INDIA – URBAN CLIMATE CHANGE FACT SHEETS

# Urban Flooding



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## Introduction

Urbanisation is posing numerous challenges for city administrators, planners and policy makers, of which urban floods are increasingly becoming an important challenge. Urban floods are a result of inadequate or poor maintenance of storm water drains, improper planning, encroachment on drains and water bodies, occupation of low lying areas, modification of catchments, and climate change. Urban flooding is typically characterised by[1,2]:

1. Increase in flood peaks by 2-8 times;
2. Increase in flood volumes by up to 6 times;
3. Decrease in time required to reach flood peak;
4. Excessive economic losses (in the form of damage to property and loss of productivity)

With climate change, urban floods are expected to be more frequent (particularly in tropical regions), there is likely to be longer flooding season and newer areas would experience flooding. Urban flooding has been observed worldwide and it is becoming a regular event in Indian cities too, as can be seen in the list below[3].

| Cities | Flooding Years |
|---|---|
| Ahmedabad | 2001 |
| Bangalore | 2005, 2009, and 2013 |
| Chennai | 2004 and 2015 |
| Delhi | 2002, 2003, 2009, 2010, 2013, 2016 |
| Guwahati | 2010 and 2011 |
| Hyderabad | 2000, 2001,2002, 2006 and 2008 |
| Jamshedpur | 2008 |
| Kolkata | 2007 and 2013 |
| Mumbai | 2005, 2007, and 2015 |
| Srinagar | 1992, 2014 and 2015 |
| Surat | 2006 and 2013 |

