LEAD

Playing catch up in flood forecasting technology

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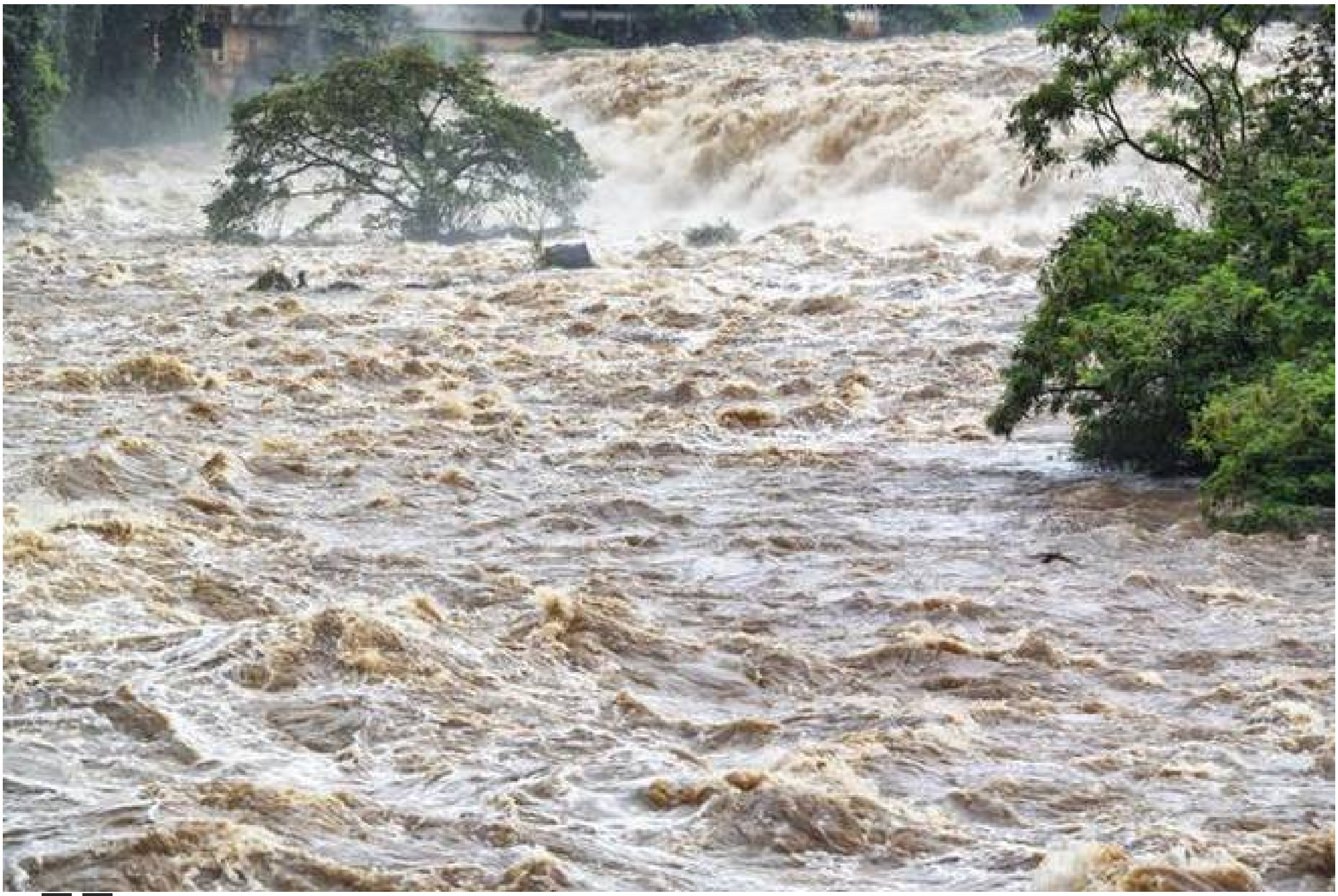
India needs a technically capable workforce that can master ensemble weather and flood forecast models



Have you ever wondered how a local agency makes a decision if a flood forecast merely uses the words "Rising" or "Falling" above a water level at a river point? Especially when the time available to act is just 24 hours, there is no idea of the area of inundation, its depth, and when the accuracy of the forecast decreases at 24 hours and beyond?

There are many times this happens in India during flood events, when the end users (district administration, municipalities and disaster management authorities) receive such forecasts and have to act quickly. These compelling scenarios are often experienced across most flood forecast river points, examples readers will be familiar with — in Assam, Bihar, Karnataka, Kerala or Tamil Nadu.

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Compare this with another form of flood forecast (known as the "Ensemble forecast") that provides a lead time of 7-10 days ahead, with probabilities assigned to different scenarios of water levels and regions of inundation. An example of the probabilities ahead could be something like this: chances of the water level exceeding the danger level is 80%, with likely inundation of a village nearby at 20%. The "Ensemble flood forecast" certainly helps local administrations with better decision-making and in being better prepared than in a deterministic flood forecast.

