

MUMBAI, INDIA

DISASTER RISK MANAGEMENT PROFILE

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Mumbai, India



1 Introduction

Demographic, economic, social and cultural characteristics

Mumbai (known as Bombay until 1996) is located on the west coast of India facing the Arabian Sea and is the capital of the state of Maharashtra. It is India's financial capital. India itself is a South Asian country bordering the Arabian Sea and the Bay of Bengal, between Burma and Pakistan. It has a land area of 2,973,190 sq km on which live 1,065,070,607 people (July 2004 est.), making India the second most populous country in the world after its neighbor China.

With a \$3.319 trillion GDP_{ppp} (2004 est.)¹, the Indian economy is the fourth largest in the world, and is the world's second-fastest growing economy with an average growth rate of 6% since 1990. It encompasses traditional village farming, modern agriculture, handicrafts, a wide range of modern industries, and a multitude of support services. However, the country has a continuing public-sector budget deficit of an approximate 60% of GDP.

Governance style

The Republic of India is a democratic republic with a bicameral parliament. It is a union of states within a federal structure. It has 28 states (subdivided into districts), 6 Union Territories and the National Capital Territory of Delhi. States have their own elected government; while Union Territories are governed by an administrator appointed by the union government.

The head of state is the President which is mainly a ceremonial position. The President and Vice-President are elected indirectly through an electoral college for 5 year terms. The Prime Minister holds the executive power and is designated by the political party or coalition commanding a parliamentary majority. The Prime Minister nominates subordinate ministers to be appointed by the president.

National hazardscape

India has been traditionally vulnerable to various hazard types. Floods, droughts, cyclones, earthquakes and landslides have been recurrent phenomena. About 60% of the landmass is prone to earthquakes of various intensities; 13.45% (40+ million hectares) is prone to floods; about 8% of the total area is prone to cyclones and 68% of the area is susceptible to drought. "In the decade 1990-2000, an average of about 4344 people lost their lives and about 30 million people were affected by disasters every year. The loss in terms of private, community and public assets has been astronomical".²

Damage due to Natural Disasters in India

Year	People affected (Million)	Houses and buildings damaged	Property damage/loss (Million Rs)
1985	59.56	2449878	400.6
1986	55.00	2049277	307.4
1987	48.34	2919380	205.7
1988	10.15	242533	406.3
1989	3.01	782340	204.1
1990	3.17	1019930	107.1
1991	34.27	1190109	109
1992	19.09	570969	200.5
1993	26.24	1529916	508
1994	23.53	1051223	108.3
1995	54.35	2088355	407.3
1996	54.99	2376693	504.3
1997	44.38	1103549	n.a
1998	52.17	1563405	7.2
1999	50.17	3104064	10209.7
2000	59.43	2736355	8000
2001	78.82	846878	120000

Data: Annual Reports, NDM Division, Ministry of Agriculture

"Floods and high winds account for 60 % of all disasters in India [...] Losses in the Orissa Cyclone in 1999, and later, the Gujarat Earthquake in 2001 amounted to several thousand crore of Rupees, while the total expenditure on relief and reconstruction in Gujarat has been estimated at Rs 11,500 crore. Similarly, the country has suffered four major earthquakes in the last fifty years along with a series of moderate intensity earthquakes that have occurred at regular intervals. Since 1988, six earthquakes have struck different parts of the

One *crore* is 10 million.

country. These caused considerable human and property losses. [...] In the recent earthquake in Gujarat, more than 14,000 lives were lost, ten lakh houses were damaged and the asset loss has been indicated to be worth 15,000 crore.”³

The Building Materials and Technology Promotion Council (BMTPC) of India states that the vulnerability to natural hazards in terms of area affected is as follows: 54% to earthquakes, 28% to drought, 5% to floods, and 8% to cyclones. According to IIPA, about one million homes are damaged annually with human, economic, social and other losses (BMPTC, 2003).⁴

Regarding earthquakes, the country has been divided into five earthquake zones (Zone V having the largest probability of a high consequence event.) The BMTPC estimates earthquake vulnerability in terms of land area affected as follows:

- 12% is liable to severe earthquakes (intensity MSK IX or more)
- 18% is liable to MSK VIII (similar to the earthquakes in Latur/Uttarkashi)
- 25% is liable to MSK Vii (similar to the Jabalpur earthquake).

The east coast of the Indian subcontinent experiences more cyclones than the west coast (262 cyclones in the east compared with 33 cyclones between 1891 and 1990. Nineteen cyclones had more than 10,000 fatalities each. The floods in the Indo-Genetic-Brahmaputra plains render a few hundred lives lost and millions homeless every year.

BMTPC’s tool for disaster management, the Vulnerability Atlas of India is under revision; the use of hazard maps to earthquakes, cyclones, and floods at the local/district level is actively being pursued by the Government of India in the projects with the United Nations Development Programme (UNDP) and the United Nations Centre for Human Settlements (UNCHS or also known as Habitat). The Atlas covers issues like physical vulnerability assessments of different building types (using seismic and cyclone intensities), disaster damage scenarios, technical guidelines for hazard resistant construction of buildings,

One *lakh* is a 100 thousand.

upgrading of hazard resistant construction of existing housing stock by retrofitting, and techno-legal regime to be adopted.

