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ASSESSING THE MAGNITUDE OF FLOOD DAMAGE IN INDIA

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Abstract: Flood disasters are a natural phenomenon resulting from heavy rainfall and other environmental factors; however, anthropogenic activities like deforestation, urbanization, and faulty agricultural practices can exacerbate them. Floods become a hazard when they inflict significant damage to human life and property. India has been severely affected by floods, especially in the Ganga plain areas. The magnitude of flood damage in India is shown in Table II. Effective flood management is vital to minimize the impact of floods on human society and the environment. Delaying runoff, hastening the discharge of river water, reducing the volume of water, diverting floodwater, and reducing the impacts of floods are some measures that can be taken. Overall, this document emphasizes that understanding the causes and consequences of flooding and implementing effective flood management strategies are crucial steps to minimize the impact of floods on society and the environment.

Keywords: Flood, disaster, anthropogenic, deforestation, urbanization, agriculture, Ganga, flood plains, effective management, delay, hasten, divert, impacts, minimizing, society, environment.

Introduction

Besides river floods which involve extensive areas, there are localized floods such as urban floods, coastal floods, etc. the urban or city floods are in fact the result of water logging caused by extremely heavy rain (more than 250 mm within 24 hours). Such water logged floods occurred in Mumbai in the last weak of july, 2005 when more than 944.2 of rainfall was recorded within 24 hours on july 26. Similar situation developed in Mumbai in the 1st week of july, 2006 when heavy rains occurred in couple of days (since july 2 to 6, 2006). Coastal floods occur due to strong storm surges when a few meters high tidal waves transgress into low costal zones but such situation does not persist for longer duration but great damage is done to human health and wealth.

Causes of floods

Since the floods of rivers are the response of both natural and anthropogenic factors, the causes of floods of the alluvial rivers become highly complex and their relative importance varies from place to place. Among the natural factors which cause river floods, important are prolonged gigh intensity rainfall; meandering courses of the rivers; extensive flood plains; break in slope in the long profiles of the rivers i.e. sudden change in channel gradient at the intervening zones of foothill slope of the mountains and upper end of the plains; blocking of free flow of the rivers because of enormous debris provided by landslides and due to volcanic eruptions; nature of river valleys and channels etc. anthropogenic activities such as building activity and eventual urbanization, channel manipulation through diversion of its (of the river) course, construction of bridges, barrages and reservoirs, agricultural practices, deforestation, land use change etc. by man invite several hazards in the river system viz. disastrous floods, landslides and slumping along the banks, massive erosion along the river banks causing large-scale riparian decay, shifting of channels and even of the river courses, silting of beds, deposition of sands, silts and clays in the flood plains etc. which pose a serious threat to human society and necessitate river regulation and flood control (Savindra Sing, 1983). The flowing causes may be held responsible for devastating floods of alluvial rivers. It may by pointed out that these factors should never be considered separately because it is the cumulative effects of several factors which ultimately cause severe floods.

- Heavy incessant rainfall,
- Spell of extremely heavy rainfall,
- highly sinuous and meandering courses of rivers,
- large-scale deforestation,
- increased urbanization,
- faulty agricultural practices,
- Blocking of natural flow of water etc.

A. Heavy rainfall

Heavy rainfall for long period in continuation is the root cause of river floods because immense volume of water either through high-intensity rainfall or largescale snow-melt is the prerequisite condition for river floods. Heavy rainfall in the upper catchment areas of the concerned river causes sudden increase in the volume of water downstream. This causes overtopping of river banks by enormous volume of water and consequent inundation and flooding of flood plain areas. It may be pointed out that the occasional heavy rainfall resulting from strong rainstorms can cause severe floods only in those regions which are characterized by seasonal regime of rainfall or say seasonality of rainfall such as the regions of monsoon climate (rainfall during 4 wet summer months e.g. June to
September), Savanna climate (rainfall during wet summer months), Mediterranean climate (rainfall during wet winter months) etc. because of the fact that the rivers maintain very low flow and low discharge of water during most parts of the year and hence sudden torrential rainfall cause sudden increase in the volume of water which cannot be disposed off by the rivers immediately and thus the river banks are overtopped by the swelling water and instantaneous floods are caused.

