STUDY ON URBAN FLOODS OF INDIA: A GEOGRAPHICAL ANALYSIS OF URBAN FLOODSIN INDIA

Submitted by –

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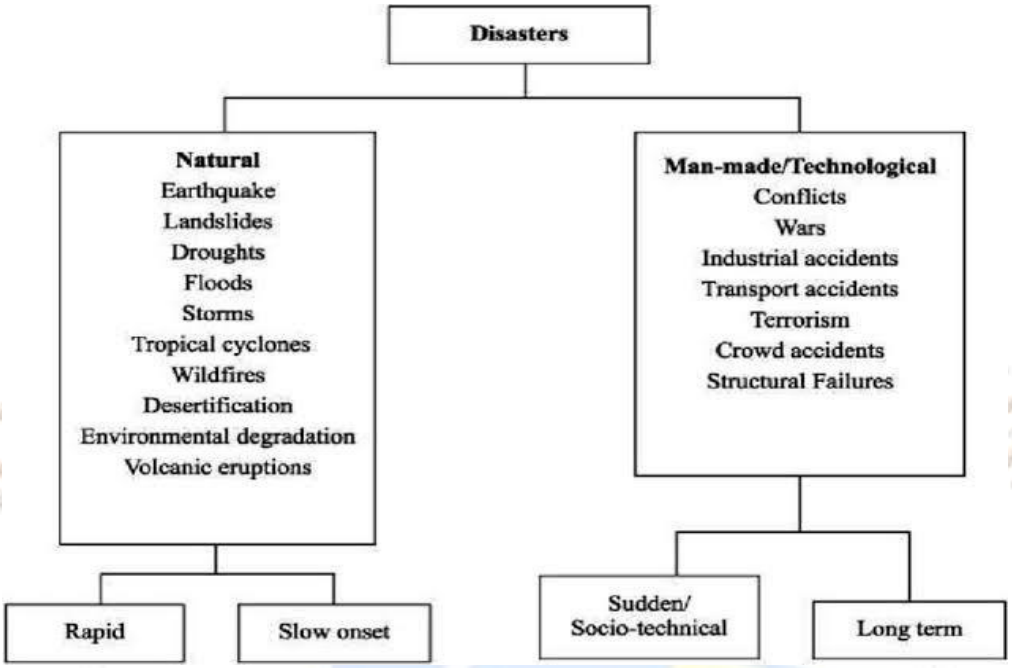
Abstract-

Our cities represent progress and development and there is a need to study the urban floods and the causes of urban floods is important to make our cities flood mitigation measures robust and Flood resilient. Frequent flood devastation is part of monsoons in major cities of our country. We Need to understand and study the reasons behind the mass disaster event like floods that is very hard to manage in the highly populated urban areas and it disrupts livelihoods of millions of Urban dwellers directly or indirectly. In this study, I preferred theoretical way to explain about urban flood in India. There has been an increasing trend of urban flood disasters in India over the past several years whereby major cities in India have been severely affected. The most notable amongst them are Hyderabad in 2000, Ahmedabad in 2001, Delhi in 2002 and 2003, Chennai in 2004, Mumbai in 2005, Surat in 2006, Kolkata
in 2007, Jamshedpur in 2008, Delhi in 2009 and Guwahati, Delhi in 2010, Bangalore in 2015, Mumbai in 2017 and the Hyderabad floods of 2020. In this study on urban floods in major cities of India I found factors like, lack of infrastructure and the Poor governance and inefficient town planning as the important factors leading to massive Floods. Which could have been averted by sound planning and governance as most of the experts have pointed out same views.

DISASTER MANAGEMENT

Disasters

Disaster are serious disruptions to the functioning of a community that exceed its capacity to cope using its own resources. Disasters can be caused by natural, man-made and technological hazards, as well as various factors that influence the exposure and vulnerabilityof a community.



Types of Disasters

routinely divided into natural or human-made

Natural Disasters

A natural disaster is a natural process or phenomenon that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economicdisruption, or environmental damage. Various phenomena like earthquakes, landslides, volcanic eruptions, floods, hurricanes, tornadoes, blizzards, tsunamis, cyclones, wildfires, and pandemics are all natural hazards that kill thousands of people and destroy billions of dollars of habitat and property each year.

Artificial disasters (Man made Disasters)

Human-instigated disasters are the consequence of technological or human hazards. Examples include war, social unrest, stampedes, fires, transport accidents, industrial accidents, conflicts, oil spills, terrorist attacks, nuclear explosions/nuclear radiation.

Other types of induced disasters include the more cosmic scenarios of catastrophic climate change, nuclear war, and bioterrorism

Hazards A Hazard is a potential source of harm or adverse health effect on a person orpersons

Natural hazards are elements of circumstances in the natural environment that have the potential to cause harm to people or property or both.