National disaster management structure and relevant legislation⁵

Relief in the wake of natural calamities has been traditionally the principal focus of disaster management actions, and has been treated primarily as a responsibility of the States. The Central Government can, however, associate itself with relief measures although its response is determined by factors such as (i) the gravity of the disaster in question, (ii) the scale of the relief operation necessary, and (iii) the requirements of Central assistance for augmenting the financial resources at the disposal of the State Government. The national agency responsible for disaster management is currently the Ministry of Home Affairs, Government of India, which took over this task from the Ministry of Agriculture in 2003. It should be noted that the reason why the Department of Agriculture was given the lead role, lay in the predominance of famine relief actions where the Central Government was called upon to assist.

The Central Relief Commissioner (CRC) in the MOHA is the nodal officer to coordinate relief operations for natural disasters through a Crisis Management Group (CMG), which also counts on a nodal officers in every Ministry/Department/Organization to manage an emergency situation. The nodal officer is responsible for preparing sectoral Action Plan/Emergency Plan for managing the disaster. A National Crisis Management Committee (NCMC) headed by a Cabinet Secretary gives direction to the CMG.

A Control Room or Emergency Operations Room functions around the clock based on MOHA, its main role is transmission of information among different parties involved. To facilitate the launching of relief operations, a National Contingency Plan is periodically updated. Finally, each State Government has relief manuals/codes to identify the role of each officer in the wake of a natural disaster.

Funding wise, a Calamity Relief Fund (CRF) has been set up in each State, 75% of this fund is allocated by the national government, while the 25% is contributed by each State. The size of the CRF in each state has been suggested by the national authorities based on relief expenditure statistics of the past 10 years. When the emergency exceeds the capacity of the state CRF,

the national government can assist through its National Calamity Contingency Fund (NCCF).

At present the Government of India, through the Minister of Home Affairs and its National Disaster Management Division is pursuing the implementation of a revised Institutional and Policy Framework that proposes the creation of Disaster Management Authorities, both at the National and State Levels with representatives from the relevant Ministries/Departments to bring about a “coordinated and multi-disciplinary with experts covering a large number of branches.” A National Emergency Management Authority is being proposed. “The organization will be multi-disciplinary with experts covering a large number of branches [...] proposed as a combined Secretariat/Directorate structure” The structure will be “an integral part of the Government while, at the same time, retaining the flexibility of a field organization” with linkages to ministries/departments of health; water resources, environment and forest; agriculture; railways; atomic energy; chemicals; science and technology; telecommunications; urban development and poverty alleviation, and the Indian Meteorological Department. The authority would meet as often as required and review the Status of warning systems, mitigation measure and disaster preparedness. Details of the Authority’s activities are found in [Annex 1](#). The “Status Report of Disaster Management in India (2004)” and a summary of the broad features of the draft national policy on disaster management are found in [Annex 2](#).

The following instruments provide the existing legal framework that assigns roles and responsibilities of different entities to disaster risk reduction in India:

- The Disaster Relief Act, 1982, which covers the national policy, strategy and legislation addressing DRR.
- The National Building Code that was launched in 1994 has not been fully implemented yet.

National land use management system and relevant legislation

Land use regulations and development are a function of city and state governments. The Town and Country Planning Organization is the organisation of Central government that deals with planning (regional, urban and rural) and developmental policies. It formulated a Model Town and Country Planning Act

(1960) that provides:

1. Provisions for preparation of comprehensive Master Plan for urban areas of various states. The states may adopt the Model legislation with suitable modifications for this purpose.
2. To constitute a board to advise and to coordinate in the matter of planning and plan formulation by the Local Planning Authorities in the State.
3. Provisions for implementation and enforcement of the Master Plans and the miscellaneous provisions to achieve planned urban growth of various urban areas in the state.

This model was revised in the Model Regional and Town Planning and Development Law (1985). Under this law, planning and plan implementation have been combined together so that a single agency could undertake both. This law has been to a large extent the basis for the enactment of comprehensive urban and regional planning legislation in the States and Union Territories. A revised model for Urban and Regional Planning and Development law was later brought out, and Guidelines on Urban Development Plan Formulation and Implementation (1991) has been formulated.

The Ministry of Home Affairs constituted a Committee to develop Model Building Bye-Laws and a review of Town and Country Planning Act, and development of the Zoning Regulations (January 20, 2004) on the recommendation of the National Core Group on Earthquake Mitigation set up by the Ministry. The Core Group suggested a Model Bye-Laws “should be a speaking and self-contained document” as far as possible by including the main features of the BIS Codes and the non-structural aspects, which have bearing on seismic safety. It was also of the view that the State Town and Country Planning Act as well as Zoning regulations be reviewed so as to ensure that these are in conformity with the mitigation requirement.

In January 2004 the Ministry of Home Affairs constituted a Committee to develop a Model Building Byelaw review of the Towns and Country Planning Act, and develop Zoning Regulations. This committee proposed several amendments to incorporate natural hazards terminology, proneness and mitigation under relevant sections. Hazards due to earthquakes, cyclones, floods and landslides were included.

A two-volume document entitled “Proposed Amendment in Town and Country Planning legislations, Regulations for Land Use Zoning, Additional Provisions in Development Control Regulations for Safety & Additional Provisions in Building Regulations / Byelaws for Structural Safety in Natural Hazard Zones of India,” was prepared and published in September 2004⁶.

