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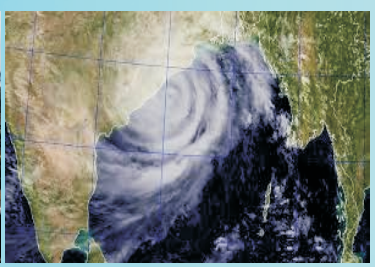
Disaster Governance in India

SERIES - 4


CENTRE FOR DISASTER MANAGEMENT
Lal Bahadur Shastri National Academy of Administration, Mussoorie

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Director

DIRECTOR'S MESSAGE

Due to its unique geographical and geological conditions India is vulnerable to various natural disasters. The incidents of flood, drought and other natural disasters are on the rise and pose tremendous challenges for the Administration. In this context, the training of Civil Service Officers in Disaster Management assumes critical significance. Each disaster heightens the urgency to equip ourselves better for coping and managing them. The recurring incidence of such disasters necessitates learning from our own experience as well as the best practices adopted all over the world in the field of Disaster Management.

Well documented best practices that can be circulated widely for creation of awareness at all levels of administration play an important role in such a context.

It gives me immense pleasure that Centre for Disaster Management, LBSNAA, under the capacity building project from National Disaster Management Authority (NDMA) is bringing out the edited volume " Disaster Governance in India- Series IV". This is a compilation of case studies, learnings and experiences of the Officers Trainees of 2014 batch of Indian Administrative Service, as part of their district training. I hope the volume will be of use to the administrators in handling disasters and emergency situations across the country.

Upma Chawdhry

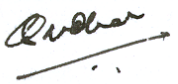
PREFACE

Disaster have adversely affected human civilization since the dawn of our existence. Natural disasters and human induced disasters have increased both in frequency and fury over the years. India has suffered enormously, in terms of loss in lives and livelihoods and damage to both public and private property due to recurrence of major natural and human induced disasters. In response various strategies have been formulated and implemented with regard to mitigation, prevention, response, rehabilitation and reconstructions during pre-disaster and post-disaster periods. All these efforts have the same underlying goal; Disaster Management and Disaster Governance.

By virtue of the Disaster Management Act, 2005 District Magistrate/ Divisional Commissioner is the pivotal role of the District Disaster Management Authority (DDMA) and hence, it is essential that he should be well versed in various aspect of Disaster Management.

In continuation to the successful publication of the two issues of " Disaster Governance in India" under the project" Capacity Building for IAS and Central Service Officer on Disaster Management" sponsored by NDMA, Centre for Disaster Management (CDM), LBSNAA is coming with the third series of the book named " Disaster Governance in India- Series IV" compiled from case studies based on the inputs received from young IAS officers 2014 batch during their district training. The book will be useful to administrators, at various levels, who are handling Disaster Management. It can also serve as a good reference material for ATIs and CTIs for their in- house courses.

The book "Disaster Governance in India- Series IV" will delve into the emergency management and Disaster Governance issues in various districts of India. The book will also provide perspectives of IAS officers posted across India on the subject of Disaster Management.



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2.	Challenges and Opportunities in Disaster Governance: Urban Flooding case of Chennai in the Era of Changing Climate	• M.B. Rao, Professor & Head, Dept.of Management Science, Rajiv Gandhi University of Knowledge Technologies, APIIT, RK Valley, Kadapa Dist, Andhra Pradesh. • Abhinav Walia, PhD Researcher, University of Newcastle, Australia
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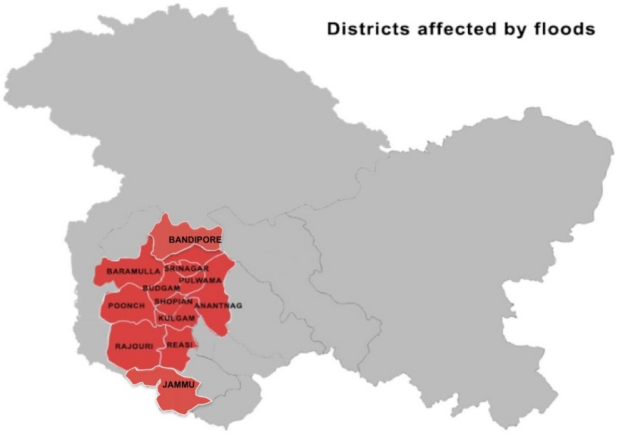
Jammu & Kashmir Floods 2014

Saurabh Jain, Abhinav Walia and Sh. Syed Abid Rasheed Shah

INTRODUCTION TO FLOODS 2014



Jammu & Kashmir experienced one of the worst floods in the past 60 years, during first week of September 2014, due to unprecedented and intense rains. The Jhelum River and its tributaries were in spate and caused extensive flooding in the region. A total of approximately 40 people lost their life because of the floods while. Below table depicts an overview on the relief grant in respect of death and property damages. Several houses, especially in low lying areas, have been washed away or entirely damaged. More than 2500 major and minor roads have been damaged, numerous footbridges washed away and more than 100 motorable bridges damaged. There has been a major communication and power breakdown due to transformers and towers being damaged. An estimated 19,00,000 people in 2600 villages and towns, have been affected in the floods, and an estimated 543,000 displaced people in entire J & K, many of whom have returned to their homes, are still in extreme distress, particularly the children, women and aged. Access routes are gradually being restored and the rescue operations need to be followed up with immediate relief measures to prevent any further anguish for the victims.

The quantity of water over flowing the embankments because of which flood was uncontrollable. The quantity of water passing through the breaches was too high which had occurred on the both side of the river at many places. Overall flood was catastrophic with huge economic losses along with environmental, human and cattle losses.

Kashmir Valley

The valley of Kashmir has an intrinsic genetic relationship with the complex of mountain systems which splay out of the Pamir Knot in different directions of the valley clearly defining the watersheds and basins. The general aspect of the valley is that of a basin, bounded on every side by lofty mountains, and in the middle is a huge alluvial tract, intersected by the Jhelum River and its numerous tributaries which flow down from the mountains and are fed by the abundant snow and rainfall in those elevated regions. The flat alluvial basin measures 150 kms from south-east to north-west and 42 kms from south-west to north-east. In altitude the flat plain varies from 1500 to 1800 m above the sea level and the grain of the land is from south-east to north-west.

History of Floods in Kashmir

Jammu and Kashmir has had a long history of flooding. Floods in the state are linked to the Jhelum River and it has history of crossing the danger mark and thereby inundating the 'Valley'. Floods have occurred at regular intervals in the past like 1903, 1905, 1909, 1928, 1948, 1950, 1951, 1953, 1954, 1956, 1957, 1959, 1962, 1963, 1964, 1969, 1972, 1973, 1976, 1986, 1992, 1995, 1996, 2006 and 2014. Out of all these floods, the floods of 1903 & 1959 were considered to be the worst of all till 2014. The flood of 2014 is in no doubt the most devastating breaking all the previous records.

According to Sir Walter Roper Lawrence in his book, The Valley of Kashmir (1895), "Many disastrous floods are noticed in vernacular histories, but the greatest was the terrible inundation which followed the slipping of the Khadanyar mountains below Baramulla in AD 879. The channel of the Jhelum river was blocked and a large part of the valley was submerged." The other major flood to affect Kashmir happened in 1841, which Lawrence notes, "caused much damage to life and property." However, the first flood of devastating proportions to hit the state came half a century later in 1893, when 52 hours of continuous rainfall, beginning 18 July, caused what Lawrence describes as "a great calamity". The Valley also recorded major floods at the turn of the century, with the most devastating one coming 10 years after the 1893 disaster. The floods, of that day were classified as the "greatest flood ever known", which came down the Valley and inundating Srinagar on 23 July 1903, converting the city into "a whole lake". For the next quarter of a century, the Valley did not record major floods, largely thanks to lessons learnt and reparative measures, which were put in place. However, in 1929, the Valley grappled with yet another major flood, which mainly affected parts of what is today known as Pakistan-occupied Kashmir. Jammu & Kashmir hit by devastating floods. Kashmir was hit by a flood in 1948 also. Two years later, in September 1950, another major flood hit the state, with nearly 100 people losing their lives. The flood was, rather unsurprisingly, caused by the Jhelum's overflow. In August-September of 1957, another major flood was recorded in Jammu and Kashmir, with the Valley feeling its devastating impact. The floods almost submerged the entire valley. The then Prime Minister of Jammu and Kashmir, Bakshi Ghulam Mohammad was quoted as saying that, "the floods recorded in Jammu and Kashmir were the highest ever recorded in the state, and that the damage caused by them was colossal." Two years later, in July 1959, the state witnessed yet another massive "glacial" flood, perhaps worst ever at the time, when four days of incessant rains lashed the valley and

Srinagar, triggering floods in the Jhelum. While the state did witness floods thereafter in the following three decades, the one in 1992 (Fig. 3 & 4) was unprecedented in terms of its fury. Recording its heaviest rainfall since 1959, the 1992 floods were most devastating, purely in terms of casualties. According to newspaper reports from 1992, over 200 people lost their lives and the floods left over 60,000 people marooned in several north-western border districts. Floods were witnessed in 1996 and more recently in 2006 as well.

Massive floods were caused by a cloudburst in the Leh-Ladakh region of Jammu and Kashmir, which occurred on 6 August 2010, triggered flash floods in the area after a night of heavy downpour. While it only lasted for half an hour, the devastation caused by the cloudburst was enormous. It destroyed many buildings in the city of Leh.

Extreme Floods in 2014

Below table are the observations on various points of Srinagar during significant floods. Table depicts the inundation period and peak discharge and gauge height during 2014.

Flood duration observed during some major floods in the past:-			
Year	SANGAM	RAM MUNSHIBAGH	ASHAM
1973	5 days(8/8/1973 to 13/8/1973)	6 days (9/8/1973 to 14/8/1973)	7 days (10/8/1973 to 16/8/1973)
1975	3 days (15/7/1975 to 18/7/1975)	7 days (15/7/1975 to 21/7/1975)	7 days (16/7/1975 to 22/7/1975)
1976	10 days (31/7/1976 to 9/8/1976)	12 days (31/7/1976 to 11/8/1976)	13 days (1/8/1976 to 13/8/1976)
1992	6 days (9/9/1992 to 14/9/1992)	7 days (9/9/1992 to 14/9/1992)	8 days (10/9/1992 to 17/9/1992)
1995	8 days (25/7/1995 to 1/8/1995)	8 days (26/7/1995 to 2/8/1995)	14 days (27/7/1995 to 9/8/1995)
1996	6 days (20/6/1996 to 25/6/1996)	10 days (19/6/1996 to 28/6/1996)	21 days (20/6/1996 to 10/7/1996)
2006	5 days (2/9/2006 to 6/9/2006)	5 days (3/9/2006 to 7/9/2006)	7 days (3/9/2006 to 9/9/2006)
2010	3 days (28/5/2010 to 30/5/2010)	2 days (29/5/2010 to 30/5/2010)	4 days (30/5/2010 to 2/6/2010)
Peaks of 2014 Floods:-			
GAUGE	10.579M (34.70 FEET)	8.994M (29.50 FEET)	5.588M (18.33 FEET)
DISCHARGE	3262CUMEC (1,15,218 CUSEC)	2055.316CUMEC (72,585 CUSEC)	1347.84CUMEC (47,600 CUSECS)
DATE/TIME	1 AM on 6/9/2014	2 AM on 8/9/2014	5 PM on 8/9/2014

Rainfall

The Jammu and Kashmir state experienced catastrophic rainfall from 1st to 6th of September. The onset of monsoon over J&K region takes place by 1st July and withdraws by mid-September. On September 4th, 2014 J&K experienced 30hour long rainfall that has broken the record of many decades, the major parts of the state recorded an average of more than some aspects of catastrophic rain fall in J&K. Some parts of the state experienced more than 650mm of rainfall in 3 days. Even moderate rainfall was also recorded in Ladakh region. September was not considered rainy season in the Kashmir and Ladakh region, but this year both these region have recorded moderate to heavy rainfall. Although rain in Jammu region during September was a normal phenomenon but the intensity was very high. According to IMD; in Jammu region such huge rainfall was earlier recorded in 1903, 1908, 1926, 1942,1988 and Kashmir valley experienced such intensity rainfall in 1903,1911,1917,1928 and 1992.