The United States, the European Union and Japan have already shifted towards "Ensemble flood forecasting" alongwith "Inundation modelling". India has only recently shifted towards "Deterministic forecast" (i.e. "Rising" or "Falling" type forecast per model run).

The shortcomings with Indian flood forecasting are glaring.

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A case of multiple agencies

The India Meteorological Department (IMD) issues meteorological or weather forecasts while the Central Water Commission (CWC) issues flood forecasts at various river points. The end-user agencies are disaster management authorities and local administrations.

Therefore, the advancement of flood forecasting depends on how quickly rainfall is estimated and forecast by the IMD and how quickly the CWC integrates the rainfall forecast (also known as Quantitative Precipitation Forecast or QPF) with flood forecast. It also is linked to how fast the CWC disseminates this data to end user agencies.

Thus, the length of time from issuance of the forecast and occurrence of a flood event termed as "lead time" is the most crucial aspect of any flood forecast to enable risk-based decision-making and undertake cost-effective rescue missions by end user agencies.

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Technology plays a part in increasing lead time. Reports suggest that the IMD has about 35 advanced Doppler weather radars to help it with weather forecasting. Compared to point scale rainfall data from rain gauges, Doppler weather radars can measure the likely rainfall directly (known as Quantitative Precipitation Estimation or QPE) from the cloud reflectivity over a large area; thus the lead time can be extended by up to three days.

But the advantage of advanced technology becomes infructuous because most flood forecasts at several river points across India are based on outdated statistical methods (of the type gauge-to-gauge correlation and multiple coaxial correlations) that enable a lead time of less than 24 hours. This is contrary to the perception that India's flood forecast is driven by Google's most advanced Artificial Intelligence (AI) techniques!

These statistical methods fail to capture the hydrological response of river basins between a base station and a forecast station. They cannot be coupled with QPF too.

Google AI has adopted the hydrological data and forecast models derived for diverse river basins across the world for training AI to issue flood alerts in India. This bypasses the data deficiencies and shortcomings of forecasts based on statistical methods.

Also read | **IMD begins impact-based forecast**

Not uniform across India

A study by the National Institute of Technology, Warangal, Telangana shows that it is only recently that India has moved to using hydrological (or simply rainfall-runoff models) capable of being coupled with QPF. So, a lead time of three days is sporadic in India, and at select river points.

Just as the CWC's technological gap limits the IMD's technological advancement, the technological limitations of the IMD can also render any advanced infrastructure deployed by CWC infructuous. Here is another example. The United States which is estimated to have a land area thrice that of India, has about 160 next generation S-band Doppler weather radars (NEXRAD) with a range of 250-300 km. India will need at least an 80-100 S-band dense radar network to cover its entire territory for accurate QPF. Else, the limitations of altitude, range, band, density of radars and its extensive maintenance enlarge the forecast error in QPF which would ultimately reflect in the CWC's flood forecast. Conspicuously, the error margin is always away from the public gaze.

Therefore, outdated technologies and a lack of technological parity between multiple agencies and their poor water governance decrease crucial lead time. Forecasting errors increase and the burden of interpretation shifts to hapless end user agencies. The outcome is an increase in flood risk and disaster.

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Ensemble technology

Global weather phenomenon is chaotic. For instance theoretically, "the flap of a butterfly's wings in Chennai can create a Tornado in Tokyo" according to MIT's Edward Lorenz. In simple terms and scientifically, any small change in the initial conditions of a weather model results in an output that is completely unexpected. Therefore, beyond a lead time of three days, a deterministic forecast becomes less accurate.

The developed world has shifted from deterministic forecasting towards ensemble weather models that measure uncertainty by causing perturbations in initial conditions, reflecting the different states of the chaotic atmosphere. Probabilities are then computed for different flood events, with a lead time beyond 10 days.

India has a long way to go before mastering ensemble model-based flood forecasting.

Although, the IMD has begun testing and using ensemble models for weather forecast through its 6.8 peta flops supercomputers ("Pratyush" and "Mihir"), the forecasting agency has still to catch up with advanced technology and achieve technological parity with the IMD in order to couple ensemble forecasts to its hydrological models. It has to modernise not only the telemetry infrastructure but also raise technological compatibility with river basin-specific hydrological, hydrodynamic and inundation modelling. To meet that objective, it needs a technically capable workforce that is well versed with ensemble models and capable of coupling the same with flood forecast models. It is only then that India can look forward to probabilistic-based flood forecasts with a lead time of more than seven to 10 days and which will place it on par with the developed world.

With integration between multiple flood forecasting agencies, end user agencies can receive probabilistic forecasts that will give them ample time to decide, react, prepare and undertake risk-based analysis and cost-effective rescue missions, reducing flood hazard across the length and breadth of India.

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