Mumbai – Urbs Prima in Indis

- Covers an area of about 437.71 Sq. Km.
- Houses about 11.9 Million people (c. 2001)
- Population density of about 27,209 people per Sq. Km.
- Approximately 60% population resides in informal settlements
- Approximately 27,68,910 structures including residential, commercial and industrial

Mumbai vis-à-vis the World

<table>
<thead>
<tr>
<th>Sr.</th>
<th>City</th>
<th>Country</th>
<th>Agglomeration (c. 2003)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Tokyo</td>
<td>Japan</td>
<td>33,850,000</td>
</tr>
<tr>
<td>2</td>
<td>Mexico City</td>
<td>Mexico</td>
<td>22,050,000</td>
</tr>
<tr>
<td>3</td>
<td>New York</td>
<td>USA</td>
<td>21,850,000</td>
</tr>
<tr>
<td>4</td>
<td>Seoul</td>
<td>South Korea</td>
<td>21,850,000</td>
</tr>
<tr>
<td>5</td>
<td>Sao Paulo</td>
<td>Brazil</td>
<td>19,850,000</td>
</tr>
<tr>
<td>6</td>
<td>Mumbai</td>
<td>India</td>
<td>19,100,000</td>
</tr>
<tr>
<td>7</td>
<td>Delhi</td>
<td>India</td>
<td>18,550,000</td>
</tr>
<tr>
<td>8</td>
<td>Los Angeles</td>
<td>USA</td>
<td>17,650,000</td>
</tr>
<tr>
<td>9</td>
<td>Osaka</td>
<td>Japan</td>
<td>16,700,000</td>
</tr>
<tr>
<td>10</td>
<td>Jakarta</td>
<td>Indonesia</td>
<td>16,550,000</td>
</tr>
</tbody>
</table>

Mumbai’s Population Dynamics

- Average population density
  - 27,209 persons per Sq. Km (population / area)
- Majority of the population resides in the suburbs and commutes to the city area in south for work in the morning and back in the evening
- Case Study - Ward ‘A’ (South Mumbai)
  - Daytime population : 45,00,000 persons
    - Density : 3,94,390 persons / Sq. Km.
  - Nighttime population : 2,00,000 persons
    - Density : 17,528 persons / Sq. Km.

Description of Disaster

- Nature of event
  - Very heavy rainfall started at 1430 hrs on the 26th July 2005.
  - 994 mm of rainfall measured at Santacruz Meteorological Centre for a period of 24 hrs starting 0830 hrs on the 26th July, 2005.
  - Excessive rain resulted in waterlogging in several suburbs.
  - Mithi River overflowed and consequently led to water logging of Western Express Highway.
  - Additionally, heavy rains at Raigad, Thane and Konkan region resulted in Dahanur and Poisar River overflowing, compounding waterlogging problem.
  - There were 6 instances of landslide on 26th, 3 on 27th, one each on 28th, 30th and 1st August respectively
- Names of severely affected locations
  - Kalina, Bandra Kurla complex, Saii Naka, Air India Colony, LBS Road, Malol Military Colony, Dharavi, Versova, Goregoan, Kandivli, Borivili and Dahanur.

Description of Disaster

- Overall Assessment of Impact
  - As many as 419 people lost their lives in the flashfloods and the landslides and 216 persons have so far died of various deluge related illnesses.
- Names of roads blocked/congested
  - Most arterial roads and highways in the suburbs were severely affected due to waterlogging and traffic jams resulting from vehicle breakdown in deep waters. Roads that witnessed major traffic jams include Western Express Highway, Eastern Express Highway and LBS Marg.
- Estimated number of establishments/vehicles damaged
  - As per the estimates received from the office of the collector B.S.D, The estimated Number of damaged buildings and vehicles is as follows:
    - Residential establishments - partly damaged: 50,000
    - Residential establishments - fully damaged: 2,000
    - Commercial establishments: 40,000
    - Vehicles: 30,000

NDMA_PPT 1
Description of Disaster

- Overall Assessment of Impact
  - Effect on train services
    - Heavy rains led to railway tracks being submerged and consequent stoppage of services on central (main and harbour lines) and western railways around 4:30 pm on the 26th July.
  - Effect on air services
    - Heavy rains led to airport being flooded. Additionally there was extremely poor visibility as a result of which flight services in and out of Mumbai were stopped on the night of the 26th July 2005.
- Effect on power supply
  - Electricity supply was stopped in most parts of Mumbai’s Western Suburbs in the night of the 26th July 2005.

