spots at NH 4 i.e. Mumbai-Pune highway (51) and State highways have 50 of such spots. This highway has the maximum traffic density and the main cause of accidents on this highway apparently was due to carelessness of drivers especially during overtaking.

2.9 Industrial accidents[5]

Industrial hazards occur mostly due to accidents during chemical processing, manufacturing, storage, transport and disposal of toxic waste. Thousands of industries are involved in the manufacturing, processing or storage of hazardous goods. Many of the storage godowns are in the close proximity of the residential and industrial estates, which increased the risk of fires and chemical explosions in these areas.

Districts with a large number of Major Accident Hazard Units in Maharashtra are Thane, Mumbai, Nashik, Pune, Raigad and Ratnagiri. Maximum number of accidents in industries manufacturing chemical and chemical products were in Nashik, Mumbai and Thane divisions. The number of accidents recorded in the manufacture of non-metallic mineral petroleum is almost half of those recorded in the other two categories. Raigad division shows

the maximum number of accidents due to gassing. Thane and Aurangabad had the maximum number of explosions, while fire related accidents were the highest in Nashik. The major concentration of the hazardous industries is seen in the Chembur-Trombay belt, spread over an area of about 10 sq.km, having major chemical complexes, refineries, fertiliser plants, atomic energy establishment and thermal power station. Clustering of various operating units make them highly vulnerable. This area is also in close proximity to the port activities of Mumbai Port Trust (MPT), which handles hazardous cargo. MPT has identified 32 hazardous chemicals, require frequent handling and storage during loading and unloading operations.

2.10 Fire accidents[5]

The fire risk can arise either from industrial processes, accidents in storage godowns or closely built timber framed buildings. Many areas in the State have faced fire accidents in godowns, during manufacturing in factories and festival seasons

2.11 Major Disasters

a) Man-Made[10]

- Serial bomb blast, Mumbai, Mar 1993
- Bomb blast in suburban trains, Mumbai, Jul 2006
- Terrorist attack, Mumbai, Nov 2008

b) Industrial accidents[5]

Among industrial hazards, oil and gas industry is one of the major culprits. Some of the industries are receiving crude oil through underground pipelines. These include, NOCIL, HPCL, BPCL and Patalganga. There have been incidents of underground leakages and fires.

c) Earthquake[5]

On several instances, earthquakes have caused severe damage in the State. A massive earthquake struck Maharashtra on September 30, 1993 at Killari in Latur district. Extensive damage was caused to life and property in the districts of Latur and Dharashiv with 7,928 people killed, 16,000 injured and 15,847 livestock killed. In Latur and Dharashiv, 52 villages were razed to ground wherein 27,000 houses, amenities and related infrastructure facilities were totally damaged. Nearly 2,20,000 houses in the adjoining villages of Latur and Dharashiv and 11 other districts of Solapur, Satara, Sangli, Beed, Parbhani, Ahmednagar, Nanded, Kolhapur, Aurangabad, Pune and Nashik suffered varying degrees of damage. A moderately strong earthquake of magnitude 5.1 Richter occurred on 14 March 2005, with its epicentre around Koyna. This area has been witnessing a large number of tremors of low magnitude consistently over a quarter of a century since the first earthquake appeared in 1968.

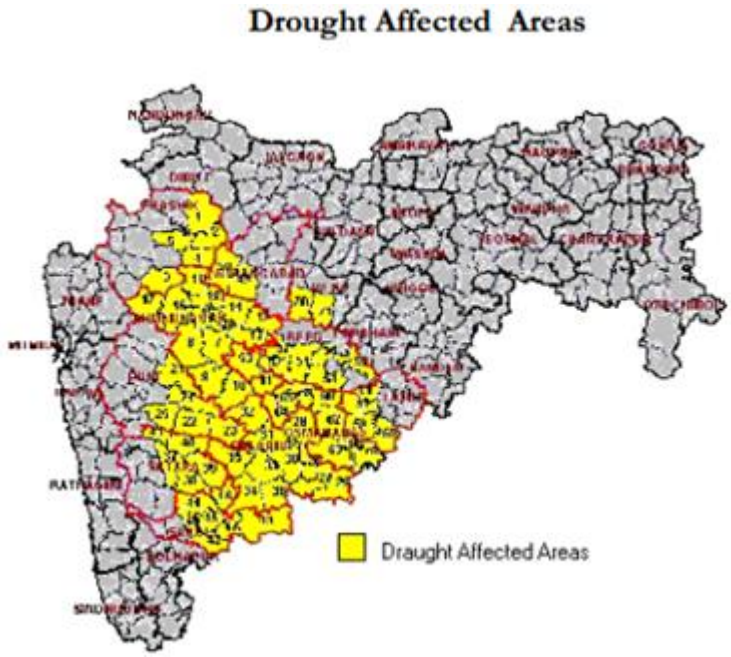
d) Flood[5]