Integration of disaster risk management in development programs

The most recent Five Year Plan (10th:2002-2007) included a chapter entitled “Disaster Management: The Development Perspective” (Volume 1, Chapter 7). It states that “Five Year Plan documents have, historically, not included consideration of issues relating to the management and mitigation of natural disasters. The traditional perception has been limited to the idea of “calamity relief”, which is seen essentially as a non-plan item of expenditure. However, the impact of major disasters cannot be mitigated by the provision of immediate relief alone, which is the primary focus of current calamity relief efforts.

Disasters can have devastating effects on the economy; they cause huge human and economic losses, and can significantly set back development efforts of a region or a State. Two recent disasters, the Orissa Cyclone and the Gujarat Earthquake, are cases in point. With the kind of economic losses and developmental setbacks that the country has been suffering year after year, the development process needs to be sensitive towards disaster prevention and mitigation aspects. There is thus a need to look at disasters from a development perspective as well. Further, although disaster management is not generally associated with plan financing, there are in fact a number of plan schemes in operation, such as for drought proofing, forestation, and making drinking water more available, that deal with hazard prevention and mitigation. External assistance for post-disaster reconstruction and the streamlining of management structures also is a part of the Plan. A specific, centrally sponsored scheme on disaster management also exists. The Plan thus already has a defined role in dealing with the subject.”⁷

This approach has been translated into a “National Disaster Framework” roadmap covering institutional mechanisms, disaster prevention strategies, early warning system, disaster mitigation, preparedness and response and human development. National, state and district levels have been identified and listed in the roadmap. Ministries and departments of Government and Union

Territory Administrations have been advised to develop their respective roadmaps taking the national framework as a broad guideline. Section V of the Status Report on Disaster Management in India, 2004, contains the National Government' vision and mission statements for DM in the country:

“Our mission is vulnerability reduction to all types of hazards, be it natural or manmade. Our vision 2020 is to build a safer and secure India through sustained collective effort, synergy of national capacities and people's participation”⁸

Significance of the city to the nation

Occupying an area of 437.71 sq km (14% of the total area of the State of Maharashtra), Mumbai is India's most populous conurbation and the sixth most populous agglomeration in the world. According to the 2001 census, the population of Mumbai has increased from 9.93 million in 1991 to 11.91 million in 2001. However, city officials estimate that an additional 2-3 million 'floating population' also resides in Mumbai. The official population density (about 27,209 people per sq. km.) is one of the highest in the world. Roughly 60% of the population resides in informal settlements and the number of structures including residential, commercial and industrial comprise 2,768,910 (1991 census).

Mumbai has been the 'Urbs Prima in Indis'. Its port handles 50% of India's total foreign trade business and generates 40% of India's GNP. It also rates as one of the largest cotton textile industries in the country. It has the largest source of oil and natural gas, the largest stock exchange in India, and third largest exchange in the world. Mumbai is also the capital of India's pharmaceutical trade industry. Many multinationals and corporate head offices are located here, as is the largest motion picture industry in the world.

Geographical setting of the City

Mumbai is located on a peninsula on the island of Salcette and spread linearly along the Arabian Sea coast. It consisted originally of seven island which were joined together by land reclamation projects through the years. Mumbai has a tropical climate with moderate to high levels of humidity. The coolest month is January with the day temperature around 26 degrees Celsius when the city is

enveloped with a thick layer of smog due to the inversion effect.

It is well connected to the world through its international sea port and the international Sahar airport located only 32 km from the city center. The Western and Eastern Express Highways bond Mumbai with the rest of India.

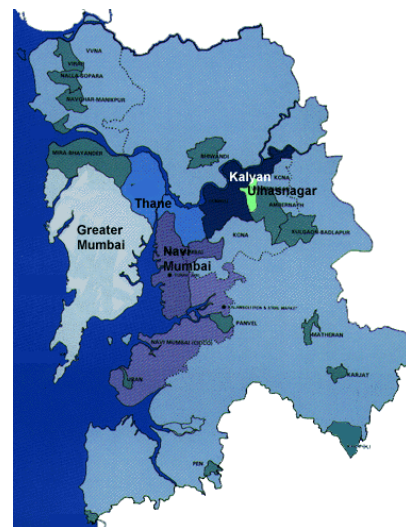
2 *Inter-City Linkages*

This section provides information on how the City functions in terms of interactions between relevant components

Internal division of the City

Greater Mumbai Metropolitan area is divided in two revenue districts: **Mumbai city District** (67.79 sq. km) and **Mumbai suburban District** (370 sq km.) The downtown area extends from the southern tip of the peninsula to the Mahim and Sion Creeks in the north (Old Bombay). The suburban district is largely semi-urban and lies to the north of old Mumbai.

For administrative purposes Greater Mumbai is divided into 6 zones, each consisting of 3 to 5 wards named alphabetically from A to T under the jurisdiction of Brihanmumbai Municipal Corporation (BMC) -previously known as Bombay Municipal Corporation-. The Mumbai Metropolitan Region Development Authority Act, 1974 further treated Greater Mumbai with its rapidly growing hinterland as one region for developments purposes under the name "Mumbai Metropolitan Region (MMR)". The region adds 3.887 Km² to the Greater Mumbai area of 468 Km², while only adds 5.90 million inhabitants to its 11.91 million population (2001 statistics).