Natural hazards are naturally occurring physical phenomena. They can be:

- Geophysical: a hazard originating from solid earth (such as earthquakes, landslidesand volcanic activity)
- Hydrological: caused by the occurrence, movement and distribution of water on earth (such as floods and avalanches)
- Climatological: relating to the climate (such as droughts and wildfires)
- Meteorological: relating to weather conditions (such as cyclones and storms)
- Biological: caused by exposure to living organisms and their toxic substances or diseases they may carry (such as disease epidemics and insect/animal plagues)

Man-made and technological hazards are events that are caused by humans and occur in or close to human settlements. They include complex emergencies, conflicts, industrial accidents, transport accidents, environmental degradation and pollution.

DISASTER MANAGEMENT

Disaster management is a process of effectively preparing for and responding to disasters. It involves strategically organizing resources to lessen the harm that disasters cause. It also involves a systematic approach to managing the responsibilities of disaster prevention, preparedness, response, and recovery.

Disaster Management consists of the set of continuous and integrated processes of planning, Organizing, coordinating and implementing measures for prevention, preparedness, mitigation, Response, rehabilitation, reconstruction, capacity building etc. That are undertaken before, during and after disasters with the objective of minimizing damages to lives, livelihood, economy or Environment. It also involves organization and management ofresources and responsibilities.

Pearce (2000) defines disaster management as "a process that assists communities to respond, both pre- and post-event, in such a way as to save lives, to preserve property; and to maintain the Ecological, economic, and political stability of the impacted region."

Why disaster management is required?

Disasters result in casualty, affects individuals and cause significant damage and losses to the Socio-economic processes, services and the environment. These impacts can be minimized or avoided through preventive processes and preparedness and by reducing vulnerabilities. Also, the Post disaster chaos and stress can be minimized through proper planning, coordination between Intervening agencies and institutional strengthening. The reconstruction process also plays an Important role in creating or reducing future risks. Thus, to minimize vulnerabilities and to reduce Exposure of the society to hazardous events, disaster management is required.

The above diagram indicates that disaster management involves three key stages of activities:

1. Pre disaster stage – comprises of activities undertaken to prevent disasters or reduce the Risk of disasters. It involves

- Prevention – Measures aimed at impeding the occurrence of a disaster event and/or preventing such an occurrence having harmful effects on communities in known as Prevention. e. g controlled burning off in bush fire prone area before fire risk season.
- Preparedness – The state of readiness to deal with a threatening disaster situation or Disaster. Preparedness is aimed to reduce casualties, damage to and destruction of Property, damage to subsistence and cash crops, disruption of services, damage to National infrastructure, economic loss, and loss of livelihood through effective response. It tends to be strongly oriented towards action by individual organizations and Community at large. e.g., Mock crisis exercises, public awareness activities, post disaster reviews.

- Mitigation–Processes and initiatives to reduce the impact of hazards. “While it may be possible to prevent some disaster effects, other effects will obviously persist. The concept of mitigation recognizes this and maintains that the application of certain measures (usually in the form of specific programs) can moderate or reduce disastereffects “It can be classified in two categories:

- Structural mitigation – These are structural (built environment) measures that are Recommended to minimize hazard impacts. Structural mitigation measures are specific to Hazard types based on multi hazard mapping. E.g., drains, by pass channels in urban flood Prone areas, building embankments and dykes where appropriate in flood prone areas, Implementation of building codes during construction of buildings, retrofitting, site Planning.

- Non structural mitigation – These include processes which are not related to the built Environment but are more socio politically oriented. It includes:

a) Legal framework – Policies and legislations mandating land-use planning, application of Building codes while construction, implementation of rainwaterharvesting

b) Incentives – Government grants or subsidies to include mitigation measures, incentives by Insurance providers

c) Awareness – generating community understanding of hazards and their potential impacts, Risk areas, at risk population

d) Training and education – disaster awareness through training and education to public Officials, technical students, builders and craftsmen, school children

e) Socio economic and Developmental trajectory – Mitigation measures incorporated in Developmental activities like promotion of Livelihooddiversification, agricultural Mitigation etc.

1. **During disaster**- the main activity is to take prompt response to deal with the emergent Situations and addressing the needs and requirements of victims or affected while the Disaster is occurring or has just occurred. E.g., Running flood camps while a flood is Occurring, Search & Rescue Operations, Rehabilitations etc.

2. **Post Disaster** -activities taken after a disaster has occurred with the objective to recover from the adverse impacts of the emergency situation as early as possible. It involves: Response – The provision of emergency services and public assistance during or Immediately after a disaster in order to save lives, reduce health impacts, ensure public Safety and meet the basic subsistence needs of the people affected (UNISDR 2009). These are measures undertaken following disasters. (Occasionally it is taken immediately Prior to a disaster as well) Aspects of response include:

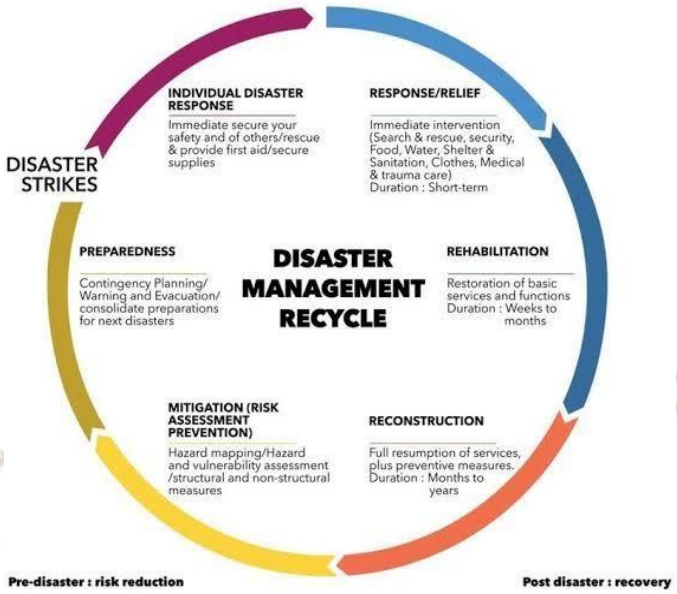
- Evacuation (post impact).
- Search and rescue.
- Restoration of essential life support and community system.
- Effective identification of requirement.

Key consideration in the response phase is the Logistical constraints, coordination and Information flow. Response is undertaken in conjugation with the following activities:

- Assessment – To identify the impacts of disasters, likely response requirements and that might emerge post disasters. It is also required to identify recovery Requirements and provide base of transition from response to recovery phase e.g., Rapid Visual Screening, Post Disaster Impact Assessment, Post Disaster Needs Assessment etc.

- Immediate relief–It involves provision resources (which include but is not limited to Provisioning of materials, services, provisions and human resources) to the affected area to restore normal functioning of the society as early as possible. The type of materials and Services provided is described in other modules. Response phase can take certain weeks to months.

- Rehabilitation & Reconstruction – Resumption of services for the returning to Normalcy while implementing preventive measures in order to minimize the impacts in Case a disaster event recurs. It takes months to years depending on the response Processes.



URBAN FLOOD

Flood is defined as "an overflow of a large body of water over areas not usually inundated". Thus, flooding in urban areas is caused by intense and/or prolonged rainfall, which overwhelms the capacity of the drainage system. Urban flooding is different from normal flooding, both in respect to magnitude and size of the population affected: this is because-

Urbanization increases flood risk by up to 3 times, increased peak flow result in flooding veryquickly.

It affects a large number of people due to the high population density in urban areas. Urban areas are densely populated and people living in vulnerable areas suffer due to flooding, sometimes resulting in loss of life. It is not only the event of flooding but the secondary effect of exposure to infection also has its toll in terms of human suffering, loss of livelihood and, inextreme cases, loss of life.

Urban areas are also centres of economic activities with vital infrastructure which needs to be protected 24x7. In most of the cities, damage to vital infrastructure has a bearing not only for the state and the country but it could even have global implications. Major cities in India have witnessed loss of life and property, disruption in transport and power and incidence of epidemics. Therefore, management of urban flooding has to be accorded top priority.

Increasing trend of urban flooding is a universal phenomenon and poses a great challenge to urban planners the world over. Problems associated with urban floods range from relatively localized incidents to major incidents, resulting in cities being inundated from hours to several days. Therefore, the impact can also be widespread, including temporary relocation of people, damage to civic amenities, deterioration of water quality and risk of epidemics.

Context

Urban Flooding in India

Recently many people have lost Their lives due to incessant rain in Mumbai, Maharashtra, reinforcing the gravity problem of urban flooding in Indian cities.

Earlier, in October 2020, a similar incident happened in Hyderabad, Telangana, resulting in the deaths of more than 50 people. And many similar cases of urban flood recorded in other parts of India, some of the most significant events of urban flooding include Mumbai Floods of 2005, Kolkata in 2007, Delhi in 2009, Bangalore in 2015, chennai in 2018, Pune in 2019 and Hyderabad in 2020

A special feature in India is that we have heavy rainfall during monsoons. There are other weather systems also that bring in a lot of rain. Storm surges can also affect coastal cities/ towns. Sudden release or failure to release water from dams can also have severe impact. In addition, the urban heat island effect has resulted in an increase in rainfall over urban areas. Global climate change is resulting in changed weather patterns and increased episodes of high intensity rainfall events occurring in shorter periods of time. Then the threat of sea-level rise is also looming large, threatening all the coastal cities. Cities/towns located on the coast, on river banks, upstream/ downstream of dams, inland cities and in hilly areas can all be affected.

URBAN FLOOD RISK IN INDIA

There has been an increasing trend of urban flood disasters in India over the past several years whereby major cities in India have been severely affected. The most notable amongst them are Hyderabad in 2000, Ahmedabad in 2001, Delhi in 2002 and 2003, Chennai in 2004,
Mumbai in 2005, Surat in 2006, Kolkata in 2007, Jamshedpur in 2008, Delhi in 2009 and Guwahati and Delhi in 2010 Bangalore in 2015, chennai in 2018, Pune in 2019 and Hyderabad in 2020.

