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Flash Floods: Challenges and its Management

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Flash Floods Challenges & Its Management

H C Singh
Executive Engineer, Irrigation Division, Nainital, Irrigation Department, Govt. of Uttarakhand
singh.harish.harishchandra@gmail.com

INTRODUCTION

Flash floods are characterized by very fast rise and recession of flow of small volume and high discharge, which causes high damages because of suddenness. This occurs in hilly and not too hilly regions and sloping lands where heavy rainfall and thunderstorms or cloudbursts are common. Depression and cyclonic storms in the coastal areas of Odisha, West Bengal, Andhra Pradesh, Karnataka, and Tamil Nadu also cause flash floods. Arunachal Pradesh, Assam, Odisha, Himachal Pradesh, Uttarakhand, the Western Ghats in Maharashtra and Kerala are more vulnerable to flash floods caused by cloud bursts. Sudden release of waters from upstream reservoirs, breaches in landslide dams and embankments on the banks of the rivers lead to disastrous floods. Severe floods in Himachal Pradesh in August 2000 and June 2005, and in Arunachal Pradesh in 2000 are a few examples of flash floods caused by breaches in landslide dams. Floods in Assam, Bihar, Uttar Pradesh, Odisha and Andhra Pradesh are generally caused by breaches in embankments. Incidents of high intensity rainfall over short durations, which cause flash floods even in the area where rains are rare phenomena, are on the rise and the problem needs to be tackled in a scientific manner.

Floods are recurrent phenomena in India from time immemorial. Floods of varying magnitude, affect some or the other parts of the country, almost every year due to different climates and rainfall patterns. With the increase in population and developmental activities in the country, there has been a tendency to occupy the floodplains, often resulting in serious flood damages and loss of lives over the years. Of late, some areas, which were not traditionally prone to floods, also experienced severe inundation. Floods cause severe bank erosion if the river banks are fragile and not protected against the heavy flood discharges.

India is one of the most flood-affected countries in the world. There is not a single year when some or the other part of the country does not get inundated during floods.

The floods are now considered as natural disaster. But unlike other natural disasters such as, earthquakes, landslides, etc, it is possible to manage floods to a great extent. As widely known, there are two options for flood management viz. structural measures & non-structural measures. The modern flood management strategy is a judicious mixture of both options.

Measures for flood management and erosion control different measures have been adopted to reduce the flood/erosion losses and protect the flood plains. Depending upon manner in which they work, flood protection and flood management measures may be broadly classified as under.

Non-structural Measures

The non-structural methods to mitigate the flood damages are as under:

- Flood Plain Zoning;
- Flood Forecasting, Flood Warning and evacuation of the people;
- Flood Proofing; and
- Living with Floods.

Govt. of India has given model draft for flood plan zoning but unfortunately after lapse of about more than four decade most of the state governments have not implemented it in true sprite.

Structural Measures

The structural measures for flood management/ erosion control (may further be classified into long term measures and short term measures) which bring relief to the flood prone areas by managing the flood flows and thereby the flood levels are:

- ❖ Creation of reservoir;
- ❖ Diversion of a part of the peak flow to another river or basin where such diversion would not cause sizeable damages;
- ❖ Construction of flood embankments;
- ❖ Channel improvement;
- ❖ Watershed management;
- ❖ Construction of spurs, groynes, studs etc.;
- ❖ Construction of bank revetment along with launching apron;
- ❖ RCC porcupines in the form of screens, spurs, dampeners etc.; and
- ❖ Vetivers, geo-cells, geo-bags etc.

The structural measures for flood management mentioned above are designed as per BIS codes. However, many works like RCC porcupines, Geotextile materials, vetivers etc are not covered in the existing BIS codes.

Flood Damages in India

As per record available damage due to flood in India during 1953-2010 are shown in **Table 1**.

Causes of Floods

Inadequate capacity of the rivers to contain within their banks the high flows brought down from the upper catchment areas following heavy rainfall, leads to flooding. The tendency to occupy the flood plains has been a serious concern over the years. Because of the varying rainfall distribution, many a time, areas which are not traditionally prone to floods also experience severe inundation. Areas with poor drainage facilities get flooded by accumulation of water from heavy rainfall.