Mumbai Metropolitan Region (MMRDA map)

Governance/management style

The **Municipal Corporation of Greater Mumbai (MCGM)** was formed in 1865

as Mumbai's fully autonomous civic body responsible for medical services, education, transport, electricity supply, water supply, fire services, garbage disposal, markets, gardens, and engineering projects such as drainage development and the improvement of roads and street lighting. The **Mumbai Municipal Corporation Act of 1888**, which stated the framework of the Corporation and the Commissioner functions, specifies nine statutory collateral authorities charged with the distinct responsibilities of City government. Each operates within the limitation set for it. Through the executive authority vests in the Municipal Commissioner, the 221 elected representatives, the Municipal Councillors exercise general authority over civic affairs through budgetary and financial controls by determining taxes and allocating expenditure approving contracts and other financial proposals and approving appointments to senior posts.

The centralized administrative system was reorganized in 1964, when for the first time a decentralized pattern was introduced. The objective was to speed up disposal, improve efficiency and effect economy. In pursuance of this policy decision, the entire city is now divided into six administrative zones with 24 wards. The six zones are supervised by a Deputy Municipal Commissioner with assistance from Ward Officers. In all there are thirteen Deputy Municipal Commissioners which include one post of Director (Engineering Services & Projects); two of these are designated Joint Municipal Commissioner.⁹

Mumbai is one of the five cities included in the centrally sponsored Mega City Scheme launched by the Government of India in the Eighth Five Year Plan. The Scheme aims to prepare local governments to use institutional finance and eventually market instruments like municipal bonds for the capital investment requirements. In order to induce local bodies, of the total outlay, the Government of India and the State Government are expected to provide 25% each as grant and the remaining 50% is to be raised from financial institutions. The Scheme for Mumbai, is being implemented with Mumbai Metropolitan Region Development Authority (MMRDA) as its nodal agency for the Scheme.¹⁰ MMRDA also have projects related to slum households upgrading, procurement of equipments, and strengthening of the municipal services in the Mumbai Metropolitan Region. It submitted a Draft Regional Plan for MMR 1996-2011 which was sanctioned by the Government of Maharashtra in September 1999.

Relevant legislation/regulations

“The Municipal Commissioner vide order No.ENV/1093/DEA/CR/36/TK dated 16th February, 1994 is appointed as the District Disaster Officer for Greater Mumbai. It is anticipated the BMC will manage disaster situations without intervention from State authorities in most circumstances. Micro-level plans at ward level have been prepared for all the 23 wards incorporating specific responsibilities of ward officer who will act as Ward Disaster Manager. However, in cases of disasters of exceptionally large magnitude which require co-ordination with a wide range of lateral agencies including central government agencies, the Additional Chief Secretary (Home) within the state government will assume the responsibility of Disaster Manager for Mumbai.”¹¹

3 *Land Use Management*

This section deals with land use planning and management practices that focus on the control of existing hazards and the reduction of future hazards.

Relevant legislation

A Draft Regional Plan for Mumbai Metropolitan Region 1996-2011 provides a basic framework for land use policies and directions for planning within the context of the policy, framework and priorities listed.

Responsible agents and their relationship

The city body in charge is the Municipal Corporation of Greater Mumbai through its Department of Disaster Management formed in December 2000. It has 12 full time employees and sufficient number of engineers, medical officers, fire-fighters and other employees through MCGM and other line departments.

The Disaster Management Department is a single-point source for all issues regarding disaster management, which includes mitigation, preparedness and response and rehabilitation issues. It is the command and control agency between administration and field units.

Disaster management is a component of specific planning and development purposes in the city, namely: priority rail projects proposed under MUTP II, Road over Bridges and flyovers, road widening and additional roads, special

corridors for Brihanmumbai Electric Supply and Transport Undertaking (BEST) buses, non parking roads.

Effectiveness of current arrangements

The saturated building levels in parts of Mumbai are creating vulnerabilities through sheer numbers of structures. Even though this is recognized, there are still building approvals being made that are exacerbating this situation.

Realistic land use planning and appropriate counter-measures in anticipation of seasonal monsoon effects seem to be lacking. A gap analysis between what is currently being done and what can be done, with specific timeframes, might assist to remedy this situation.

An inter-jurisdictional issue requiring resolution is the fact that over half the land area in Mumbai is not owned or controlled by the City Government. Moreover, no mechanism for coordinating between the land-owning sectors currently exists.

In a recent analysis on the light of the 2005 flooding in Mumbai, The economic and Political Weekly Analysis of September 3, 2005, cites Aromar Revi, (Lessons from the Deluge, 2005), Mumbai's greatest vulnerability emerges from its land market. "The city has one of the most skewed land markets in the world, which makes it dollar-for-dollar the eighth most expensive city in the world [Richard Ellis, Global Rent Review, 2000]. The primary outcome of this is that more than 55 per cent of its residents [...] cannot afford to live in anything other than squatter settlements, slums and chawls, even though their per capita incomes are significantly higher than many other regions in India". And he goes further when he suggests that there would be a great opportunity for Mumbai if the authorities may consider a new urban organization based on a flexible network of smaller urban centers with appropriate changes in its economic structure, land use, urban ecology and metabolism. The said will require a review from the current urban governance, planning and service delivery and institutional arrangements to link urban renewal and development with risk mitigation.

4 *Vulnerability Issues*

This section highlights current issues pertaining to vulnerability issues including information on at-risk groups and hazard-prone locations.

With the support of the Government of Maharashtra (GoM), the Municipal Corporation of Greater Mumbai (MCGM), the Indian Institute of Technology (IIT), the Earthquake and Megacities Initiative (EMI) and the Earthquake Disaster Mitigation Research Center of Japan (EdM-NIED), the first-one-day megacity workshop to launch the Cross-Cutting Capacity (3cd) Development Program, was carried out on the 23 of August, 2004.

