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“Rethinking solutions to urban flooding”

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A Combination Of Grey And Green Infrastructure Could Help Avoid Inundation, Runoff

Rethinking solutions to urban flooding

K Ashok Vardhan Shetty

What do Chennai and Zhengzhou in China have in common? During the 2015 floods, Chennai received about 25% of its average annual rainfall on a single day (December 1). In July 2021, Zhengzhou went underwater when it received its entire year's quota of rainfall in four days. Climate change in recent years has led to a larger percentage of precipitation in intense, short spells.

There is a second reason for urban flooding that seldom makes news. The cement concrete and asphalt surfaces (such as buildings, roads, sidewalks and parking lots) that dominate our urban landscape are impervious to rainwater. The average city block generates five-and-a-half times as much runoff as a wooded area of equal size. Due to ill-planned urbanisation, water bodies, wetlands and floodplains that could have absorbed and stored stormwater runoff have also been paved over indiscriminately. An April 2020 study in Geophysical Research Letters shows that for every percentage point increase in impervious surface area, annual floods increase on average by 3.3%.

The conventional solution to this problem is to convey the stormwater runoff through expensive cement concrete drains and canals (termed grey infrastructure) to the nearest lake or river. The runoff carries with it garbage, debris and other pollutants. Studies show that a water body that has more than 10% impervious surface area in its watershed becomes degraded due to stormwater runoff. And all it takes is a cloudburst and a few bottlenecks in the stormwater network to flood localities. Expansion of the stormwater network can never keep pace with a growing city.

Unless the entire stormwater network is kept in fine fettle, which is administratively difficult for megacities, it will underperform. Problems can be exacerbated by design and construction flaws. For example in Chennai where the stormwater flow is almost entirely by gravity, improper mapping of contour levels and shoddy construction in some areas cause flooding. Moreover, the stormwater network is useful only if it is complete and leads to a water body as a disposal point. In Chennai, the stormwater drains have been built as multiple, disjointed networks some of which are yet to be linked, resulting in localised flooding.

Dissatisfaction with the recurring failures of grey infrastructure to manage urban flooding is global. For example, the American Society of Civil Engineers' Report Card for US Infrastructure 2021 gave a lowly rating of 'D' to its stormwater network. As a result, interest has grown in green infrastructure technologies instead or in combination with grey infrastructure to manage urban flooding. Green infrastructure uses trees, parks, constructed wetlands, rain gardens, planter boxes, bioswales, green roofs and green walls so as to slow down, soak up, filter, and store rainwater where it falls.

Large constructed wetlands can afford protection against flooding of lakes and rivers besides cleansing the stormwater inflows. Green roofs, green walls and rain gardens can help increase a property's green plot ratio, measure of re-greening that is the ratio of the area of planted vegetation to the area of the plot with 100% as the minimum requirement.

Green infrastructure also uses technologies such as permeable pavements, rain barrels, cisterns and underground stormwater vaults. Permeable pavements have demonstrated up to 90% reduction in runoff volume, while underground stormwater vaults constructed under parks, playgrounds or parking lots store runoff and reduce peak flows. Unlike grey infrastructure projects which are large-scale, expensive, and publicly funded interventions, a green infrastructure approach allows small-scale, decentralised interventions and encourages participation by homeowners and businesses. Since nearly 60% of a city's area is likely to be privately owned, roping in non-government players is crucial.

Green infrastructure is multi-functional too. It reduces stormwater runoff. Improves quality of stormwater discharged to water bodies, increases infiltration to the aquifers, reduces the heat island effect through evapotranspiration, cleanses the air, provides relaxing spaces for people as well as habitats for animals and birds, beautifies the city and in turn increases property values.

A programme for Chennai

In Chennai and other cities prone to flooding, there's a need to broaden the discourse that is fixated on loss of water bodies due to urbanisation and the stormwater network. This begins with eviction of encroachments from water bodies and their protection, not just through executive or judicial fiats, but with constructed wetlands around lakes and alongside river banks. These should also serve as recreational spaces which will motivate the public to take care of the water bodies.

To show quick results, Chennai should construct large underground stormwater vaults below parks and playgrounds in low-lying localities like T Nagar and Velachery that get flooded frequently. Mumbai is constructing one in the low-lying Gandhi Market area. Permeable pavements should replace the existing concrete/asphalt sidewalks and interior roads in a phased manner, and be made mandatory for new developments. The concrete medians on roads should be replaced with planter boxes and bioswales provided alongside street curbs wherever feasible.

A programme for planting 10 lakh saplings (ft-10ft tall) should be launched in Chennai over the next 10 years. Wherever possible rain gardens and 'pocket parks' should be constructed including in open space reservation areas.

Green roofs should be mandated for all (existing and new) residential, commercial, industrial, and office buildings with plinth areas greater than 2,000sqm. These buildings should be mandated to attain a green plot ratio of at least 100% within five years. A graded stormwater fee should be levied in all buildings with a plinth area greater than 300sqm. To incentivise it, states can offer suitable rebates based on the green plot ratio and area of permeable surfaces.

While awareness campaigns and recognition programmes are necessary to encourage private initiatives, Chennai's Third Master Plan should stipulate the provision of green infrastructure not only for urban flood control, but as part of an overall action plan to make the city climate-resilient. Delhi Development Authority is planning the same.

For green initiatives like this, liberal funding from external aid agencies is available. The Union government should launch a national mission on the lines of the Sponge Cities programme of China. It's time for a serious course correction.

(The author is a retired IAS officer)

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GREY TO GREEN INFRASTRUCTURE

In the book 'Cities and Wetlands', Rod Gilbert points out that cities such as London, Paris, Berlin, St Petersburg, New York, Washington DC, Chicago, Toronto, Melbourne and Shanghai were built on water bodies, marshes, and swamps. Here are some of the green infrastructure solutions from some of the cities:

> In 2009, Toronto became the first city to mandate green roofs for **all buildings with a plinth area more than 2,000sqm**

> Berlin's Rummelsburg neighbourhood has done away with stormwater drains by **implementing green roofs, rain gardens, bioswales and permeable pavements**

> Paris plans to increase **its green cover from 9.5% to 50% by 2030**

> Amsterdam has augmented its green cover by creating 'pocket parks'

> In 2020, Singapore launched a programme **to plant one million trees by 2030**

> Jinhua in China has replaced a concrete floodwall at the confluence of three rivers **with a 26-hectare wetland park without compromising flood protection**

News Item in The Times of India newspaper, Chennai Edition dated 06th December 2021

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Unless the entire stormwater network is kept in fine fettle, which is administratively difficult for megacities, it will underperform. Problems can be exacerbated by design and construction flaws. For example in Chennai where the stormwater flow is almost entirely by gravity, improper mapping of contour levels and shoddy construction in some areas cause flooding. Moreover, the stormwater network is useful only if it is complete and leads to a water body as a disposal point. In Chennai, the stormwater drains have been built as multiple, disjointed networks some of which are yet to be linked, resulting in localised flooding. Dissatisfaction with the recurring failures of grey infrastructure to manage urban flooding is global. For example, the American Society of Civil Engineers' Report Card for US Infrastructure 2021 gave a lowly rating of 'D' to its stormwater network. As a result, interest has grown in green infrastructure technologies instead or in combination with grey infrastructure to manage

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