B. Heavy spell of rainfall

Heavy spell of rainfall in arid and semi-arid areas where the rainfall is scant, low and infrequent causes flash floods because such areas have poor natural drainage systems and existing rivers and streams are unable to accommodate enormous volume water caused due to huge volume of runoff resulting from high intensity rainfall during occasional rainstorms. For example, unprecedented rainfall of 836.4mm between July 17, 1981 and July 21, 1981 in and around Jaipur city (Rajasthan, India: July 17-4.2mm. July 18-235.8mm July 19-353.6mm., July 20228mm, July 21-14.2mm) caused flash floods because the chocking and blocking of lateral drainage from the hill though the dunes by human activity has resulted in a situation whereby this catastrophic runoff could not be eased out (H.S.
Sharma, 1983).

C. Sinuous and meandering courses of the rivers

Highly a sinuous and meandering courses of the rivers obstruct the normal discharge of water and thus the velocity is reduced which delays the passage of water resulting into stagnation of water. Consequently, the meandering valleys are immediately over flown and meander deltas and loops are flooded.

D. Deforestation

Large-scale deforestation in the upper catchments is perhaps the most important anthropogenic factor of the causes of the river floods. Large-scale deforestation effected by man for various purposes (such as for extension of agricultural land, for the supply of raw materials to the factories, for domestic uses as firewood, for commercial purposes etc.) decreases infiltration capacity of the cutover land and consequently increases surface runoff which helps tremendously in increasing the magnitude of floods. It may be pointed out the dense vegetation allows maximum infiltration of rainwater into the ground because rain intercepted by forest canopy and thus reach the ground slowly in the from of aerials streamlets through the leaves, branches and stems of trees and hence infiltrates easily into the spongy soil layer, formed because of decomposition of fallen leaves (leaf litters). On the hand, in the absence of forests and other vegetation covers raindrops stake the ground surface directly and in case of heavy downpour the rainfall exceeds the limit of infiltration soon and thus maximum runoff is generated which reaches the rivers though rills, rivulets and streams and causes floods.

E. Increasing urbanization

Increasing urbanization also helps in increasing the surface runoff and therefore dimension and magnitude of floods because extension in the pucca ground cover through the construction buildings, courtyards, roads, streets, pavements, etc. reduces infiltration of rainwater significantly and increases surface runoff considerably which increases the volume and discharge of storm drains of urban areas. Thus the rainwater resulting from torrential rainfall is quickly disposed off though the city storm drains to nearby streams and thus the volume of river water is increased causing floods. Besides, obstruction of river flow due to bridges across the rivers, silting of river beds due to pouring of wastes and garages from the nearby centers, gradual encroachment of human settlement towards the channels and low-lying areas, filling of 'nallas' (natural urban drains), construction of new road and bridges etc. are also significant factors (related to urbanization) of floods which not only degrade the physical environment of the rivers and surrounding terrains but the recession of deluge also causes accumulation of human refuse, sewage materials, silts etc. bringing the epidemics and thus degrading the human environment in most of the reverie cities of alluvial regions of the developing countries in general and India in particular (Kanpur, Allahabad, Varanasi etc.located along the mighty Gnaga river are during example of degradation of environment caused by recurrent floods of the Ganga river at frequent intervals).