According to the experts and city officials gathered for this event, the following hazards have impacted or can potentially impact the city of Mumbai:

- **Fire and industrial accidents** have been part of the landscape of the city. The worst event recorded is the Victoria dock explosion in 1944 which killed up to 6,000 and devastated 1,2 sq Km. In the heart of the city. This can be exacerbated with the presence of at least 1,000 hazardous old industrial units in the city.
- **Floods.** Mumbai DMP identifies 10 sections along the Central Railway and 12 along the Western Railway prone to serious flooding, along 235 other flooding points within the city. But the recent event of July 26, 2005 is maybe the worst that the city has faced in long time, an exceptional series of rainstorm seriously disrupted the lives of many millions: basic amenities, telecommunications, banking services, civic and political organizations were paralyzed in a situation that has not been seen before.
- **Chemical (transport, handling), biological, and nuclear hazards.** Mumbai is maybe one of the few big urban centers or megacities to count on a nuclear facility within the city limits.
- **Earthquakes.** Mumbai lies in the Bureau of Indian Standards (BIS) in Seismic Zone III. Its most severe historical earthquakes appear on table II at the end of this item.

Cyclones, Landslides, Bomb blasts, terrorism, riots and tidal surge are additional hazards that need to be analyzed too.

The following factors have been identified as those that contribute to create vulnerabilities and associated risks in the city:

- Being an “Island city”, the transport networks are in general poor.
- Inadequate road width vs. parking space
- Buildings – poor design and construction practice
- High-rise and old building stock
- Change of use of buildings from ordinary to critical functions without retrofitting or strengthening the building
- Utilities: water supply – lack of back-up system; inadequate sewerage system
- Infrastructure: flyovers, hospitals in weak condition
- Power failures (interstate power grid)

Other factors that contribute to risk creation are:

The extensive reclamation of sea-cost, existence of hazardous industries, oil spills, the presence of large floating population during office hours, the high population density in commercial areas and slums, and the improper and inadequate garbage collection and disposal.

Table 2. Historical Earthquakes in Mumbai Region $MMI \geq V$; $M \geq 4$

Year	Month	Intensity (MMI) / Magnitude (R)
1618	May	IX**
1832	October	VI
1906	March	VI
1929	February	V
1933	July	V
1951	April	VIII
1966	May	V
1967	April	4.5
1967	June	4.2

* Source: Compiled by Sinha and Adrash from catalogues of IMD, NGRI, EPRI and MERI.

** There is some uncertainty about this damage being caused due to an earthquake.

At-risk groups

Most of Mumbai’s population resides in the suburbs and commutes to the central city area for daytime work. In some locations, for example, Ward A in South Mumbai, the diurnal population varies from 17,528 people per square kilometre (ppsk) at night to 394,390 ppsk during the workday. Earthquake risk estimates for suburbs indicate that morbidity and mortality figures are likely to rise dramatically should a night time tremor occur. In the monsoon season, roads, rail and other transport routes can be significantly disrupted, stranding people away from their place of residence. As Sinha and Adrash point out:

“Like most major urban centres in our country, Mumbai has grown tremendously in the last few decades due to unabated migration from the smaller towns and rural areas. As a result, the city has developed in a haphazard fashion with little consideration for proper town-planning norms. This has resulted in most areas of the city lacking basic civic amenities. In fact, almost 50% of Mumbai population lives in informal houses (often illegal and of very poor quality) in slums. Even in the non-slum areas, the basic amenities may be lacking and the structures may be of poor quality. Any long-term disruption of normalcy in this city may have extremely adverse consequences for the entire nation. There is, consequently, a need to be prepared against all possible natural and man-made disasters that are likely to occur in Mumbai. For this purpose, it is essential to have realistic understanding of the consequences of likely damage in Mumbai due to different disasters. This will permit rational planning of mitigation efforts in order to minimize effects of these disasters (Sinha and Adarsh (1997))¹².

The same study provides the following figures for three different earthquakes in the Mumbai region.

Estimated Number of Fatalities in Mumbai.

Time	MSK VI	MSK VII	MSK VIII
Midnight	11,200	42,600	100,100
6 A.M.	9,000	34,000	80,000
12 Noon	6,700	25,500	60,100

Sinha and Adrash, 1999

Several studies (RADIUS-GHI 2001, Sinha et al 1999), suggest that one of the most vulnerable elements exposed in Mumbai is its building stock, which certainly contributes to increasing risk of its population. The Mumbai region is 100% urban and the building stock exhibits a rich mix of several different building technologies. The most commonly used building categories are: (1) reinforced-concrete frame buildings with partition walls; (2) brick masonry buildings with reinforced concrete roofs and using cement mortar; (3) informal brick masonry buildings (which may or may not use cement mortar); (4) buildings made of other materials such as tin sheets, thatch and other light weight elements. The first two categories typically constitute engineered

constructions in which the assistance of qualified engineers is usually taken at each stage. The last two categories are non-engineered constructions, wherein the services of skilled engineers may not have been employed. In Mumbai, however, it has been observed that several reinforced concrete and brick masonry buildings have been constructed without the assistance of qualified engineers. Due to this reason, these buildings are also not engineered since they may be improperly designed or constructed resulting in lower strength.

