TECHNICAL SESSION - VII

MANAGEMENT OF FLOODS

General Report
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Major water resources schemes are generally constructed at potential sites located in the mountainous areas which are characterised by steep slopes, will defined boundaries, thin soil, high rainfall and low evapotranspiration. Now a days small hydropower schemes are being planned in mountainous catchments to meet the growing demands of electricity because of rapid industrialisation and increase in population. For planning and design of such schemes the estimation of design flood is one of the important tasks before the hydrologists. It involves estimation of design storm which could be a probable maxinum storm (PMS) or a standard project storm (SPS) and then deriving the design flood hydrograph using an appropriate rainfall-runoff relationship. Various methods which have been used for design flood estimation include rational method, empirical method, flood frequency method, unit hydrograph technique and event based watershed models (lumped and distributed). The rational method and/or the emperical method should be used to provide the preliminary estimates for the design flood peak as these methods have limited applicability particularly in mountainous areas. The frequency analysis approach is statistical methods to predict the flood peaks of a specified return period. The application of this approach to mountainous areas particularly for snow fed basins is required to be investigated before its results are utilised for the design of the water resources schemes. Unit hydrograph technique is one of the most widely used techniques available for the estimation of the design flood hydrograph. But the direct application of this technique to mountainous areas is questionable due to inherent assumption of the uniform precipitation in time as well as in space. In mountainous areas, the characteristics of precipitation are influenced by orographic effects and the storms have non-uniform spatial and temporal precipitation. With the advent of high speed digital computers number of event based models (lumped as well as distributed models) have been developed and applied for the estimation of design flood by many investigators.

The event based distributed models capable of representing the spatial vairability of the precipitation overcomes many of the deficiencies associated with the event based lumped models including those based on the unit hydrograph technique. Thus the distributed models are likely to give bettter estimates for design flood provided the spatial distribution of the probable maximum precipitation (PMP) values are known.

Flood forecasting is the another area which is of fundamental importance to the hydrologists. In order to formulate an accurate, reliable and timely forecasts no. of deterministic flood forecasting models have been developed and applied. These models can be foradly classified in two graphs (i) flood routing models and (ii) real time rainfall-runoff models. Both types of models can be empirical, system theoretic or conceptual. An operational forecasting system may, however, incorporate both types of models.

In many cases, mountainous areas have no well defined flood plains to store water as the hill side slope continues right down to the stream bank. As a result flash flood usually occur in mountainous catchment. Techniques have been developed to formulate the flash flood forecast

which is important from the point of view of safety of water resources structures, flood control and flood warning to the down stream people in the mountainous areas.

There are following ten papers for presentation and discussion in this session on theme "Management of Floods".

1. Kinematic Wave Modelling : where do we go from here?
   - V.M. Ponce (USA)

2. A Model on Reservoir to Reservoir Routing and Estimation of Net Discharge from Reservoirs
   - G.C. Basu (India)

3. Assessment of Design Flood Peaks for Rongai Barrage in Meghalaya
   P.R. Rao (India)

4. Estimation of Design Inflow Flood for Existing Reservoirs - Case Study of Linganamakki Reservoirs
   - P.R. Mallikarjuna, H.B. Sathish Kumar, S. Radhakrishna (India).

5. Real-time Flood Forecasting - A Case Study for a Small Basin
   - S.K. Jain (India)

6. Reservoir Operation Using Stretched Thread Rule
   - S.K. Jain, M.K. Goel (India)

7. Simulation of Flood Flows in a Mountainous Catchment in Western Ghats
   - M.K. Jain, K.S. Ramasastri (India)

8. Flood Frequency Estimates for Sub-Himalayan Region by Regional Flood Frequency Approach
   - Rakesh Kumar and R.D. Singh (India)

9. Considerations in Design Flood Estimation of a Diversion Dam in Ethiopia
   - Vijay Kumar (India)

10. Rainfall Runoff Study of Vamsadhasa for Improved Flood Forecasting
    - C.S. Sastry (India).

In paper No. 1, 2 and 7 different forms of the rainfall-runoff relationships are investigated with particular reference to mountainous catchments. The paper No. 3, 4, 8 and 9 discuss the problems pertaining to design flood estimation. The paper No. 5 and 10 deal with the flood forecasting problem in small mountainous catchments. The paper No. 6 describes a methodology for reservoir operation.