F. Faulty agricultural practices

In India valley side slopes of alluvial rivers are ploughed down to the channel transverse to the channel or say transverse to the contours (inordes to dry out the moisture accumulated due to alleviation during floods) during 'rabi season' (winter cropping season) and the farms are never irrigated. After the crops are harvested, the ploughed fields are baked hot in the scorching sunlight of summer month with the result loose soils become extremely dry. These dried soils are soaked with water during first summer showers and are slumped into the river bed by overland flow.This slumping of moistened soils result in the gradual silting of river bed. On the other hand, the cultivation of valley-side slopes reduces the gradient of river banks. These two processes flatten the valley and thus reduces the water accommodation capacity of the river valley with the result the river takes very little time in attaining its bank full capacity and afterward water spreads over the valley sides, inundates the low lying floods plains and helps in aggravating the flood situation.

Floods disaster in India

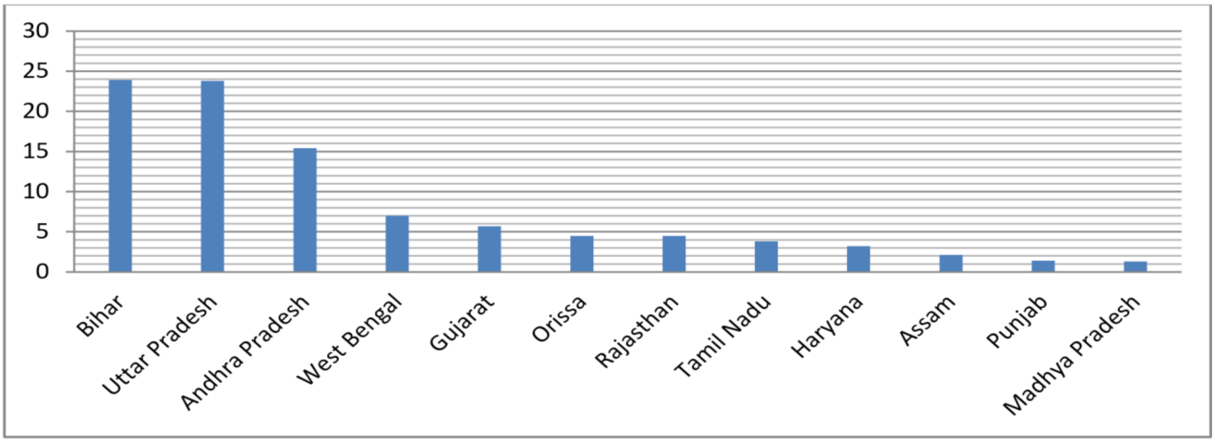
Most of the flood-prone and flood affected areas of the country are located in the northern parts mainly in the Ganga plain of the states of Uttar Pradesh, Bihar and West Bengal. The flood hazards and disaster in Uttar Pradesh, Bihar and Andhra Pradesh combined together account for 62 percent of the total damages causes by flood hazards in the country. Table 19.9 percents the state wise damages causes by flood hazard in India.

Table I

State-wise share of damage done by flood (in percentage) (average of 1971-78)

States	Share of damages (in percentage)	States	Share of damages (in percentage)
Bihar	23.9	Rajasthan	4.5
Uttar Pradesh	23.8	Tamil Nadu	3.8
Andhra Pradesh	15.4	Haryana	3.2
West Bengal	7.0	Assam	2.1
Gujarat	5.7	Punjab	1.4
Orissa	4.5	Madhya Pradesh	1.3

Source: National commission on floods, 1980, ministry of energy and irrigation, New Delhi.



'During recent years, both the frequency and intensity of floods have increased significantly. For example, compared to 1950-65, the average loss from floods got doubled in 1966-76 and went upto 3 times in 1971-75 and 5 times in 1976-78 showing a constant upward trend. According to another estimate, the loss caused by floods within two years (1976-78) remained more than 5 times as compared to earlier period of twelve years…As National Commission on Floods reports, the country suffers a damage of Rs.1000 cores every year on this account and the figure is rising steadily. What is more, the total area subject to flooding has double from 20 million ha (hectare) in 1971 to 40 million ha in 1981 (J. Singh and D.N Singh, 1988). Table 19.10 depicts the damages done by flood hazard in India during 20-year period (1953-75).