Table 1 Flood damages in India during 1953-2010

Item	Unit	Average Annual Damage	Maximum Damage	
			Extent	Year
Area affected	MHa	7.06	17.50	197
Population affected	million	36.86	70.45	1978
Human lives lost	nos.	1611	11316	1977
Cattle lost	nos.	93202	618248	1979
Cropped area affected	MHa	3.46	10.15	1988
Damage to crops	Rs crore	703	4247	2000
House damaged	nos.	1193877	3507542	1978
Damage to house	Rs crore	276	1308	1995
Damage to public utilities	Rs crore	828	5605	2001

Excess irrigation water applied to command areas and increase in ground water levels due to seepage from canals and irrigated fields also are factors that accentuate the problem of water logging.

The problem is exacerbated by factors such as silting of the riverbeds, reduction in the carrying capacity of river channels, erosion of beds and banks leading to changes in river courses, obstructions to flow due to landslides, synchronization of floods in the main and tributary rivers and retardation due to tidal effects.

Planning & Design of River Embankment:- GFCC Guidelines has recommend that the embankments shall be designed as per the provisions of IS 12094-2000. This standard covers planning and design of river embankments (levees) on dry land. The salient features/main design aspects covered in this code are described in the following paragraphs:-

Design High Flood Level

Protection of agriculture land- 25 year flood frequency. Protection of township, Industrial area- 100 year flood frequency

Free Board

1.5 m over design HFL (for $Q<3000$ Cumecs) 1.8 m over design HFL (for $Q\geq 3000$ Cumecs)

Planning & Design of Groynes/Spur (IS 8408-1994)

This standard covers the planning and design of Groynes (Spurs) in alluvial rivers.

Design Discharge: should be equal to that for which any structure in close proximity is designed or 50 year flood whichever is higher.

Length of spur: Normally effective length should not exceed 1/5th of width of flow. Spacing of spur is normally 2 to 2.5 times the effective length.

Top level: Depends on the type namely submerged, partially submerged and non-submerged and will be best decided by model experiment.

Flood discharge: It may be worked out from Dicken's formula.

$$Q = C \times A^{3/4}$$

Where, Q = Estimated peak flood in m^3/sec ,

A = Catchments sq km

Value of C = (12-14 for Hilly area, 11-14 for North Indian region

The silt factor $f = 1.76\,(D50)^{1/2}$

Scour Depth - "D"= $0.473(Q/f)^{1/3}$

where, D = the depth of scour below HFL,

Q = discharge in Cumec,

f = silt factor

Lacey's Waterway (IS Code 6966- Part-I, Clause 10.2):

Lacey's Waterway = $4.89\,Q^{1/2}$

Computation of velocity of flow $Q= A \times V$.

Spurs may be aligned either normal to flow direction or at angle pointing towards u/s or d/s of the flow. A spur pointing u/s of the flow repels the flow away from the bank and is known as repelling type spur/groyne. When a short length spur changes only direction of flow without repelling, it is known as deflecting spur/groyne. Spur pointing d/s of the flow attracts the flow towards the bank and is known as attracting spur/groyne. Generally, repelling type or deflecting spurs are provided for anti- erosion measures. Repelling type spurs may be kept at an angle of 5 to 10 degree against the direction of flow.

Checking for destabilizing forces e.g. Hydrodynamics Drag & Lift-

As per IS code 14262 (Planning and Design of Revetment- Guide Lines), Stone used in revetment for river bank protection is subjected to hydrodynamic drag and lift forces. Weight of the stone on horizontal bed may be expressed as:

$$W = 0.02323 \times S_s \times V6 / (S_s - 1)^2$$

Where, W = weight of stone in kg,

S_s = specific gravity of stone,

V = mean velocity of water in m/s

Computation of 'discharge for non-uniform and composite cross-sections (As per IS Code 2912- Liquid Flow Measurement In Open Channels - Slope-Area Method

