wipro earthian

Urban flooding: strategies to mitigate the impact of urban flooding in Indian Cities

Introduction

Urban flooding is a serious and growing threat to the lives, livelihoods and infrastructure of millions of people living in urban areas across the world. Urban flooding occurs when the volume and intensity of rainfall exceeds the capacity of the drainage systems. This results in water accumulation and inundation of low-lying areas. It is exacerbated by factors such as rapid urbanization, land-use changes (reduction in green cover, increase in paved surfaces), encroachment of water bodies and water channels, blockages or obstruction in water courses, climate change, and poor waste management.

Flooding in cities causes significant economic, social and environmental impacts. These include damage to property, disruption of essential services, displacement of people, health risks, and ecological degradation. In recent years, due to climate change effects, there have been unpredictable and excessive rains. Our urban infrastructure is not equipped to handle this. Cities like Chennai, Bengaluru, Gurugram, etc. have all been subjected to the impacts of flooding in recent times. There is an urgent need to develop and implement effective strategies to prevent, mitigate and adapt to urban flooding and enhance the resilience of urban communities.

Some of the key factors causing urban flooding

1. Meteorological factors: Currently most Indian cities have been experiencing heavy and unexpected rainfall leading to flood situations. Most urban floods in recent times were consequent to episodes of heavy rainfall. According to an India Today Report (Oct 23, 2022), cumulative annual rainfall in Bengaluru during 2022 stood at 1,709 mm as of October 20, making it the highest ever annual rainfall figure recorded in 121 years by the city's meteorological centre. Climate change is a key factor behind this increase in rainfall peak intensity.
2. Hydrological factors: Flood risk arises when the surface runoff is significantly greater than the infiltration rate**.** Urbanization reduces rate of infiltration due to paved roads and lack of vegetation cover. Lower infiltration leads to higher run-off and flooding.
3. Anthropogenic/human factors: Some of the key human factors leading to urban flooding are discussed below.
    a. Land-use changes: Changes in the use and management of land by humans, which may lead to a change in land cover (for example, deforestation), expansion of cities and towns and reservoir installation, i.e., creation of artificial lakes for water storage leading to altering cities' water drainage systems, may potentially result in floods.
    b. Exploitation of floodplains by construction: Urbanization has led to encroachments on water bodies and construction on beds of rivulets, rivers and lakes. This takes away the buffer zones and the natural water sponges (storage areas, inundation zones, and water holding areas) of the city.
    c. Poor solid waste management: Garbage hotspots and unscrupulous dumping of solid waste on roadsides and open areas can contribute to urban flooding by blocking drainage, throttling flow, and increase associated health risks, viz., water contamination, spreading disease vectors.

d. Unplanned urban development and outdated drainage systems: Most Indian cities have undergone haphazard urbanization. The infrastructure has not been commensurately upgraded with the rising population. For example, storm water drainage lacks capacity to adjust for loss of natural run-off due to construction. The Karnataka State Action Plan on Climate Change (2013) had noted that drain infrastructure of Bengaluru is not enough to handle even moderate rainfall events. Yet, the infrastructure has not been upgraded till date.

e. Destruction of natural drainage systems due to extensive road construction: Encroachment of natural lakes for construction purposes in various cities has impacted natural drainage of rainwater leading to frequent floods. As per the recent data of 2021 by BBMP, out of the 204 lakes in BBMP area, 131 are encroached upon.

f. Improperly designed cross drainage structures, viz., bridges, culverts, etc.

g. Excessive channelization of flow (through concretization of drains): To reduce flooding in upstream areas, one inadvertently increased the flood risk in downstream areas.

h. Sewage flow in drains: Most storm drains are also acting as channels for conveying sewage to downstream areas, viz., agricultural fields in the peri-urban areas, ultimately reaching rivers and water bodies. Growth of cities and high water consumption has led to significant capacity of storm drains (>25-30%) being taken up and blocked by sewage flows (acting almost as a base flow).

How can this be addressed?

Urban flooding is a complex and multidisciplinary issue. Thus, it requires the collaboration and coordination of various stakeholders. These include urban planners, engineers, hydrologists, geographers, environmentalists, policymakers and citizens. As the incidence of climate variability and extreme weather events increases, urban flooding is becoming increasingly common. It is inevitable that we look at the issue from a broad-based perspective. Our focus must be on increasing community resilience and the adaptive capacity of our infrastructure.

Cities need various mitigation methods like adopting water sensitive urban design and planning techniques, using tools such as predictive precipitation modelling. EIAs and enforcement will remain vital to ensure that fragile wetlands and floodplains are not concretized.

The following solutions, or a combination of these solutions, can be looked at for a typical urban area where flooding is an increasingly pertinent issue.

Watershed analysis: Studying hydrological characteristics and processes of a catchment area, such as rainfall, runoff, infiltration, evaporation and groundwater flow is critical. Watershed analysis helps to understand the sources, pathways and destinations of water in an urban area. It also aids in identifying potential flood hazards and vulnerable zones.

Flood modelling and mapping: Use of mathematical models and geospatial tools to simulate and visualize flood scenarios for different rainfall events and land-use patterns is important. Flood modelling and mapping helps to estimate the flood extent, depth, duration and frequency. These processes also aid in assessing the flood risk and impact on the urban environment and population. Identifying hotspots where flooding is likely to cause damage year on year, and plugging in previous years' data, will help in designing preventive measures before the rains.

Flood control and mitigation measures: Designing and implementing structural and non-structural interventions to reduce flood risk and impact are important aspects of mitigating the impacts of urban flooding. Structural measures include the construction and maintenance of stormwater

drains, culverts, retention ponds, detention basins, levees, dams and floodgates. Non-structural measures include the regulation of land use and development, the enforcement of building codes and standards, the preservation and restoration of natural water bodies and green spaces, the promotion of water-sensitive urban design and infrastructure, the implementation of early warning systems and emergency plans, and the enhancement of public awareness and participation.

Flood adaptation and resilience strategies: Developing and implementing long-term and holistic approaches to cope with and recover from flood events, and to improve the urban system's capacity to withstand and respond to future flood events is also important. Adaptation and resilience strategies include the integration of flood risk management into urban planning and governance, diversification and decentralization of water supply and sanitation systems, the improvement of social and economic security and equity, the promotion of innovation and learning, and the strengthening of institutional and community networks and partnerships.

Suggest solutions for a typical dense urban city keeping the following points in mind:

- Techniques to map potential areas where flooding is a possibility
- Policy level changes required to resolve urban flooding problem in the future
- Governance or partnership models where the relevant governmental body (e.g., BBMP) and private real estate builders can collaborate to mitigate urban flooding issues while planning a new residential or commercial property/ community
- Urban design and planning techniques that can help mitigate urban flooding in a densely populated city
- Platforms to crowd-source critical flooding related data in real time, which can be used for immediate disaster response and for mitigation planning in the future
- Low-cost techniques to gather real time data on high water levels in drains, inundation levels in low lying areas, water levels in water bodies, etc., to be used for trouble shooting, and to plan and design mitigation measures