Rainfall Recorded on 26/07/05 by IMD at Santacruz

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Rainfall in mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>26-07-05</td>
<td>8.30 to 11.30</td>
<td>0.9</td>
</tr>
<tr>
<td>26-07-05</td>
<td>11.30 to 14.30</td>
<td>10.4</td>
</tr>
<tr>
<td>26-07-05</td>
<td>14.30 to 15.30</td>
<td>100.2</td>
</tr>
<tr>
<td>26-07-05</td>
<td>15.30 to 16.30</td>
<td>100.3</td>
</tr>
<tr>
<td>26-07-05</td>
<td>16.30 to 17.30</td>
<td>90.1</td>
</tr>
<tr>
<td>26-07-05</td>
<td>17.30 to 18.30</td>
<td>100.4</td>
</tr>
<tr>
<td>26-07-05</td>
<td>18.30 to 19.30</td>
<td>95.6</td>
</tr>
<tr>
<td>26-07-05</td>
<td>19.30 to 20.30</td>
<td>72.2</td>
</tr>
<tr>
<td>26-07-05</td>
<td>20.30 to 21.30</td>
<td>59.5</td>
</tr>
<tr>
<td>26-07-05</td>
<td>21.30 to 22.30</td>
<td>22.5</td>
</tr>
<tr>
<td>26-07-05</td>
<td>22.30 to 23.30</td>
<td>19.4</td>
</tr>
<tr>
<td>26-07-05</td>
<td>23.30 to 00.30</td>
<td>40.2</td>
</tr>
<tr>
<td>27-07-05</td>
<td>00.30 to 01.30</td>
<td>40.2</td>
</tr>
<tr>
<td>27-07-05</td>
<td>01.30 to 02.30</td>
<td>33.7</td>
</tr>
<tr>
<td>27-07-05</td>
<td>02.30 to 05.30</td>
<td>11.6</td>
</tr>
<tr>
<td>27-07-05</td>
<td>05.30 to 06.30</td>
<td>48.2</td>
</tr>
</tbody>
</table>

Total: 944.2

Hydrograph of Santacruz Raingauge Station

- Situation on 26/07/2005
  - It was unprecedented rainfall

<table>
<thead>
<tr>
<th>Time</th>
<th>Rainfall in mm</th>
<th>Rainfall in mm/hr.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1430 to 1830</td>
<td>481.2</td>
<td>120.3</td>
</tr>
<tr>
<td>1430 to 2130</td>
<td>706.6</td>
<td>101.2</td>
</tr>
<tr>
<td>1430 to 0230</td>
<td>865.7</td>
<td>72.15</td>
</tr>
</tbody>
</table>

- High tide on 26/7/05 at 1500 hrs. 4.48 m
- Low tide on 26/7/05 at 2213 hrs. 9.90 m
- High tide again on 27/7/05 at 0442 hrs. 3.82 m
- Low tide on 27/7/05 at 0855 hrs. 1.57 m
- Max. recorded rainfall in Mumbai in a day
  - 05/08/1976: 265 mm
  - 10/09/1991: 475 mm
  - 10/08/1930: 548 mm
  - 05/07/1974: 575 mm
- 26/07/2005: 944 mm (in first 6 hrs. 0830 to 1430 hrs. only 19.3 mm rainfall and in last 6 hrs. 0230 to 0830 hrs. only 59.2 mm rainfall)

Land Slide at Vishvadeep Society, Raigad Vibhag, Vikhroli Park Site, Mumbai-400 079 on 01/08/2005

Flood Relief Operation at Kurla & Kalina
Post-Flood Sanitation measures undertaken

- **Solid waste and debris**
  - Due to incessant rains, waste had accumulated in various areas in the city. MCGM deployed 107 JCBs, 438 Dumpers and 511 Compactors and lifted a total of 253612 metric tons of garbage from all wards from 29th July till 21st August, 2005. The waste lifted on a daily basis is almost double of what MCGM lifts on a normal day.

- **Carcasses**
  - A total of 16307 carcasses were disposed of including those of 15000 sheep and goats (mainly from Deonar) and 1307 buffaloes (mainly from Goregaon, Kandivli and Andheri), in a massive operation involving 27 cranes, 87 dumpers and 24 JCBs spread primarily over three days between 27th and 30th July 2005.

