Development must be climate-smart

Hardship in August: A waterlogged road in Mumbai this monsoon. | Photo Credit: Rajanish Kakade

Heavy rains this year from the southwest monsoon and accompanying floods have devastated people's lives in parts of Mumbai, Chandigarh and Mount Abu (Rajasthan), all in the same period as Hurricane Harvey's rampage through Houston. **Mumbai is reported to have received 400 mm of rain** within a matter of 12 hours while **Houston received about 1,300 mm** over several days with Harvey.

Climate models have indicated with high confidence that climate change will lead to an increase in extreme rainfall events. According to the Intergovernmental Panel on Climate Change (IPCC) Special Report on Extreme Events, global warming leads to "changes in the frequency, intensity, spatial extent, duration, and timing of extreme weather and climate events, and can result in unprecedented extreme weather and climate events".

Après le déluge: on the Mumbai floods

For India, the average monsoon rainfall is expected to increase initially and then reduce after a few decades. Examining daily rainfall data between 1951 and 2000, B.N. Goswami, former Director of the Indian Institute of Tropical Meteorology, Pune, showed that there has been a significant increase in the magnitude and frequency of extreme rainfall events along with a decrease in the number of moderate events over central India. These changes interacting with land-use patterns are contributing to floods and droughts simultaneously in several parts of the country.

The main reason for understanding extreme events is to help policymakers, emergency responders and local communities to plan and prepare for them. Cities could be laid out to reduce flooding by following natural contours, drainage and tank systems. Emergency responders should be well prepared to transport and care for people who may become stranded during disasters. Insurance companies might also be concerned about underwriting places that are at perpetual risk in the future. Once an extreme event such as a heat wave or heavy rain occurs, people want to know to what extent a single event has been caused by climate change, that is, by greenhouse gases released through human activities.

All you need to know about Assam floods

Research that tries to understand this relationship between anthropogenic climate change and extreme events in particular locations is called "attribution". Is an extreme event, such as torrential rainfall or record storm surges, part of a natural cycle of variability or due to human-induced climate change? To what extent do poor preparedness and ecologically insensitive land-use worsen the impacts? According to much of the literature, it is easier to determine attribution for severe heat or cold waves. NASA scientist James Hansen earlier found, for instance, that the Texas heat wave of 2011 and the Russian heat wave of 2010 were due to climate change.

Conversely, for rainfall simulation, climate models cannot mimic or simulate extreme rainfall such as the kind Chennai experienced in 2015. According to a paper by Geert Jan Van Oldenborgh and colleagues, the 494 mm rain in Chennai was a rare event, with less than a 0.2% chance of occurring in any given year. The Chennai flood of 2015 did not have a clear climate signature to show that it was due to warming of the earth. On the other hand, with regard to Hurricane Harvey, Michael Mann, a well-known climate scientist, wrote in *The Guardian* that climate change made

the impact much worse, because of higher sea surface temperatures and a blocking region of high pressure that kept the rain clouds over Houston for a long period.

Urbanisation and hydrology

The actual patterns of flooding in Chennai, Mumbai and Houston, however, were due to several human-induced activities: rampant increase in built-up area across natural drainage channels, the diversion or damming of rivers upstream leading to sediment transport and siltation, coastal subsidence and other effects of development.

Any rain that falls on soil or vegetation is mostly absorbed into the earth's surface. Some of it slowly trickles into shallow or deep protected aquifers that make up what we call groundwater. The rest usually flows downhill along surface or subsurface stream channels. The spread of infrastructure such as roads, highways, buildings, residential complexes, tiled or asphalt-covered land obstructs rainwater from percolating into the soil. Often there are further barriers that block movement of water and increase flooding.

In many parts of the world, construction in cities or in urbanising areas does not take into consideration the existing topography, surface water bodies, stream flows or other parts of terrestrial ecosystems. In much of India, urban growth over the past few decades has blithely ignored the hydrology of the land. In Chennai, for example, systematic intrusion into the Pallikaranai marsh and other wetlands by housing complexes and commercial buildings, slums along Cooum and Adyar rivers, and large-scale construction along the coast are just examples of the flagrant encroachment of the built environment that obstructs rivulets and absorption of rainwater into the earth.

When it rains heavily, exceeding the capacity of the soil to absorb it and regular stream flows are blocked from proceeding into the sea, these heavily built-up areas get inundated. Satellite images from 15 or more years back show the existence of hundreds of lakes and tanks, and several waterways within the city's boundaries.

For decades, urbanisation has ignored ecological principles associated with water bodies, vegetation, biodiversity and topography. These are not 'environmental' issues to be disregarded or attended to only after we have attained 'growth'. Rather, they are part and parcel of and integral to how we live and whether we prosper.

Development needs to be climate-smart, but also avoid social and institutional challenges such as moral hazard. If investments are made in places where severe impacts are likely, the government will end up bailing out those engaging in such risky activities. If the built environment and structures of financing and housing are 'locked-in' or get firmed up with regard to institutional arrangements, these can lead to further complications.

Still, construction on existing lake beds and other waterbodies needs to be removed or redesigned to allow flood drainage along natural water channels. As the frequency of extreme weather events increases around the world, losses in rich countries are higher in terms of GDP, but in terms of the number of people at risk, it is the poor countries that suffer the most. Those who are the most vulnerable and the poorest end up bearing the brunt of the burdens of climate change and mal-development, which together operate to worsen impacts.

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The new U.S. Fed Chairman is unlikely to opt for policies that might upset the President's plan

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