Floods, though, are not a regular phenomenon, took 180 lives in 1996 and, more recently, in July 2005, about 900 people died in the Konkan Region due heavy rainfall.

A severe flood hit Wardha, Yavatmal, Kolhapur and few other districts in 1994. Chandori, Saikheda and Niphad are the three major flood-prone areas in Nashik district. A series of landslides triggered by heavy monsoon rains have killed at least 418 people in Maharashtra in the month of July, 2005, and more than half of these deaths are reported from Mumbai.

e) Droughts[5]

In 2001, droughts affected about 20,000 villages in 23 districts; 28.4 million people and 4.5 million hectares of crops in the State. According to a report from the GoM, number of districts affected by droughts in the year 2002-03 and 2003-04 were 33 and 11, respectively. The situation of droughts in Maharashtra continued to deteriorate in 2004. Following the failure of monsoon in 2003, the Govt. of Maharashtra (GoM) declared droughts in 11 districts namely, Pune, Satara, Sangli, and Solapur (Pune Division), Nashik and Ahmednagar (Nashik Division) and Beed, Latur, Dharashiv and Aurangabad (Aurangabad Division). Altogether 71 talukas in these 11 districts are seriously affected by the droughts.



Map showing drought affected areas in the State (Source: http://moef.nic.in/soer/state/SoE%20report%20of%20Maharashtra.pdf)

f) Landslides[5]

A number of landslides had occurred in Mumbai and Raigad districts due to heavy rains in July and August 2005 killing several people and causing loss to property.

3. INSTITUTIONAL SETUP

3.1 Introduction[10]

The National emergency management authority was constituted in Aug 1999, which submitted a report in 2001, to have separate department for Disaster management in India Government enacted the National disaster management act on 23rd Dec 2005, which lead to the creation of National disaster management authority (NDMA).

3.2 Maharashtra State Disaster Management Authority (MSDMA)[12]

The Maharashtra State Disaster Management Authority was constituted on 24th May 2006 under section 14 of the Disaster Management Act, 2005, with the Chief Minister as Chairperson, Deputy Chief Minister as Vice-chairperson, three Ministers, three unofficial members and the Chief Secretary as the Chief Executive Officer. It was stated by the Director (SDMA) that all members of the Authority hold position in their ex officio capacity. However, this position is apparently not correct since three unofficial members have been appointed by name and not by designation on ex officio basis. There is, however, no legal infirmity in the constitution of the State Authority which is in accordance with the provisions of the Act.

