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Understanding urbanization and urban flooding scenario in India

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ABSTRACT

With the ever-growing development in our country and due to its organic growth throughout the years urban flooding has become a matter of serious problem in many of the cities of India. Urban flooding is the flooding of various zones and pockets of an urban fringe due to overflow of drainage lines, waterlogging scenarios, etc. which creates a situation where the water through precipitation is not able to seep down to the earth but rather remain on the surface creating a situation of a health crisis for all the residents of the society. Urban flooding is defined as not only increase in the water table at the river basin resulting in the submergence of the land area but also waterlogging scenarios due to undulating topography and geography of the place, lack of softscapes in the urban fringe, improper land use, exploitation of the drainage patterns, etc. Urban flooding not only affects the health conditions of the residents but also hinders the basic urban functions like transportation, electric supply, drainage supply, etc. creating an uninhabitable urban environment. Flooding has resulted in the outbreak of many epidemics due to an increase in diseases and also creates non-availability of important medical services resulting in loss of lives alongside a loss of property. In India, improper disposal of solid waste also is a major cause of waterlogging. People here tend to throw their waste from their residences and working places in the stormwater drainage lines resulting in clogging and waterlogging which in turn results in the birth of many vector-borne diseases. After a devastating flood in the year, the 1953 government of India came to know about the seriousness of the problem and started created policies and planning measures to cope out with flooding scenarios in urban cities. In recent years, heavy precipitation in our country and poor drainage services has led to extreme flooding scenarios around the country. The stormwater drainage systems in our country were designed earlier but the overall increased rainfall intensity has overwhelmed the structure which often also does not work due to the poor maintenance of the drains resulting in blockages and clogging of water. Natural streams and watercourses have formed over thousands of years due to the forces of flowing water in the respective watersheds. The drainage lines in an urban fringe should have been widened as according to the increasing strain on the system and according to the widening of the roads but on the contrary. The volume of the stormwater drainage system has been greatly reduced due to the encroachments done by the people resulting in a flood situation whenever rainfall occurs. In the absence of a proper solid waste disposal system, people tend to throw away their garbage in the stormwater drain which further clogs the drains and decreases its capacity even further. Whenever the question of drainage appears in our country, we cite the examples of the well planned and organized gravity-based drainage system in the cities of the Indus valley civilization like Mohan-jo-Daro (now Pakistan) and Lothal (Gujrat). Such examples of organized drainage systems are not to be seen anywhere in our country in modern times. Few of the notable examples of flooding of the urban areas in India are the 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, Srinagar in 2014, Guwahati in 2014, Chennai in 2015, Hyderabad in 2016, Ahmedabad in 2017, Kerala in 2018. So the flooding scenario in our country occurs in a part or another every year due to excessive rainfall, human encroachment in the softscapes, and inefficient drainage lines with overwhelming pressure. The unorganized and improper land use planning in our cities has also created zones that are geologically and topographically in the high vulnerability of flooding which poses a large number of population and property at risk. Generally, socially and economically backward class of people is forced to live here which faces the flooding scenario in their localities in every monsoon season. Unorganized developments of ever-growing habitations near the water sources like rivers and watercourses have disturbed the natural water streams and their courses resulting in surface runoffs and waterlogging.

Keywords: Urban flooding, Surface runoff, Waterlogging, Topography, Risk management