Natural causes behind the flood

- Precipitation
- Inadequate capacity (within banks)
- Bank erosion and silting
- Land slides
- Poor drainage
- Snow melt and glacial out bursts

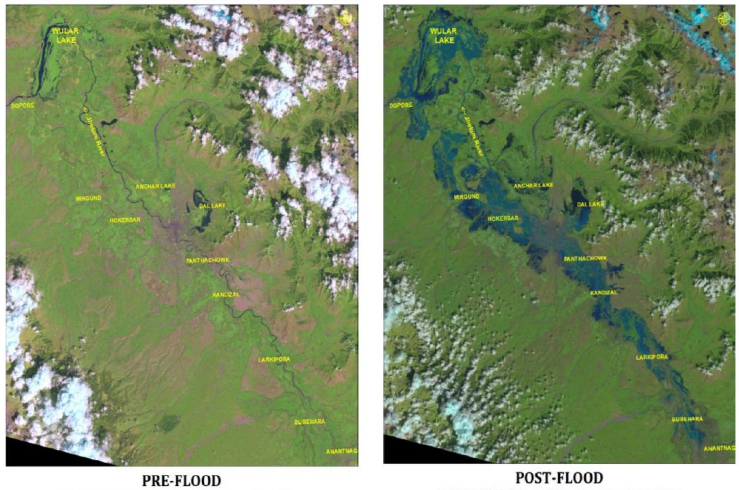
Man-made causes behind the flood

- Indiscriminate encroachment
- Increasing economic and developmental activities in flood plains
- Lack of regulations
- Inadequate drainage system
- Inadequate maintenance
- Lack of disaster preparedness

ROLE OF GEOINFORMATICS IN KASHMIR FLOODS 2014 MANAGEMENT

The Decision Support Centre (DSC) of NRSC in collaboration with Department of Environment & Remote Sensing, J&K have taken necessary action on satellite data acquisition and processed and kept a close watch on the flood situation. All possible data from Indian Remote Sensing (IRS) satellites, as well as foreign satellites, covering Kashmir valley were obtained and analyzed. Rapid flood mapping and monitoring was done on almost daily basis and the flood inundation information was prepared. addition, cumulative flood inundation, flood progression and recession maps were also prepared. Below is the comparative LANDSAT-8 Satellite image of the pre and post Kashmir Floods 2014.

Geographical Information Systems (GIS) play a highly significant role in all the phases of Disaster and Emergency Management. GIS provide us the opportunity to visualize, question, analyze, interpret, and understand data to reveal relations, patterns and trends for a robust management of disasters and emergencies. The initial task is to reduce the impact of a hazard,

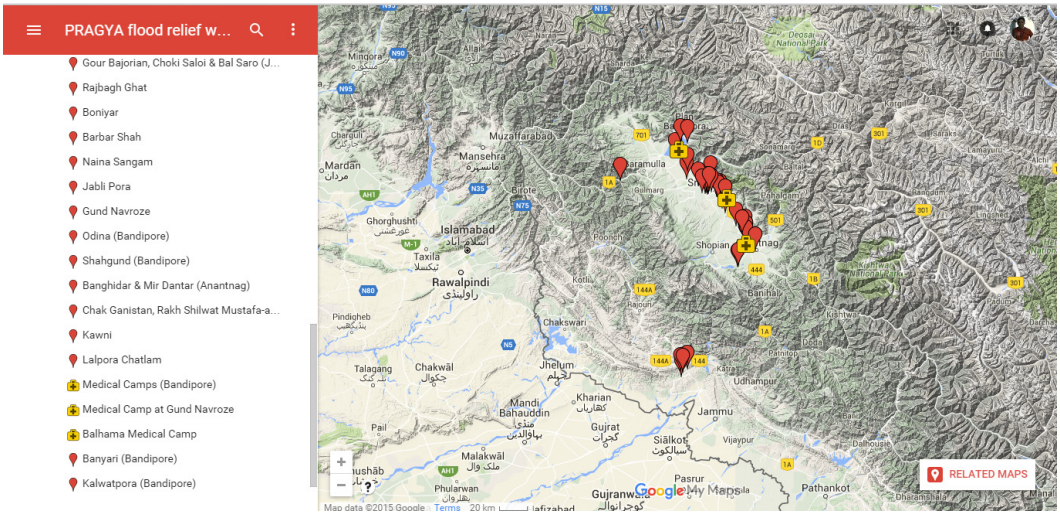


PRE-FLOOD
LANDSAT-8 Satellite Image showing Floods as on 25 August, 2014

POST-FLOOD
LANDSAT-8 Satellite Image showing Floods as on 10 September, 2014

which has the potential to convert into a disaster. Through GIS we can carry risk assessment initiate long term mitigation strategies in an effective manner. Risk mapping land-use planning and risk analysis through GIS are the activities which we can carry in pre disaster phase. During a disaster/emergency situation we can use GIS based Decision Support System for overall management. The major advantage of the GIS is that we can store all the relevant data and can run SQL (structured query language) queries on it. On one click we are able to locate the nearest hospital, rescue shelter, fire station or police station.

The most useful function they may have is to find alternate routes, safe sites for shelter etc. during disaster situation. For the recovery phase, we can identify the safer places for the reconstruction, damage assessment, temporary shelters and for the allocation of claims, etc. NGOs also done tremendous work during Kashmir floods, below is the snapshot of an NGO named “Pragya”who coordinated their relief activities through GIS platform.



ECONOMY LOSS DUE TO FLOOD

Devastating floods in J&K have caused an economically loss over 5,000 crore to the state with heavy damages of infrastructure (public/private) like livelihood / employment/ tourism & industry/ Agriculture & Horticulture and also impact on human life and social impact/Homelessness, Destitution, Crimes, WCD.

J&K has been also impacts on administration damages like power, railways, transport, communication (mobile, landline, radio, TV), abject shortage of resources at hand to manage the disaster- Boats, Divers, communication systems lost to the deluge govt. offices flooded, rendered inaccessible ,surface transportation axis lost in many districts ,all major hospitals lost to floods, majority of the PS's /PCR's flooded, electricity transmission Shut down-Total blackout, water Supply plants lost-Shortage of drinking water

Immediate Relief

J&K Floods 2014 has been set up to mobilize resources from state and central government and NGG to support the relief and rehabilitation programs in Jammu and Kashmir. Government India will aim to raise resources and work hand in hand with credible disaster relief organizations to address this major calamity. Hope Foundation and local administration officials, we have identified the following needs of the people which need your immediate support.

Distribution of Medicines/ Health check-ups/ Medical Referrals with special focus on women and children needs in the most affected villages till the local health infrastructure is restored.

i. Health and Hygiene Kits: Sanitary napkins, Soaps, Towels, Medicines, ORS Sachets, etc.

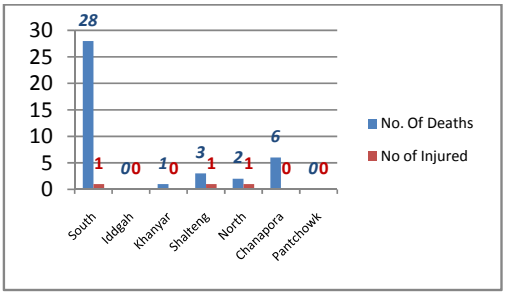
ii. Family Kits: Set of utensils, floor mats, mosquito nets, Flash Lights, Batteries, Portable Mobile Chargers, etc.

iii. Winter Kits: Blankets and warm clothes for protection against ensuing harsh winter in the state.

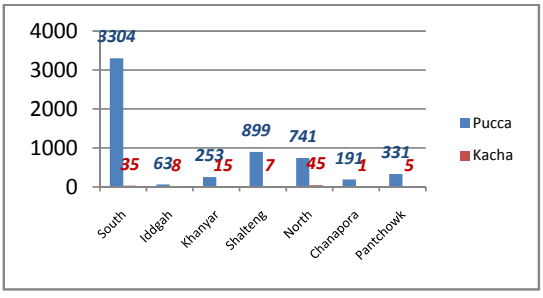
iv. School Kits: Black board, chalks, chairs and stationery, Books, Bags, etc. (to help children continue their schooling once the flood waters recede).

3. Shelter: Construction of Emergency and Transitional Shelters for families whose houses have been destroyed or are currently unfit for use due to submersion and until further provisions are made for their rehabilitation.

Deaths & Injured



Death/ Injured



Damages

Statement showing the details of ex gratia relief sanctioned in respect death/property damage cases of floods as on 21-12-2015

SNo		No of Deaths	Amount Sanctioned	No of Injured	amount sanctioned	No of houses damaged fully		Amount Sanctioned		No of houses damaged Severely		Amount sanctioned		No of houses damaged partially		Amount sanctioned		No of residential sheds damaged	Amount sanctioned	No of Partially / Severely Damaged Sheds	Amount sanctioned	No of Cow sheds damaged	Amount sanctioned	Total Amount sanctioned
						Pucca	Kacha	Pucca	Kacha	Pucca	Kacha	Pucca	Kacha	Pucca	Kacha	Pucca	Kacha							
1	South	28	42	1	0.031	3304	35	2478	6.16	12440	3	1567	0.114	9652	3	366.8	0.069	36	1.08	194	4.46	160	2.4	4469
2	Iddgah		0			63	8	47.25	1.408	667	10	84.04	0.38	4601	0	174.8	0	12	0.36	330	7.59	36	0.54	316.4
3	Khanyar	1	1.5			253	15	189.8	2.64	1438	51	181.2	1.938	5692	61	216.3	1.403	156	4.68	1135	26.11	82	1.23	626.7
4	Shalteng	3	4.5	1	0.031	899	7	674.3	1.232	4979	1	627.4	0.038	22512	0	855.5	0	24	0.72	991	22.79	1314	19.71	2206
5	North	2	3	1	0.093	741	45	555.8	7.92	2871	20	361.7	0.76	1203	19	49.93	0.437	182	5.46	830	19.09	164	2.46	1007
6	Chanapora	6	9			191	1	143.3	0.176	377		47.5	0	11363	0	431.8	0		0	59	1.36	118	1.77	634.8
7	Pantchowk		0			331	5	248.3	0.88	1261	4	158.9	0.152	1507	1	57.27	0.023	11	0.33	204	4.69	431	6.465	476.9
	Total	**40**	**60**	**3**	**0.155**	**5782**	**116**	**4337**	**20.42**	**24033**	**89**	**3028**	**3.382**	**56530**	**84**	**2152**	**1.932**	**421**	**12.63**	**3743**	**86.09**	**2305**	**34.58**	**9736**

Lesson Learnt

- Mobilizing and channelizing of monetary and in-kind donations and volunteers
- Identification of credible NGO partners for on-ground implementation after thorough due diligence (on the basis of their past track record in disaster relief and rehabilitation, legal compliances, etc.)
- Thorough need assessment of the affected communities including consultations with the government, local organizations and local community.
- Facilitation and monitoring of relief and rehabilitation programs and efficient management of fund utilization.
- Tracking the progress of the response interventions and reporting to the donors. This includes keeping the local Government and government agencies apprised of the progress.
- Ensuring coordination between NGO partners, volunteer agencies and local government agencies for a comprehensive approach towards relief/ rehabilitation.

Recommendations

- Flood Zone mapping will be an effective step to deal with recurrent flood problem in Kashmir Valley.
- Kashmir valley have trend to develop big houses and being on mountain terrain it is not appropriate to live in big houses because of limited usable land. In these houses most of the land is unusable and construction is being done in the flood plains. Small houses will add
- Automated weather stations and Doppler Radars need to be installed.

Challenges and Opportunities in Disaster Governance: Urban Flooding case of Chennai in the Era of Changing Climate

Prof. M.B.Rao and Abhinav Walia

This was the another rainy morning of November 2015 for District Collector (DC)Chennai, who resides in the heart of the city. During October to December its generally rainy because of the northeast monsoon in southern parts of India. This was last week of November, IMD issued severe rain warning for next 72 hours in Chennai and nearby places. While going to office, DC was aware of the consequences of warning issued by the Indian Meteorological Department, as he already had bad experience of two rounds of extreme rainfall happened in same month. Possible water logging problem was somewhere in the sub conscious mind of DC because of the sense of inadequate capacity of the storm water drainage system for severe rain events in Chennai. Almost all the rivers had already access water consequences of the continuous rainfall in the catchment area. The hazy picture of worst scenario was developed in the mind of DC in view to the prediction issued by IMD. On November, 30th, rain started heavily in the city, the lower parts and suburbs slowly started getting inundated. Later, Every minute picture was getting worst because of the continuous inundation. On the morning of December 1st, The houses at Jafferkhanpet was fully inundated, which is a neighbourhood in southern Chennai,. By 5 A.M, most of the city was inundated. This situation was remained same for the next 72 hours. Out of three spells of extreme rain, this spell was the most intense that had battered the city in just one month. Other spells of rain happened during November 11 to 13, and from November 15 to 17. The existing drainage system was inefficient to manage huge rain water of 2015. In November 2015 the total rainfall was 1,200 mm in Chennai which was the highest rainfall in the month of November in last century. The average rainfall in the onth of November is approximately 407.4 mm. December 1, have been recorded the wettest day of December by receiving 300 mm rainfall. The average rainfall in the month of December is 191 mm.

Background

Chennai is located at 13.04°N 80.17°E on the southeast coast of India and in the northeast corner of Tamil Nadu in the Eastern Coastal Plains. The city is a flat coastal terrain. The average elevation of city is 6 metres (20 ft), its highest point being 60 m (200 ft). The climate of Chennai is tropical wet and dry. The most of seasonal rainfall receives from north-east monsoon winds, from mid-September to mid-December. City is highly prone to cyclones which develops in Bay of Bengal. Two rives pass through the city, the Cooum River (or Koovam) in the central region and the Adyar River in the southern region. Most of the Indian states suffer flooding every year during the annual monsoon rains from June to September. The northeast monsoon has

been particularly forceful over Chennai and southern India. During the Northeast Monsoon 2015 extremely heavy, Deep depression rains in Tamil Nadu with sudden downpour in these short span of time caused damages in the state from 08.11.2015 to 05.12.2015. Many parts in Tiruvallur, Kancheepuram, Chennai and Cuddalore districts were inundated for days together. Detailed Meteorological condition have been provided separately as Annexure.

