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Sustainable Management Of Urban Flooding - A Growing Challenge

By Chitranjan Kaushik

Over the past few centuries there has been a rapid increase in urban population. Parallel to this, there has also been sharp rise in instances of flooding within urban areas. Rapid urbanization coupled with uncoordinated infrastructure development, especially in developing countries like India, has made flooding in urban areas a major socio-economic hazard. To further compound the problem, extreme rainfall events are becoming more frequent due to the effects of climate change. ☞ **www. ecofirst.in**

The examples of urban flooding of Mumbai, Chennai or even drier areas like Jaipur due to sudden heavy rainfall have placed question marks over the cities' drainage planning. These events have not only had a socio-economic impact but also political controversies. Three consecutive years of flooding in Bharatpur (Rajasthan), India has triggered negative growth of of the city. Moreover, it is not only the frequency of flooding but the rise in intensity of floods and their after effects which are more worrisome. Cities in India often have severe problems because of much heavier local rainfall, poor drainage standards and above all, poor maintenance of the existing drainage system.

This situation continues to get worse primarily because many cities are growing rapidly without appropriate planning and design of their drainage systems where a holistic approach is badly needed. For a long time now, storm water management solutions have focused on capturing rain water and passing it out of the site as fast as possible, thereby treating storm water as a problem that needed to be "got rid of". This approach needs to undergo some serious rethinking and an approach which looks at storm water as a "valuable resource that needs to be gainfully harnessed", is a far more sustainable approach.

It is important to understand the mechanism of urban flooding to find a sustainable solution for it. Flooding in urban areas is a complex function of several processes like ratio of paved and unpaved areas, rainfall-runoff volume, flow pattern on surface area, drainage system. It may be caused by one or multiple reasons which may be within or surrounding the urban area. Intra urban area mechanisms, that may cause surface flooding are influenced by the change in rainfall pattern, changes in the physical infrastructure of the catchment, new development, wider use of new technologies, and even by the changes to the management and operation of the drainage system.

Handling Urban Flooding through Green Infrastructure

As mentioned earlier, changes in land use associated with urban development affect flooding in many ways. Removing vegetation and soil, grading the land surface, and constructing drainage networks increase runoff to streams from rainfall. As a result, the peak discharge increases accompanied by an increase in the volume and frequency of floods. The obvious consequence is that not only higher volumes are generated but they travel faster and peak flow conditions arrive

in lesser time and with higher peaks. This gives the system lesser time to react and makes the existing infrastructure and flood handling mechanism inadequate and ineffective. Moreover designing for such peak events makes the system costlier to build with low utilization ratio.

Most of our cities are struggling with such a scenario. However, the solution to the problem doesn't necessarily lie in expensive, cutting edge technology. It lies, instead, in simple design principles which employ natural processes to curtail and channelize the flow of water. For this it is important to understand the hydrology of the catchment and hydraulics of the runoff volume. An effective approach to handle increased runoff and discharge peaks is by cutting off tributary run off from approaching main channels or by delaying the same i.e. increasing the Time of Concentration of the runoff. While this can be done by various means, an approach like Green Infrastructure will be particularly useful. Moreover, if green infrastructure can be integrated with the project's design philosophy early in the process, it will not only bring in efficiency in the system but will also bring down project costs.

Green infrastructure is an approach to wet weather management helps to infiltrate, evapo-transpire, capture and reuse storm water to maintain or restore natural hydrology. They effectively reduce stormwater runoff volumes and reduce peak flows by utilizing the natural retention and absorption capabilities of vegetation and soils. By increasing the amount of pervious ground cover, green infrastructure techniques increase storm water infiltration rates, thereby reducing the volume of runoff entering our drainage systems, and ultimately our lakes, rivers, and streams.

At the larger scale, the preservation and restoration of natural landscape features (such as forests, floodplains and wetlands) are critical components of green stormwater infrastructure. By protecting these ecologically sensitive areas, communities can also improve water quality while providing wildlife habitat and opportunities for outdoor recreation.

On a smaller scale, green infrastructure practices include rain gardens, porous pavements, green roofs, grass swales, infiltration planters, trees and tree boxes, and rainwater harvesting for non-potable uses such as toilet flushing and landscape irrigation. Various direct or indirect benefits associated with Green infrastructure are:

- The natural infiltration capabilities of these technologies can improve the rate at which groundwater aquifers are 'recharged' or replenished. This is significant because groundwater is an important part of the scheme for supply of drinking water for private and public uses.
- Such techniques infiltrate runoff close to its source and help prevent pollutants from being transported to nearby surface waters. Once runoff is infiltrated into the soil, plants and microbes can naturally filter and break down many common pollutants found in storm water. Moreover the plants and soils serve as sources of carbon sequestration, where carbon dioxide is captured and removed from the atmosphere via photosynthesis and other natural processes.
- Utilizing the natural retention and infiltration capabilities of plants and soils, green infrastructure limits the frequency of sewer overflow events by reducing runoff volumes and by delaying stormwater discharges.
- Urban heat islands form as cities replace natural land cover with dense concentrations of pavement, buildings, and other surfaces that absorb and retain heat. Additionally, tall buildings and narrow streets trap and concentrate waste heat from vehicles, factories, and air conditioners. By providing increased amounts of urban green space and vegetation, green infrastructure can help mitigate the effects of urban heat islands and reduce energy demands. Trees, green roofs and other green infrastructure can also lower the demand for air conditioning energy, thereby decreasing emissions from power plants.
- Incorporation of trees and vegetation in urban landscapes as a part of green infrastructure strategies will contribute to improved air quality. If widely planted throughout a community, trees and plants can even cool the air and slow the temperature-dependent reaction that forms ground-level ozone pollution (smog).
- Greenways, parks, urban forests, wetlands, and vegetated swales are all forms of green infrastructure that provide increased access to recreational space and wildlife habitat.
- Green Infrastructure effectively reduce sediments and pollutant loads in our streams or street flows, which have frequently been stated as a prime reason by city planners and designers for failure of infrastructure (including road) in general and drainage systems in particular.

In summary, going forward, flood management would be as serious a problem as water shortages in our towns and cities and our builders & city planners need to recognise this. A holistic approach to sustainable infrastructure design that integrates - site grading, road design, storm water design (as an integral part of an overall water management strategy), water and waste water infrastructure design, electrical design, waste management systems design - is needed to achieve best results. At Ecofirst Services Private Limited, we offer exactly this kind of integrated and sustainable design services through our multi-disciplinary team of Water specialists, Energy specialists and green Architects.

About the Author

Chitranjan Kaushik is the Senior Vice President at Ecofirst Services Private Limited and oversees Water Resources Planning & Design, Urban Drainage Modelling and Land Development Planning & Design. Ecofirst offers integrated services for Master Planning, Water Management, Energy Management, Waste Management Solutions and Green Building Certification to large townships, SEZs, Commercial / mixed use developments, Education and Healthcare developments which are translated into design drawings through its "Sustainable Infrastructure and MEP design" offering. Ecofirst has a highly qualified and vastly experienced team of architects, engineers, infrastructure design specialists, water experts and energy experts.

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