Issues of Urban Drainage—Present Status and the Way Forward

Kapil Gupta

Abstract The 2007 Fourth Assessment Report by the Intergovernmental Panel on Climate Change (IPCC) has indicated that the global surface temperature is likely to rise a further 1.1–6.4 °C during the twenty-first century, while studies by NASA indicate that the urban heat island effect over cities has resulted in an increase in rainfall over several urban areas. A major concern is the likely effects of changes in the frequency and intensity of extreme weather events, especially droughts and floods—"an increased risk of drought" while "precipitation is projected to be concentrated into more intense events, with longer periods of little precipitation in between." Cities/towns located on the coast, on river banks, upstream/downstream of dams, inland cities, and in hilly areas can all be affected. 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 2009, and Guwahati and Delhi in 2010 and again in September 2011. There is therefore an urgent need for adaptation and mitigation options for tackling the impacts of climate change on water resources, especially flooding from extreme rainfall. This paper describes the measures being taken at the local, national, and international level to make our cities flood resilient.

Keywords Urban drainage · JNNURM · NDMA guidelines · Drainage design · Climate change

K. Gupta (✉)
Department of Civil Engineering, Indian Institute of Technology, Mumbai, India
e-mail: k.gupta@civil.iitb.ac.in

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1 Introduction

The 2007 Fourth Assessment Report by the Intergovernmental Panel on Climate Change (IPCC) has indicated that the global surface temperature is likely to rise a further 1.1–6.4 °C during the twenty-first century while studies by NASA indicate that the urban heat island effect over cities has resulted in an increase in rainfall over several urban areas. A major concern is the likely effects of changes in the frequency and intensity of extreme weather events, especially droughts and floods—"an increased risk of drought" while "precipitation is projected to be concentrated into more intense events, with longer periods of little precipitation in between." Cities/towns located on the coast, on river banks, upstream/downstream of dams, inland cities, and in hilly areas can all be affected. 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 2009, and Guwahati and Delhi in 2010 and again in September 2011.

There is therefore an urgent need for adaptation and mitigation options for tackling the impacts of climate change on water resources, especially flooding from extreme rainfall.

2 Adaptation and Mitigation Measures in Mumbai

The Mumbai floods of July 2005 turned out to be an eye-opener not only for Mumbai but also for India. On July 26, 2005, Mumbai suffered severe flooding due to 944 mm rainfall in 24 h recorded at Santa Cruz observatory at Mumbai airport. According to the Government of Maharashtra, over 60 % of Mumbai was inundated to various degrees. At that time, there was no reliable real-time rainfall forecast mechanism and IMD was unable to issue advance warnings due to the lack of state-of-the-art equipment like Doppler weather radar and tipping bucket rain gauges. Thus, disaster managers had no means of knowing the spatial or temporal variation of rainfall in real time. To improve the response and determine the spatial and temporal variation of rainfall in real time, a network of 35 weather stations with tipping bucket rain gauges has been setup in the city by the Municipal Corporation of Greater Mumbai (MCGM) and Indian Institute of Technology Bombay in June 2006. Majority of them are installed on the roof of the fire station control rooms. These rain gauges have been programmed to give rainfall intensity in real time (every 15 min) to the emergency control room at MCGM headquarters through Internet. The average rain gauge density is 1 per 16 km^2 and interstation distances ranges from 0.68 to 4.56 km. This network has enabled monitoring of rainfall in real time and has been of immense benefit to disaster managers for mobilizing rescue and relief to the flood affected areas during heavy rainfall since 2006. An

automatic Doppler flow gauge has also been set up in the upstream reaches of Mithi River to measure the flow levels and issue early warnings for downstream areas. Under an international European Union funded project Collaborative Research on Flood Resilience in Urban areas (CORFU), work is presently ongoing to mitigate flooding by issuing advance warnings using real-time rainfall data and improve forecasted flood levels along the Mithi River using hydraulic flow modeling software in real time. The Municipal Corporation of Mumbai is also finalizing a comprehensive Disaster Risk Management Master Plan (DRMMP) for Mumbai which includes other disasters like earthquakes, floods, epidemics, oil fires, transportation escape routes, etc. before July 2011.