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We studied some of them in details-

Hyderabad Flood 2020

The formation of deep depression over the Bay of Bengal triggered the heavy rainfall over some parts of southern India. Hyderabad was suffering from the rainiest days in history. It was recorded as the rainiest day in 117 years, with 19.2 cm of average rainfall in October, the highest rainfall recorded in October since 1903, and flooding over 20,000 houses. The foremost influenced ranges were Belapur,
L. B. Nagar, parts of Ancient City such as Hafiz Baba Nagar, Al Jubail Colony, Omer Colony, Osman Nagar, Nabeel Colony, Falernum, Camerata, etc.

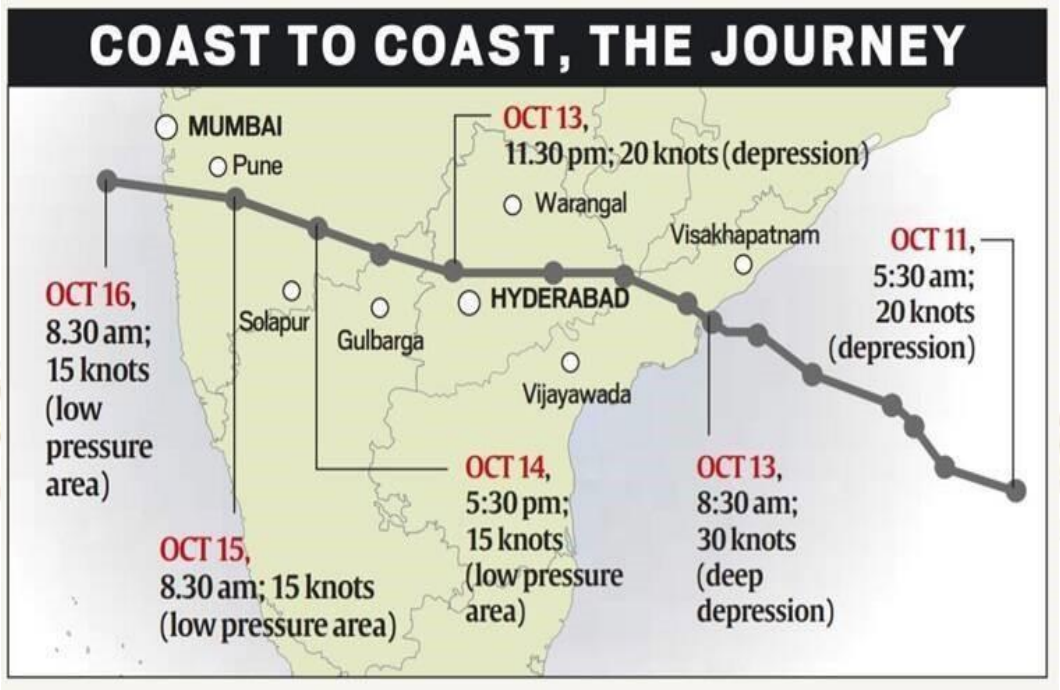
Details:

Hyderabad was recently listed as the wettest place in the country by weather forecaster Sky met after recording 72.5mm of rain. According to the Indian Meteorological Department (IMD), the city witnessed its third wettest day in October of the last 10 years – Hyderabad on 10 October 2013 and 3 October 2017 Length 98.3 mm and 82.6 mm respectively. Precipitation this month: The city has seen356 mm of rain in 18 days, four times normal, according to IMD data.

Causes

Causes of this devastation

This changed into due to a climate that fashioned within side the Bay of Bengal, hit the east coast and moved westward, weakening at the way. Ordinarily, violent winds lose steam upon making their landfall. This unique system, however, clocked a protracted east-west song reducing throughout Andhra Pradesh, Telangana, north-indoors Karnataka and Maharashtra. All those states skilled above- ordinary rain throughout the latest monsoon season. As a result, the soil in those areas has retained sizeable moisture content. In expansion, vertical wind shear — the result of a critical distinction in wind speed between higher and lower barometrical levels — made a difference in the framework to maintain its escalated as a deep depression or a well-marked low-pressure zone indeed on arrival.
Reason for occurring flood in Hyderabad could be a framework of catchments



- The western edge is within the Godavari River basin
- To the east, it's within the Krishna River basin.
- Also, Hyderabad is within the Deccan areas, which includes a chaotic drainage pattern — the water here does not stream in a single course as the incline is in numerous bearings.

