ASSESSMENT OF FLOOD IN GAUGED AND UNGAUGED CATCHMENTS

Estimation of flood magnitudes and their frequencies has been engaging attention of the engineers the world over since time immemorial, as this information is needed for design of different types of hydraulic structures. As per Indian design criteria, frequency based floods find their applications in estimation of design floods for almost all the types of hydraulic structures viz. small size dams, barrages, weirs, road and railway bridges, cross drainage structures, flood control structures etc., excluding large and intermediate size dams. For design of large and intermediate size dams probable maximum flood and standard project flood are adopted, respectively.

Whenever rainfall or river flow records are not available at or near the site of interest, it is difficult for hydrologists or engineers to derive reliable flood estimates directly. In such a situation, flood formulae developed for the region are one of the alternative methods for estimation of design floods, especially for small to medium size catchments. The conventional flood formulae developed for different regions of India are empirical in nature and do not provide flood estimates for desired return periods. Considering wide applicability of the frequency based flood estimation approach and need for development of regional flood formulae for estimation of floods of various return periods for the ungauged catchments, regional flood formulae using the L-moment based approaches have been developed for various regions of the country such as: (i) Mahi and Sabarmati subzone 3(a), (ii) Lower Narmada and Tapi subzone 3(b), (iii) Upper Narmada and Tapi subzone 3(c), (iv) Mahanadi subzone 3(d), (v) Upper Godavari subzone3(e), (vi) Lower Godavari subzone 3(f), (vii) Krishna and Penner subzone 3(h), (viii) Middle Ganga plains subzone 1(f), (ix) Sone subzone 1(d), and (x) North Brahmaputra region.

TECHNOLOGY

Following two types of approaches are proposed for estimation of floods of various return periods for small to medium size gauged and ungauged catchments lying in the respective subzones/regions:

(i) Regional flood frequency relationships for estimation of floods of various return periods for gauged catchments, and

(ii) Regional formulae for estimation of floods in ungauged catchments for various return periods.

For Gauged Catchments

Procedure for estimation of floods of various return periods using regional flood frequency relationships developed for small-size gauged catchments is mentioned below:

Step-1: Compute the mean annual peak flood (MAF) in cubic meter per second for the gauged catchment by taking the mean of the annual maximum peak flood values observed at the gauging site of the catchment during various years.

Step-2: Substitute the value of MAF computed in Step-1 and value of the desired return period (T) in the regional flood frequency relationship of the respective subzone/study area and compute the flood of desired return period (Q_T). For example, the regional flood frequency relationship for subzone-1(f) is given by:

$$Q_T = \left[47.534 - 46.8\left(-\ln\left(1-1/T\right)\right)^{0.01}\right] * MAF \quad ...(1)$$

where, Q_T is flood in cubic meter per second for T year return period, T is return period in years, and MAF is the mean annual peak flood for the catchment in cubic meter per second.

Alternatively, compute the flood of desired return period (T) by multiplying the value of MAF of the catchment with the corresponding value of growth factor of the respective subzone/study area. For example, for subzone-1(f), the values of growth factors for some of the commonly adopted return periods, viz. 2, 10, 25, 50, 100 and 200 years are given below.

Values of growth factors (Q_T/MAF) for various return periods

Subzone/ Region	Return Period (Years)					
	2	10	25	50	100	200
1(f)	0.906	1.776	2.209	2.527	2.840	3.151

For ungauged catchments

Procedure for estimation of floods of various return periods using the developed regional flood formulae for small size ungauged catchments lying in the respective subzones/regions is mentioned below:

Step-1: Find out area of the ungauged catchment (A) in square kilometres.

Step-2: Substitute the value of catchment area (A) mentioned at Step-1 and value of desired return period (T) in the regional flood formula of respective subzone/ region. For example, regional flood formula for subzone-1(f) is given by:

$$Q_T = \left[34.842 - 34.304 \left\{ -\ln\left(1 - \frac{1}{T}\right) \right\}^{0.01} \right] A^{1.084} \quad ..(2)$$

where, Q_T is flood in cubic meter per second for T year return period and A is the catchment area in square kilometres.

The tabular form and graphical representation of these regional flood formulae have also been prepared.

ENVIRONMENTAL IMPACT

As the above methodology is meant for estimation of floods of various return periods for small hydraulic structures and small-scale flood control measures etc., it will not have any adverse impact on the environment.

ECONOMICS

Overestimation of design flood results in increase of the cost of a hydraulic structure and under estimation of design flood leads to increased risk of failure of a hydraulic structure. Hence, the rational flood estimates obtained from the regional flood formulae will help in optimal economic design of the hydraulic structures and flood protection schemes. Therefore, it has both tangible and intangible benefits.

BENEFICIARIES

Central and State Government Organisations including other Professionals involved in planning, design and operation of water resources projects and flood protection works.

INTELLECTUAL PROPERTY RIGHTS

The regional flood frequency relationships for the gauged catchments and the regional flood formulae for ungauged catchments have been developed at the National Institute of Hydrology, Roorkee. Therefore, the Institute owns the IPR of this technology.