At-risk locations

The population at large may be at risk in Mumbai, given at least two elements already discussed, the building stock which is rather old and lacks earthquake resistant design and the important number of poor living in this megacity.

Figures concerning poverty in Mumbai are not available. However, the State of Maharashtra estimates the percentage of urban poor as 35.15% of the population of the state. "Official estimates of poverty are based on the minimum required consumption levels of food. A calorie norm of 2400 calories per capita per day for rural areas and 2100 calories per capita per day for urban areas is taken as the basis. A per capita expenditure level at which these norms are met is taken as the poverty line." (s. Estimates of Poverty, Urban Statistics Handbook 2000, National Institute of Urban Affairs, New Delhi.) Moreover, it is not known how many of the 2-3 million 'floating population' might be within the classification of 'urban poor'.

A high percentage of the total population in Greater Mumbai lives in hutment or slum colonies. Aromar Revi in his article Lessons from the Deluge, September, 2005, estimates that 6.5 million people live in slums, chawls and squatter settlements. "Due to escalating costs of land and materials and increasing population, it has become almost impossible to acquire residential property on ownership or even rental basis for a very large proportion of households."¹³

By 1985, 2335 slum settlements could be identified, by 1991 this figure was reduced to 1068. Slums tend to be located in low-lying areas with tendency to flood during high tides, coastal locations, along water mains or open drainage, within industrial zones or under high tension wires. Ownership of these lands has implications for intervention strategies, and a survey recently conducted shows the following pattern:

Slums Land Owner	Percentage
State government	25%
BMC	20%
Housing Board and Central Government	5%
Private Sector	50%

The Dhavari area of Mumbai is one the largest slums in the world, containing around three quarters of a million people. Slums are considered vulnerable primarily because of their location, density and access to infrastructure. They include hilltops, slopes, nallahs, low-lying areas with tendency to flood during high tides, coastal locations, among other conditions. These figures, however, seem to disregard the 'floating population', which, if taken into consideration would greatly inflate slum occupancy, and vulnerability levels.

City policies on vulnerability alleviation

"BMC has focused its efforts to provide the basic amenities like water, toilets and electricity in authorised slum colonies but still large proportion of population is staying in unauthorised slums and these basic amenities are very rare in such slums."¹⁴

When a disaster occurs, economic support is provided to citizens through budgetary provisions made in the MCGM yearly budget. Recently, a memorandum drafted in consultation with States, sent to the Finance Commission, includes creation of Disaster Mitigation Fund of Rs 100.000 millions or approximately US\$ 2.2 Billion.

5 *Disaster Risk Management Arrangements*

This section highlights how the City manages public safety issues, including the functional arrangements of emergency services, risk assessment practices and risk communication mechanisms.

Functional arrangements

Consistent with the national approach, Mumbai's Disaster Management Plan refers to its goals of mitigation strategy as:

- To substantially increase public awareness of disaster risk so that the public demands safer communities in which to live and work.
- To significantly reduce the risks of loss of life, injuries, economic costs, and destruction of natural and cultural resources that result from disasters.

Maharashtra is the first state to prepare a comprehensive State DM Plan and undertake risk assessment and vulnerability analysis. These studies address the vulnerability of various districts, blocks/talukas and clusters of villages to earthquakes, floods and cyclones, epidemics, road accidents, fire, and chemical and industrial disasters. A Standard Operating Procedure, details the various departments to be activated during an emergency.

The construction of a disaster communications network has been carried out as an integral component of the plan. The network, based on VSATs and VHF networks in each of Maharashtra's 30 districts, is also planned to be used for general state government administration and rural development programs. The Maharashtra disaster management project was implemented at a cost of US \$ 11 million and became operational in March 2000.

They also contain a multi-hazard response structure, capability analysis, including an inventory of resources, and mitigation strategies, apart from a directory of personnel and institutions in the districts with their contact addresses, telephone and fax numbers.

As a part of this project, maps of the districts with blocks/talukas and village details were prepared using GIS, for developing a comprehensive DM Information System (DMIS) by the Maharashtra Remote Sensing Applications

Centre (MRSAC). This integrated facility of multi-hazard response plans, communication network, GIS and disaster geomorphology, geophysical data and data on climate, can enhance the level of preparedness of the district administration and improve the capability of the district machinery to respond to disasters more effectively. Maharashtra was the first state in India to employ IT in the disaster management area; following the Latur earthquake

All districts have undertaken an inventory of existing resources to identify gaps and needs, to improve preparedness and response capability to future disasters. Structural mitigation measures such as strengthening of government and public buildings have already been initiated. It is proposed to set up fire brigades in strategic municipal towns based on risk assessment studies. Non-structural mitigation measures like the modification in zoning for irrigation and building codes, earthquake-resistant construction for non-engineered buildings, and so forth have also been initiated.

A District Disaster Management Committee assists the District Collector to review the threats of various disasters, assess vulnerability of the district, evaluate the preparedness, and consider suggestions for improving the district disaster management plan.

The administration deals with planning, coordination and awareness issues.



Planning has been working on a multi-hazard disaster plan, a micro-level resource chart, a response strategy for subversive activities and the composition of an experts group on DM. Effective coordination among all involved agencies for effective response has been one of the major concerns and awareness creation has included various campaigns to sensitize and inculcate concepts about disasters, safety measures etc, among school and college students, teachers, governmental organizations and NGOs.

- SAR Taskforce includes 26 members from various City departments, has undergone basic training and is seeking membership of the UN-based

INSARAG (International Search and Rescue Advisory Group). Further improvement is required.