The discharge of a stream in a particular reach shall be calculated from the formula (Para 10 of the IS Code)

$$Q = K \times S^{1/2}$$

$$K = 1/n \times (A \times R^{2/3}),$$

Where:- Q is the discharge in Cumec,

S is the friction slope in m/km, and,

n = Manning's Coefficient of Rugosity

Design of Launching Aprons

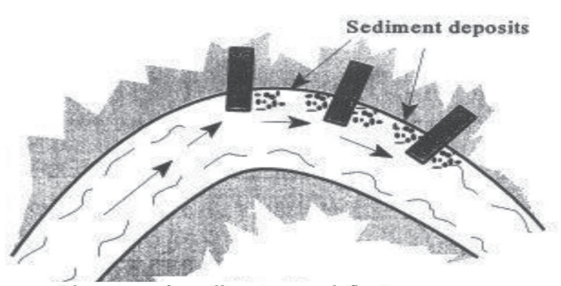
As per IS 8408 Clause 5.9.2, the S code, directs that the scour depth at the nose of spur is to be designed for a maximum scour depth of 2.0 to 2.5 times the normal scour depth.

Thickness of protection works

The slope of launched apron is to be taken as 1.5 H: 1V as per the provision in IS Code 10751 (Planning and Design of Guide Banks For Alluvial Rivers).

Report of working group on flood management and region specific issues for XII plan Published by the Planning Commission, Government of India During October2011.

In order to formulate 12th five year plan, the Planning Commission constituted various Working Groups. The Working Group on Flood Management and Region Specific Issues was constituted under the Chairmanship of Prof. Nirmal Sengupta of IGIDR, Mumbai with Commissioner



Plan view of repelling type or deflecting spurs

(Ganga), MOWR as Member- Secretary. The working group recommendations submitted to planning commission for the 12th Plan regarding the river dredging/river channelization are as below are:

Channelization of Rivers

Some of the States are proposing channelization of rivers, at least in certain reaches, in the context of tackling the extensive meandering problems of the rivers, activating navigational channels and training these rivers into their original courses. While venturing to channelize rivers, thought must be given in allowing the river certain freedom to flow and right of way to pass its flood waters and silt load within its natural waterway. The dynamic nature of the rivers should be appreciated and preventive measures planned accordingly instead of pinning down the river by channelizing.

Channel Improvement

The method of improving the channel by improving the hydraulic conditions of the river channels by desilting, dredging, lining etc., to enable the river to carry its discharges at lower levels or within its banks has been often advocated but adopted on a very limited extent because of its high cost and other problems.

Dredging operations of the Brahmaputra, which were undertaken in the early seventies on an experimental basis, were discontinued because of their prohibitive cost and limited benefits. Dredging in selected locations may perhaps be considered as a component of a package of measures for channel improvement to check the river bank erosion subject to techno-economic justification. It may be economically justifiable as a method for channel improvement where navigation is involved. Dredging is sometimes advocated for clearing river mouth or narrow constrictions.

Comparison for measures taken in Mandakini Valley after Kedarnath flood & Jhelum Valley after Kashmir flood

Alluvial rivers are usually meandering in nature and, therefore, raise problems of erosion and silting at various locations. This is a natural phenomenon and results in loss of land at one location and gain at some other. Generally, there is a tendency of the meander to shift progressively downstream. The process of bank erosion is, therefore, consistently active and measures for protection of banks are a recurring necessity. Anti-erosion works are normally taken up only for protection of towns, industrial areas, groups of thickly populated villages, railway lines and roads where re-location is not possible on socio-technoeconomic grounds, long lengths of vital embankments benefitting large areas in case retirement is not technically or otherwise feasible and agricultural lands where the cost-benefit ratio justifies such works.

