Bracing for flood hazards

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Spells of intense–extreme rainfall

On the basis of a climate modelling study, Lal *et al.*[1] predicted that during the winter months there will be 5–25% less rainfall and in the summer season the monsoon rainfall will be not only 10–15% more than the normal, but also quite variable and specially irregular in Central India. In other words, there will be more spells of intense rainfall and frequent instances of extreme rainfall[1]. This prediction is coming true, particularly in the central sector of the Himalayan belt, where there is pronounced decline in winter precipitation (both rain and snow) and prolonged spells of drought in summer broken by cloudbursts in localized areas. Moreover, there is perceptible shifting of the seasons.

Obstructions in floodways

Intense and extreme rainfalls are making the floodways of all rivers vulnerable to greater floods, particularly in east-central, eastern and northeastern India. A floodway is that part of the river basin/valley which experiences at least one-foot inundation by floodwaters at least once in a 100-yr period[2]. In other words, a floodway conveys the highest discharge of the river at least once in 100 years (Figures 1 and 2). There is therefore, 1% chance of floodwater rising at least 1 ft above the bed of the waterway – the floodway.

The compulsion of pressure on land due to expanding urbanization, increasing industrialization and uncontrolled growth of population has resulted in indiscriminate occupation of, and attendant obstruction in the floodways, in practically all the floodplains in India. All kinds of construction such as residential buildings, commercial and industrial complexes, road embankments and bridges impede the free flow of floodwater *moving in its own waterway*. Whereas the railway bridges span the floodways and are therefore less vulnerable to damage and less problematic, the road bridges span just the river channels – the relatively narrower normal passage during drier seasons. Bridges with closely spaced piers or with projecting abutments restrict this passage. The road embankments, with which the bridges are invariably linked, are like dams across the floodways, the bridges serving as open sluice gates. The small and large houses that have been built in the floodways have compounded the problem by not allowing free flow of rivers in spate.

Since there will be more frequent spells of intense and extreme rainfall, the people occupying the floodways have to brace for the disasters that the floods will bring. Whatever we do, the rivers will reoccupy their natural waterways – the floodways – during spells of heavy discharges.

In order to cope with the hazards of floods, it is imperative that floodways of all major rivers are identified and precisely delineated in the 1 : 50,000 scale topographic maps. Remote sensing and study of aerial maps will be helpful. The second step is to make bypasses for excess floodwaters through canals skirting the settlements on the floodway. We must have and implement strictly the floodway regulations.

Loss of carrying–holding capacity of rivers

In northeastern Uttar Pradesh and adjoining Bihar, yet another factor is playing a powerful role. It is the tectonic activity. While the Lesser Himalayan terrane of the Nepal Himalaya is rising at the rate of 3–4 mm/yr (ref. 3) or 2–3 mm/yr in the spatial wavelength of 25–35 km (ref. 4), the northern part of the Indo-Gangetic Plain in the front of it is subsiding at the rate of 0.2–0.3 mm/yr (ref. 5). The uplift of the Nepal Himalaya is accelerating the rate of denudation which is more than 6 mm/yr (ref. 6), with attendant greater generation of sediments and their transportation to the plains during floods. The subsidence of the northern part of the Kosi–Gandak floodplains is resulting in the decrease of the gradient of channel beds, slackening of flow of water, and consequent deposition of sediments in the channels. The Bagmati River, for example, is being filled the rate of 9.3 cm/yr (ref. 5). Similarly, in Assam, the Brahmaputra channel aggraded

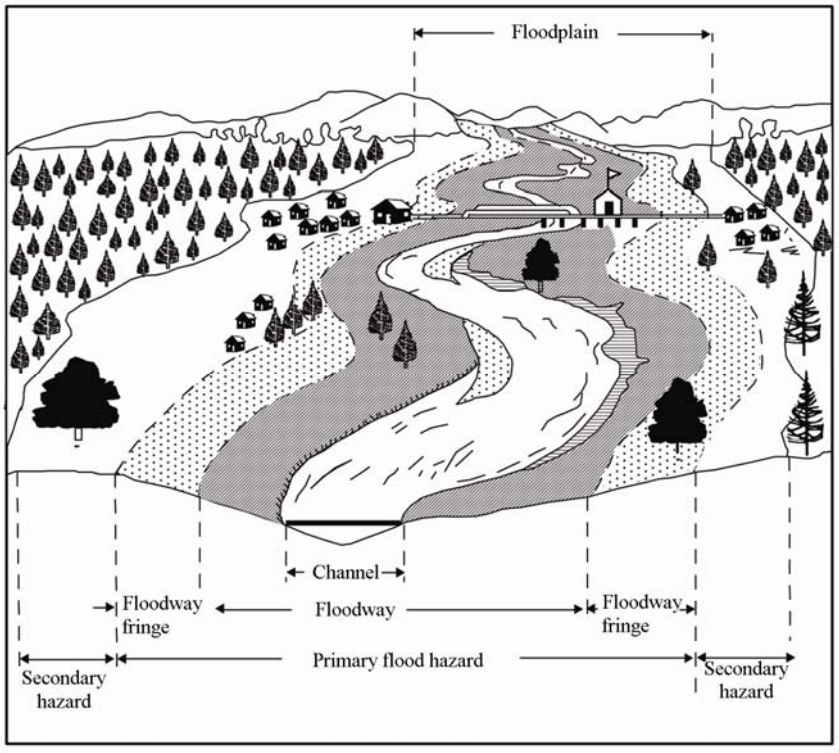

Figure 1. Sketch map showing the floodway and channel of a river.