- An EOC is currently being planned, and is expected to include state-of-art communication system, networked computer systems press conference rooms and uninterruptible water, power and food supply.

- From the administration perspective, a multi-hazard disaster plan that includes vulnerabilities, preempts possible disaster, documents institutional and rescue mechanisms is in place. At the Ward level DM plans define responsibilities of each MCGM agency.

The two District Collectors of Mumbai City and suburb are assisting the Municipal Commissioner in all aspects of disaster management. The existing control rooms in Greater Mumbai that are coordinated by the Disaster Management Department are depicted in the following diagram.



Risk Assessment

Floods have a severe impact potential in the daily routine of the city, for example, at least 10 rail sections in Central Railway get submerged during heavy rains, 12 in the Western Railway and countless flooding points in different wards, which result in disruption of traffic, flooding of settlements and a tendency to paralyze the city life.

Also, Greater Mumbai's diverse economic and commercial activities create most types of fire risk although the most common causes are from:

- Large numbers of closely built old timber framed buildings and large slum settlements
- High rise buildings with inadequate fire-fighting facilities
- Commercial activities and hazardous industries in suburban areas
- Widespread dock areas, oil refineries and petrochemical industries

Concerning earthquakes, tremors that have occurred in the Mumbai region

during the last 400 years include 3 events of MMI=V, 2 intensity VI, one of intensity VIII and another one of intensity IX. A well marked fault is seen near Antop hill. Sukheswala (1958) has given evidence for two north-south running faults in Mumbai island, one to the east of Western ridge and other running along the western ridges. The faults extend into Salsette Island and have maximum throw of 75' and 40' respectively.

Most cases of landslide in Mumbai occur during the annual monsoonal rain with its associated high velocity winds, often resulting sometimes in loss of human lives and damage to structures. Sixteen sites have been identified as vulnerable to landslides in the Mumbai city district while Mumbai suburban district are essentially located near abandoned quarries and hill ranges, but are also prone to landslides.

The high traffic density and day-to-day population dynamics, suggest that commuting between the suburbs to the city area causes traffic accidents, many resulting in fatal and serious injuries. As an example, a case study of Ward A in South Mumbai shows a daytime population of 4,500,000 persons (density 394,390 persons/Sq. Km.), while the night population is only of 200,000 persons (density 17,528 persons/Sq. Km). Approximately 30,000 accidents occur in a year in Mumbai city, with near 400 deaths in the same period.

Road haulage of hazardous materials compounds the riskiness of surface transportation. There are approximately 900 separate industrial sites involved either in the manufacture, processing and storage of hazardous goods. They include refineries, fertilizer plants, the atomic energy establishment, thermal power stations, and the Mumbai Port Trust, which handles hazardous cargo. Many of these are in close proximity of residential areas or other storages, thereby increasing the risk of fires and chemical explosions in residential or industrial sectors.

Risk Communication

Community participation in mitigation and emergency preparedness is promoted through media coverage oriented to preparedness, opinion programs and NGOs and private sector participation in diffusion activities. The Indian Institute of Technology in Powai (IIT-Powai), and different NGOs have organized several programs and workshops for administrators, teachers, students, and citizens of

Mumbai.

In order to enhance the quality and reach of awareness campaigns, partnerships with different national and international organizations such as UNICEF, UNDP, EMI, All India Institute of Local Self-Government (AILLSG), and others, has been looked upon.

6 *Disaster Risk Management Vision*

This focuses on what City decision-makers and/or other sectors want to put into place with respect to DRM Vision details

To be completed

7 *Issues*

Lack of a clear appreciation of the implications of Mumbai's hazard exposure; the considerable vulnerabilities of its people, infrastructure and institutions; and the lack of coordinated interventions by a series of governments to mitigate the multiple risks the city is exposed have been identified as major impediment for a better DRM organization and delivery in Mumbai, as pointed out by A. Revi.

Other issues relate to conflicting rights of tenants and landlords that appears to be a major stumbling block with respect to maintaining building structures. Apparently, tenants acquire 'squatters rights' after a certain number of years of occupying a particular building and cannot be evicted or have rents raised. This is a disincentive for landlords since there is no financial opportunity for them to maintain or improve their building investments.

Another disincentive for building owners pertain to State Government decisions on building taxes. Taxes are determined at the time a structure is originally completed and are not amended unless substantial alterations are made. Not only does this reduce the likelihood of building owners refurbishing structures, but also acts as a disincentive to build new structures to replace older ones. The tax mechanism has also created an iniquitous situation between owners of newer buildings in the suburbs, who are paying higher taxes than do owners of buildings in higher density inner-city locations.