District Collector was in continuous touch with the Chennai Municipal Corporation and other concerned departments for the updates on the situation. Being a metropolitan, the main responsibility of disaster management is mainly with the Municipal Commissioner of Chennai rather than District Collector. Chennai, is the fourth largest Metropolitan City in India. The Chennai Metropolitan Area (CMA) comprises the city of Chennai, 8 Municipalities, 11 Town Panchayats and 179 Village Panchayats in 10 Panchayat Unions. The extent of CMA is 1189 Sq.km.

DRAINAGE FACILITIES IN CHENNAI

The rainfall of December 01, 2015 was so heavy that the rivers swelled, tanks, bunds and embankments were breached. The Storm Water Drainage (SWD) system was already collapsed by the load of Novembers rainwater that filled the city's roads, houses and bridges. The SWD system of Chennai city was already struggling with the problems of excess load, heavy encroachments and illegal construction. The Corporation of Chennai and Chennai Metropolitan Development Authority are responsible for approving building plans and town planning, and for enforcing urban planning. The flat terrain of Chennai City needs effective Storm Water Drainage System to prevent water stagnation in roads. Because of the flat terrain and partial coverage of roads with storm water drains, flooding and water stagnation happens in the city during every monsoon season. ***Section 176 of the Chennai City Municipal Corporation Act, 1919 entails the Greater Chennai Corporation to provide and maintain a Sufficient System of public drains throughout the city.*** In accordance with the Statutory rule, the Storm Water Drain Department of Greater Chennai Corporation Constructs and maintains a network of Storm Water Drains and Canals. Greater Chennai Corporation developed and maintains a Storm Water Drain network of 1660.31 km in the city. The sewage system in Chennai was originally designed for a population of 0.65 million at 114 litres per capita per day of water supply; it was further modified during 1989-1991, but is now much below the required capacity, a 2011 study by members of the National Institute of Disaster Management (NIDM) noted. Greater Chennai Corporation also maintains 31 canals criss crossing across the Chennai City. Rain Water runoff gets drained through Storm Water Drain network & canals and reaches the Sea Via five Waterways-Otteri Nullah, Buckingham Canal, Adyar River, Cooum River a and Kosathalaiyar River -running across the city. Timely cleaning of water bodies and SWDs is important to ready for the rainy season. Residents also have responsibility not to throw plastics and other wastes in the drains and water bodies as this also had a major contribution to the consequences of 2015 floods.

THE PROBLEM

According to "Care Earth" a Chennai based research institute Chennai disaster was a manmade disaster rather a natural. Soil and rock types of Chennai suggest that the city is historically a flood plain. The city had many wetlands and natural channels through which excess water from

the city can be drained off. Currently, the city is experiencing rains that have broken a record of about hundred years. With more rainfall in store, the city needs to relearn its water management system.

The expansion of the city has been done in west and south direction only because of the sea in the east and bordering state in the north. Chennai become a major information technology hub since 2000. Huge number of IT industries are present in the city with high number of employment migrated crowed. In the process of expansion, the city engulf several fishing and agricultural villages and hamlets, thus paving way for several ecological and environmental challenges that the administration could not tackle. According to Indian Institute of Science, Bangalore report, city corporation area has been increased four times of its original size. The Chennai Metropolitan Area (CMS) has a size of 1,189 sq km and comprises of eight districts, including the Chennai city district. The population has increased from 5.8 million in 2001 to 8.9 million in 2011 in CMA. In last couple of years new construction have been done significantly. The city almost changed to a concrete jungle. The open areas decreased drastically and the built up and paved areas, according to an analyses by IISC, increased from 29.53 per cent in 1991 to 64.4 per cent in 2013. Urban Planning was not done in a proper manner considering hydrology and other related aspects. Ground water is severely polluted because of unpinned solid waste dumping. The recharge structures like lakes, tanks, ponds and other wetlands in the city have been disregarded and the natural course of water has been tampered. This is one reason for urban flooding in the urban and peri-urban areas.

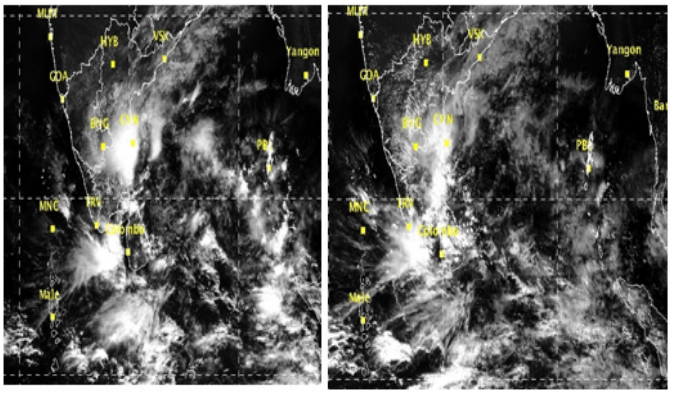
The city has large marsh in the south (about 20 km south of the city centre), smaller satellite wetlands around it and large tract of pasture land. The southern marshland called Pallikarni marshland is known as the flood sink area of the city as it drained about 250 sq km of the city in the eighties. The marshland is housed in CMA. There were smaller wetlands around the marshland that served as a source of irrigation in the area that cultivated only paddy. The marshland that was around 5,000 hectares (ha) during independence got reduced to almost 600 ha around 2010-11. The only reason for all this was rapid urbanization and most of all wetlands of Chennai became sites of waste disposal, housing, commercial and industrial purposes.

Transport System of the Ministry of Railways, the National Institute of Ocean Technology, the Chennai Corporation, and the Centre for Wind Energy Technology. In 2002, a survey by the Tamil Nadu Pollution Control Board showed that that the marsh lost around 90 per cent of its original extent. This is also the year when the city observed a big flood event. The most affected areas were the adjoining areas around the marsh. Citizens started movement to save the marsh land.

The 2014 analyses of IISC showed that in just past four decades the urbanization increased almost 20 times at the cost of open and green areas. The areas got converted to urban impervious surfaces that increase the runoff and create water logging in absence of proper drainage.

METEOROLOGY

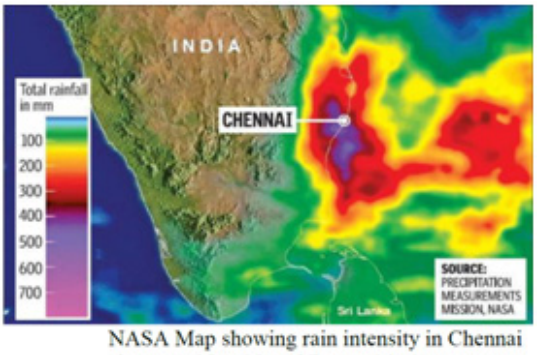
The total rainfall was 1,200 mm in the month of November 2015 which was the highest rainfall in the month of November in past 100 years. The city on an average receives 407.4 mm rainfall in November. On December 1, Chennai received 300 mm rainfall, making it the wettest December day ever recorded in the city. The normal rainfall for Chennai in December is 191 mm. North East



Monsoon in 2015 was +53% above the normal over Tamilnadu and Puducherry. One day maximum record for December over Chennai (N) surpassed. (Dec, 10, 1901- 26.1 cm; Dec 2, 2015 – 29.4 cm). One day maximum record for December over Chennai (M) surpassed. (Dec, 9, 1957- 17.1 cm; Dec 2, 2015 – 34.5cm). Monthly total for November over Chennai (M) surpassed(1985- 1071.5mm ; 2015 – 1178.3 mm). The normal pattern of rainfall distribution during the normal year is as follows:

Season	Months	Normal rainfall (in mm)	Percentage of annual rainfall
Winter rains	January-February	31.3	3.40%
Summer rains	March-May	128.0	13.90%
Southwest monsoon	June-September	321.2	34.88%
Northeast monsoon	October-December	440.4	47.82%
Average rainfall		920.9	100.00%

It may be seen from the above that the State receives nearly 48% of the precipitation from the NE Monsoons during the period October to December. Typically, rainfall during this season is in multiple spells, following formation of systems of low pressure area over the Bay of Bengal, which may intensify to deep depression and cyclones, when accompanied by high speed winds.



NASA Map showing rain intensity in Chennai between Nov 28 and Dec 4, 2015
(*Source:* PMM, NASA)

In addition to Chennai metropolitan area, the coastal districts of Chennai, Cuddalore, Kancheepuram and Tiruvallur were also severely affected. The situation was further worsened due to the release of water from reservoirs in Andhra Pradesh, which flows into the waterbodies and drainage systems in the northern districts Chennai, Kancheepuram

and Tiruvallur of Tamil Nadu. Further heavy surplus outflow from the four major reservoirs of Chembarambakkam, Cholavaram, Poondi and the Red Hills, which form the catchment areas for Chennai, inundated the low-lying areas in Chennai. This resulted in extensive damage to infrastructure including roads, buildings, bridges, water supply and power systems infrastructure. The water level in most of the settlements rose to the first floor-level and in many areas it was more than 12 feet as a result of which the the personnel could not move during the initial hours of the disaster. Hundreds of houses in Varadarajapuram, CTO Colony, Bharathi Nagar, Jothi Nagar, Thirumudivakkam and Harita Enclave, Velachery Ambattur, Ponneri, Maduravoyal, Tiruvottriyur and Madhavaram areas were completely marooned.

Though the Chennai District Collector E. Sundaravalli issued a flood alert, asking people living on the banks of the Adyar river to move to safer places, this could not be followed by the administration in ensuring effective implementation. According to official figures, about 44,000 cubic feet of water per second flowed into the Bay of Bengal. In other words, the State had made no plans to store the surplus waters of the Adyar. The river overflowed its banks, leading to a couple of hundreds of the Tamil Nadu Slum Board tenements being marooned in Kotturpuram. Water, rising to a height of several feet, barrelled through Madipakkam, Adambakkam, Nanganallur, Velachery, Medavakkam, Madambakkam and Selaiyur, where lakhs of people live.

FLOOD SCENE

Raja who is a private taxi driver work for Chennai Circuit house wake up early in the morning and found all the area was inundated. His car was under water and his all important documents were sunk in the flood water. His situation was like a handicap as his car was the only way for his and family's livelihood and also he don't had soft copies of his important documents. The houses on the ground floor in Jafferkhanpet, a neighbourhood in southern Chennai, was fully inundated. Almost 80 per cent of the city was under four metres of water by early morning. The situation continued for the next 72 hours, killing more than 500 and destroyed infrastructure worth Rs 500 crore. It was most intense of the three spells that had battered the city in just one month. The government of Chennai done tremendous job of organizing camps for providing copy of all the important documents which has been damaged because of the floods. Raja received all his important documents immediately after the flood receded. This was really a big relief for Raja and other residents who have been lost their documents.

TEACHING NOTE

The case study could be taught in two ways, either as ***standalone case study*** or as ***flip type study*** with other case studies for different types of disaster issues. The stand alone case study will be circulated in advance, a day prior to the class and officers can be divided into groups of four with issues i.e. (i) Geographic and Physical Vulnerability of Chennai, (ii) Preparedness and Mitigation, (iii) Response and (iv) Relief and Rehabilitation. To conduct the session flip type other case studies on different types of disasters can be circulated before the class and issues can be discussed to give exposure on other types of disasters.

The case is based on an actual flood incident that took place during November-December 2015 in Chennai, Tamilnadu. Before commencing discussion on the case, the faculty member

may ascertain whether Trainees have read the case or not. The case of Chennai flood is little elaborative so it is advisable to allow the Trainees 15 minutes to quickly browse through the study before starting discussion. Alternatively, one Officer Trainee may be asked to recount the events given in the case narrative.

Officer Trainees may be asked to step into the shoes of the dramatis personae District Collector, Chennai and then examine as to what could have been done to avert the unfortunate incident. The specific issues that may be raised by the facilitator during discussion could be the following:

- What could be the strategy for effective response to deal with such extreme events?
- Can roles and responsibilities be defined in advance for each concerned officials.
- What would be the possible strategies to protect the important documents
- What would be the possible strategy t to deal with media and rumours.
- What need to be done for to prevent Chennai from such type of incidents.
- What could be the possible methods to carry our risk assessments more useful?
- How warnings can be more robust and propagated systematically from one chain of command?
- How Climate Change play a role in such type of extreme events, what need to be done for Climate Change Adaptation.

HOW SOCIAL MEDIA MADE THE DIFFERENCE

Social networking websites are very much useful for online discussions, updates, preparedness and response activities for any disaster and emergency situation. Famous film actor Kamal Haasan, Balaji, Siddharth including other celebrities and professionals from Information Technology and corporate organisations based in Chennai done a wonderful job for Chennai Flood response. Film stars Kamal Haasan and Siddharth shared the info on how even the affluent neighbourhoods have gone under water. Haasan who lives on the posh Eldams Road in Chennai's Teynampet area, told Firstpost**,** *"To describe the situation as calamitous would be an understatement. If this can happen in Chennai can you imagine the plight of the rest of Tamil Nadu?"* Popular South Indian actor Siddharth, who is known in Bollywood for his role in Rang de Basanti and Chashme Baddoor, tweeted photographs of the flooding in his house saying, *"I am an affluent actor. This is my house. Imagine rest of Tamil Nadu"*. Siddharth @Actor_Siddarth 7:01 PM - 1 Dec 2015 *House flooded. Moving to the terrace. God save Tamil Nadu*. Siddharth @Actor_Siddarth 7:08 PM - 1 Dec 2015 *Bathrooms submerged. Water coming out of the drains. I am an affluent actor. This is my house. Imagine rest of TN.*

Social media played a highly significant role in the management of this disaster. All the information was widely disseminated through twitter, facebook, websites and other media sources in an effective manner with the use of social media. People across the world were able to get the latest updates of their relatives/friends and also able to communicate to the Disaster Management Departments for assistance. Efforts done by celebrities and others have been well appreciated as all the activities done have set the examples on how social media can make difference.