1. INTRODUCTION

With the ever-growing development in our country and due to its organic growth throughout the years urban flooding has become a matter of serious problem in many of the cities of India. Urban flooding is the flooding of various zones and pockets of an urban fringe due to over flow of drainage lines, water logging scenarios etc. which creates a situation where the water through precipitation is not able to seep down to the earth but rather remain on the surface creating a situation of health crisis for all the residents of the society. Urban flooding is defined as not only increase in the water table at the river basin resulting in the submergence of the land area but also waterlogging scenarios due to undulating topography and geography of the place, lack of softscapes in the urban fringe, improper land use, exploitation of the drainage patterns etc. Urban flooding not only effects the health conditions of the residents but also hinders with the basic urban functions like transportation, electric supply, drainage supply etc. creating a uninhabitable urban environment. Flooding has resulted into outbreak of many epidemics in due to increase in diseases and also creates non availability of important medical services resulting in loss of lives alongside loss of property. In India, improper disposal of solid waste also is a major cause of water logging. People here tend to throw their waste from their residences and working places in the storm water drainage lines resulting in clogging and water logging which in turn results in birth of many vector borne diseases. After a devastating flood in the year 1953 government of India came to know about the seriousness of the problem and started created policies and planning measures to cope out with flooding scenarios in urban cities. In recent years, heavy precipitation in our country and poor drainage services has led to extreme flooding scenarios around the country. Storm water drainage system in our country were designed earlier but the overall increased rainfall intensity has overwhelmed the structure which is often also do not work due to the poor maintenance of the drains resulting in blockages and clogging of water. Natural streams and watercourses have formed over thousands of years due to the forces of flowing water in the respective watersheds. The drainage lines in an urban fringe should have been widened as according to the increasing strain on the system and according to the widening of the roads but on the contrary. The volume of the storm water drainage system has been greatly reduced due to the encroachments done by the people resulting in a flood situation whenever rainfall occurs. In the absence of proper solid waste disposal system, people tend to throw away their garbage in the storm water drain which further clogs the drains and decrease its capacity even further.

Whenever the question of drainage appears in our country, we cite the examples of the well planned and organized gravity-based drainage system in the cities of the Indus valley civilization like Mohan-jo-daro (now Pakistan) and Lothal (Gujrat). Such examples of organized drainage systems are not to be seen anywhere in our country in the modern times.

Few of the notable examples of flooding of the urban areas in India are the 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, Srinagar in 2014, Guwahati in 2014, Chennai in 2015, Hyderabad in 2016, Ahmedabad in 2017, Kerala in 2018,. So the flooding scenario in our country occurs in a part or another every year due to excessive rainfall, human encroachment in the softscapes and inefficient drainage lines with overwhelming pressure.

The unorganized and improper land use planning in our cities have also created zones which are geologically and topographically in high vulnerability of flooding which poses large number of population and property at risk. Generally, socially and economically backward class of people are forced to live here which face the flooding scenario in their localities in every monsoon season. Unorganized developments of ever-growing habitations near the water sources like rivers and watercourses have disturbed the natural water streams and their courses resulting surface run offs and water logging.

2. CAUSES OF URBAN FLOODING

Urban flooding are generally a result of natural events and anthropogenic human activities. In Indian urban area, we are facing the issue of urban flooding constantly every year due to hydrological factors and human factors with latter being more predominant. In India, illegal construction, encroachment of the sewer drain, dumping of rubbish in storm water lines, illegal connections in the drainage lines, further increase the problem. As organic and unplanned development cover the pervious grounds, the water through precipitation is not able to seep in ground and creates surface run off and water logging scenarios due to the already depleted condition and capacity of the drainage lines.

Urbanization pose major hydrological effects in the modern timeframe. Some of the effects of urbanization area:

- Increase in the demand of water resources.
- Increase in the waste water generation which lead to pollution and burden in natural water resources.
- Increase in the peak flow.
- Reduce in the ground water recharge due to encroachments and over development.
- Reduces amount of infiltration.

Some of the issues which lead to urban flooding are listed below:

- Increase in the population which force the people to settle down in geographically risky zones vulnerable to flooding.
- Increased impervious surfaces led to surface run offs as rainwater is not able to seep down in the earth and drainage system overflow with overwhelming pressure.
- Climate change leading to excessive precipitation. NASA studies indicates that urban heat island effect also results in increase in increase in precipitation in the urban zones.
- Unplanned development with improper land use planning leading to development of vulnerable zones in a city.
- Lack of management and disaster control policies lead to extensive flooding scenarios which in turn lead to massive damage and property loss.

Factors leading to urban flooding are:

- Meteorological factors:

Meteorological factors that might lead to flooding situation in any urban zones can be precipitation, storms, temperature, snowmelt etc.
- Hydrological factors:

Hydrological factors that might lead to flooding situation can be natural surface permeability, drainage channel cross section, shape and roughness, presence of impervious surface, storm water drainage channel connectivity, linkage and network, presence of surface run-off overflow system etc.
- Human Factors:

Human factors that might lead to flooding situation can be Land use changes leading to lack of green and blue cover, ill maintained municipal infrastructure, construction on the flood plain area prone to submergence in case of excess rainfall, climate change, frequency and magnitude of precipitation and floods, micro and macro climate, improper solid waste disposal in storm water drain lines etc.