Some groups within Mumbai recognize the urgent need to initiate discussions on city-scale mitigation measures which will be with no doubt resource-intensive. One of them Mr. Revi*, draws a very comprehensive plan for the national, regional, city and district levels which is summarized as follows:

1. Re-examining the urban governance, planning and service delivery framework and institutional arrangements for Greater Mumbai and the Mumbai Metropolitan Region (MMR) with a focus on linking urban renewal and development with risk mitigation.
2. Developing a structure plan for the MMR that links strategic urban services (transportation, energy, water supply, sewerage, sanitation, drainage and solid waste management), land-use planning and strategic risk mitigation.
3. Developing a long-range (30-year) vision and action plan for strategic risk sharing and mitigation for the MMR, through a multi-stakeholder engagement and appropriate fiscal and financial incentives for risk mitigation.
4. Updating the Mumbai Disaster Management Plan and the ward DMPs [GoM 1999] within this, linking it to zonal development planning and building regulation via a common publicly accessible GIS database.
5. Launching a Greater Mumbai multi-agency disaster mitigation mission with a chief secretary rank officer at the head that has sweeping powers of mobilizing public, private and civil society organizations and intervening in the land market, infrastructure planning and development, urban planning and regulation. This should include:
 - a. Strengthening emergency response and mitigation functions through a process of devolution of functions to the ward level.
 - b. Developing and placing in the public domain a GIS-based probabilistic composite risk assessment and mitigation framework for different hazards.
 - c. Establishing a credible urban disaster response and recovery capacity in the city, built around existing specialized agencies (e.g., police, fire and trauma care services).
 - d. Development of a comprehensive multi-hazard, techno-legal regime for

* Aromar Revi, Lessons from the Deluge, Economic and Political Weekly, Sep. 3, 2005

Mumbai: that covers land cover and use, zoning regulations, building and infrastructure.

- e. Establishing a public-private-community/owner partnership to finance, build and retrofit housing to disaster resistant standards.
- f. Establishing a public-private partnership to finance, build and retrofit infrastructure to disaster resistant standards including the development of strategic flood, cyclone, storm surge and sea defenses.

The participants to the 3CD First City Workshop, held in Mumbai on August 21, 2004, identified the need for a critical review of the existing DMP. The review should identify both sound practices as well as deficiencies in the plan. The process should also help develop an overall strategic vision for the city's DMP. The necessity of evaluating the coordination between different agencies and evolving more efficient methods for coordination during disasters has also been brought out.

The revised disaster management plan, under the DRMMP framework, should include short, medium and long-term objectives as well as their roadmaps. The plan should also incorporate triggering mechanisms that can be used to initiate the plan during different emergencies.

Some additional recommendations are summarized as follows:

- Incorporate new forms of disasters such as terrorism and mass destruction technologies.
- Consider slow onset disasters like ecological disasters, deforestation, global warming, etc.
- Strengthening current response capacity by improving SAR Task Force and creating additional SAR Teams, revamping communications systems, strengthening current Emergency Medical Service and creating new ones, establishing more specialized Trauma Care Centers, setting up ultra-modern fire training center at Wadala.
- Effective coordination is needed among all organizations that constitute the DRM system.
- Shift the vision from response oriented to preventive by incorporating urban planners, government officials, engineers, architects and others that can contribute to a broader vision.

Annex 1: National Disaster Management Authority's activities

When a disaster strikes, the Authority will coordinate disaster management activities. The Authority will be responsible for:

Providing necessary support and assistance to State Governments by way of resource data, macro-management of emergency response, specialized emergency response teams, sharing of disaster related data base etc.

Coordinating/mandating Government's policies for disaster reduction/mitigation

Ensuring adequate preparedness at all levels

Coordinating response to a disaster when it strikes

Assisting the Provincial Government in coordinating post disaster relief and rehabilitation

Coordinating resources of all National Government Department/agencies involved.

Monitor and introduce a culture of building requisite features of disaster mitigation in all development plans and programmes.

Any other issues of work, which may be entrusted to it by the Government."¹⁵

Annex 2: Features of the draft national policy on disaster management

The status report of Disaster Management in India (2004) summarizes the broad features of the draft national policy on disaster management as follows:¹⁶

- i. A holistic and pro-active approach towards prevention, mitigation and preparedness will be adopted for disaster management.
- ii. Each Ministry/Department of the Central/State Government will set apart an appropriate quantum of funds under the Plan for specific schemes/projects addressing vulnerability reduction and preparedness.
- iii. Where there is a shelf of projects, projects addressing mitigation will be given priority. Mitigation measures shall be built into the on-going schemes/programmes.
- iv. Each project in a hazard prone area will have mitigation as an essential term of reference. The project report will include a statement as to how the project addresses vulnerability reduction.
- v. Community involvement and awareness generation, particularly that of the vulnerable segments of population and women has been emphasized as necessary for sustainable disaster risk reduction. This is a critical component of the policy since communities are the first responders to disasters and, therefore, unless they are empowered and made capable of managing disasters, any amount of external support cannot lead to optimal results.
- vi. There will be close interaction with the corporate sector, nongovernmental organisations and the media in the national efforts for disaster prevention/vulnerability reduction.
- vii. Institutional structures/appropriate chain of command will be built up and appropriate training imparted to disaster managers at various levels to ensure coordinated and quick response at all levels; and development of inter-State arrangements for sharing of resources during emergencies.
- viii. A culture of planning and preparedness is to be inculcated at all levels for capacity building measures.
- ix. Standard operating procedures and disaster management plans at state and district levels as well as by

- x. relevant central government departments for handling specific disasters will be laid down.
- xi. Construction designs must correspond to the requirements as laid down in relevant Indian Standards.
- xii. All lifeline buildings in seismic zones III, IV & V – hospitals, railway stations, airports/airport control towers, fire station buildings, bus stands, major administrative centres will need to be evaluated and, if necessary, retro-fitted.
- xiii. The existing relief codes in the States will be revised to develop them into disaster management codes/manuals for institutionalizing the planning process with particular attention to mitigation and preparedness.
- xiv. To promote international cooperation in the area of disaster response, preparedness, and mitigation in tune with national strategic goals and objectives.

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