Table II Magnitude of flood damage in India

Details of damages	Average during 1953-75	Annual maximum damages
Areas affected by floods	7.4 million hectares	1.372 million hectares
cropped areas affected	3.1 million ha	7.6 million ha
Number of houses damaged	8,00,000	23,10,000
Number of cattle lost	50,331	270,000
Number of persons died	742	3,498
Total direct losses	Rs 2104 million	Rs 8,850 million

Source: National commission on floods, vol. I, Energy and Irrigation, govt. of India, 1980.

Management of flood disaster

The flowing steps should be taken for the reduction and management of flood hazard and disaster:

- Preparedness (P),
- Mitigation (M),
- Prevention (P),
- Rescue operation (R),
- Relief work (R),
- Recovery (R), and Rehabilitation.

Let as discuss the preventive steps first. The following floods control measures should be adopted to mitigate the adverse impacts of severe floods and to prevent ordinary floods:

Delay the return of runoff resulting from torrential rainfall to the rivers,

- Hasten the discharge of river water,

- ➢ Divert the flow of rivers, and
- ➢ Reduce the impacts of floods.

It may be pointed out that the floods are natural phenomena and one cannot entirely get rid of them but their impact can be minimized by mom's technological skill, better warning systems and positive human response to flood warnings and various control measures adopted by the governments.

A. **Delay the runoff**

The first and foremost step to control floods is to look into their basic cause which is perhaps the high intensity rainfall and resultant surface runoff. Man cannot stop high intensity rainfall and there is no need at all to interfere with natural processes. What man can do is to delay the return of surface runoff resulting from the high intensity rainfall to the rivers. This can be achieved by large-scale reforestation and forestation in the hilly source catchment areas of those rivers which are notorious for their reoccurring disastrous floods. The thick vegetal covers mostly of dense forests help in this regard in a number of ways as follows:

- ➢ Forests delay the return of rainwater to the rivers because these intercept the falling raindrops and leaf litters and herbaceous ground covers hold waters.
- ➢ These encourage more infiltration of rainwater and therefore reduce, though marginally, amount of surface runoff.
- ➢ These significantly reduce soil erosion and hence reduce sediment load of the rivers,
- ➢ Marked reduction in soil erosion and sediment load discourage siltation and hence reduction in the water accommodation capacity of the rivers etc. It is therefore apparent that making the hills, having the source of flood producing rivers, green though large-scale tree plantation can effectively reduce the frequency and dimension of floods.

B. Hasten the discharge of river water

It has already been mentioned that too much bends and meander loops in the highly sinuous and meandering rivers retard the quick disposal of water. It is , therefore, advisable to straighten the sinuous and meandering courses of the rivers at some place (where meanders and loops have become extremely sharpened) by performing artificial cutoffs of individual bends or a series of bands so that the flood discharge may move downstream more rapidly and the water may be disposed off by the rivers quickly. Such devices are required to train the alluvial rivers because these rivers (like all of the alluvial rivers of the Ganga plains e.g. the Ganga, the Ramaganga, the Rapti, the Gomti, the Gandak, the Kosi etc.) develop highly meandering courses due to alluvial filled flat terrain. There are two main difficulties in the implementation of these controls measures e.g. (i) the device requires huge mony which may not be easily forthcoming in the developing countries, and (ii) meandering is a natural process of alluvial rivers, if meanders are removed at some place the river may develop meanders at other places. The lower Mississippi river near Greenville (U.S.A.) was shortened in its length from 530 km to 185 km between 1933 and 1936 to reduce flood crests. Similarly, the Missouri river (U.S.A.) was shortened in its length by 52 km between Sioux City and its confluence with the Mississippi in 1960 for flood control and navigation improvement.

C. Reduce the volume of water

The volume of water during flood stage of a river may be reduced though a series of engineering device such as construction of flood-control storage reservoirs. Such storage reservoirs impound enormous volume of water during flood period and thus these help in two ways e.g. firstly, these storage reservoirs reduce the volume the water of the rivers, and secondly, these provide water for irrigation and drinking purposes. If the reservoirs are succeeded by huge dams, they also help in the generation of hydroelectricity.