FLOOD MONITORING AND CONTROL

District Collector and Municipal Commissioner were directly involved in the monitoring of floods. Immediately after disaster, rescue operations were initiated with a simultaneous mobilization of human resources from unaffected districts. To oversee the response, to hasten administrative process and decision making, an experienced Administrative officer (IAS-Indian administrative officer) officer was deputed for each area as a **"monitoring officer"** who was performing as like head of **Incident Response System** for assigned area. In the Chennai collectorate, the Emergency Operation Control Room was functioning with a team of officials. The officers were continuously updating the information to the EOC and senior officials. Complaints regarding the relief measures were attended on high priority. All the concerned jurisdiction officers ensured to attend the problems regarding water logging, power failure, falling of trees, emergency medical attendance etc. Fire and rescue functioned round the clock during floods.

The Chennai district administration has taken immediate measures for disbursement of relief. Zonal teams were constituted under the Deputy Collectors (zonal heads) to monitor the situation. Financial relief was distributed to the victims. Rice, kerosene, saree, dhoti were distributed to the victims. Prompt medical attendance was provided through teams of doctors, nurses and other para-medical staff. Medicines including emergency medicines were mobilised in abundance. There was no shortage of medicines, doctors and nurses to attend the victims in all the affected areas of the metropolis through the magnitude of the flood is very severe and almost entire city was inundated and a large number of people were affected. Special attention was paid to low laying and viable areas which have experienced more than 10" depth of water.

RESPONSE

District Collector and team was directly involved in response management. Rapid response have been initiated and nearly 23.51 lakhs persons were rescued and evacuated in 7244 relief camps. Food and drinking water provided to them by the Government departments. The affected people were treated in 31,320 Medical Camps and also 690 metric tonnes of milk powder were distributed. More than 80,000 persons from the Government's side have been involved in round the clock rescue and relief operations. 1,200 Army personnel, 600 personnel from Navy, Coast Guard and Air Force and 1920 NDRF personnel were engaged in rescue and relief operations. Six helicopters of Air Force and two helicopters each of Navy and Coast Guard participated in rescue operations. 470 heavy duty pumps, 71 super sucker machines, 49 Fire and Rescue Department vehicles, 82 JCBs/Poclains, 111 jet-rodding machines and 200 desiliting machines were deployed to pump out the water or to cut open channels to dewater areas. 100% electricity distribution restored. More than 1250 M.T of various kinds of materials like bread, biscuits, ready to eat food items, water packets, toiletries, bed sheets, mats, dress materials, shoes, chappals, torch lights, candles, etc., have been received and distributed affected people.

Special camps were organised for two weeks at Taluk level for issue copy of valuable belongings like Patta, Educational Certificates, Aadhar Card, Voter ID Cards, Bank Pass books, RC books, Driving licences etc., in flood affected Districts. More over 37,707 students who have lost their text books, note books etc., have been issued with text books, note books and one set of school

uniforms. A sum of Rs.3,043.59 crore have been sanctioned from the SDRF / NDRF for Relief and Restoration measures. Response of the Government of Tamilnadu have been praised for the way they handled the camps and response.

ISSUES FOR DISCUSSION

The general problems noticed during the brief study include lack of comprehensive risk assessment, lack of cooperation and coordination, lack of consultation and information sharing among various government departments, municipalities, organizations and institutions and other stake holders. Administration was not ready to respond for such a rapid and mega urban flood as city never witnessed such type of floods during the last one hundred years. Mock drills and preparedness for extreme events considering climate change need to be done. The state administration could have done more over the years despite being the flood-prone.

Geographically Chennai have genuine problem, the average elevation of the city is only about 6.7 meters above mean sea level, with many neighborhoods actually at sea level, which makes drainage a challenge even under normal circumstances. Because of climate change such incidents could have more intense, frequent and unpredicted so flood management need to be taken into serious consideration. Robust Disaster Management Plan need to be prepare in advance, the experience of December, 2015, once again brought the need for training of officials and all other stakeholders in preparation of disaster management plans and readiness for extreme incidents.

Providing hundred percent and absolute flood security is neither financially viable nor technically feasible for a major metropolitan city like Chennai. Floods have to be managed by reducing flood risks to an acceptable level and by retaining, sharing and transferring flood risks to some limited extent. The basic steps involved in an integrated flood management process like vulnerability analysis, assessment risk identification and risk reduction and risk transfer (Planning and implementation measures), have to be undertaken in the city of Chennai on priority basis. In Chennai, flood risks result from a combination of components, comprising hazard, exposure and vulnerability. The recognition of these components facilitates the understanding of flood risks because it underlines that only the combination of natural and human factors create flood risks. A number of advanced scientific and technological tools and techniques are now available for ensuring effective engineering preparedness and mitigation measures to handle any flood situation in Chennai. Engineering personnel play a key role in all these flood preparedness and mitigation activities since they are directly in charge of planning and implementation of these activities. Engineering personnel also guide the policy makers and planners and provide technical advice for them. With a competent and vibrant engineering community in place, with further building up of their capabilities at all levels through training and institutionalization of various scientific and technical mechanisms with appropriate systems in place, through sustained collective efforts, with the involvement of these engineering personnel at all levels and use of appropriate technological options, with a coherent and meaningful approach towards flood risk management, through effective regulation and implementation measures with the involvement of all departments, organizations and institutions, it is quite possible to control floods in Chennai and avoid damages in future.

Lesson Learnt

- Updating of Disaster Management Plan in consultation with the Municipal Corporation (Greater Chennai Corporation) and all other stakeholders.
- SITREPS should be sent (RIF data, reports reg. human loss, no. of people affected areas inundated, damages to property and infrastructure, no. of houses collapsed, cattle loss, power/transportation/ comm. disruption on 8/6 hourly basis (thrice daily)
- Community participation in flood risk assessment as well as in planning and implementation of risk management measures is key for the success of flood risk management plans. Meeting the needs of stakeholders is only possible if stakeholders are involved in the decision-making process.
- Floods management measures have to be planed across administrative and sectoral boundaries. Institutionalized links between concerned authorities and various organizations and departments is required facilitate cooperative planning.
- Meetings with the officers and staff of all the Line Departments periodically i.e. before the onset of south west (SW) monsoon and also before cyclone season i.e. Oct - Nov.
- Strengthen local hydro-metrological data network and establish well co-ordination mechanism between the govt. departments and orgn & institutions (IMD, State Revenue Dept., CWC, Water Resources Dept., M & UD Dept etc)

Conclusion:

This topic attempted to develop an inventory of infrastructure in visible areas and monitor its maintenance. Even the tsunami (Dec, 2004) that hit Chennai was not that much destructive. Since it was confined only to coastal areas in Chennai & Cuddalox, Nagapattinam and Kanyakumari Districts. In some areas, relief has not reached the people even after 2 days. This need to be channelized in advance. Fisherman brought their boats and catamarans to the flood hit areas (in lorries and mini vans) and assisted rescue teams. This also need to be channelized properly in planning pahse. There should be strict regulation of settlements and economic activity in the Flood Prone Zones.

Case study of Cyclone Phailin – Ganjam

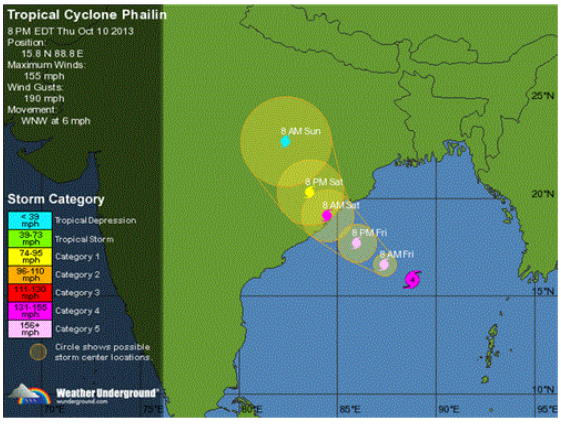
Abhinav Walia and Indrajit Pal

INTRODUCTION

Early cyclone warning is possible these days through the advance satellite monitoring. Meteorologists warned in advance about the monster storm ploughing towards India's east coast, all the disaster preparedness teams in the region snapped into action, pre-positioning emergency response teams and supplies, and evacuating nearly a million people - ultimately saving countless lives. Indeed it was an impressive show of the robust preparedness by the lesson learnt from the 1999 Orissa sup er cyclone which claimed 10,000 lives with severe infrastructure losses.

Phailin is the strongest storm ever measured in the Bay of Bengal with a low loss of life, would almost certainly not have been possible without learning lessons from previous cyclones and tsunamis that have hit this coastline."

Cyclone Phailin, India's fiercest storm in 14 years, smashed into the coastline of Andhra Pradesh and Odisha states over the weekend, flooded swathes of farmland and ripped apart tens of thousands of mud-and-thatch homes - but surprisingly, only 15 people have been reported dead.



Early preparedness in terms of pre-positioning of food rations and packaged drinking water in shelters, and the orderly - and sometimes forceful - evacuation of close to one million people saved huge number of lives.

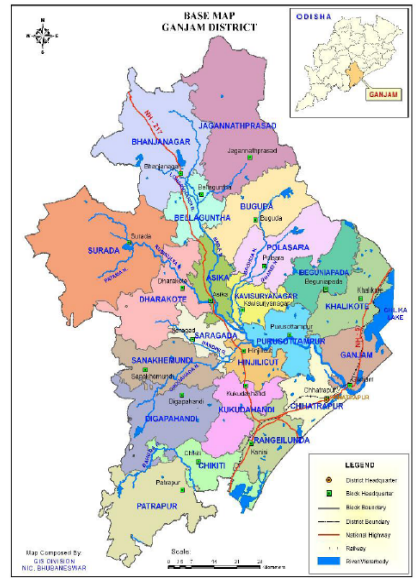
After receiving the information about the approaching Phailin, all the concerned authorities, cancelled the Dussehra holidays of all the concerned civil servants and other concerned officers, deployed disaster response teams with heavy equipment and positioned helicopters and boats for rescue and relief operations. Trains and flights were cancelled, roads barricaded and helplines and control rooms set up. Satellite phones and generators were dispatched to the heads of districts to ensure they remained in contact with the state capital.

Armed forces (Army, Air force, Navy and others) were put on standby and contacted in advance for any help required in case things go bad. Telecom and power companies were informed in advance for the quick restoration of the damaged infrastructures.

All the fishermen were informed in advance, not to venture out to sea and to put their boats in safe places about the cyclone to save their livelihood and farmers also advised to harvest their standing crops.

It is indeed a kind of miracle that so many lives were saved even though the cyclone was the strongest one. Expectation of life losses were very high but robust preparedness saved the life and proved that its is always worth to invest in preparedness rather than only investing into the relief and rescue.

GANJAM

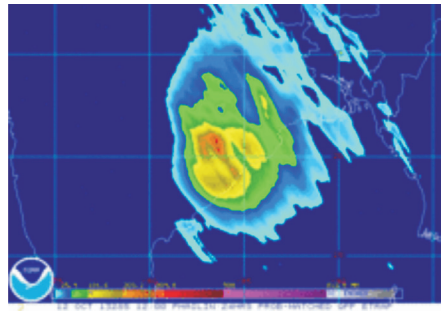


Located on the boarder of Andhra Pradesh, Ganjam District came into existence on 1st April 1936. Ganjam District is on 19.4 to 20.17 degree North Latitude and 84.7 to 85.12 degree East Longitude. It covers an area of 8070.60 sq km. The district is braodly divided into two divisions, the Coastal plain area in the east and hill and table lands in the west. The eastern ghats run along the western side of the District. The climate of Ganjam is characterized by an equable temperature round the year, particularly in the coastal regions. The District's cold season from December to February is followed by hot season from March to May. The District experiences normal annual rainfall of 1444 mms.

Agriculture is a traditional occupation and the way of living of the inhabitants of the Ganjam District. The District is well known for its fertile soil and agricultural productivity. A large variety of crops are grown here like Paddy, Ground nut, Sugar cane, Oil seeds, Ragi, Mung, Biri etc. Because of the agro climatic condition Ganjam is included as the agricultural District.

The literacy rate of the ganjam district is above 60 percent. There are many reputed educational institutes in the District like Brahmapur University, Ganjam Law college, Lingaraj Law college, NIST, Khalikote College Brahmapur, R.C.M. Science college Khalikote, Government Science College Chhatrapur, Maharaja Krushna Chandra Gajapati Medical College, Nursing College, and Pharmaceutical Colleges etc.