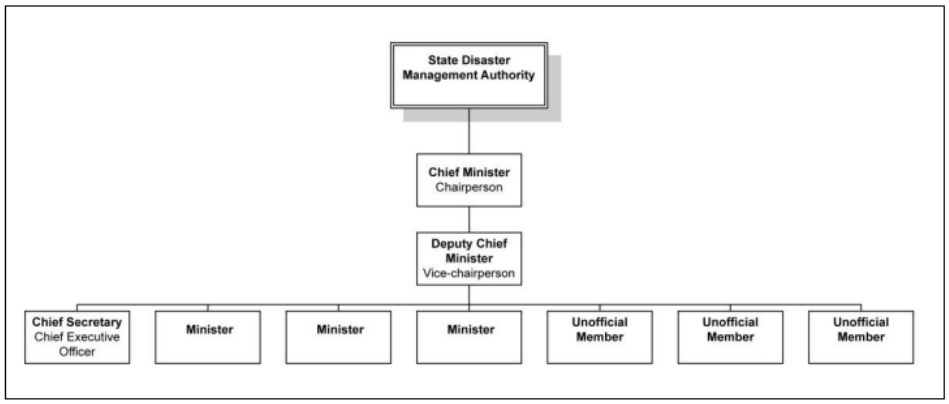


Chart showing the organizational setup of MSDMA

3.3 State Emergency Operation Centre (SEOC)[13, 15]

Emergency Operations Centre (EOC) is proposed with desk arrangements for specific activities during a disaster. The EOC will be linked to State Emergency Operation Centre (SEOC) constituted at state level. Division Emergency Operations Centre will have very limited participation of people to avoid chaos and confusion. Therefore, the non-government agencies although having a role in the rescue and relief operations will not be represented in the Division Emergency Operations Centre. However, to ensure the utilization of the manpower and material resources of these agencies, the Plan advocates to constitute a Sub-Group comprising of representatives of only non-government agencies, which will be responsible for distribution of relief materials obtained from external source, and also to support the government's requirement of additional manpower and material.

Emergency Support Functions (ESF) are the essentials of Emergency Management that provide the coordination mechanisms among the various agencies; they provide the

organization and process to plan, manage and coordinate specific response and preparedness activities common to - any hazardous event that can result in an emergency from the most frequent one to the most extreme one. Each ESF is headed by a lead agency and is supported by identified support agencies. These ESFs form an integral part of the Emergency Operation Centers.

3.4 State Executive Committee[12]

Simultaneously, a State Executive Committee (SEC) was also constituted with the Chief Secretary as the Chairperson and Additional Chief Secretary (Home), Additional Chief Secretary (Finance), Secretary (Public Health), Secretary (Relief and Rehabilitation) as Members and a retired General as Member Secretary.

A composite secretariat has been established for SDMA, as well as SEC, under the Chairmanship of Additional Chief Secretary (Relief and Rehabilitation). He is supported by a full time Executive Director with two full time Directors, one each for mitigation and response. A post of Financial Advisor is in the process of being created. Likewise, there are six Desks already in position, two each for mitigation, response and finance.

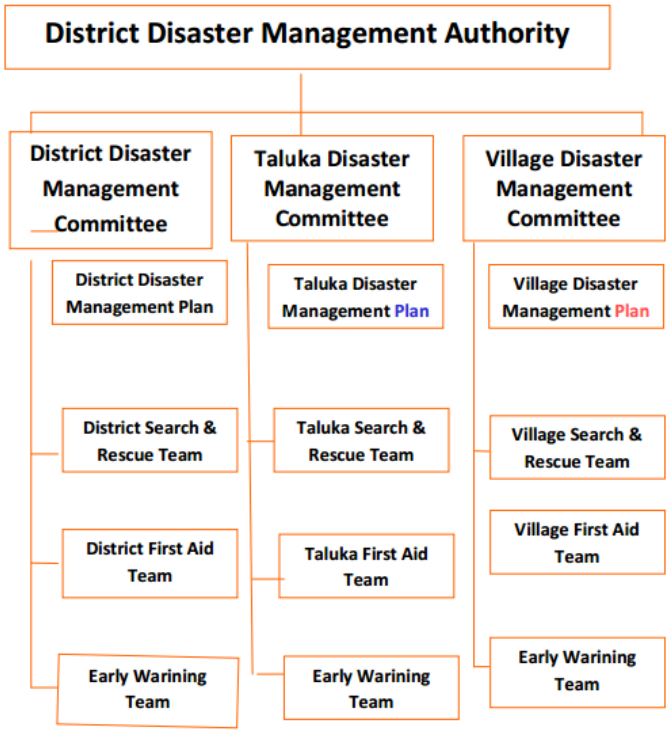
3.5 District Disaster Management Authority (DDMA) [10]

The disaster management will be more effective and sustainable if it is institutionalised. For this purpose Government of India has already passed Disaster Management Act on 23rd December, 2005, where it is clearly outlined that a Disaster Management Authority to be formed at the district level. It will be the apex body at the district level. Disaster management would involve many layers of participating organization. The three focal levels would be State, District and the site of the disaster. The State level agencies would be involved in policy/decisions making, resource and budget allocation and monitoring through the State Emergency Operations Centre.