Post-Flood Sanitation measures undertaken

- **Preventive measures**
  - Several preventive measures to minimize risk of infection from all possible source were undertaken. Extensive spraying of disinfectants and insecticides was undertaken to control pests, and minimize flies and mosquitoes. In addition, water purification tablets and prophylactic medications were also distributed.
    - Disinfection of open spaces and waste collection areas
    - Over 24 metric tons of bleaching powder disinfectant and over 2 metric tons of carbophenol powder were sprayed to disinfect public spaces.
    - Larval mosquito control measures
      - Vector detection activities were resumed in less than 48 hours after the deluge.
    - Adult mosquito control measures
      - Insecticide was sprayed and fogging operations completed in all identified 1174 vulnerable locations immediately after the deluge.

- **Disinfection of open spaces and waste collection areas**
  - Over 24 metric tons of bleaching powder disinfectant and over 2 metric tons of carbophenol powder were sprayed to disinfect public spaces.

- **Larval mosquito control measures**
  - Vector detection activities were resumed in less than 48 hours after the deluge.

- **Adult mosquito control measures**
  - Insecticide was sprayed and fogging operations completed in all identified 1174 vulnerable locations immediately after the deluge.
Post-Flood Sanitation measures undertaken

- Fly control measures
- Fly menace was also effectively controlled by removing garbage from the 29th July to the 20th August 2005 on a war footing.
- Vigorous application of disease prevention methods played a significant role in minimizing the emergence of severe outbreaks of water borne and vector-borne diseases such as gastroenteritis, hepatitis.
- Treatment measures
  - In view of the fact that lack of people had to wade through dirty waters on the 26th and 27th of July 2005 there were apprehensions of major outbreak of leptospirosis which requires early diagnosis and treatment in all suspected cases, for reducing the risk of mortality.
  - MCGM therefore decided to provide comprehensive healthcare services through 130 odd specially constituted medical teams that have treated over 3 lac patients virtually at their door steps through health camps and outreach program.

The Need for Disaster Management

- Mumbai:
  - India’s financial capital
  - Maharashtra’s state capital
  - Extreme population and structural density
  - Coastal city with massive reclamation
  - Falls in an active seismological zone
  - Presence of industries dealing in hazardous material
  - Large number of vulnerable informal settlements
  - Strategic target in wartime & for subversive activities
- Any disaster would cause massive loss of life and property

Department of Disaster Management

- Department of Disaster Management specifically formed in December 2000
- Single-point source for all issues regarding disaster management
- Risk Assessment
- Preparedness
- Response
- Recovery & Reconstruction
- Mitigation
- Command & Control agency between administration and field units
- Multi-Hazard Disaster Plan
  - Plots out vulnerabilities
  - Prepares for possible disasters
  - Documents institutional mechanisms
  - Defines rescue mechanisms
- Micro-Level Resource Chart
  - Plots out vulnerabilities and resources at ward level
  - Describes rescue and rehabilitation resources
  - Complements the Disaster Management Plan
- Micro-plans at Ward level
  - Decentralization for faster response
- Experts Group on Disaster Management

Planning

- Multi-Hazard Disaster Plan
- Micro-Level Resource Chart
- Micro-plans at Ward level

NDMA_PPT
Risk Assessment and Vulnerability Analysis

- The DMP provides detailed listing of:
  - Vulnerable Settlements
  - Details of flooding points
  - Fire hazards
  - Earthquakes and house crashes
  - Areas prone to Landslides
  - Areas prone to Road Accidents
  - Areas prone to Industrial and Chemical accidents
  - Areas prone to Cyclones

Institutional Mechanisms

- Mumbai Disaster Management Committee
  - Headed by ACS(Home)
- BMC Disaster Management Committee
  - Headed by Municipal Commissioner
- Ward wise Disaster Management Plan Headed by Assistant Commissioner of Ward

Mumbai Disaster Management Committee

- Secretary, Relief & Rehabilitation
- Secretary, Home (Law & Order)
- Secretary, Housing
- Secretary, Medical Education
- Secretary, Food & Civil Supplies
- Divisional Commissioner (Konkan)
- Transport Commissioner
- Municipal Commissioner
- Police Commissioner
- General Manager, Central Rly.
- General Manager, Western Rly.
- General Manager, Konkan Rly.
- General Manager, BEST
- Deputy Director General, Meteorology
- Secretary, Industries
- Chairman, M&PT
- Director, NPCB
- Secretary, Public Works
- Director, AAI (Mumbai)
- GoC, Mah & Guj Area
- Commander, Mumbai Sub-area
- Colonial General (Staff)