Impact

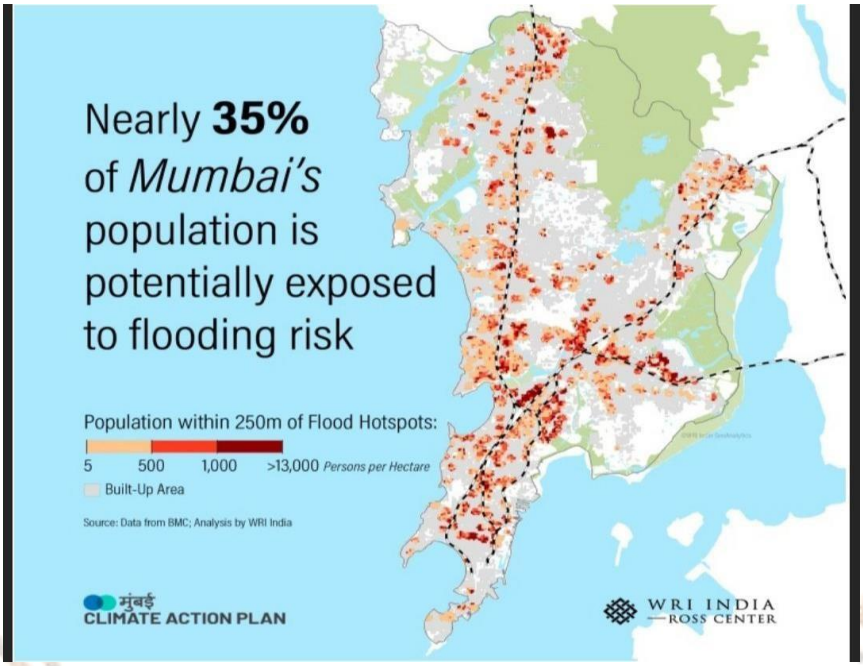
The effect of the deep depression is especially grave within the states of Andhra Pradesh and Telangana. The precipitation resultant water logging and solid winds driven to 30 casualties over Telangana and Andhra Pradesh, of which 17 were in Hyderabad and its rural areas, numerous caused by divider and roof collapse. Numerous individuals were cleared absent by the turbulent floodwaters, and a few misplaced their lives due to electric shock. The IT centre of Hyderabad and the abutting areas bore the brunt of the downpour due to streak surges wreaking ruin within the More prominent Hyderabad zone. Ceaseless precipitation brought about extreme water logging in a few zones, totally inundating low-lying areas, including a clinic within the Majagua zone of Hyderabad. A few power posts and trees were evacuated, and transformers were washed absent, causing widespread disturbance of control supply over the city, with power outages over 24 hours in a few city regions. Activity development was disturbed in numerous parts of the city, with cars seen drifting in floodwaters. The Hussain Sagar Lake has begun to flood into the centre of the city. The conduits of the Himayat Sagar were lifted as the water come to full store levels, and the Musi Waterway streamed full stream, flooding a few territories and streaming over two causeway bridges. Due to BOB 02, Puducherry, Andhra Pradesh, Telangana, Kerala, Maharashtra, and coastal Karnataka experienced overwhelming rain on 12 and 13 October with the capital city, Hyderabad encountering 32 cm of record-breaking heavy rain making streak surges on the city by 13 October. 2 individuals passed on in Vijayawada, and 50 individuals kicked the bucket on distinctive parts of Telangana, counting 19 in Hyderabad. Moreover, 27 individuals passed on in Maharashtra. Extraordinary edit misfortune in north Karnataka, Andhra Pradesh, and Telangana happened due to the framework. The Chief Serve of Telangana assessed ₹5,000 crore (US$681 million) worth of harm. On 18 October, a moment violent wind slaughtered two more individuals in Hyderabad. Over 37,000 families were influenced by the moment surge. Precipitation come to over 110 millimetres (4.3 in) in parts of Hyderabad, with heavier precipitation sums outside of the city. With over 80 individuals having misplaced their lives and approximately 40,000 families being uprooted, post-rain gathering up to 20,000 tons of squander.

Mitigation taken after flood

360 National Disaster Response Force personnel, as well as Indian Armed Forces powers, were sent. The Telangana government asked the Central government to supply alleviation to Hyderabad and encompassing zones. Chief Minister K. Chandrashekhar Rao composed a letter to Prime Minister Narendra Modi looking for prompt discharge of ₹1,350 crores, which ₹600 crores for ranchers and ₹750 crores on relief and recovery work within the More prominent Hyderabad Municipal Corporation range. On 14 October, the Telangana Government pronounced a two-day occasion for all unnecessary laborers due to flooding and encouraged everybody to remain domestic. In the midst of the plausibility of assist flooding, more than 2,100 families were emptied close to Gurami Chervil.
More than 150,000 supper parcels were conveyed to flood-affected zones. Moreover, 60 groups were entrusted with spreading fades in cellars and open ranges to avoid the spread of waterborne and vector-borne infections.