Similarly, at district level a District Disaster Management Authority is already formed and activated to mitigate any unexpected situation in the district. There are seven members included in this authority.
Table showing the structure of DDMA

Sl No	Designation	Position
1.	District Collector (District Disaster Manager)	Chairperson
2.	Chairperson, Z.P. (Zilla Parishad)	Vice Chairperson
3.	Chief Executive officer, Z.P.	Member
4.	Superintendent of Police	Member
5.	Civil Surgeon	Member
6.	Executive Engineer (PWD)	Member
7.	Executive Engineer (irrigation)	Member
8.	Additional Collector / RDC	Member Secy.

The District Disaster Management Committee (DDMC) is an apex planning body and plays a major role in preparedness and mitigation. The district level response is co-ordinated under the guidance of the District Collector, who acts as a District Disaster Manager.



The Institutional Framework for disaster management developed at the District, Taluka and Village level is as follows:-

At each level, apart from disaster management committee, each level has a disaster management plan along with the various task forces like search and rescue, first aid, early warning, shelter management, etc.

At taluka level every taluka in the district has a taluka disaster management committee headed by tahsildar. As said above all line departments at taluka level are its members. Also a search and rescue team as well as first aid team have been set up at every taluka.

At village level, every panchayat has a village disaster management plan as well as village disaster management committee. The VDMC chaired by sarpanch includes talathi, gramsevak, teacher, health workers, etc. of 10 – 12 persons. Also a search and rescue team as well as first aid team have been set up and trained at every village.

3.6 Revenue and Forests Department[12]

The Relief and Rehabilitation Division under the Revenue and Forest Department in the Government of Maharashtra is the nodal agency for disaster management in the state. The Organizational Chart of R & F Department is given below:

Figure 5: Organizational Chart of Revenue & Forests Division

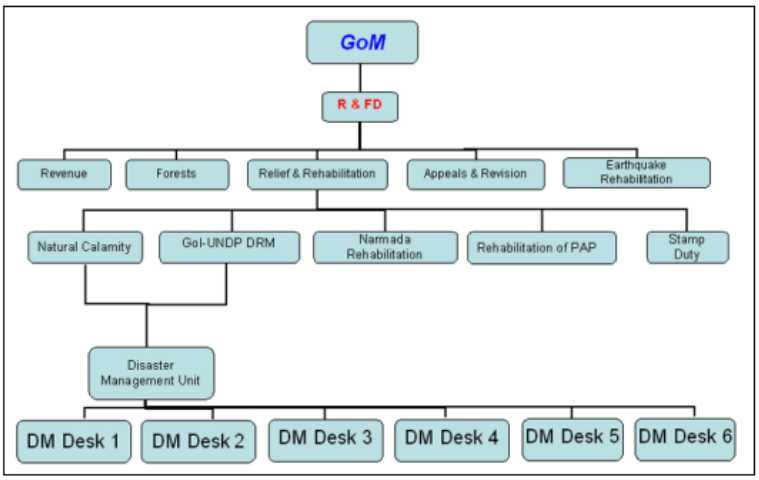


Chart showing the organization of Revenue and Forest Division

3.7 Bhabha Atomic Research Centre (BARC) [12]

Bhabha Atomic Research Centre is a premier multi-disciplinary nuclear research centre of India having excellent infrastructure for advanced research and development with expertise covering the entire spectrum of nuclear science and engineering and related areas. It functions under the Department of Atomic Energy (DAE). BARC has developed several spin-off technologies which find wide applications in a variety of sectors. The Centre has been passing on these technologies to the government, public and private sectors. It maintains a strong R & D base, a contingent of highly qualified and specialized manpower and a vast infrastructure consisting of ultra modern facilities and latest equipment, BARC provides consultancy and expert scientific services in hi-tech areas. BARC supports the achievement of DRM related objectives e.g. putting in place systems for radiological emergencies, establishment of Nuclear Power Plants for power generation, mitigation of the effects of climate change, etc. by sharing the outputs of its researches.