Future strategies should recognize that sea-level rises worldwide cannot be reversed. The only alternative is to have increased investment in flood defenses. For example, the MCGM is now in the process of installing floodgates in combination with high-discharge pumps at eight of the hitherto un-gated sea outlets.

3 Adaptation and Mitigation Measures in India

Realizing that the causes of urban flooding are different and so also are the strategies to deal with them, the National Disaster Management Authority, Government of India has addressed urban flooding as a separate disaster and has released the Urban Flood Guidelines in September 2010.

Urban flooding is significantly different from rural flooding as urbanization leads to developed catchments which increases the flood peaks from 1.8 to 8 times and flood volumes by up to 6 times. Consequently, flooding occurs very quickly due to faster flow times, sometimes in a matter of minutes. Problems associated with urban floods range from relatively localized incidents to major incidents, resulting in cities being inundated from a few 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.

Gist of Some of the Key Action Points of the NDMA Flood Guidelines

1. Ministry of Urban Development will be the Nodal Ministry for Urban Flooding;
2. Establishing Urban Flood Early Warning System;
3. Establishment of Local Network of Automatic Rainfall Gauges for Real time Monitoring with a density of 1 in every 4 km^2 in all 2325 Class I, II, and III cities and towns;
4. Strategic Expansion of Doppler Weather Radar Network in the country to cover all Urban Areas for enhanced Local-Scale Forecasting Capabilities with maximum possible Lead-time;

5. India Meteorological Department will develop a Protocol for Sub-Division of Urban Areas on the basis of Watershed and issue Rainfall Forecast on the Watershed-basis;
6. Catchment will be the basis for Design of Stormwater Drainage System;
7. Watershed will be the basis for all Urban Flooding Disaster Management Actions;
8. All 2325 Class I, II, and III cities and towns will be mapped on the GIS platform;
9. Contour Mapping will be prepared at 0.2–0.5 m contour interval;
10. Inventory of the existing stormwater drainage system will be prepared on a GIS platform;
11. Pre-Monsoon De-silting of Drains should be completed before March 31 every year;
12. Involve the Residents' Welfare Associations and Community-Based Organizations in monitoring this and in all Urban Flood Disaster Management actions;
13. Every building shall have Rainwater Harvesting as an integral component of the building utility;
14. Better Compliance of the Techno-legal Regime will be ensured;
15. Establish the Incident Response System for Coordinated Response Actions;
16. Capacity Development at the Community and Institutional level to enhance UFDM capabilities;
17. Massive Public Awareness programmes covering Solid Waste Disposal, problems of Encroachments, relevance of Techno-legal Regime besides all other important aspects; and
18. Involve elected Public Representatives in Awareness Generation.

4 National Mission on Sustainable Habitat: Climate Change Adaptation and Urban Drainage Parameters

The Prime Minister released India's first National Action Plan on Climate Change (NAPCC) outlining existing and future policies and programs addressing climate mitigation and adaptation in June, 2008. The NAPCC has set out eight "National Missions" as the way forward in implementing the Government's strategy and achieving the National Action Plan's objective. The focus of these missions is on "promoting understanding of climate change, adaptation and mitigation, energy efficiency and natural resource conservation." The National Mission on Sustainable Habitat is one of the eight missions.

The National Mission on Sustainable Habitat aims to address sustainability concerns related to habitats, primarily in urban areas through improved management of solid and liquid waste is to improve the ability of habitats to adapt to climate change by improving resilience of infrastructure, measures for improving advance warning systems for extreme weather events and conservation through appropriate changes in legal and regulatory framework. The development of parameters is essential for developing legal frame work/regulations to improve urban planning in respect of storm water drainage. These parameters/indicators are generally in the form of indices, for systematic and scientific assessment of situation, progress and deficit. In February 2011, 20 Sustainable Habitat parameters on Urban Stormwater Management have been formulated by the Ministry of Urban Development. Parameters such as Climate Change Stress Index, Preparedness Index/Early Warning Index, Rainfall Intensity Index, etc., have been formulated.

5 Summary and Conclusions

Some of the aspects related to climate change, adaptation, and mitigation have been presented. Ignoring the change will not make the problem go away, but we can make use for science and technology to improve the warning, response, and mitigation to reduce our losses.

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