Mumbai flood Mumbai –

originally a group of 7 islands; many reclaimed areas are just 5 mtrs above low tide sea level. Area- 437 Sq.Km; Population-12 Million (2001); Population density - 29000 per sq-km. Mithi river dividing the city, the western & the eastern suburbs can cause floods. Rapid urbanisation - mostly private houses - has blocked the waterways. The 2017 Mumbai flood refers to the flooding that occurred on 29 August 2017, following heavy rain on 29 August 2017 in Mumbai. Transport systems were unavailable through parts of the city as trains and roadways were shut. Power was shut off from various parts of the city to prevent electrocution. The International Federation of Red Cross and Red Crescent Societies (IFRC) called the South Asian floods one of the worst regional humanitarian crises in years. This event can be compared with the 2005 floods in Mumbai, which recorded 944 mm (37.17 inches) of rainfall within 24 hours on 26 July. DETAILS The extreme rainfall on 29 August 2017 was forecasted by the Indian Meteorological Department (IMD), five to six days in advance.However, the government failed to respond quickly, leading to the crisis.[3] Recent research indicates that these floods could be attributed to climate change. Climate change has led to huge fluctuations in the monsoon winds carrying the moisture from the Arabian Sea, resulting in heavy rainfall over central India, lasting for two to three days. Mumbai recorded 468 mm of rainfall in twelve hours, the highest in a day in August since 1997, according to data from the India Meteorological Department. Transport systems came to a virtual standstill with local trains in Mumbai stationary and various flights cancelled with almost all delayed. On Link Road, a building collapsed. The Maharashtra Government declared 30 August 2017 a holiday for all schools and colleges. As of the morning of 30 August 2017, fourteen people were confirmed killed. Flooding caused a building to collapse, killing atleast 21 people. All of this raised the question that why India does suffer from such extreme flooding after all.



ISSUES IN URBAN FLOODING

Among the important cities of India, the average annual rainfall varies from 2932 mm in Goa and 2401 mm in Mumbai on the higher side, to 669 mm in Jaipur on the lower side. The rainfall pattern and temporal duration is almost similar in all these cities, which receive the maximum rainfall from the south-west monsoons. The average rainfall for the month of July in Mumbai is 868 mm and this far exceeds the annual average rainfall of 611 mm in London.

Storm water drainage systems in the past were designed for rainfall intensity of 12 – 20 mm. These capacities have been getting very easily overwhelmed whenever rainfall of higher intensity has been experienced. Further, the systems very often do not work to the designed capacities because of very poor maintenance. Encroachments are also a major problem in many cities and towns. Natural streams and watercourses have formed over thousands of years due to the forces of flowing water in the respective watersheds. Habitations started growing into towns and cities alongside rivers and watercourses. As a result of this, the flow of water has increased in proportion to the urbanization of the watersheds. Ideally, the natural drains should have been widened (similar to road widening for increased traffic) to accommodate the higher flows of storm water. But on the contrary, there have been large scale encroachments on the natural drains and the river flood plains. Consequently, the capacity of the natural drains has decreased, resulting in flooding. Improper disposal of solid waste, including domestic, commercial and industrial waste and dumping of construction debris into the drains also contributes significantly to reducing their capacities. It is imperative to take better operations and maintenance actions.

Causes of Urban Flooding

- Meteorological Factors: Heavy rainfall, cyclonic storms, and thunderstorms.
- Hydrological Factors: Overbank flow channel networks, the occurrence of high tides impeding the drainage in coastal cities.
- Anthropogenic Factors: Unplanned Urbanization: Unplanned Urbanization is the key cause of urban flooding. A major concern is blocking of natural drainage pathways through construction activity and encroachment on catchment areas, riverbeds, and lakebeds. Some of the major hydrological effects of urbanization are:

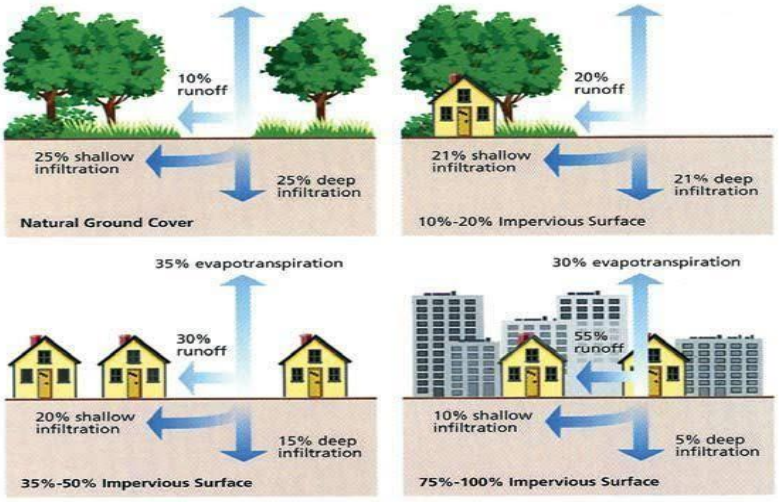
1. Increased water demand, often exceeding the available natural resources;
2. Increased wastewater, polluting rivers and lakes and endangering the ecology-

3. Destruction of lakes is a major issue in India cities. Lakes can store the excess water and regulate the flow of water. However, pollution of natural urban water bodies and converting them for development purposes has increased the risk of floods.
4. Reduced infiltration due to paving of surfaces which decreases ground absorption and increases the speed and amount of surface flow
5. Reduced groundwater recharge, increased use of groundwater, and diminishing baseflow of streams.
6. Increased peak flow

- Storm-water Drainage systems: These were designed for a rainfall intensity of 12-20 mm. Indian urban centres receive much heavier rainfalls and these outdated designs are not relevant now. The old and ill-maintained drainage system is another factor making cities in India vulnerable to flooding.