There was a catastrophe in Mandakini valley on 16th& 17th June 2013 due to bursting of Chorbari Lake which was situated at an elevation of approximately 3746 m above mean sea level upstream of Sri Kedarnath temple, After the catastrophe/cloud burst of June2013, when the debris deposited on the hill slopes were washed to the Mandakini River, the quantum of debris was much more than the carrying capacity of the river due to which Mandankini river bed was raised from 5 to 8. M. These extra debris are being transported to the downstream during the Monsoon period, the river is yet to achieve the regime conditions. Dredging will accelerate the movement of debris deposited in the upstream towards the dredged area, and during the first rain the dredged stretch of the Mandakini River may be aggregated to its original level due to deposition of eroded material from the upstream side of Mandakini & Songanga due to steeper slopes.

i. Upstream of Sonprayag, the river bed slope of Mandakini has been computed as approx. 66m/Km, and for the Songanga river as 63.70m/Km while as the Mandakini river bed slope in the proposed river stretch for dredging is 52.5m/km & after dredging this river stretch, the changed river bed slop will be 59.0m/km, this indicates that the debris in the river bed of Mandakini as well as Songanga will have a tendency to move towards the downstream side till the regime flow of the river is attained.

ii. After disaster in June 2013 in Kedarnath Valley, the Mandakini River slope downstream of Sitapur/Byung diversion side upto Ukhimath town has been computed as 30.44m/km, that indicates that the Mandakini River will not be able to transport the additional bed load from the upstream of Sitapur towards the downstream side due to gentler river bed slops in the downstream due to which, the river current will slack down and most of the bed load will drop there itself, thereby further reducing the river bed slope, resulting in more aggradation to the river bed.

iii. It is very difficult to maintain the straight dredged channel of the river due to the tendency of erosion of bed & banks and deposition of shoal in the river bed, again to form a sinuous channel. This tendency will be more dominant as the river flows in a concave shape in the river stretch proposed to be dredged, as the river have got a tendency to erode along the outer bank and deposition along the inner bank.

iv. Heavy bank protection will be needed to protect the bank to retard the meandering tendency of the river, which is a natural phenomenon for the rivers, especially in the hills where the bed slope are high.

Hence throughout Mandakini valley after disaster in Kedarnath in June 2013. Intensive anti-erosion/bank protection works have been executed to protect the area, from the probable erosion due to the river flow/meandering tendency of the river.

The low carrying capacity of the Jhelum river is due to very mild slope of the order of 1/10000 between Sangam and Wular lake resulting in very low flow velocity in the river reach of about 96 km. This slope also results in steep rise of river water level in case of high discharge in river. The bowl shape of the valley and very mild slope of river makes the area between Sangam and Wularlake susceptible to flooding in case of heavy rainfall in the drainage area. This aspect needs to be considered while taking any future development work in the adjoining area of Jhelum between Sangam and Wularlake.

To reduce flood damage and to increase the flood routing efficiency of Wullar Lake, & the enhancement of discharge capacity of River Jhelum in general and of out fall channel it requires immediate dredging on short term basis to develop hydraulic efficiency of water courses system of the valley. The bed grade of River Jhelum from its source up to Wular Lake and from Wular Lake up to Khadinyar Srinagar O.F.C is very mild and from Khadinyar onwards the grade increase rapidly while flowing through Uri into Pak Occupied Kashmir. Under regard of same there is a large scope of increasing the bed grade of out fall channel from Ningli (Sopore) up to Gantmulla, which can tremendously increase the discharge carrying capacity of out fall channel as well as that of Jhelum. Total Estimated quantity to be dredged out from river Jhelum from different stretches is approx. to the tune of 18.001 lac cum.

The above details indicate that in the channelization work of Jhelum River, the river section is being

widened and slope is proposed to be steeped from very mild to enhance the discharge carrying capacity of the river, as to avoid the submergence of city population. This can be achieved as the river slope beyond the outfall channel is steeper than that of the Jhelum River in Srinagar City, while as in case of Mandankini River, it is not so & these is every possibility for scouring of bank, movement of debris & dredged bed may be silted in the very first rains/flood so intensive anti-erosion/bank protection works has been executed in Mandakini Valley as an protection measure.

Eroded bank of Mandakini Valley after Kedarnath flood

Flood protection work carried out in Mandakin valley

Hence, from above it may be stated that various measures may be adopted as per situation which may be different for different locations.

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