3. CASES OF URBAN FLOODING IN INDIA

3.1 Chennai Floods, 2015

The city has a decadal growth rate of 7.6 percentage and is one of the fastest growing metropolitan cities of the country. The total population as per 2011 census is 7.08 million and the geographical area is 1189 square kilometres. Chennai experienced floods in the year 2004 and 2015 as it lies in the basin of Adyar and Coolum rivers. Massive loss of properties and disruption in the social services were seen due to these events.

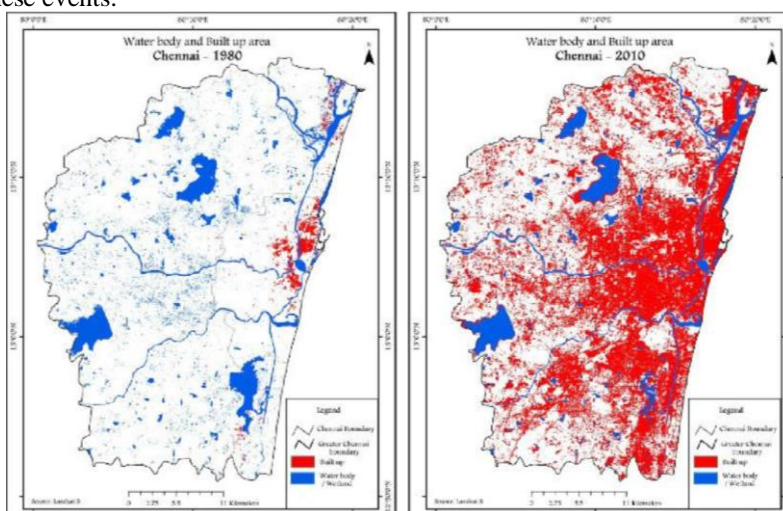


Fig. 1: Growth of Chennai City

The Chennai floods have taught us the various flaws that we have in our urban planning policies. The floods in the year 2015 cost highly in terms of overall expenses (nearly 3 billion dollars) in loss of livelihoods and damage to the property.

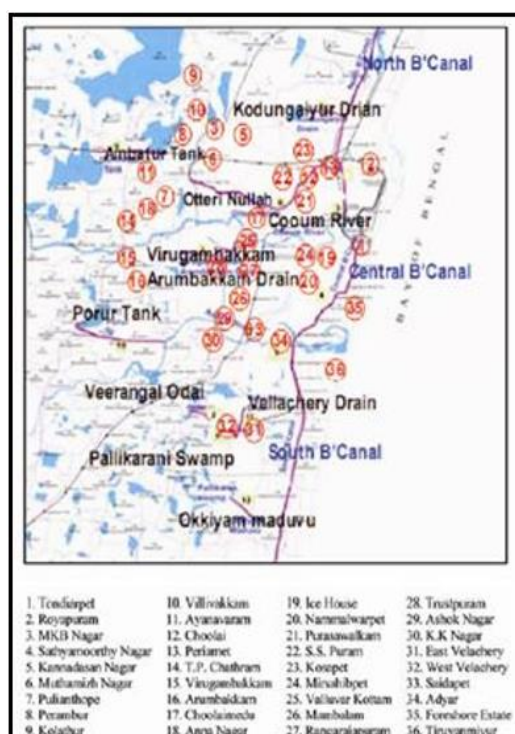


Fig. 2: Chennai 2015 flood affected area

In southern India, the geography of the area illustrates that the ponds and streamline rivers emerging from the Western Ghats flows towards the eastern coast near Tamil Nadu which highly vulnerable to the storms and tsunamis. Originally the area near Chennai had various sizes of ponds which were connected with each other and worked as an overflow system. The overflow water traditionally was naturally divided into fields and the smaller ponds which helped in percolation of the excess water and in turn supported the rice farming and fish farming.

Due to industrialization these porous surfaces and ponds were covered with built form mainly industrial and residential structures resulting in highly decreased impervious surface in the city. Climate change and excessive rainfall added up to the problem and the overflow from the precipitation founded its way to the city resulting in the floods of the year 2015. Although the disaster of 2015 was termed natural due to excessive rainfall, poor land use planning and irresponsible development of the drainage system multi-folded the problem resulting in huge loss to the area.