3.8 Mumbai Metropolitan and Region Development Authority (MMRDA) [12]

MMRDA28 was set up on the 26th January 1975 under the Mumbai Metropolitan Region Development Authority Act, 1974 Government of Maharashtra as an apex body for planning and co-ordination of development activities in the Region. It prepares plans, formulates policies and programs and helps in directing investments in the Region. It conceives, promotes and monitors the key projects for developing new growth centres and brings about improvement in sectors like transport, housing, water supply and environment in the Region. Moreover, if a project is of particular significance, the MMRDA takes up the responsibility for its implementation. MMRDA functions in close coordination with MCGM. As for DRM related function, MMRDA considers the DRM plan while conducting review of the regional plan for the Mumbai Metropolitan Region, integrates risk reduction in the planning and

implementation, e.g. recognition of proneness to natural hazards of each geographical location, site adaptation of construction, revision of building codes, etc.

3.9 Maharashtra Housing and Area Development Authority(MHADA)[12]

MHADA30 was established by the State Government in 1977 through the Maharashtra Housing and Development Act, 1976. It had over 19,642 old dilapidated tenanted buildings and is concerned with repair of these buildings and development of alternate housing units where these buildings are beyond repairs and may collapse. MHADA engineers conduct visual inspections of buildings to determine their structural safety and carry out repairs where necessary. MHADA also undertakes vulnerability assessment in the context of these old buildings.

3.10 Maharashtra Fire Services[12]

The subject of Fire Services in the State of Maharashtra is vested with the Urban Local Bodies. The Service was initially expected to focus on fighting fires, and the law constrained what they could do. Since then, the role of the Fire Service has changed a great deal. As a result, under the new Act, Fire and rescue Authorities now have a range of statutory duties to:

- Promote Fire Safety;
- To prepare for fighting fires and protecting people and property from fires; rescuing people from Road Traffic Accidents; and dealing with other specific emergencies, such as flooding or terrorist attack which are set out by Statutory Order and can be amended in line with how the role of the Service may change in the future. In addition, all Fire and Rescue authorities will be able to do other things to respond to the particular needs of their communities and the risks they face.

4. INITIATIVES [5, 10]

4.1 State Disaster Management Plan[14]

http://www.geospatialworld.net/Paper/Application/ArticleView.aspx?aid=927

Maharashtra is the first state to prepare a comprehensive State Disaster Management Plan and also undertake risk assessment and vulnerability analysis of the state. These studies address the vulnerability of various districts, talukas within these districts, and clusters of villages in these districts to earthquakes, floods and cyclones, epidemics, road accidents and fire, and chemical and industrial disasters. A separate volume on Standard Operating Procedures, details the manuals for various departments to be activated during an emergency.

4.2 District Disaster Management Plan[14]

The Government of Maharashtra identified one district from each of the six revenue divisions for preparing the multi-hazard response plans, with financial support from the ODA, UK.

This was also supplemented with the preparation of multi-hazard response plans for the remaining 25 districts, with financial support from the UNDP, through the Centre for Disaster Management at YASHADA. These multi-hazard response plans include an exhaustive risk assessment and vulnerability analysis of the district, with reference to earthquakes, floods and cyclones, epidemics, road accidents and fire, and chemical and industrial disasters. They also contain the multi-hazard response structure, capability analysis, including an inventory of resources, and mitigation strategies.

4.3 Disaster Management Plan[10]

As a part of overall preparedness of the State, the GoM has a State Disaster Management Plan to support and strengthen the efforts of district administration. The Centre for Disaster Management (CDM) of the GoM was set up in August 1996 with support from the Natural Disaster Management Division, Department of Agriculture and Cooperation, Ministry of Agriculture, Govt. of India. Its infrastructure consists of Documentation Centre and a stand-by Control Room (with 30 seconds connectivity for Video Conferencing, VSAT, Email and Fax Communication (www.yashada.org).