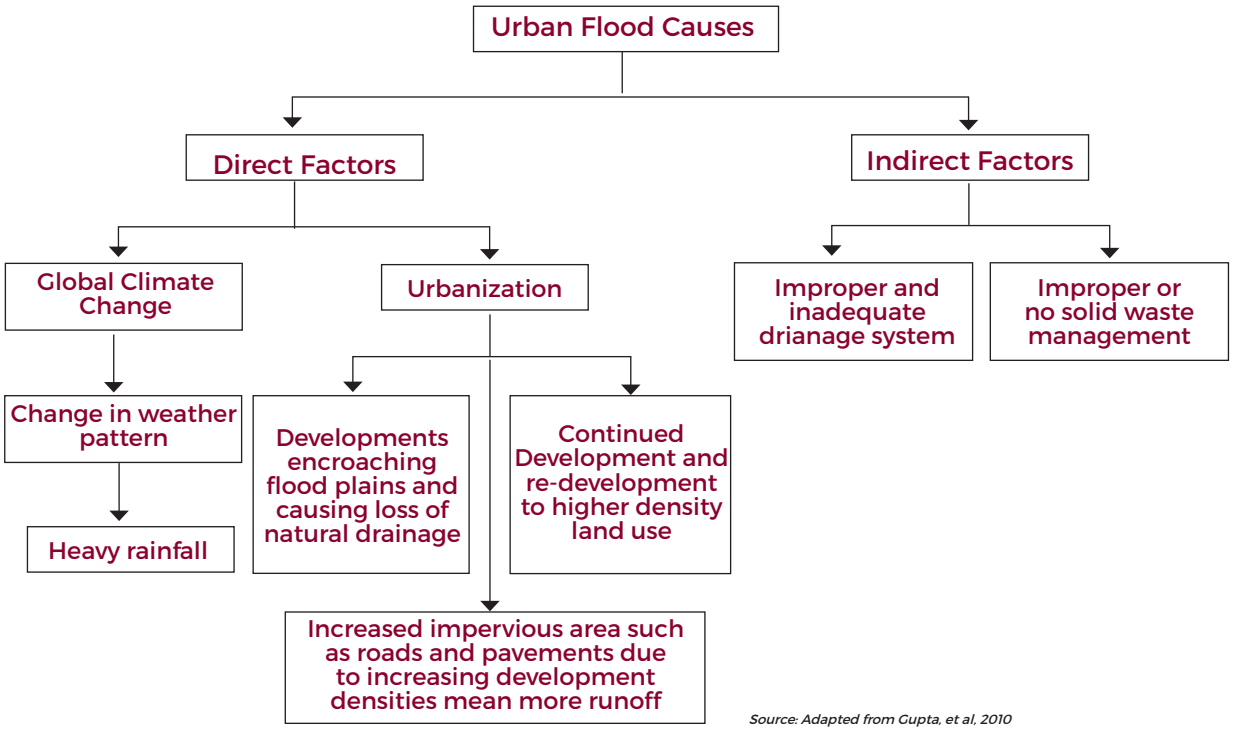
## Causes

Urban floods are caused by natural events and anthropogenic activities. In Indian cities flooding is becoming frequent due to both human factors and meteorological/hydrological factors, with the former factor being more predominant. some of the issues contributing to urban floods are listed below[1]:

1. Planning issues: Increasing population, habitations coming up in low-lying areas, encroachment on drainage channels and immediate upper catchment of hilly urban areas.
2. Technical issues: Increased imperviousness leading to increased runoff as compared to drainage capacity, improper waste disposal resulting in clogged drains, high intensity – high load of runoff.
3. Meteorological issues: Exacerbated by changing climate, resulting in extreme events, NASA studies indicate that the urban heat island effect also results in increased rainfall over urban areas.
4. Policy issues: Lack of integrated flood control implementing agency

## Impacts - flooding in urban areas affects more than one sector

1. Traffic jams
2. Damage to public and private property
3. Mixing of solid waste in flood waters causing further choking of drains
4. Vector and water borne disease
5. In coastal cities, increased inundation of low lying areas during high tide, reduced capacity of drains to discharge storm water
6. Disruption of power supply and telecommunication
7. Mixing of faecal matter in the flood water due to open defecation




*Source: Adapted from Gupta, et al, 2010*

## Solutions

An integrated approach combining watershed and land-use management with development planning, engineering measures, flood preparedness, and emergency management should be adopted for controlling urban floods (Gupta, 2012). Three aspects viz. flood avoidance, flood tolerance and flood resilience should be addressed in an integrated way for flood management in cities[4].

Technical measures include:

a. Planned and proper construction of drainage network
b. Regular maintenance of storm water drains
c. Use of porous construction material for pavements
d. Putting in place water sensitive infrastructure
e. Taking drainage basin as the base for city master plans.
f. Protecting lakes/water bodies from encroachments and clearing existing encroachments by the departments/

### HYDERABAD

#### About the City

Hyderabad is the state capital of Telangana and de jure capital city of Andhra Pradesh. The city's population is 6.7 million and metropolitan population of 7.7 million (2011 Census). The city is located on the banks of river Musi and is an established IT and knowledge hub of India.

#### Flooding Events

- August 1954
- 1970
- August 2000 (240mm in one day and 469mm total rainfall) major flood
- August 2001
- August 2002
- 2006
- August 2008 (220.7mm in 36 hours)

#### Losses

In 2000 floods damaged 35,693 homes worth Rs.135 lakhs and affected 2 lakh people.
In year 2008, floods affected 1.5 lakh people

### DELHI

#### About the City

Delhi, is the capital of India, and with a population of 22 million in 2011 (area 33578km$^2$ as per NCRPB), it is the world's second most populous urban agglomeration. Delhi's population is 16.8 million and it has an area of 1483 km$^2$.River Yamuna is major water body in the city.

#### Flooding Events

- 1977, 1978, 1988, 1995, 1998
- 2010 (water level in Yamuna had crossed the 207 m mark), 2011
- 2013 (117.8 mm in four and half hours)
- 31st July 2016 (62mm rain in 3 hours)

#### Losses

In 1978, total damage to crops, houses and public utilities was estimated at Rs.176.1 million;
In 1988, floods affected approximately 8,000 families;
In 1995, floods rendered approximately 15,000 families homeless
In 2016, extreme heavy spell of rainfall created city wide traffic jam at morning office hours.

### CHENNAI

#### About the City

At 7.6 % decadal growth of population, Chennai is one of the fastest growing metropolitan cities in India. The metropolitan area has a population of 8.6 million as per Census 2011 (7.08 million in city). The geographical area of Chennai metropolitan area is 1189 km$^2$, while the city area is 426 km$^2$. Adyar and Cooum Rivers are the main river of the city.