The second face of the Chennai floods is also man -made issue. The Adyar river at the south side of the river has a very wide flood plain which generally submerges traditionally during the monsoon season due to its low-lying terrain. These low-lying terrains has been built with multi corporate structures and slums resulting in extreme vulnerable zones. The area of planned development alongside the river basin acted as water outlet but is now developed via government sponsored planning as government owned all the area of the region. In the past 30 years extreme development in this area created lack of impervious spaces leading to a very vulnerable zone for water logging and flood situation. Poor land use planning and our inability to enforce environment laws resulted in the calamity of the floods in the Chennai city in 2015 which puts millions of people in danger of their lives and livelihood.

Unable to create a disaster warning system and faulty water shed management plan due to greed of occupying more and more land resource resulted in the massive flood situation which is likely to reoccur if high intensity rainfall occurs in the area. Unorganized urban planning policies, improper garbage disposal, excessive destruction of mangroves is constituted as the contributing factors for flood risk in Chennai.

Excessive urbanization in the city of Chennai has led to constant accumulation of storm water on the roads, surfaces and even railway tracks in the monsoon season which highly effects the transportation system of the city resulting in loss of time and economy. Entire system gets disturbed and main services and amenities in the city is hindered resulting in substantial increase in price of essential commodities. After the floods the government bear heavy losses as they have to rebuild the infrastructure, buildings and transportation networks. The aftermath of these events leads to disruption in essential services, break of epidemic like situation in low lying zones, resistance of people towards displacement from the calamity hit zone, stagnation of water, water pollution, accidents, challenge in providing medical assistance etc.

3.2 Bangalore

Bangalore is known as the Silicon Valley of India due to the presence of all the IT companies and is the 5th largest metropolitan city of the country with 8.52 million population and 741 square kilometre area. Precipitation, intensity and duration of precipitation are the key elements which decide whether an urban fridge can come under flooding scenario or not. Sometimes even a small 8 to 10 cm rainfall within a small-time frame can create flooding situation as seen in the Bangalore city. In the city, even a rainfall of 30 mm within a time span of 30 minutes can create a flooding situation especially in the low-lying zones. The highest rainfall recorded in a single day has been in the month of may in the year 2002 which was 10 cm approximately. With the rapid urbanization and improper land use less and less are is present for surface water to percolate. This leads to land pollution and urban flooding scenarios.

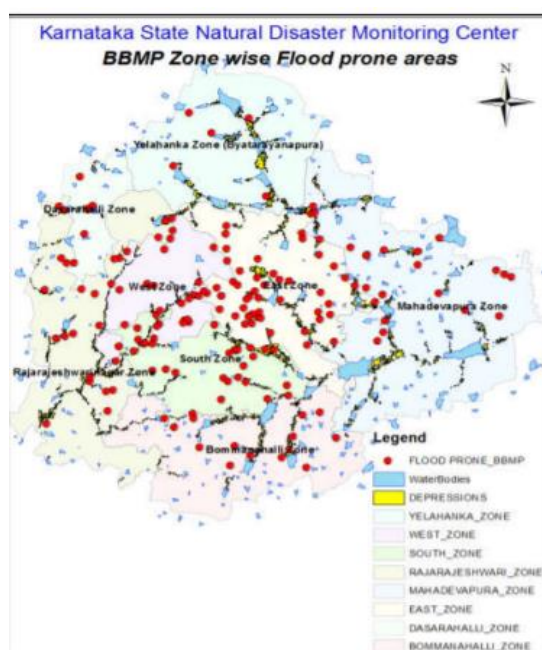


Fig. 3: Frequently Flood Prone Locations

Urbanization is a major cause of flooding in the city and causes abomination of lakes and ponds, widening of natural water streams and bank erosion, changes in the natural direction of water channels, increase in the flood plain elevation, increase in peak magnitude of flooding level in the low lying area, and increased frequency of events throughout the year.

According to a study, 7% of the total households in the city has reported instances of flooding in their area. 10 % of the total households belonging to the social and economic backward classes reported that they have faced flooding in the past decade or so. Of these households, 72% reported that they faced flooding situation in the last year, 15% reported flooding in 1999, 7% from 1995-1998, while 2% reported before the year 1995. Majority of these people belong to residents of the slum forced to reside in the low lying area of the city which pose high vulnerability to the residents of these place. Many of the people effected in the year 1995 and 1998 belonged to daily wage labourers and retailers. The coping ability of such class of people is quite less as compared to the other lass resulting in high economic loss resulting in wider gap between the communities.