Paper 1 : Kinamatic Wave Modelling : where do we go from Here?
- V.M. Ponce (USA)

It is an excellent review paper which focuses on three areas of concern : (i) the applicability of kinematic waves, (ii) the role of numerical diffusion in kinematic wave modelling, and (iii) the nature of kinematic shock. Author has cautioned about the numerical diffusion problem which is likely to creep up when applying the kinematic wave to overland flow and streamflow in the context of a numerical computer model. In this regard the author has suggested that the method of matched diffusivities can be used to solve both kinematic and diffusion waves problems. However, more research is needed in to the nature of kinematic shock and its relevance to the modelling of flash floods. The role of the Vedernikov number in flood wave diffusion has been briefly discussed in the paper. An important question

has been raised "can a hazard rating be established for flash floods, in terms of regional climate, catchment geology, physiography and drainage density and channel slope, friction and cross sectional shape ?".

Paper 2 - A model on Reservoir to Reservoir Routing and Estimation of Net Discharge from Reservoirs
- *G.C. Basu (India)*

The paper attempts to present a model consisting of n-linear unequal linear reservoirs in series for simulating the response of a mountainous catchment. The procedures have been suggested for finding the storage co-efficients for each linear reservoir by summing up all the levels of the reservoir. I wonder how the author would estimate the storage levels and outflows for different linear reservoirs unless the storage co-efficients for each reservoir are known? It seems to me that the paper is just a mathematical representation of some hypothetical ideas of the author and it has no relevance for the application to the field problem. However, the author may clarify : (i) the type and amount of data needed for the calibration of the parameters (including computation of excess rainfall) and (ii) calibration procedure in order to enhance the practical utility of the proposed model.

Paper 3 - Assessment of Design Flood Peaks for Rongai Barrage in Meghalaya
- *Dr P.R. Rao (India)*

This paper presents design flood peaks of various return periods, SPF and PMF assessed for the Rongai Valley Irrigation Scheme of Meghalaya. The author adopted an approach which is based on the practical consideration since water use projects cannot be delayed for the want of data of adequate quality and quantity. Author has suggested that the Hydrological and Meterological data collection is essential to enable review and to implement corrective measures if found necessary. It would be interesting to comapre the results obtained based on the above approach using limited information to that derived from the adequate data for no. of schemes where hydrological and meteorological data have been collected after setting up the appropriate instrumentation network. It may give some qualitative idea about the corrective measures which have to be implemented.

Paper 4 - Estimation of Design Inflow Flood for existing Reservoirs - Case study of Linganamakki Reservoir
- *P.R. Mallilarjuna et. al (India)*

The paper explains the methodology adopted for estimation of probable maximum flood of Linganamakki dam and the constraints imposed on the routed flood for safety of the Honnavor town. The paper also includes the recommendations of a commission of Enquiry appointed by Government of Karnataka for ensuring the safety of downstream people. It is a case study which has been taken up to review the design flood of Linganamakki dam. In the paper it has been stated that the peak of the design flood hydrograph is 6701 cumec for pre-reservoir condition and 14369 cumec for post reservoir condition. Authors may clarify about the pre-reservoir and post reservoir conditions and may explain methodology (in brief) which has been used to estimate the design flood peaks under two different conditions.