#### Events

- 2004
- 2015 (Mega Floods in November and December)

#### Losses

New developments in southern and western Chennai flooded. Rail and Air services disrupted. Floods claimed 280+ lives in Chennai and more than 1,27,580 people rescued. All schools, colleges, offices, AUTO and IT companies were closed. Assocham reported a loss of Rs. 15,000 crore (CNBC)

## MUMBAI

### About the City

Mumbai is the financial capital of India. The metropolitan population is 20.7 million (12.4 million population of Mumbai city). The decadal growth rate (2001-11) of Mumbai city was 4.2%. The metropolitan region of Mumbai is 4355 $km^2$, while the city covers an area of 603 $km^2$. Meethi river, Powai lake, Vihar lake, Tulsi lake are main water bodies within the city.

### Flooding Events

- July 2005 (944mm of rain in 24 hours)-Mega Floods
- 2007
- 2015 (300mm rainfall in 24 hours)

### Losses

In 2005 floods, 1094 lives lost, all major suburbs affected, train services, buses, airport operations suspended (for about 30 hours);
Loss of Rs. 550 crores in two days.

## BANGALURU

### About the City

It is the 'IT city' or 'silicon valley' of India due to the presence of several software companies. Bangaluru is the 5th largest metropolitan region of India with population of about 8.52 million. Bangalore's population registered a decadal growth of 46% between 2001-11. Bangalore's city population is 8.4 million and it covers an area of 741 $km^2$.

### Flooding Events

- October 2005 (525 mm in 24hours)
- 2009, 2013
- July 2016 (38 mm rain in 24 hours, 96 mm rain in 72 hours)

### Losses

In 2005, 100 homes were damaged and 54 collapsed, 10 persons died. Schools and colleges were closed. WIPRO and Hinduja TMT offices were flooded.
In July 2016, 38 mm rainfall in just 24 hours on 28th July led to over flowing of lakes which flooded the city, particularly IT hub in south-east Bangaluru. The rainfall inundated all arterial roads upto 3 feet, cars submerged, trees uprooted, and traffic snarls reported.

## SRINAGAR

### About the City

Srinagar is the summer capital of Jammu and Kashmir and is also the largest city in the state. It is a popular tourism destination in Kashmir valley. Population of Srinagar urban agglomeration was 12,73,312 (as per census 2011). Jhelum river, Dal lake and Wular lake are main water bodies in the city.

### Flooding Events

- 1950, 1957, 1959
- September 1992 (151 mm rainfall in 24 hours)
- 2-6 September 2014 (breach in the levee of river Jhelum)

### Losses

In 1992 floods, 200 people lost their lives, 60,000 marooned
In 2014, floods affected entire Kashmir valley (including the city of Srinagar). Srinagar inundated as river Jhelum crossed danger mark. Water was as high as 12 feet in many neighbourhoods of Srinagar. Preliminary estimate of damage was Rs. 5000-6000 crores. City administration, transport, telecommunication and hospitals operations were affected.

agencies concerned

g. Rejuvenating water bodies back to their original state.

Initiatives to be taken at government level include:

a. Training programs should be organised for staff involved in operation and administration to enable them to take action as per the operating procedures.
b. Sensitization programs should be organised for public on flood related aspects.
c. Damage assessment should be done in vulnerable areas and sufficient funds should be allocated for flood prevention related works . This will help in reducing the recurring expenditure for the same damages every year.
d. Documentation - Activities undertaken by government agencies for controlling and managing floods should be documented and publicized in all forms of media.
e. Stopping illegal construction: Public should be educated on the risks involved in illegal constructions on or along drains and water bodies. Vulnerable areas should be cleared of habitations. Government should consider relocation of the poor to other areas.
f. Institutional arrangements - A unified flood control implementing agency needs to be in place. Officials of Revenue, Police and Fire, Emergency Services and Army should be included in the flood control unit.

Source of cover page photographs (from left to right):
Photo 1: Image of people making their way through flooded main road during Chennai Floods (2015) - *Source - CNN*
Photo 2: Image of Srinagar city under flood waters (2014) - *Source - BBC*
Photo 3: Image of Uttarakhand floods, river Alaknanda in spate - *Source - Indianexpress*

## References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