4. PREVENTION AND MEASURE

Following are preventive measures we need to take to safeguard ourselves from the urban flooding scenario.

➤ **Proper Land use planning:**

Proper land use planning is very important as it defines the area for construction and open areas in any city. With the incorporation of proper land use planning it should be ensured that proper spaces are provided in any urban fringe ensuring the free flow of natural water streams and enough open space should be provided with pervious strata for the excess water to percolate.

➤ **Green roofs and roof gardens, vertical greenification**

Green roofs and roof gardens help in absorbing the excess precipitation and in turn minimizes the effect of over precipitation in urban areas. In absence of large open spaces, construction of green roofs in the residential and commercial zones of a city can highly minimize the effects of flooding.

➤ **Creation of flood plains and overflow areas.**

To cope with the problem of urban flooding flood plains need to be widened and unhindered from concretization. This needs to be kept in mind while devising the master plan of the city. These flood plains help in retaining and absorbing storm water.

➤ **Separate rain water from sewer system.**

This has dual functionality. First of all, it helps in decreasing the road in the existing sewer system by segregating the two which helps in avoiding the overflow scenario. Also, it helps in decreasing the load in filtration plants of the city.

➤ **Proper solid waste collection and management system**

A city needs to develop a proper solid waste collection system such that the residents are not bound to throw away the garbage in the drains clogging the drains which in turn create water logging scenarios and creates health problems. A proper collection and segregation system can help in reducing the problem of pollution while also dealing with the problem of urban floods.

➤ **Creation of permeable pavements, sidewalks and gardens**

Using various new technologies and materials, government should ensure creation of permeable surfaces, alongside the roads and pavements which will ensure the percolation of water inside the highly densified urban zones. If in case the water enters these areas, it can be drained out using these permeable members and minimize the effect of flooding while also helping the transportation and essential services inside the city.

➤ **Plan for the worst-case scenario**

Proper disaster management plans should be ready for the city keeping in mind the geography and topography of the place. Proper zones and areas should be identified based on the vulnerability and urban risks a special attention should be given to the highly vulnerable zones; Zonal development plan can also be undertaken to regulate the scenario in the vulnerable areas. Plus, proper fund allocation should be given in such area for capacity building of the people in those areas to deal with the problem.

➤ **Improve flood warning systems**

Development of tools to warn about the upcoming flood event is the need of the hour. These tools be incorporated which with the help of climate prediction can give the authorities enough time to prepare for the upcoming event. These tools also help in informing the public such that preparedness for such events can be ensured.

➤ **Ensure public participation and action**

Public participation needs to be ensured for dealing with such events. People needs to be educated about its effects, ways to deal and community bonding should be promoted by the authorities to ensure that in case of such events the damage can be minimized. Proper community drive must be done and public views and opinions must be taken to deal with the problem. Also, problems of the people need to be heard and should be incorporated in the development plan.

5. CONCLUSION

A cohesive planning approach integrating the informal sectors with proper land use planning of the residential zones away from the flooding basin and availability of pervious land area is the solution to the problem of urban flooding in our country. The governmental bodies need to operate keeping in mind the environmental laws of the state and also integrating proper land use planning in the development plans of the city which will ensure a smooth and progressive development of the area. Greed in terms of over utilization of the land resource has resulted in creation of zones where water stagnates and stands in case of rainfall as the natural water streams have been severely damaged.

Flood avoidance, flood tolerance (capacity building) and flood resilience should be incorporated in the development plan to train the authorities and the people in case of any flooding situation such that there can be minimum loss due to urban flooding. Few of the technical measures which are already discussed earlier includes:

- Organised and proper connectivity and volume of drainage network
- Regular maintenance of the sewage infrastructure including storm water drainage system
- Use of traditional and porous construction materials specially in pavements and wherever water percolation is possible.
- Educating the general public on solid waste segregation and disposal.
- Flooding assessment prior to the event and policy making based on it.
- Charging heavily on encroachments and illegal constructions.
- Encouraging public participation in case of events.
- Development of funds for the reoccurring floods in the low-lying regions.