- Encroachments: Encroachments are also a major problem in many cities and towns. Habitations started growing into towns and cities alongside rivers and watercourses. As a result of this, the flow of water has increased in proportion to the urbanization of the watersheds. The capacity of the natural drains has decreased, resulting in flooding.The number of wetlands has reduced to 123 in 2018 from 644 in 1956.

- Climate Change: Climate change due to various anthropogenic events has led to extreme weather events.



- Poor Solid Waste Management System: Domestic, commercial and industrial waste and dumping of construction debris into the drains also contribute significantly to reducing their capacities. Improper waste management system, clogging of storm- water drains because of silting, accumulation of non-biodegradable wastes and construction debris are major concerns.

- Reducing Seepage: Indian cities are becoming increasingly impervious to water, not just because of increasing built up but also because of the nature of materials used (hard, a non-porous construction material that makes the soil impervious).

- Lax Implementation: Even with provisions of rainwater harvesting, sustainable urban drainage systems, etc, in regulatory mechanisms like the Environmental Impact Assessment (EIA), adoption at user end as well as enforcement agencies remains weak.

- No Community Participation: Flood control measures planned without participation of the affected community are unsustainable as they do not meet the needs of relevantstakeholders

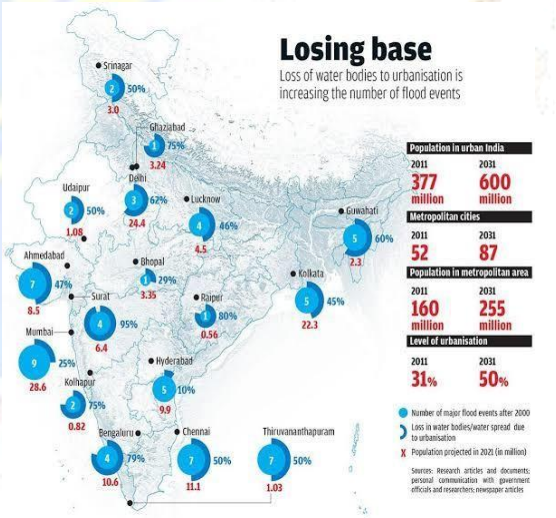
Impacts of Urban Flooding

1. Impact on Human Life:
- Loss of life & physical injury
- Increased stress; psychological trauma
- Contamination of water supplies leading to diseases
- A rise in mosquito-borne disease

2. Impact on Economy:
- Damage to buildings, roads, and other infrastructures
- Disruptions to industrial production
- Disruptions to utility supplies
- Impact on heritage or archaeological site
- Post-disaster rescue and rehabilitation adds to the financial burden of thegovernment

3. Impact on Transport and Communication:
- Increased traffic congestion, disruption in rail services
- Disruption in communication- impact on the telephone lines, internet cables

4. Impact on the environment:
- Loss of tree cover, loss of habitat
- Impact on animals in the zoo, the prevalence of stray animals.



Measures to prevent Urban Flooding

Need for Climate Resilient Infrastructure

Given the unprecedented rate of climate change-related severe disaster in recent times, urban areas must have a climate-resilient infrastructure.

According to UN projections, by 2050 more than 68% of the world's population could be concentrated in urban areas.

Additionally, daily life in urban areas is highly dependent on certain critical services and products provided by critical infrastructures (Cis).

Therefore, it is especially relevant to understand how Climate Change affects urban Cis in order to develop mechanisms to improve their capacity to handle crises derived from CC.

In this context, resilience-based strategies provide a holistic approach, considering both predictable and unpredictable threats.

Innovative approaches like Sponge Cities- wetland restoration, flushing systems using collected rooftop water, bioswales, and public spaces as flexible water retention facilities canbe applied to Indian urban areas.

Early Warning Systems and Communication

Dissemination of flood warnings must be carried out, using a wide range of latesttechnologies.

This would help in giving real-time data where traditional systems fail.

Tools such as predictive precipitation modelling can help do that and are also able to link it with the adaptive capacity of urban land use.

Design and Management of Urban Drainage System

Watershed management and emergency drainage plan should be clearly enunciated in policyand law.

Proper management of the drainage system is necessary to ensure that the water does not get stored in one place.

Solid waste increases hydraulic roughness, causes blockage and generally reduces flowcapacity.

These drains need to be cleaned on a regular basis to permit the free flow of water. Vulnerability analyses and risk assessments should form part and parcel of city master plans.

Rainwater Harvesting

Due to urbanization, groundwater recharge has decreased and the peak runoff from rainfall and consequent flooding has increased.

It will serve the twin purposes of lowering the peak runoff and raising the groundwater table. Many municipal corporations in India have already made rainwater harvesting compulsory.