PREPAREDNESS FOR PHAILIN

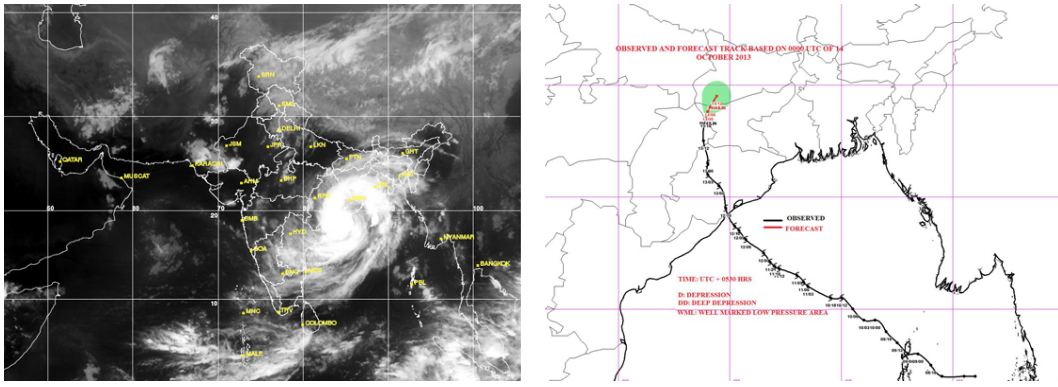


Preparedness includes strengthening the capacity of communities to withstand, respond to and recover from hazards, and of government, implementing partners and Concern to establish speedy and appropriate interventions when the communities' capacities are overwhelmed. In advance, District Administration

conveyed of District Disaster Management Authority Meetings, functioning of round the clock Control room at District, Sub-District and Block Level, Evacuation & Rescue Strategy, Preparation of Rescue Micro Plan, Assignment of duties to Senior Officers, Senior Officers coordinated with Line Departments etc. number of other activities have been initiated by the district administration. Along with the mentioned activities, all the relavent departments have also taken the responsibity seriously and performed all the desired actvities in an effective manner. Cyclone shelter management have been done in an effective manner. A total of 591719 persons have been accommodated in 2191 cyclone shelters in 23 blocks. Below is the brief on the departmental activities undertaken by each concerned department:

Brief on PHAILIN:

- On 08.10.2013 India Meteorological Department(IMD) reported about the formation of a Depression over North Andaman Sea.
- Govt. of Odisha & District Administration started closely monitoring the situation.
- The tracking of "Depression over Bay" was thoroughly analyzed through GIS softwares at regular intervals on 9th, 10th, 11th and 12th October 2013.
- The position and movement of the system was intimated to all the Block Development Officers(B.D.Os)/ Tahasildars & Line Department Officers.
- Accordingly, all the B.D.Os/ Tahasildars were informed about the system well in advance. They were directed to take all precautionary / preparatory measures to meet the cyclonic threat.



Satellite image and predected track of the Cyclone Phailin

Occurrence & Intensity

- "PHAILIN" hit Odisha coast on 12.10.2013 and the landfall point was Gopalpur in this District.
- The wind velocity was recorded to be 205 to 220 kmph after hitting the Gopalpur coast,
- The cyclonic storm with tidal waves of 3.0 to 3.5 meter height ravaged the coastal area of Ganjam.
- The cyclone was accompanied with torrential rains for 3 days, leading to floods in a number of rivers.

- 3212 villages have been affected. Public and private properties, agricultural crops and horticultural plantations have suffered severe damage.
- All surface communication systems, telcom, power supply and water supply were totally disrupted

Torrential rain Accompanied with PHAILIN

- Rainfall accompanied with Severe Cyclone:
  - Due to the effect of cyclonic storm Ganjam district faced torrential rainfall from 9th to 14th October 2013. The cumulative amount of rainfall during this spell was as high as 241.1 mm in the district.

Sl. No.	District	DATE						Total [mm]
		9th	10th	11th	12th	13th	14th	
1	Ganjam	4.6	25.0	4.1	24.4	183.0	0.0	241.1

Rivers Flooding

Due to heavy rainfall from 9th to 14th October 2013, Rushikulya river witnessed floods/flash floods affecting the downstream areas of the district.

River	Forecast station	DL	WL	Water Level in Meter			
				12th	13th	14th	15th
Rushikulya	Purushottampur	16.83	15.83	15.16	18.65	17.10	16.21

Flood Due to Heavy rain

- Heavy rainfall from 9th to 14th October 2013 & subsequently due to Low Pressure on 23rd October 2013 to 26th October 2013.
- Rivers like Rushikulya, BadaNadi, Bahuda, Ghodahada & Loharakhandi river system and other areas of Ganjam district resulting in floods/flash floods affecting the river side and downstream areas of the district.

GLIMPSE TO THE PHAILIN DAMAGES

RESPONSE

Response phase consists of a number of elements, for example; warning/evacuation, search and rescue, providing immediate assistance, assessing damage, continuing assistance and the immediate restoration of infrastructure.The aim of emergency response is to provide immediate assistance to maintain life, improve health and support the morale of the affected population. Such assistance may range from providing specific but limited aid, such as assisting refugees with transport, temporary shelter, and food, to establishing semi-permanent settlement in camps and other locations. It also may involve initial repairs to damaged infrastructure. The focus in the response phase is on meeting the basic needs of the people until more permanent and sustainable solutions can be found. Below are the response efforts done by the Orissa Government.

Marooned/Cut off Villages

Sl. No	Name of the Block	No of GP/ Ward	No of Shelter Centre	Persons evacuated & provided relief	Family	Remarks
1	Chikiti	8	34	31474	7952	Chuda & Gur & Free Kitchen has been provided
2	Patrapur	17	42	5500	1100	-do-

Sl. No	Name of the Block	No of GP/ Ward	No of Shelter Centre	Persons evacuated & provided relief	Family	Remarks
3	Sanakhemundi	8	24	4500	900	-do-
4	Digapahandi	9	22	3500	700	-do-
5	Rangeilunda	3	3	500	100	2 reported dead due to Wall collapsed.
6	Sheragada	10	40	43000	9985	Chuda & Gur & Free Kitchen has been provided
7	Dharakote	11	10	3500	700	-do-
8	Kukudakhandi	2	2	800	160	-do-
9	Aska	21	81	81321	21300	-do-
10	Bellaguntha	7	14	1200	240	-do-
11	Bhanjanagar	2	03	800	160	-do-
12	Sorada	4	6	700	140	-do-
13	Buguda	2	5	500	100	-do-
14	JNPrasad	4	10	500	100	-do-
15	Chatrapur	6	20	32308	6781	1 person dead due to drowning
16	Ganjam	4	12	3500	700	1 person dead due to drowning
17	Hinjilicut	10	30	18950	4928	-do-
18	Khallikote	2	08	3500	170	-do-
19	Polasora	7	16	8500	1700	-do-
20	Purushottampur	20	52	18000	3600	-do-
21	Kodala	8	20	2200	420	-do-
22	KS Nagar	10	30	2000	400	4 persons had been rescued
23	Berhampur MC	40	30	25000	5000	Chuda & Gur & Free Kitchen has been provided
	215	**514**	**291753**	**67336**		

Search & Rescue Measures

- 06 units of ODRAF, 08 units of NDRF were pre-positioned at strategic and vulnerable places.
- All the Fire Service personnel were kept alert to meet the pre & post cyclone challenge.
- The teams assisted the local administration and police in evacuating people from low lying and unsafe buildings and moving them to cyclone shelters and relief camps.
- Post cyclone, the teams were engaged in cutting the fallen trees and clearing the roads to establish road connectivity.
- Apart from these, 130 personnel of Indian Army divided into 2 groups and 90 personnel of Air Force were deployed in strategic locations of the district.

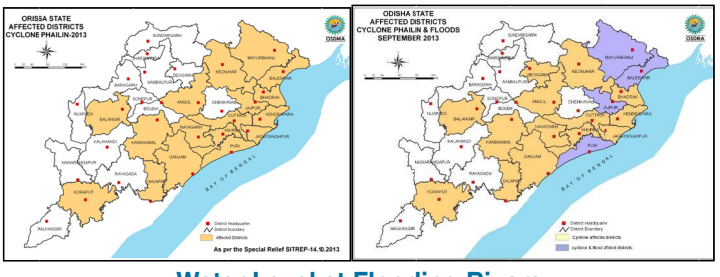
Direct response

- Appointment of District Nodal Officers (DNO):

  Senior Officers were assigned different Blocks/ULBs vide Order No.1364 Dt.15.10.2013.

- Similarly Officers at Collectorate were appointed as Nodal Officers and Senior Supervisory Officers for ensuring effective relief and rehabilitation measures vide Order No.1387 dt.16.10.2013.
- INTER-AGENCY COORDINATION CELL:

Inter Agency Coordination Group (IACG) was formed at Collectorate vide Order No.1475 Dt.19.10.2013.The Inter Agency Coordination meeting for NGOs & Corporate Sector was held on 19-10-2013.



Water Level at Flooding Rivers

Sl No.	Gauge Station	River	Danger Level (in Metre)	24th	25th	26th	27th
1	Surada	Rushikulya	81.99	82.53	82.15	81.43	81.35
2	Aska		34.75	36.53	36.11	34.95	34.88
3	Janibili		53.18	53.76	53.31	52.34	52.64
4	Hiradharabati		23.18	25.15	24.81	24.20	22.09
5	Purushottampur		16.85	18.70	18.61	17.60	16.85
6	Madhabarida	Badanadi	60.65	61.93	61.51	59.37	60.35
7	Aska		35.42	37.55	38.00	34.80	35.05
8	Nuagam Bridge		70.93	71.53	71.10	69.63	71.15
9	Gallery Anicut		102.11	102.03	101.23	100.60	101.62
10	Kabisuryanagar	Baghua	34.06	35.13	34.97	33.10	32.07
11	Bhanjanagar	Laharakhandi	72.31	72.25	70.95	70.25	70.05

RIVERS

River Flooding

- Due to heavy rainfall from 9th to 14th October 2013, Rushikulya river witnessed floods/ flash floods affecting the downstream areas of the district. The water level of rivers is given below

River	Forecast Station	DL	WL	Water Level in Meter			
				12th	13th	14th	15th
Rushikulya	Purusottampur	16.83	15.83	15.16	18.65	17.10	16.21

- Again due to low pressure, very heavy rain occurred in the catchment of Bahuda, Rusikulya, Ghodahada, Loharakhandi, Badnadi, Baghua and Dhanei river systems which caused unprecedented flood in the district

Impact & Damages

- In this district, 37 lakh people in 22 Blocks, 18 Urban Local Bodies, 475 GPs and 3212 villages have been affected due to severe cyclone.
- 19 persons have lost their lives due to cyclone and the floods thereafter.
- The standing crops in 195674 hectares have been damaged.
- The fishing communities have been severely affected due to huge loss to their boats and nets.
- The poor artisans have lost their looms, equipment, accessories and raw materials &farmers have lost their livestock.
- This district also suffered from damage of houses and crop due to the wind and heavy rainfall activity of the cyclone.
- 4 persons have lost their lives due to subsequent flood. 20 lakh people in 22 Blocks, 18 Urban Local Bodies, 475 GPs and 3212 villages
- Massive and unprecedented damage has been caused to public properties like canal / river embankments, roads, bridges, culverts, drains, water works, tube wells, LI points, electrical installations, telecommunications infrastructure, Government buildings etc.

EXTENT OF DAMAGES CAUSED DUE TO PHAILIN AND FLOOD

Due to Cyclone :

Sl.	Name of the districts	Blocks Affected (Nos.)	Villages Affected (Nos.)	ULB Affected (Nos.)	Population Affected (Nos.) due to cyclone	Human Casualty due to cyclone
1	Ganjam	22	3229	18	3700000	13

Due to Flood :

Sl.	Name of the districts	Blocks Affected (Nos.)	Villages Affected (Nos.)	ULB Affected (Nos.)	Population Affected (Nos.) due to flood	Human Casualty due to flood
1	Ganjam	22	3144	18	200000	6

Sector Wise Impact & Damages

Sector Wise Impact & Damages	
House Damages	▸ 22 Pucca houses and 3556 kutcha houses have been fully damaged. ▸ Besides 4341 pucca houses and 36618 kutcha houses have been severely damaged and 233546 houses (both pucca and kutcha) have been partially damaged. ▸ These apart, 2316 huts and 47387 cowshed attached to houses have been damaged.
Crop Damages	▸ An area of Hc. 293900 of agriculture and horticulture crops and perennial crops have sustained damaged ▸ Out of these affected area, Hc. 216749 areas have sustained more than 50% crop loss. ▸ Similarly, an area of Hc.96566 of agriculture and horticulture crops and perennial crops have sustained crop-loss. ▸ Out of these affected area, Hc. 80116 areas have sustained more than 50% crop loss.
Livestock Affected	▸ Due Cyclone and torrential rain: ▸ 19.95 Lakh livestock were affected. ▸ 13244 cattle (milch / draught animals) have been lost.

District	Livestock Affected			Total
	Large	Small	Poultry	
Ganjam	632000	253500	1110000	1995500

Damage to Nets and Boats of Fishermen

- 12830 fishermen have been affected during Cyclone-Phailin on 12.10.2013 and Very Heavy rain & Flood.
- 10202 numbers of Boats & Nets of Marine and in-land Fishery department Ganjam
- 887 boat and 4080 nets of Ganjam-Chilika area has been damaged.