MCGM Disaster Management Committee

- Additional Chief Secretary, Home (Chairman)
- AMC (In charge Disaster Management)
- Collector, Greater Mumbai
- Collector, Mumbai Suburban
- Collector, Thane
- Transport Commissioner
- Joint C.P., Law & Order
- Additional C.P., Traffic
- Chief Fire Officer
- General Manager, Central Rly.
- General Manager, Western Rly.
- Director, Medical Services (GoM)

Ward wise Disaster Management Plan

- Assistant Commissioner (Disaster Manager)
  - Sr. Police Inspector of Local Police Station
  - BEST Depot Manager
  - Station Master of local station.
  - Fire Officer from local Fire Station
  - Medical Superintendent of Local Municipal & Govt. Hospital
  - Other concerned local officers

Relevant Legislation / Regulation

- Municipal Commissioner vide order No. ENV/1093/DEA/CR/36/TK dated 16th Feb 1994 appointed as District Disaster Officer for Greater Mumbai.
- Ward Officer (Assistant Commissioners) appointed as “Disaster Manager” during any disaster under number A.C.S.Home/ 2906 dated 20th July, 1998; Principal Secretary (Urban Development) under no. 343 to coordinate with local line departments.
Other features of the DMP

- Role of NGOs and voluntary agencies is explicitly spelled out
- Well defined reporting formats
- Page 71 to 81, Volume I
- Decentralized planning and response, including ward level micro plans
- Detailed inventory of resources contained in Volume II

Legal Status for Disaster Plan

- There is no legal backing to Mumbai DMP and Ward DMP.
- No Penal clause for non-compliance of instructions pertaining to Disaster Management as vests with Collector for Election.
- No specific Standard Operating Procedure (SOP) for line of command.

Control Rooms

- Mantralaya
- GVM
- Fire Brigade
- Civil Defense
- Army
- Collector
- MCGM
- Police
- Railways

Response Structure during Warning Stage

- Emergency Operations Centre
- Chief Secretary / Additional Chief Secretary, Home
- BCC Control Room
- MCGM Control Room
- Railway Control Room
- Civil Defense Control Room
- Collector Control Room
- Fire Brigade Control Room
- Home Guard / Home Vigilance
- Police Control Room
- Collector (2)
- Mantralaya
- GVM
- Railways
- Civil Defense
- Army
- MCGM
- Collector
- Police
- Fire Brigade
- Control Rooms

Future Plan for Enhancement of Response Capacity
Improvisation of Emergency Control Room

It will be equipped with:
- An array of communications systems
- Television sets tuned to major news channels
- Networked Computer Systems with DM Software
- Video Conferencing Setup
- Conference and Press Rooms
- Private Water Supply and Ration Stocks
- Uninterruptible Power Supplies with Generators
- Pantry, Dormitory and Toilet facilities

Thus, it will be a self-sufficient control center built to withstand and outlast disasters
- The total estimated cost is Rs. 7 Crores.
- Work has already started.

MCGM’s SAR Task Force One

- Comprises of 26 members from various disciplines
- Have undergone basic training on:
  - Collapsed Structure Search & Rescue
  - Confined Space Search & Rescue
  - Rope Rescue
  - Medical First Response
- Training based on INSARAG guidelines and ADPC course material and simulations
- Advanced training in the pipeline
- Team will acquire membership to INSARAG
- Team will be ready for national / international deployment on short notice

A) Restructuring

- 6 Individual command centers.
- Headed by Deputy Chief Fire Officers.
- With all types of emergency fighting and rescue gears including suitable boats.
- Lien with Disaster Management & Zonal Deputy Municipal Commissioners.
- Search command to have attached highly specialized Search & Rescue Team.

B) Augmenting

- Emergency Medical Service
  - Bolstering current EMS at Sion and KEM Hospitals
  - Creating EMS at Nair Hospital
- Establishing more specialized Trauma Care Centers
- Setting up ultra-modern emergency training center at Wadala
- Commissioning 7 new fire stations by 2006
- Additional fire fighting and rescue appliances and equipments.
- Specialized Search & Rescue equipments and tools.
- Up gradation of training facilities.
- State of art communication equipments.
- Personal protective equipments.
- Budgetary cost – 300 crores.
- Future steps for improving compliance
  - As part of IT initiative MCGM is setting up GIS system.
Enhancement of Dedicated Communication Lines

- MCGM is procuring heavy duty vehicles one for each Asst. Commissioner.
- These vehicles will be fitted with wireless system as well as public announcement system.
- Upgradation of present Communication system.
- The approximate cost is Rs. 9 Crores.
- Each Fire Station will be provided fully equipped mobile control unit.