The functions and activities of the CDM are-

- To co-ordinate the activities related to disaster management in Maharashtra, especially, at the State and District levels;
- To develop a set of training modules and case studies on disaster management; and
- To develop disaster preparedness and capacity building through preparation of district disaster management plans.

Under 1996 Disaster Management Council's mandate, the Government of Maharashtra prepared a plan, which involves:

- Scrutinising disasters like earthquakes, floods, cyclones, epidemics, road accidents, industrial and chemical accidents, and fires,
- Estimating their footprint and reach,
- Listing down the monitoring facilities and regulatory regimes,
- Tracing the counter measures available to handle the disasters.

To support and strengthen the efforts of district administration, every district has evolved its own District Disaster Management Plan (DDMP) that addresses the districts' response to the disasters.

The objectives of DDMP are-

- To improve preparedness at the district level, through risk and vulnerability analysis of disasters and to minimise their impact in terms of human, physical and material loss.

- To ascertain the status of existing resources and facilities available with the various agencies involved in the district and make it an exercise in capacity building of district administration.
- To utilise different aspects of the disaster for development planning as a tool for location and area specific planning for development of district.

4.4 District Disaster Management program (DDMP) [10]

The Disaster Management Program exclusively works for developing the disaster management plans, providing trainings, and strengthening the capacity of the different Disaster Management Teams (DMTs) and creating awareness among public on various disasters. Plan development is one of the vital objectives of this project much more attention has been paid by the district administration to develop the plan so that it will be more useful to handle the disasters timely in future. Therefore, genuine efforts have been dedicated to develop the District Disaster Management Plan (DDMP).

Disaster Management has comprehensive cycle that includes preparedness, response, recovery and reduction phases. Based on this cycle, the response part is addressed with Incident Command System, (ICS) a best management tool, and linked with resource inventory connected to website India Disaster Resource Network, www.idrn.gov.in (IDRN). In fact, ICS and IDRN make it more effective.

District Disaster Management Plan (DDMP) has been developed and covered all relevant information related to human resources, equipments and critical supplies.

Objectives of DDMP

- To prevent loss of human life and property damage
- To study, analyze and evaluate the disasters
- To identify the vulnerable locations and do the vulnerability and risk analysis
- To improve preparedness, prevention and mitigation at district level
- To ascertain the status of existing resources and facilities available
- To recommend appropriate strategies and responses to deal with future disasters

4.5 District Disaster Management Committee (DDMC) [10]

Besides this, the Disaster Risk Management Programme also traced much to form Committees at the three levels with plans and task forces. A Disaster Management Committee exists to assist the Collector in

- Reviewing the threat of disasters
- Vulnerability of the district to such disasters
- Evaluating the preparedness
- Considering the suggestions for improvement of the response document DDMP

The Committee meets once a year under the chairmanship of the Collector and consists of the following functionaries.

Table showing the structure at district level

The Collector	Chairman
The District Superintendent of Police	Member
The Chief Executive Officer, Zilla Parishad	Member
The Additional Collector	Member
The Resident District Collector	Member-Secy
The Chief Fire Officer	Member
The District Health Officer	Member
The District Agriculture Officer	Member
The District Animal Husbandry Officer	Member
The Civil Surgeon	Member
The Executive Engineer, P.W.D.	Member
The Executive Engineer, Irrigation Department	Member
The Executive Engineer, Minor Irrigation Division	Member
The Executive Engineer, M.S.E.D.C.	Member
The Executive Engineer, MWSSB	Member
The Deputy Director of Education	Member
The Divisional Manager, Railways	Member
The Regional Transport Officer	Member
The Regional Manager, M.S.R.T.C.	Member
The District Publicity Officer	Member
The District Supply Officer	Member
The Local Station Director, A.I.R.	Member
The Local Station Director, Doordarshan	Member