Post Flood initiatives by the District Administration

People evacuated and placed in cyclone / flood shelters & other relief camps were provided with adequate quantities of dry food and cooked food through free kitchen centres. 1060 free kitchen centres were opened covering 343695 beneficiaries. During flood 514 free kitchen centres were opened accommodating 291753 persons.In view of the extensive devastation, emergent relief was sanctioned for a period of 7 to 15 days for the affected people of the cyclone & flood affected in the District. Emergent relief in shape of Chiwda & Gur and rice was distributed to the people. In addition to dry food, candles, matchboxes, kerosene and other essential materials were distributed. 2.62 lakh families were provided with polythene sheets for temporary shelter since houses were damaged either fully or severely. The Departments of Works, RD, PR and H& UD Dept. took immediate steps for cutting of the fallen trees and clear the roads to restore road connectivity. The Police, ODRAF, NDRF, and Fire Service units helped them in the work. Most of the roads up to Block level were cleared within 2 days. There was excellent inter-department coordination in this work. The energy(Electrical) infrastructure was the worst affected among all public properties. 222 feeders, 7595 sub-stations, 6921 km of LT line & EHT Line, 354746 electric poles and 65 EHT towers were severely damaged. 59 feeders, 860 sub-stations, 546.1 km of LT & EHT Line & 11092 electric poles could be restored within 15 days of the devastation. Power supply to 54 out of 14496 affected villages were restored within 15 days. Additional technical manpower (gangs) and materials have been mobilized for restoration of electricity. 237 water tankers were deployed. Restoration of power to water supply systems has been accorded top priority. Besides, DG sets have been hired and 30 nos. of PWS projects have been restored within 15 days. The cyclonic storm and the floods arising out of heavy rainfall due to the effect of cyclone badly affected all drinking water sources like tube wells, open wells, ponds etc. 10440 tube wells were disinfected.

In order to restore the health services in the affected areas, 312 Doctors, 1196 paramedics were mobilized and 22 camps have been conducted in the affected areas of the District. Life saving drugs placed to all institutions. MHUs & ambulances were kept ready for emergency transportation 221 health camps have been conducted in the cyclone & flood affected areas deploying 30 Vets & 42 Para Vets. 41377 livestock have been treated and 44800 cattle vaccinated. 160.5 MT of cattle feed of high quality has been distributed. As per Planning 291753 persons of 514 villages and wards of 215 GP/Ward of Ganjam district were kept at 514 Shelter Centres and were given dry ration and free kitchen for 3 days as per details given below. 11 NDRF/Navy Team, 9 ODRAF Team and 3 Helicopters were engaged for evacuation, rescue and providing relief to the affected persons to the cut-off marooned areas. A total 20 lakhs people of 22 Blocks and 18 ULBs of the district were severely affected.

Steps Taken by Various Departments

Sector Wise Impact & Damages	
Panchayatiraj Department	▪ 24 hours control room was made operational(All blocks). ▪ Nodal officers were designated for the control room.
Home Department	▪ The control rooms were made operational at both the office of Superintendent of Police, Ganjam & Berhampur. ▪ Officers were designated as Nodal Officers for the control rooms with team of staff. ▪ Rescue and relief teams were formed to attend any rescue and relief related assignments.
P W D (R&B) Department	▪ Contingency plan with J.C.B, Hydraulic tractor with POL, Driver & other manpower for clearance of roads due to impending cyclone.
Rural Development Department	▪ A team of officers headed by one Asst. Engineer in each Sub Division was formed along with required machinery to clear the road.
Energy Department	▪ The cyclone room at targeted area was made functional and the Executive Engineers of the respective Division were made the Nodal Officer to monitor the situation. ▪ Mobile teams were formed and stocks of minimum material were kept ready to mitigate any emergency situation.
Public Health Department	▪ 24 hours control room was made operational (upto block level) ▪ Contingency plan prepared with back up facilities, life saving medicine, Ambulances & MHU were kept ready & deployment of HR to the appropriate place.
Telecommunication	▪ Meeting was held between Collector and the DGM for preparation of plan. ▪ Alternator Machine was arranged for minimum 72 hours in the important locations in case of power failure.
Forest Department	▪ The Range level task force was constituted under Forest Divisions and teams were kept ready for emergency services with all tree cutting and related materials

Phailin administration showed the world on how better readiness can make distinction amid the season of outrageous occasions. It is the most grounded storm at any point measured in the Bay of Bengal with a very low death toll, would in all likelihood not have been conceivable without taking in lessons from past violent winds and waves that have hit this coastline." Administration and other concerned departments done astounding job in the overall management which has been comprehensively appreciated globally.

Lessions Learnt

- The government of Orissa and Administration utilized the learnings from 1999 super cyclone which left huge economic, human and environmental loss. Multi Hazard Cyclone Shelters has been built for any cyclone or emergency situation.
- All the shelters were made available a week of ration supply which was a great relief for the persons living in shelters.
- The evacuation was on very large scale and it was very systematic. Huge number of people have been evacuated from the coastal areas to inland shelters. The skills on systamatic mass evecuation have been improved.
- Meteorological Department done a tremendous job in issuing the warnings and forecast, Which was very accurate and matched with international meteorological warnings. Since 2009, all major cyclones to hit the east coast – Aila, Thane, and Nilam – have been predicted well in advance, minimizing the loss to human life. The Indian Meteorological Department and other agencies are now equipped with latest advance warning equipment.
- The provoke reaction from the National Disaster Management Authority and the National Disaster Response Force firmly coordinated the precision of IMD inputs. They always checked the progress of Phailin and sent thousands of rescue and relief workers to help the state government. Inside hours of the cyclone striking Odisha, rescue and relief workers were in real action. Not exclusively did they encourage contain harm to property and life, they additionally ensured that the evacuated individuals were come back to their homes after the cyclonic wind had passed. Is delighting that the death toll was negligible against the fierceness of the severe storm.
- Media also played na important and positive role. it has frequently been reprimanded for being problematic and self-serving, however for this situation, it made a praiseworthy showing with regards to. Notices from the insides of Odisha kept individuals educated as columnists went into the remotest zones. Center moved from city-driven verbal confrontations and dramatization to revealing news that made a difference, appropriately assuming the guard dog part in guaranteeing that calamity operations did not end up plainly slack.

  The special representative of the UN secretary general for disaster risk reduction stated, “Odisha’s treatment of the very severe cyclone will be a historic point example of overcoming adversity in disaster management”. The UN featured Odisha’s endeavors in managing cyclone Phailin as a succesful best practice and case study all around.

Urban Flooding Problem in Mumbai: Challenges and Opportunities

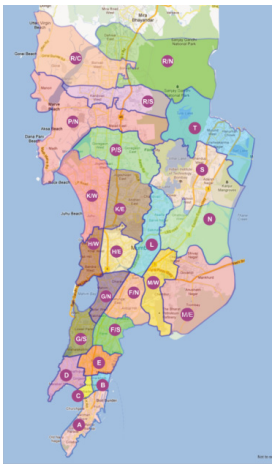
Mahesh Narvekar and Abhinav Walia

INTRODUCTION TO THE PROBLEM

Mumbai have repeated flooding problem during monsoon, especially when spells of extraordinary rainfall blend with high tide. Fast urbanization assumed a noteworthy part in infuriating the issue. played a major role in aggravating the problem. Mumbai keeps on growing basically on recovered ground. The city has a low level waterfront tract; the normal stature at a few focuses is only one meter above mean ocean level i.e. 1.5 metre underneath the high tide level. Along these lines, amid high tide a portion of the ranges get overwhelmed effectively which it slam into the spell of rain. In year 2005, overwhelming to substantial rain joined by solid windy breeze happened in city and Suburbs which came about an extreme storm in the city. 2005 dengue was one of the major catastrophe event every happened in the history of Mumbai. Mumbai Corporation of Greater Mumbai (MCGM) learnt a number of lesson from this deluge and initiated number of mitigation and capacity building activities. Control room of the MCGM has been created of world standard with all the Emergency Support Functions, help lines, live cameras, live weather forecasting etc. number of other activities have been introduced to the Emergency Operation Centre of the MCGM.

TOPOGRAPHY

Mumbai city lies on what were formerly two groups of islands, stretching southward of the Ulhas estuary. The southern group currently referred to as Mumbai Island City originally consisted of seven separate islands (Fig.). Since thes 17th century, these islets have been joined through drainage and reclamation projects, as well as through the construction of causeways and breakwaters to form one landmass. The northern island group, originally known as the Salsette group, on which the present Mumbai Suburban District is situated, also consisted of seven islands. These islands remained separate till the beginning of the nineteenth century. Today, Mumbai City comprises the merged seven islands of the Island City and four islands of Mumbai Suburban District.



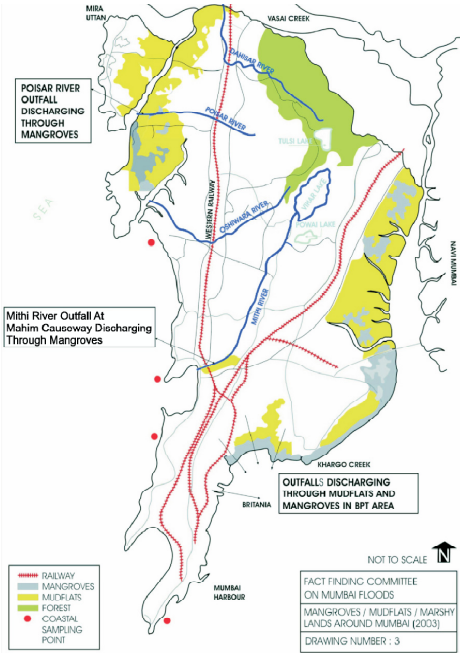
Mumbai continues to develop essentially on reclaimed lands. The city has a low level coastal tract; the average height at some points is just one meter above mean sea level i.e. 1.5 metre below the high tide level. MCGM covers an area of 437.71 sq km. The city has experienced rapid and uncont rolled population growth averaging 20% per decade associated with the influx of migrant workers. The population as per

2011 census is 12.4 million. The average population density is 28,404 persons per sq km and some areas have a large floating population. For example, Ward 'A' has a daytime population density approximately 22 times more than the night time population density. Mumbai is divided into 24 municipal wards for administrative purposes (Figure)

MAJOR CAUSES OF FLOODING IN MUMBAI

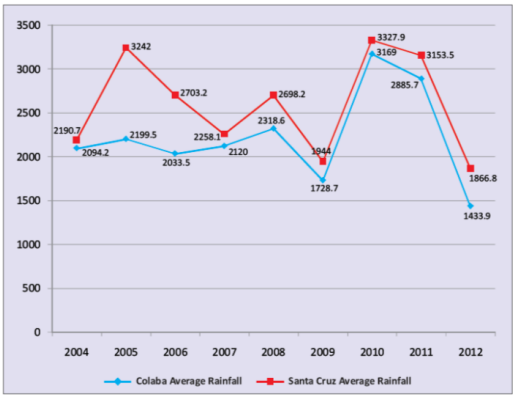
Flooding is a chronic and a recurrent problem in Mumbai during the monsoon season from June to September, particularly when spells of intense rainfall coincide with high tide. The process of urbanization, however, has played a major role in aggravating the problem as it has caused significant alterations to hydrology, morphology, habitat and ecology of the area. Floods are basically meteorological events conditioned by the characteristics of the drainage basins. If rainfall exceeds the retention capacity of the basins, drainage increases both in speed and volume causing floods. Three different types of flooding are evident in Mumbai: localized flooding due to inadequate drainage, flooding due to overflows from rivers and flooding due to combination of high tides and high river flows. Localized flooding occurs mainly due to informal settlements in the drain path, improper drainage network and reduction in drain capacity due to siltation. Land use practices, solid waste management practices and inadequate drainage maintenance in the city have also accentuated the flood hazard. An understanding of the factors which cause floods is vital in view of the need to implement a range of mitigation measures.

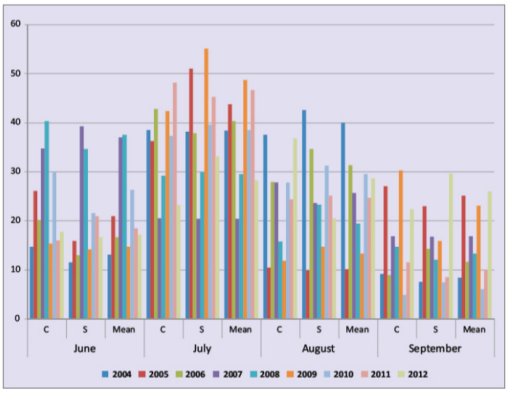
i. Rainfall Pattern



The average annual rainfall in Mumbai during 2004-2012 was 2409 mm. The variation in rainfall from year to year is quite appreciable. During 2004-2012, the annual rainfall varied from a minimum 1728.7 mm at Colaba in 2009 to a maximum 3327. 9 mm at Santa Cruz in 2010. The rainfall is usually higher in the suburbs than in the city. Almost 60 % of the average rain falls in July and August, though figures vary considerably from year to year. In 2007, 46% of the rainfall was received in July and August whereas in 2004 these two months accounted for 78% of the rainfall. July is the rainiest month, usually receiving more than one-third of the annual rainfall. In 2006, 51% of the annual rainfall in the suburbs occurred during this month. The average monthly rainfall for July alone during 2004-2008 was approx. 851 mm — higher than London's average annual rainfall of 611 mm. In addition, 50% of this rainfall is received in just 2-3 spells. The maximum annual rainfall ever recorded was 3,452 mm in 1954. The highest rainfall recorded in a single day was 944 mm at Santa Cruz (1200 mm is the average annual rainfall for India) on July 26, 2005. An analysis of the probability of such extreme events and their expected return period based on data going

back to 1886 for Colaba and 1957 for Santa Cruz reveals that in any year, the probability of 24-hour rainfall exceeding 200 mm is 50% for Santa Cruz and 33% for Colaba.