Such flood-control reservoirs were constructed on Miami river in the state of Ohio (U.S.A.) as early as in 1913. A series of storage reservoirs were completed by 1921 and thus the scheme of the construction of storage become very popular in the U.S.A. the Tennessee basin of the U.S.A. was considered to be hell till 1933 because of perpetual water logging, recurrent floods, very high incidence of malaria, typhoid and tuberculosis, accelerated rate of soil erosion and increase in the infertility of the soils and wasteland. But the construction of a series of dams and reservoirs under the scheme of Tennessee Valley Authority (T.V.A.) since 1933 has not only controlled the recurrent floods and tamed the mad Tennessee River but has entirely changed the social and economic picture of the basin to such an extent that the basin once considered as 'hell and curse' is now considered as heaven.

The success of TVA attracted more countries to launch multi-purpose river projects for watershed management. The scheme was also implemented in India to check floods and for other purposes. The Damodar Valley Corporation (DVC), a multi-purpose river project, was launched on the line of TVA whereon 4 major dams and reservoirs have been constructed on the Damodar river and its tributaries such as the Barakar and the Konar rivers for water storage and flood moderation in the lower reaches of the Damodar river. Besides flood control, the DVC also generates hydroelectricity and provides water for irrigational purposes. 'The four dams namely Konar, Maithan, Panchet Hill and Tilaiya have a flood storage of 1603 milion cubic metres and have been in operation since 1958 and have helped considerably in the maderation of floods in the Lower Damodar Region' (K.L.Rao, 1975). Similarly, the construction of Ukai Dam and Reservoir on the Tapi (Tapti) river has almost saved the lower reaches of the river and the town Surat from the disaster of flood hazards. Many more examples may storage reservoirs of flood control.

D. Divert the flood water

Flood-diversion systems imply diversion of flood ware in lowlying areas, diversions or artificially constructed channels bordered by artificial dykes so that the flood crests may be reduced and the flood magnitude may be decreased. For example, Ghaggar Diversion Schemes divert the water discharge of about 340 comics (cubic metres per second) before entering Rajasthan (India) into the depressions and in the areas between the sand dunes during flood period so that discharge of water in the main river (the Ghaggar) during flood stage may be kept within the safe limits.

E. Reduce the impacts of floods

Embankments, dikes and flood walls are used to confine the flood water within the valley or say within a narrow channel. These engineering works include the building of artificial levees of earthen materials, stones or even concrete walls. Artificial bunds (levees) of mostly earthen materials have been constructed to proyect many of the riverine cities and towns in the Ganga plains (such as Delhi,Allahabad, Lucknow etc.). Construction of dikes or artificial levees was practiced long ago in China, India etc. but there were several cases of breaches of earthen dikes and consequent more disastrous floods than natural floods. 'for example dikes failures in great floods on the Hwang Ho River' (now yellow river) in China in 1887 brought inundation to an area of 50,000 sq miles (130,000 sq km) and deathby drowning to approximately one million persons' (A.N. Strahler, 1976).

Besides, protection to the towns and citied from floods by constructing dikes and other engineering structures such as revetments, artificial levees of earthen dikes are also contracted on either side of the river for longer distances to protect the flood plains from floods. For example, the Kosi flood embankments running for 246 km are being used to check the westward shifting of the Kosi river (in Bihar, India) and to protect the floods plains from recurrent floods and deposition of sands and coarse silts which used to render vast tracts of fertile lands unfit for cultivation. It may be pointed out that the Kosi river before the construction of flood embankments has shifted its course westwards by about 112 km. the 246 km long embankments on either side of the Kosi river have been kept wide apart about 12 to 16 km so that broad areas confined between the artificial walls (embankments / dikes) may serve as silt trap.

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