Conservation of Water Bodies

Urban water bodies like lakes, tanks, and ponds also play a very important role in the management of urban flooding by reducing the storm water run-off by capturing it.

Role of Science and Technology

The management of urban flooding has to be treated holistically in a multi-disciplinarymanner.

Science and technology can play a significant role in improved monitoring, modelling/ forecasting, and decision-support systems.

One method for improving the preparedness for urban flooding is by setting up a vulnerability-based geospatial framework to generate and analyse different scenarios.

It helps in identifying and planning for the most effective/ appropriate actions in a dynamic way to incorporate day-to-day changes that take place in urban areas, having the potential to alter the prevailing vulnerability profile.

Developing Sponge Cities

The idea of a sponge city is to make cities more permeable so as to hold and use the waterwhich falls upon it.

Sponge cities absorb the rain water, which is then naturally filtered by the soil and allowed to reach urban aquifers.

This allows for the extraction of water from the ground through urban or pre-urban wells. This water can be treated easily and used for city water supply.

Other recommendations:

- Use of Doppler Weather Radars to be expanded to cover all urban areas in thecountry.
- Coordination mechanism to be established among all agencies for deriving maximum benefit from the efforts of each individual organization.
- A dedicated high bandwidth communication channel is to be built, for ensuring smooth underlying sensor web flow of all available information and products.
- State-of-the-art automatic water level recorders must be installed throughout the drainage network of the watershed, which may sometimes extend beyond the administrative boundary of the ULB.
- Technical Umbrella for urban Flood Forecasting and Warning to be established at the national and state level.
- An inventory of the existing storm water drainage system to be prepared. The inventory will be both watershed-based and ward-based.
- Catchment to be the basis for planning and designing the storm water drainagesystems in all ULBs.
- Contour mapping of urban areas to be prepared at 0.2 to 0.5 m contour interval for detailed delineation of the watershed/ catchment for planning drainage systems.
- All future road and rail bridges in cities crossing drain to be designed such that they do not block the flows resulting in backwater effect.
- Inlets to be provided on the roads to drain water to the roadside drains and these have to be designed based on current national and international practices.
- Every building in an urban area must have rainwater harvesting as an integral component of the building utility.
- Concept of Rain Gardens to be incorporated in planning for public parks and on-site storm water management for larger colonies and sites that are to be developed.
- Low-lying areas in cities have to be reserved for parks and other low-impact humanactivities.
- Encroachments on the drain should attract penal action.
- Flood hazard assessment has to ascertain the level of acceptable risk of flooding on the basis of projected future scenarios of rainfall intensities and duration and land-usechanges.
- Flood damage has to be according to the physical characteristics of the area such as land use, topography, drainage area, outfall system and the capacity of the existing storm water drainage system.

Way Forward

- Better forecasting of rainfall events Example: The Municipal Corporation of Greater Mumbai has installed 60 automatic weather stations for recording the rainfall every 15 minutes. This information is disseminated through the GMDMA (Greater Mumbai Disaster Management Authority) web portal in real-time during the monsoon.
- Installation of a proper, functional drainage system. Maintenance of existing drainage channels, providing an alternative drainage path.
- Develop ‘sponge’ cities in line with cities in China.
  Launched in 2015, the Sponge City Initiative invests in projects that aim to soak up floodwater. The projects are being built in 30 cities, including Shanghai, Wuhan, and Xiamen. By 2020, China hopes that 80% of its urban areas will absorb and re-use at least 70% of rainwater.
- Proper solid waste management system– control of solid waste entering the drainagesystems
- Restrict encroachments in natural drainage areas

- Each city should have its Flood mitigation plans strongly embedded within the masterplan of the city.

Conclusion –

According to my analysis urban floods are disruptions leading to devastation of institutions in the long run due to overburden and negligence to mitigate disasters have consequences and recent floods are example of it. Disaster in India have a short-term solution rendered to the affected people, but there is little to none action towards long term permanent solutions, many reasons can be pointed when there is a disaster but lack of planning and focus on Behavioral change, urban floods occur again and again. Lessons learnt from the previous urban Floods are not being considered in decisions sufficiently contributing to recurrent Floods in urban areas.

Experts have pointed out that **poor governance** and Red-tapism in implementation of firm rules and guidelines leading to policy paralysis towards urban lakes and rivers, land use are causing These inundation events that are taking place in a larger scale, so these events are called urban Floods.

Behavioral change towards the natural resources in the urban areas should be taught in the schools and the people should be educated and trained to protect natural resources, human Existence is a long battle with nature and urban environments are human nurtured systems that Can be modified in to sustainable-climate resilient habitations. Use of technologies like GIS and Remote Sensing, and sound knowledge of hydrology in urban Areas would help in planning the prevention and response to urban flooding in Indian cities. GIS And RS can particularly show the low-lying areas which are prone to flooding and unsafe for Human habitation. Knowledge on hydrology in urban areas can help in planning drainage system to prevent accumulation of water resulting in Flood. More expert interviews can be conducted in the future studies to understand the issue of urban flooding in india, and possible solutions.

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