II. HIGH TIDE

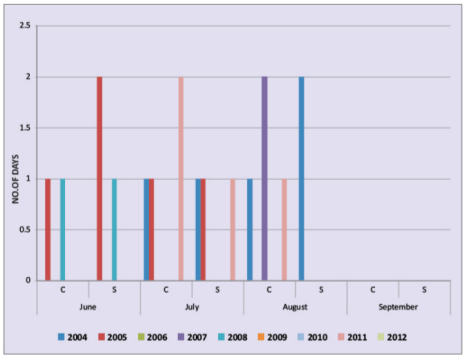
Tides are the rise and fall of sea levels caused by the combined effects of the gravitational forces exerted by the Moon and the Sun and the rotation of the Earth. Some shorelines experience two almost equal high tides and two low tides each day, called a semi-diurnal tide. Some locations experience only one high and one low tide each day, called a diurnal tide. Some locations experience two uneven tides a day, or sometimes one high and one low each day; this is called a mixed tide. The times and amplitude of the tides at a locale are influenced by the alignment of the Sun and Moon, by the pattern of tides in the deep ocean, by the amphidromic systems of the oceans, and by the shape of the coastline and near-shore bathymetry.

While tides are usually the largest source of short-term sea-level fluctuations, sea levels are also subject to forces such as wind and barometric pressure changes, resulting in storm surges, especially in shallow seas and near coasts. Tidal phenomena are not limited to the oceans, but can occur in other systems whenever a gravitational field that varies in time and space is present. For example, the solid part of the Earth is affected by tides, though this is not as easily seen as the water tidal movements.

The problem of flooding becomes acute when heavy rainfall coincides with high tide of more than 4.5 meters. Though high tide exceeding 4.5 meters is common (Table), the probability of heavy rainfall coinciding with high tide more than 4.5 meters is not frequent, as Table would indicate.

Year	June	July	August	September	Total
2004	6	7	7	2	**22**
2005	6	5	6	6	**23**
2006	3	5	5	5	**18**
2007	5	5	6	5	**21**
2008	6	6	6	1	**19**
2009	6	6	5	5	**22**
2010	5	5	7	9	**26**
2011	4	6	8	9	**27**
2012	**6**	**6**	**6**	**3**	**21**

Month	June		July		August		September		Total	
Year	C	S	C	S	C	S	C	S	C	S
2004	0	0	1	1	1	2	0	0	2	3
2005	1	2	1	1	0	0	0	0	2	3
2006	0	0	0	0	0	0	0	0	0	0
2007	0	0	0	0	2	0	0	0	2	0
2008	1	1	0	0	0	0	0	0	1	1
2009	0	0	0	0	0	0	0	0	0	0
2010	0	0	0	0	0	0	0	0	0	0
2011	**0**	**0**	**2**	**1**	**1**	**0**	**0**	**0**	**3**	**1**
2012	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**



iii. Insufficient Sewerage facilities/ unplanned construction/ Deluge of 2005

The weather forecast for the 26th July 2005 received from the I.M.D. at 13.00 hrs. on the same day had predicted "Rather Heavy to Heavy Rain Accompanied by Strong Gusty Winds Likely in City & Suburbs" in the next 24 hours, which was also the prediction for the last few days. Around 11.30 hrs. on the 26th July 2005, moderate rains started which gradually became stronger and around 14.30 hrs. The rainfall intensity became really very high so much so that between 14.30 hrs and 17.30 hrs, the suburban areas of Mumbai witnessed a record rainfall of 380 mm. The statistics below very clearly show how heavy and unprecedented the rainfall pattern was over those fateful 24 hrs. Between 0830 hrs on 26/7/2005 to 0830 hrs on 27/7/2005. During the same period, the rainfall reported by Vihar lake site was 1049 mms.

Rainfall

Date	Time	Rain Fall (m.m)		High Tide	
		Colaba	Santacruz	High	Time
26.07.05	0830 to 1130 hrs	0.0	0.9		
26.07.05	1130 to 1430 hrs	7.0	18.4		
26.07.05	**1430 to 1730 hrs**	**26.5**	**380.0**	**4.48 Meter**	**15.50 hrs**
26.07.05	1730 to 2030 hrs	6.6	267.6		
26.07.05	2030 to 2330 hrs	Nil	101.0		
26.07.05	2330 to 0830 hrs (27.07.05)	33.3	176.3	**3.82 Meter**	**4.42 hrs** (on 27/08/05)
	Total Rainfall in one day	**73.4**	**944.2**		
27.07.05	08:30 To 28/07 08:30 am	31.3	19.0		

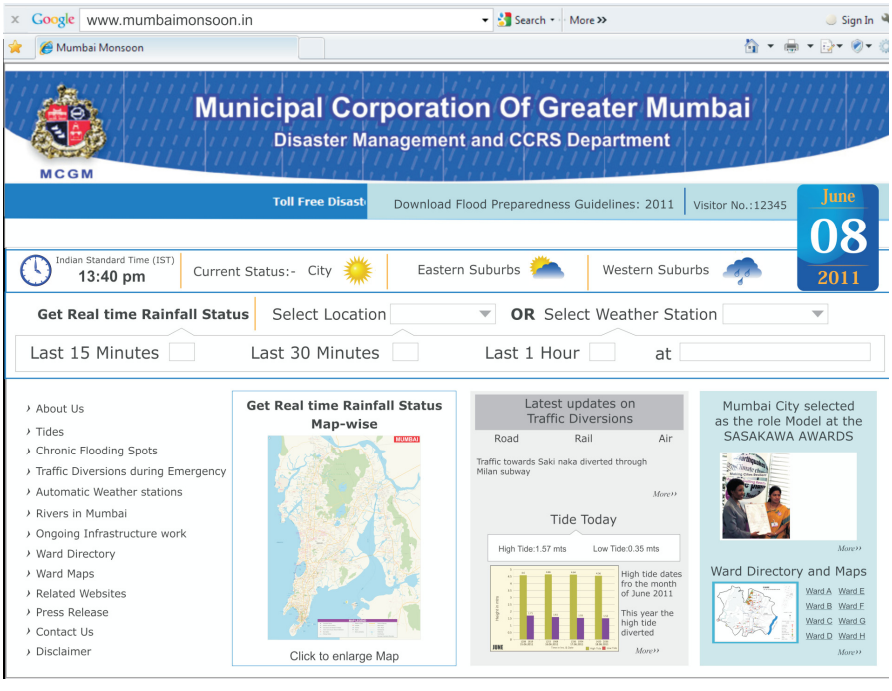
The weather forecast of the I.M.D for the 26th July 2005 had been dully intimated to all the Assistant Commissioners of Wards and the other concerned authorities as well as control rooms by SMS and on telephone, for more vigil and for keeping their machinery on high alert. But the intensity of rains in suburban Mumbai after 1430 hrs on 26/07/05 exceeded all expectations. From 1430 hrs, onwards, complaints started pouring in from several suburban areas. Concerned Assistant Commissioners of wards were intimated immediately, as the flow of flooding complaints increased Additional Municipal Commissioner (WS) in charge of the Disaster Control Room stationed himself in the control room from 1445 hrs. onwards and started monitoring the situation and interacting with various other authorities including W.Rly, C.Rly, BEST, Mumbai Police and the Municipal Commissioner who was busy in a meeting of the Crisis Management Committee at Mantralaya. Municipal Commissioner immediately rushed to the Corporation Control Room at about 1530 hrs. and started personally monitoring the situation by issuing instructions to various authorities.

POST 2005 PREPAREDNESS

Early Warning Systems

MCGM has installed 60 automatic rain gauges at 58 locations, of which currently 54 transmit rainfall data to the Disaster Control Room of MCGM every 15 minutes. Many of the rain gauges have been installed at Fire Brigade stations as they are the first respondents during disasters and are on 24-hour alert. The rain gauges also have a console capable of giving an audible alarm if preset rainfall intensity exceeds 10 mm in 15 mins.

MCGM is augmenting the drainage network for a rainfall intensity of 50 mm/hr which corresponds to a design return period of six months.



This design recommendation was based on the intensity-duration-frequency curves obtained from an analysis of the daily rainfall records since 1843 and hourly records since 1969. Data analysis for peak rainfall intensity from 1999 to 2004 shows that the peak rainfall intensity for the time of concentration of 15 minutes exceeded 72 mm/hr. over 80 % of the times. If rainfall exceeds10 mm in 15 minutes a warning is issued to the concerned wards. If rainfall exceeds 20 mm in a 15-minute period the Emergency Operation Centre issues an alert signal to localities in the catchments concerned. If this trend continues for over an hour i.e. 80mm in an hour, a "risk warning" is issued to the catchments concerned and their main river channels. If the hourly intensity exceeds 80mm in an hour, rescue operations are put in place.

INITIATIVES BY MCGM TO WIDENING AND DEEPENING OF VARIOUS RIVER

The Island City has no natural drainage outlet. The central area is a depression, barely two to three metres above sea level and is flanked by hills. It is thus prone to flood during the monsoon. There are four main streams in the suburbs. They rise in the central hill complex of Salsette Island. The Mithi River drains southwards while the Dahisar, Poisar and Oshiwara Rivers drain westward. The hydrological setting of Mumbai has been influenced by man in a variety of ways. Damming of upper reaches of the rivers, infilling and leveling of the first and second order streams, constriction of the mouth of Mithi River and Mahim Bay and reclamation of riverine wetlands have taken place. Siltation and clogging of drainage arteries have resulted in reduction of river widths and depths, compounding the problem of flooding. Encroachments inside the riverbed as well as on the banks and holding ponds have choked and constricted the water courses and aggravated flooding risks.

The width of the Mithi River which ranged between 16 to 40 meters is being increased to 16-100 meters after the 26 July 2005 flood. The widths of the Dahisar, Oshiwara and Poisar Rivers currently at 30 meters, 10 meters and 20 meters is being increased to 45 meters, 20 meters and 25 meters respectively

Following the July 26, 2005 deluge, Government of Maharashtra appointed Fact Finding Committee under the Chairmanship of Dr Madhav Chitale. MMRDA appointed Central Water and Power Research Station (CWPRS) and Indian Institute of Technology (IIT), Bombay as consultants to examine measures to mitigate flooding situations in future. In consonance with the reports of the consultants, major steps were initiated to enhance the carrying capacity of Mithi by widening and deepening its course. The work was carried out in two phases.

Phase I : Work on this phase commenced on April 8, 2006 and was completed on June 31, 2006. The 11.8 km stretch of the river between Vihar Lake and CST Road, was desilted and widened. About 3800 structures were demolished and an expenditure of Rs 32.88 crore was incurred.

Phase II : This phase of the project started in April 2007. The stretch of the river in MCGM jurisdiction was divided into five sections and work on each section was entrusted to different contractors.

Along with Mithi river, MCGM also initiated the project for the widening of other rivers i.e. Dhaisar, PoisarOshiwara etc.

STORM WATER DRAINAGE (SWD)

The Storm Water Drainage (SWD) system of Mumbai is a complex of simple drains, rivers, creeks, drains and ponds. The southern city area comprising relatively large low-lying areas has long complex networks, while short drains from small areas discharge directly to the sea. In the city the drains are covered by roads whilst there are open drains in the suburbs.

The SWD system of Mumbai comprises a hierarchical network of roadside surface drains (about 2000 km length, mainly in the suburbs), underground drains and laterals (about 525 km length in the Island city area), major and minor channels (200 km and 140 km respectively) roadside drains, dhapa drains and other water entrances (totalling 3,044 km) and 186 outfalls, which discharge all the surface runoff into rivers and the Arabian Sea. The system was designed for a rainfall intensity of 25mm per hour, at low tide, with run-off coefficient of 0.5. Though there are separate systems for disposal of sewage and storm water, there are interconnections through which storm water is discharged into the sewerage network and vice-versa. Storm drains receive about 40% of sewage from the city, either by direct discharge/ overflow from sewers or by drainage across the ground. A number of industries also discharge effluents directly into the drains.

Storm water is drained into the sea/creek/harbour through various outfalls. Of the 176 outfalls, 105 are located in the Island City. 85 of these outfalls drain into the Arabian Sea, 8 into Mahim Creek and 12 into Mahul Creek. There are 28 outfalls in the Eastern Suburbs of which 8 drain into Mahim Creek, 6 into Mahul Creek and 14 into Thane Creek. In the Western Suburbs 29 outfalls drain into the Arabian Sea while 14 drain into the Mithi River which ultimately joins the Mahim Creek. The outfall levels range from -2.0 meters GTS to 3.5meters GTS (22.4 to 28 meters Town Hall datum (THD). During monsoon when heavy rains synchronize with high tide, the outfalls get blocked, causing inundation.