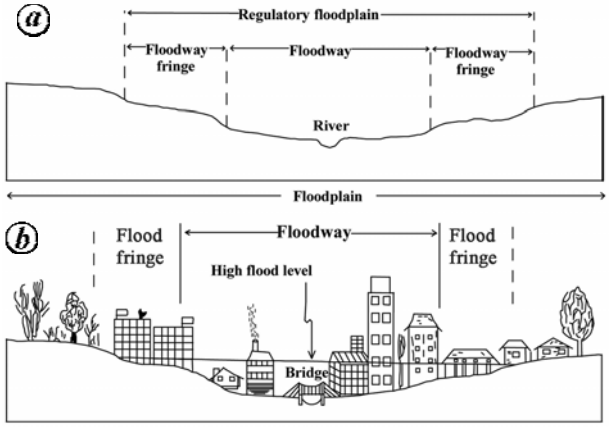

Figure 2. ***a***, Diagrammatic profile of a river basin showing the channel, floodway and flood fringe. The floodway is the vulnerable part of the floodplain. ***b***, Man-made constructions in the floodway considerably impede the flood discharge.

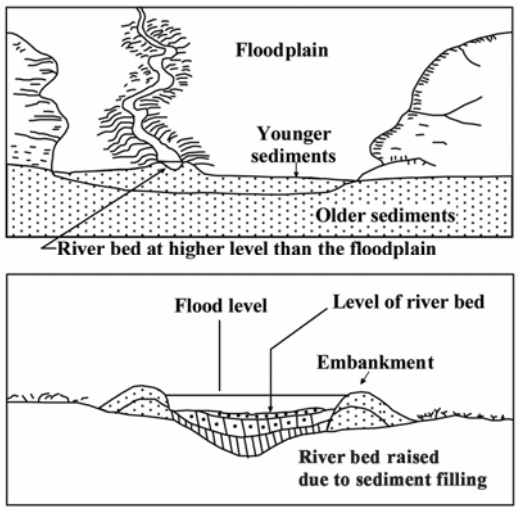

Figure 3. In the Kosi–Gandak domain, where voluminous deposition of sediments is progressively increasing, the making of higher embankments has aggravated the situation. For, the beds of the river channel now lie at a higher level than the floodplain. Overtopping of and breachs in the levees bring about disastrous flooding.

16–21 cm in just eight years, from 1971 to 1979 (ref. 7).

The inevitable consequence of voluminous accumulation of sediments is the progressive decrease in the carrying–holding capacity of the channels. In a number of areas, the channels are almost choked. Therefore, if there is even slightly higher than normal discharge, the floodwater spreads beyond the limits of its pathway.

The construction of embankments (levees) to contain floods has considerably aggravated the situation, because the phenomenal accumulation of sediments has raised the level of the channel beds between the levees (Figure 3). The channel beds are now higher than the floodplain. The spill-over of the floodwater, as it overtops the levees, occurs with greater frequency and the breachs of the levees cause inundation of vast areas with catastrophic consequences. This explains why the Kosi and the Gandak are called the 'Sorrows of Bihar'.

The recurrence interval of floods was 2–3 years in the Indo-Gangetic Plain, and the Kosi–Gandak domain used to be ravaged 5–11 times every year[8]. After the worsening of the climatic conditions, the more frequent spells of intense and extreme rainfall[1] will greatly aggravate the situation. The people living in the region must be prepared for greater hazards.

In Assam, the deposition of a large volume of sediments has resulted in the formation of large and small sandbars and islands within the 8–10 km wide channel of the Brahmaputra[7]. This explains why Assam is repeatedly ravaged by uncontrollable floods.

Channelization of floodwater

It is time to realize that building embankments or levees on the banks of the channels is not the solution to the problem of flood hazards. Embankments away from the channel on the higher edge of the floodways offer a better option. Channelization of the floodwaters would prove more effective. If the excess discharge can be distributed through a network of canals linked with rivulets and streams, the hazards of floods will considerably diminish. Not only would these canals and streams provide passage to excessive discharges, but also serve as temporary storage of floodwater for a short duration. If one were to consider the extent of the network of canals interlinked with streams and rivulets, one would realize that the total of aggregate storage would be considerable. Desilting of channels periodically, if not regularly, would also provide some relief.

Lastly, the occurrence of floods is a normal phenomenon, and the disaster they cause in the floodways of rivers cannot be regarded as an expression of nature's wrath. Since people unknowingly and indiscriminately occupy the natural waterways of rivers, they must pay the price for coming in the way of the furious flow of rivers in spate.

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