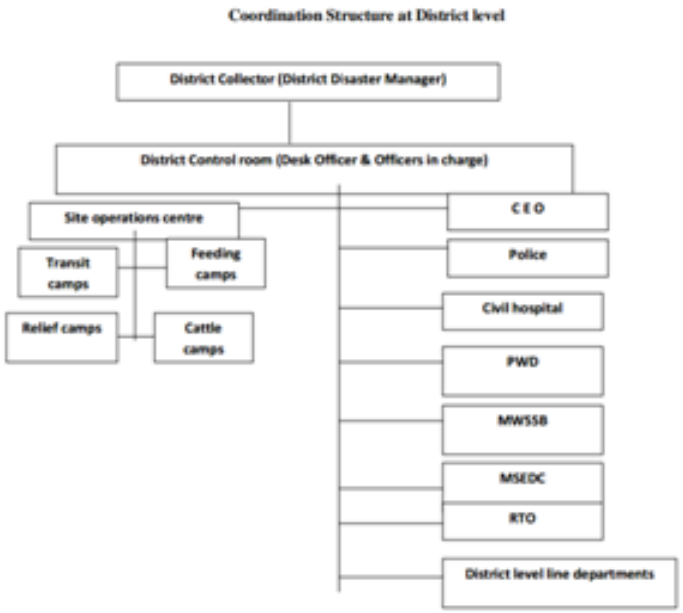


Chart showing the co-ordination structure at district level (Source: http://sindhudurg.nic.in/site/htmldocs/pdf/disaster.pdf)

4.6 Response Plan[10]

The onset of an emergency creates the need for time sensitive actions to save life and property, reduce hardships and suffering, and restore essential life support and community systems, to mitigate further damage or loss and provide the foundation for subsequent recovery. Effective response planning requires realistic identification of likely response functions, assignment of specific tasks to individual response agencies, identification of equipment, supplies and personnel required by the response agencies for performing the assigned tasks. A response plan essentially outlines the strategy and resources needed for search and rescue, evacuation, etc

Considering all this points, this response plan has been developed. For the first time Incident Command System (ICS) has also been introduced in response plan along with the resource inventory that is directly linked to the website. In fact, during disaster the ICS management tool will be more effective to handle the situation in proper way within limited time.

At district level, before the occurrence of disaster and immediately after the disaster, the district administration will activate the district control room so that proper information will be provided to the concerned authorities.

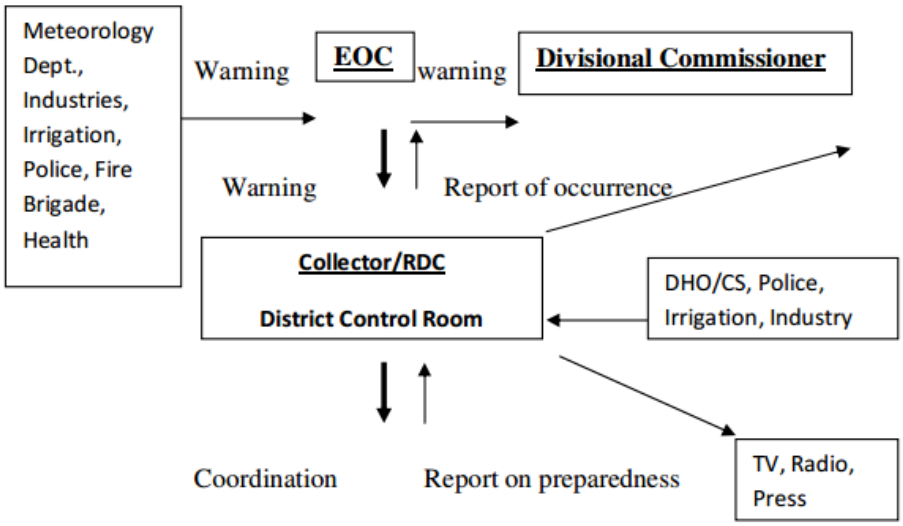


Chart showing the Response Structure during Warning Stage

4.7 Incident Command System (ICS) [10]

The Incident Command System (ICS) is a management system and an on-scene, all-risk, flexible modular system adaptable for natural as well as man-made disasters. The ICS has a number off attributes or system features.