Major deficiencies of the existing system identified were:

1. Due to flat gradients the drains are affected by tides.
2. The system is heavily silted.
3. Major outfalls discharge much below Mean Sea Level.
4. Storm water drains discharge rain water directly by gravity through outfalls as floodgates have been provided in only three of the 45 outfalls. As the outfalls discharge below mean sea level, tidal control is possible only at these three locations.
5. Capacity of drains is adequate only for rainfall of 25 mm/hr
6. Numerous obstructions in the larger drains due to siphons and other utility services.
7. Poor workmanship and lack of attention to repairs when the drains are punctured by utility service providers.
8. Gullies are poorly placed and often not very effective.
9. Poor structural conditions.

Initiatives by MCGM

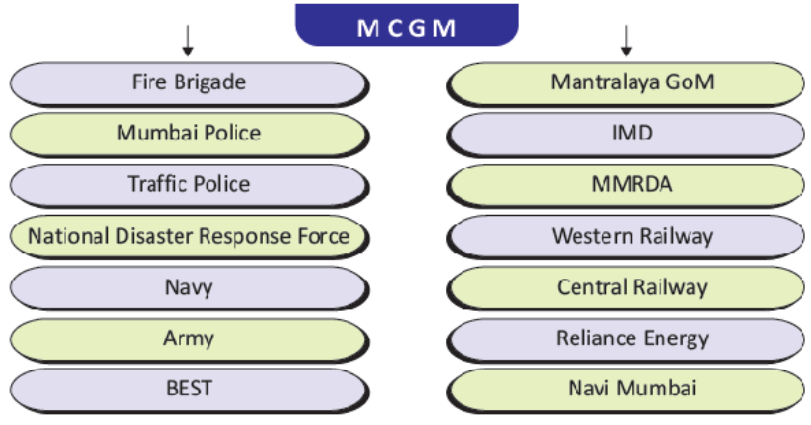
1. The SWD system is now being designed for rainfall of 50 mm/hour with run-off coefficient of one i.e. the system is being augmented four times.
2. Since 2006, the SWD system is being cleaned/desilted to the bottom-most level.
3. Automated rain gauges have been installed at 31 locations.
4. Widening, deepening and training of major nullahs
5. Rehabilitation of old arch/box drains, particularly in the Island City.
6. Installation of storm water pumping stations at Haji Ali, Love Grove, Cleaveland Bunder, Irla (Vile Parle West), Britannia (Reay Road), Guzder Bandh (Santa Cruz West), Mogra nullah (Andheri West) and Mahul Creek. In addition, 230 smaller pumps have been provided at 213 locations on storm water lines to overcome invert problems and flat gradients.
7. Rehabilitation of project-affected persons wherever required.

Every year, MCGM ensures that the city's clogged drains are cleared before the monsoon. The civic body spends over Rs 111 crore for widening and desilting of drains. 2,23,070 cu meters of silt in the City, 4,45,268 cu meters of silt in the Western Suburbs and 3,90,438 cu meters of silt in the Eastern Suburbs have to be removed before the monsoon. This is a complex task as the nullahs fall under the purview of multiple agencies such as MMRDA, Public Works Department, Railways, Mumbai Port Trust and Airport Authority. In addition, most minor nullahs are in the interior, making it difficult to place machinery at these spots. These nullahs are therefore cleaned manually.

GREATER MUMBAI DISASTER MANAGEMENT AUTHORITY

In the case of Mumbai, given its peculiar topography, burgeoning population, its numero uno status as the nation's financial and corporate hub, the Government of Maharashtra established the "Greater Mumbai Disaster Management Authority" for Mumbai City and Mumbai Suburban Districts. The powers and jurisdiction of the "Greater Mumbai Disaster Management Authority"is as per Disaster Management Act, 2005. The Municipal Corporation of Greater Mumbai (MCGM) has hotline connectivity with 14 stakeholders to respond to any disaster.

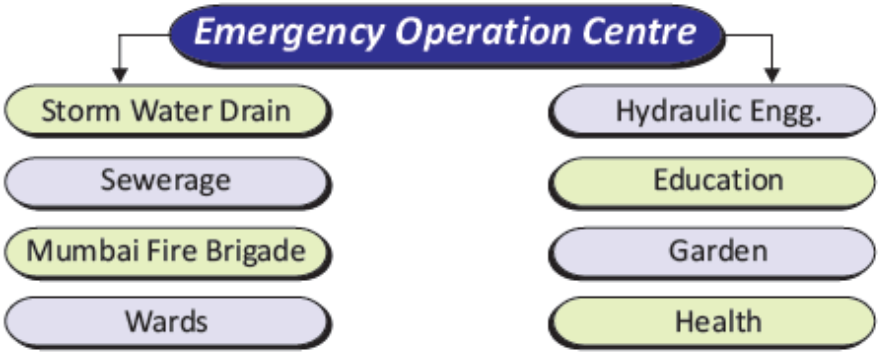
Stakeholders with hotline connectivity to MCGM Emergency Operation Center



Network of External Stakeholders

The Municipal Corporation of Greater Mumbai (MCGM) is divided into 24 administrative wards. A disaster at the ward level is commanded and controlled by the Assistant Commissioner (Ward Officer), who reports to the Deputy Municipal Commissioner, Additional Municipal Commissioner and the Municipal Commissioner. Within MCGM various departments participate in the response and mitigation of the disaster. The key departments are indicated below:

Network of internal stakeholders with Emergency Operation Centre



In the pre-monsoon stage, the Disaster Management Cell of MCGM conducts review meetings with external and internal stakeholders. MCGM's monsoon-preparedness plan is published in newspapers and by way of Information, Education and Communication (IEC) material. Mock drills are conducted at the ward-level in order to be in a state of readiness and to ensure prompt response and deeper coordination with other agencies. Fully equipped ward control rooms are commissioned; information is updated on flooding spots, landslide-prone areas and dilapidated buildings; Standard Operating Procedures are prepared by various agencies and compiled by the Disaster Management Cell. Temporary shelters are identified. Widening, deepening and silt removal from storm water drains, outfalls, rivers etc is undertaken, and dewatering pumps are installed at various flood-prone locations. Refresher training is provided to the search and rescue teams and flood rescue teams. Fire stations and regional command centres, communication devices and other equipment are kept in a state of readiness. A central control room and an epidemic control unit at Kasturba Hospital are commissioned and sufficient quantities of drugs, surgical equipment and insecticides are stocked in the Municipal Health Posts. MCGM, MMRDA and other agencies suspend major on-going infrastructure work prior to the monsoon. Coordination meetings with private and public sector hospitals, secondary and tertiary level medical institutions and organisations, blood banks, ambulance services, police etc. are conducted. A disinfection programme is undertaken wherever required. Alert warnings are issued by MHADA to occupants of dilapidated buildings and residents of landslide-prone areas. Police personnel are trained for flood rescue and a dry run is conducted for managing law and order situation during floods.

Emergency Operations Centre (DMU, MHO)

The Disaster Management Unit (DMU) was set up in 1999 at the Municipal Head Office to tackle disasters in Mumbai. After the July 2005 deluge it was upgraded with modern equipment to handle emergency situations effectively. The Unit works round the clock throughout the year. It serves as a Command & Control agency between the administration and field units. It is a single-point source for all issues related to disaster management. It coordinates with various key stakeholders for quick and effective response during a disaster.

The DMU is equipped with an array of communications systems. These include:

- Land lines
- Hotlines to 17 vital agencies, 3 major & 2 peripheral hospitals & 24 administrative wards. Each agency provides regular updates about the situation in the city.
- Cellular phones
- A Very High Frequency (VHF) wireless communication system by which the unit is connected to 58 installations for effective communication with key stakeholders and important agencies at all times to cater to any emergency.
- Television sets which are tuned to major news channels to keep abreast of the latest news.
- Arrangement for installation of HAM radio on call.
- A '108' toll-free helpline through which Citizens can inform the MCGM about major / minor accidents, fire, earthquakes, bomb blasts etc. in the city.
- 10 dedicated lines on telephone number '1916' for lodging all types of civic complaints related to MCGM.
- The MCGM website: www.mcgm.gov.in where complaints can be lodged.
- Computers, laptops, scanners, fax, etc. have been provided in the control room.

Main functions of DMU:

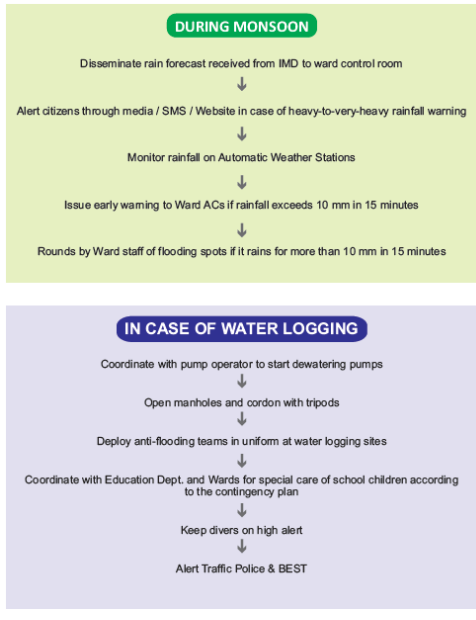
1. Single-point source for all issues related to disaster management.
2. Risk Assessment
3. Prevention & Preparedness
4. Mitigation
5. Response
6. Recovery & Reconstruction
7. Command & control agency between administration & field units

Functions of DMU:

1. Issue alert to all concerned agencies.
2. Provide early warning to citizens whenever possible.
3. Deploy first responders through Fire Brigade, Hospitals and Search and Rescue Teams.
4. Arrange for emergency supplies of water and food.
5. Arrange for transfer of stranded & marooned persons.
6. Arrange for emergency transport for the seriously injured.
7. Coordinate for setting up

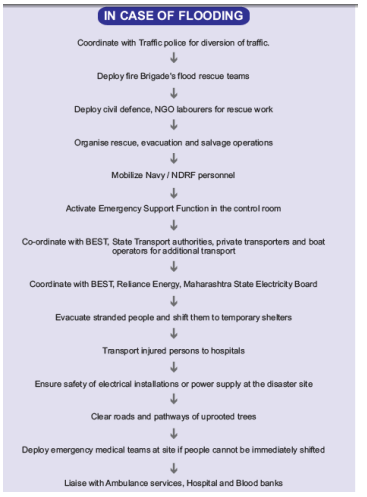
Tasks of DMU for Flood Preparedness:

1. Note High Tide levels and dates and alert the respective departments & citizens.
2. Issue early warning to citizens through SMS.
3. Disseminate Information through print, electronic media and dynamic website etc.
4. Deploy Civil Defence teams in all sensitive wards during monsoon.
5. Prepare and update the Disaster Management Plan.
6. Prepare and update the inventory of resources.



Emergency Support Functions

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 Centres and each will coordinate its activities from the Municipal Corporation of Greater Mumbai Emergency Operations Centre (EOC).



The Disaster Management Unit, MCGM, introduced the ESF concept for the first time during the 2011 monsoon. The Emergency Support Functions were prepared by holding a series of meetings, consultations and discussions between the Lead Agencies, Support Agencies, and the MCGM Disaster Management Unit, supported by EMI emergency management experts . These consultations provided a reality-check from the various agencies engaged in each ESF and ensured that all those involved understand and contribute to the development of the ESFs.

The ESFs identified are as follows from communication, public safety and law & order, fire fighting, search and rescue, transport, public health and sanitation, resource management, information management, mass care, housing and human services, relief supplies, energy (Power, Fuel & Gas), utility services, public works and infrastructure and oil & hazardous materials.

Lesson Learnt

- Mumbai's surge waters are just released in the Arabian Sea through gravity. There are international examples of balancing reservoirs and deep tunnel systems for underground storage of flood waters to be pumped out later when the tides are low. Global best practices can be taken into account for flood management.
- Adopting and conserving rainwater within a catchment area itself, through local storage and recharging alongside filtration systems.
- Unplanned urban growth increases risk to natural hazards like floods. This issue need to be taken on high priority.
- Ecosystem based approach should give high importance because of its effective mitigation role in flooding.
- The most importantly step is to clean the Mithi River. Mithi River being one of the major part of the city's storm water drainage system is full with contaminants, for example, plastics, trash from houses along its banks, effluents from business buildings. Because of this contamination, it isn't difficult to drain out the water
- Climate change impacts need to be considered in the risk assessments and city planning.

Because of climate change the storms are uncertain, frequent and more intense.

- Capacity of the officials need to be strengthen through special trainings considering best global practices.
- Community level trainings need to be scale up with covering more practical aspects.
- Special arrangements need to be done for the special section of the society.
- Additional backup staff need to be engage in advance for any emergency situation including their full contact details.

Centre for Disaster Management

Centre for Disaster Management (CDM), LBSNAA is a capacity building and research centre functions under the umbrella of LBSNAA, Mussoorie. Apart from conducting training programmes the Centre has been involved in formulation of national strategy for adaptation of the global best practices to suit Indian conditions. The Centre is involved in training to officers belonging to IAS and other Group-A civil services at induction as well as at in-service level in various aspects of disaster management, sociological aspects, use of IT, and communication technology, action research projects, documentation of best practices, case studies, teaching materials etc.

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