Development of More Number of Rain Gauges

- MCGM is installing automatic rain gauges at 25 fire brigade stations, so as to know exact pattern of the rain all over Mumbai city & suburb.
- This rain gauges data will be transmitted to control room every 15 minutes.
- The rain gauges can be further calibrated to give alarm at prefixed rainfall intensity.
- These data will serve ultimately as warning and evacuation signal if required.
- Fire brigade being first respondent and on 24 hours alert, the rain gauges will be installed at fire stations.
- The approximate cost is Rs. 2 Crores.
- IIT, Powai has been assigned the consultancy.

Long Term Measures

- Infrastructure improvement
- Communication and Public Information systems
- Land use policies and planning

Communication System

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Mitigation measures

- Infrastructure improvement
- Communication and Public Information systems
- Land use policies and planning
Infrastructure improvement
- Transport Infrastructure
- Service and related infrastructure
- Housing infrastructure

Recommendations on Transport Infrastructure
- The plan suggests:
  - Railway projects
  - Flyovers
  - Road widening and additional roads
  - Special corridors for BEST buses
  - Enforcement of Non-parking roads
- To improve transport infrastructure

Recommendations on Service Infrastructure
- Improving sanitation
- Increasing the capacity of storm water drains
- Upgrading emergency services
- Enforcing on site fire fighting capability in hazardous industries

Recommendations on Housing Infrastructure
- Retrofitting and renovation of cessed buildings
- Improving the condition of informal settlements
- Minimum access roads for clumsy settlements

Recommendations on Communications System
- Upgrading Wireless communication
- Setting up Display boards
- Setting up Public address system in local trains and at railway and bus stations
- Using Cable TV for information dissemination
- Developing GIS for mapping infrastructure facilities

Recommendations on Land use policies
- Improvement and protection of landfill sites
- Control on land reclamation
- Shifting of storage and hazardous units from residential areas
- Decongestion: Regional dispersion within Mumbai Metropolitan Region
Improvement of Storm Water Drainage system in Mumbai

- **Cause of Flooding**
  - Inadequate dilapidated drainage system in Island City, which was constructed approx. 150 years ago
  - Rapid development eliminating holding ponds.
  - Increasing the coefficient of run-off due to fast development
  - The slum encroachments over existing nalla banks have reduced the waterways

Appointment of Consultants

- The Corporation therefore thought of studying the whole SWD system
- M/s. Watson Hawksley International Pvt. Ltd. Appointed as consultant in the year 1989
- The consultant surveyed the existing drains & nallas
- The city and suburbs area SWD Network is divided into 121 chachments
- Consultants studied deficiencies, identified difficulties in cleaning and maintenance.
- They reviewed design criteria and prepared a master plan for augmentation of SWD system
- The consultants submitted their final report in the year 1993
- It is popularly known as **BRIMSTOWAD** Report

Major recommendations in the BRIMSTOWAD report

- Removal of obstructions of water mains, cables, etc. in the SWD system
- To rehabilitate old/dilapidated SWD system in City and augmentation of SWD in certain stretches
- To change the design criteria from 25 mm/hr to 50 mm/hr rainfall intensity and coefficient of runoff as 1.00 from earlier value of 0.50
- To augment the SWD system for new design criteria with tidal effects
- To train, widen and deepen nallas
- To augment railway culverts at various flood prone areas
- To provide pumping stations at the city outfalls at Haji Ali, Love Grove and Worli

Financial implications of the BRIMSTOWAD report

- The total cost of improvement suggested was Rs. 616.30 Cr.
  - Figures based on 1992 prices and planned span of 12 years
- Works could not be taken up systematically mainly because:
  - Financial constraints
  - Encroachment on sites
- In the past 10 years, works of about Rs. 260 Cr. could be completed.
- At today’s prices, the cost of the remainder of the project works out to Rs. 1200 Cr.
- Works proposed to be completed in three years
  - Phase I 2005-2006  Rs. 350 Cr
  - Phase II 2006-2007  Rs. 400 Cr
  - Phase III 2007-2008  Rs. 450 Cr
  - Total  Rs. 1200 Cr
- State and Central Governments have been requested for financial assistance

Major recommendations in the BRIMSTOWAD report

- The work of BRIMSTOWARD is being reviewed in the context of change in rainfall pattern and other parameters

Disaster Management in Mumbai

Thank You