Paper 5 - Real Time Flood Forecasting - A case study for a small Basin
- *Dr. S.K. Jain (India)*

The paper presents an application of a non-linear routing algorithm for real-time flood forecasting in Kolar sub-basin of river Narmada. The algorithm is based on relationship between kinematic and storage routing models. This model has been developed in Japan and is being extensively used there. Author has made

an excellent effort in presenting a study involving the application of a non-linear routing algorithm. However, it would be interesting to examine the applicability of the various empirical relationships used in the model for Indian conditions by conducting the studies on similar lines for a large no. of sub-basins having different flow and physical characteristics. The author has rightly pointed out that the model results are required to be compared with those using linear approaches like unit hydrograph etc. before recommending it for wider use.

Paper 6 - Reservoir Operation Using Stretched Thread Rule
- *Dr. S.K. Jain & M.K. Goel (India)*

The paper presents the stretched thread rule for the reservoir operation. The Stretched Thread Method offers a simple, computationally efficient and exact solution to the problem of derivation of reservoir operation rule curves as claimed by the authors. It has been reported in the paper that this method is superior to linear programming & dynamic programming techniques. The method has been applied for operation of Dharoi reservoir in Sabarmati Basin and the results are found to be encouraging. Authors may give step by step procedure for the benefit of the field engineers.

Paper 7 - Simulation of Flood Flows in a Mountainous Catchment in Western Ghats
- *M.K. Jain & K.S. Ramasastri (India)*

This paper attempts to derive the representative unit hydrograph for Hemavati sub-basin upto Sakleshpur using HEC-1 Flood Hydrograph Package based on Clark's Approach. The rainfall-runoff data for four events are considered for calibration. The performance of the model has been validated by reproducing the four independent events not used in calibration. Authors have concluded that the model is capable of reproducing the flood peak magnitudes, time to peak and overall flood hydrograph reasonably well. However, in my opinion, application of unit hydrograph technique is questionable due to inherent assumption of the temporal and spatial variability of the precipitation. Authors may clarify.

Paper 8 : Flood Frequency Estimates for sub-Himalayan Region by Regional Flood Frequency Approach
- *Rakesh Kumar and R.D. Singh (India)*

The paper presents the regional flood frequency analysis of sub-Himalayan Region (zone-7). Extreme value type-I, General Extreme value and wakeby Distributions have been considered in the analysis using (i) at site data, (ii) at site and regional data combined and (iii) regional data alone. The descriptive ability of these methods are tested based on some error functions evaluated from the historical records. Synthetic flood series have been generated using the regional EV1, GEV and wakeby parameters. The predictive ability tests have been performed with the generated data using Monte Carlo Experiments in order to identify the most robust method for the regional flood frequency analysis. The methodology used in the study is quite useful in developing the robust flood frequency curves for different regions in India. Further studies are needed on similar lines for other regions in India.

Paper 9 : Considerations in Design Flood Estimation of a Diversion Dam in Ethopia
- *Vijay Kumar (India)*

The paper describes the various considerations in Design Flood Estimation of Diversion Dam in Ethopia. It involves the estimation of design rainfall giving specific considerations to the Ethiopian hydrometereological conditions. Subsequently T-

year rainfall estimates are obtained using rainfall frequency analysis. Then design rainfall is distributed and applied over a unit hydrograph by Clark model to give Design Flood Estimates. The author may elaborate and clarify the following points:

(i) How the rainfall series has been developed from the historical rainfall data?

(ii) How the T-year design rainfall has been estimated?

(iii) How many event data are used for unit hydrograph derivation?

Paper 10 - Rainfall - Runoff Study of Vamshadhara Basin for Improved Flood Forecasting - *Prof C.S. Sastry (India)*

A simulation study of rainfall - runoff relationship of the typical hilly catchment of Vamshadhara river has been reported in the paper. The flood forecasts have been formulated using the synthetic unit hydrograph and Muskingum channel routing equations. The author may clarify the following:

(i) Methodology used for estimating the excess rainfall.

(ii) How Muskingum channel routing parameters have been estimated for gauged and ungauged river reach?

(iii) How lateral inflows have been considered during the Muskingum channel Routing?