The ICS seeks to strengthen the existing disaster response management system by ensuring that the designated controlling/responsible authorities at different levels are backed by trained Incident Command Teams (ICTs) whose members have been trained in the different facets of disaster response management.

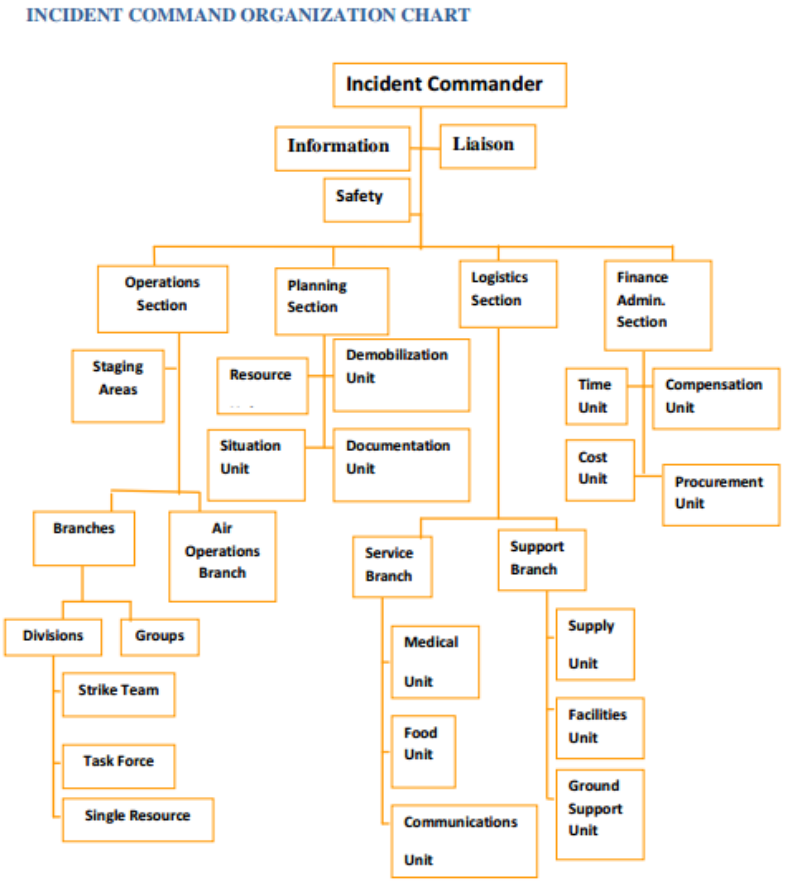


Chart showing the structure of the Incident Command System

4.8 District Level Incident Response[10]

At the district level, there will be one District Headquarters Team with the primary function of assisting the District Collector in handling tasks like general co-ordination, distribution of relief materials, media management and the overall logistics. Suitable officers from the district administration will be carefully selected and professionally trained for the different ICS positions in order to constitute the District Level Incident Command Teams (DICTs). The teams will focus on the operational aspects of response management, duly supported by other functions in ICS, e.g. Planning, Logistics, Finance/Administration, etc. The officers drawn for this assignment will be carefully selected by the District Collector depending upon their fitness, ability and aptitude for any of the DICT positions and they will be professionally trained to fulfill their assigned roles.

4.9 Center for Disaster Management [11]

The Center for Disaster Management (CDM) was set up in August 1996 with support from the National Disaster Management Division, Department of Agriculture and Cooperation Government of India.

Objectives

- To co-coordinate the activities related to disaster management in Maharashtra especially at the state and district levels.
- To develop training modules and case studies on disaster management.
- To develop disaster preparedness and capacity building through preparation of district disaster management plans.

Training Activities

- The Centre offers training to officers of senior, middle and junior levels from concerned departments of government. Training in various aspects of Disaster Management (DM) is also offered to the community. The nature of training is dynamic and has direct effect on the stakeholders.

The sponsoring agencies for CDM programmes include National Institute for Disaster Management, Delhi/ National Disaster Management Authority, Delhi / DOPT, Gol and departments of Government of Maharashtra and Zilla Parishads.

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