Report on the International Seminar "Hydrology of Extremes" (Floods & Low Flows) organised by N.I.H., at Roorkee, Dec. 1-3, 1988.

The National Institute of Hydrology organised an International Seminar on Hydrology of Extremes (Floods & Low Flows) from December 1-3, 1988. The seminar was sponsored by UNESCO and the Indian National Committee on Hydrology. The International Association of Hydrological Sciences the International Association for Hydraulic Research and the International Water Resources Association co-sponsored the seminar.

The seminar was conducted in pursuance of the decision taken by the HILTECH Expert Committee dealing with IHP. The seminar was organised with a view to provide a forum for exchange of state of knowledge and field practices in dealing with extreme events among national and international engineers, scientists and researchers engaged in the study of problems relating to floods and low flows. The holding of the seminar by NIH also coincided with the Decennial Celebrations of the Institute.

At the inaugural session on 1st Dec. '88, while welcoming the delegates to the International seminar as also to celebrate the completion of 10 years by the institute, Dr. Satish Chandra, Director NIH highlighted the activities of the Institute since its inception and the importance of the theme of floods and low flows for the seminar.

The seminar was to be inaugurated by the Hon'ble Union Minister of Water Resources, Shri B. Shankaranand. However, due to some urgent engagements on Dec. 1st, Shri Shankarnand could not be present. In his absence, the Minister's address was read by Shri Y.D. Pendse, Member (P). Central Water Commission and Ex-Officio Additional Secretary to Govt. of India. In his inaugural address, Shri Shankaranand urged the engineers and Scientists to study the impact of deforestation on the hydrological processes in general and on the phenomenen of floods and low flows in particular. He emphasised on the need for a close cooperation and interaction between hydrometeorologists river managers, engineers and planners in the management of situations arising out of the extreme events namely floods and low flows. Shri Shankaranand impressed on the necessity for taking the methodologies developed in academic and research organisations for application by field organisations.

Shri M.A. Chitale, Chairman, Central Water Commission & Ex-Officio Secretary to Govt. of India, in his thought providing address called upon the engineers and scientists to take a proper perspective of the hydrology as a subject. He mentioned that while there are a number of meteorologists, civil engineers, what is needed is a new set up for breeding experts, who could be called hydrologists in the real sense.

In his scientillating chief guest address on 1st Dec., 1988 Shri C.C. Patel, formerly Secretary Irrigation, Govt. of India presented a scenario of water resources development and management practices currently being followed in the country. He suggested a number of measures for

reducing the negative impact of floods which included flood forecasting, flood warnings, flood preparedness, floods zoning. He stressed upon the need for performance evaluation of selected/ flood control schemes to find out actual benefits and compare them with those planned. Referring to the completion of 10 years by NIH, he has indicated that it has got an important role to play in guiding the studies for adopting scientific but pragmatic approach towards developing methodologies for modelling of hydrologic system. He has also highlighted the importance of setting up of a suitable data storage and retrieval system for hydrologic data in the country.

Fourty three technical papers for the seminar were discussed, during Dec. 1 to 3, 1988, in eight technical sessions covering the themes, Extreme storms and Extreme floods, Floods Frequency Analysis, Regional floods frequency analysis, Forecasting of floods, Low flows, statistical analysis of droughts and low flows and general aspects of floods and low flows.

About 125 delegates including 18 from abroad participated in the deliberations of the seminar. At the end of the seminar a concluding session was beld in which learned delegates expressed their views and useful recommendations were made, defining the objectives in clear terms and setting the course for future action.

Smt. Krishna Sahi, Hon'ble Union Minister of State for Water Resources who was to be Chief Guest at the Valedictory Function held on December 3, 1988 could not be present at the function due to delay in the flight reaching Delhi. Her valedictory address was read by Dr. Satish Chandra, Director, NIH. In her address Smt. Krishna Sahi stressed upon the need for adopting modern methods of hydrological observations and analysis and suggested wide application of satellites radars and computers for the purposes. She also emphasised upon the need for developing a suitable data base and information system for efficient handling of the data and its use for analysis and design.

Prof. Jai Krishna, former Vice Chancellor of University of Roorkee and an eminent engineer in his Presidential address called upon the scientists in India and abroad to work together in evolving strategies for the mitigation of hardships arising out of the natural catastropies like floods and low flows. Though structural measures for flood control are being adopted for so many years, there is need for evolving new methodologies of hydrological analysis of flood and low flows. Referring to the recommendations of the seminar he stressed the need for giving a practical shape to them so that social, economic and ecological balance in the country could be maintained.

RECOMMENDATIONS

Extremes have historically occupied a central position in hydrology. In fact, evolution of hydrological science is linked to treatment of extremes. It is, therefore, entirely befitting that this international seminar is devoted to hydrology of extremes.

Extreme events can, for purposes of discussion can be distinguished a high extremes and low extremes. Some example of high extremes are : extreme precipitation (rainfall & snow fall, as well as hails), extreme atmospheric behaviour (such as extreme winds, extreme heat, extreme cold, etc.), extreme floods caused by rainfall and/or snowmelt, floods caused by dam break occuring naturally or due to man-made causes, volcanic aruptions causing large quantities of debris, etc.. and seismic vibrations causing failure of hydraulic structures. Only some aspects of rainfall and

floods are covered in this seminar as other two aspects have been recently covered by seminars, notes on which were circulated separately.

Exemplifying, low extreme events are droughts, low flows, extremely low precipitation, low temperatures, etc. Low flows adversely affect agriculture, water quality, navigation, power generation, water supply and recreation. This seminar addresses only some aspects of droughts.

Traditionally treatment of extremes has been made for design of hydraulic works, drainage systems and water resources planning. Additional important applications of extremes are found in a broad spectrum of areas typified by planning military tactical operations, environmental impact assessment, drought mitigation, urban development, tourism and commerce, development of dam safety standards, navigation, waste disposal, to name but a few.

From a hydrological standpoint, prediction and forecasting, real time forecasting, frequency analysis, and environmental impact assessment are, amongst others, the most important aspects of treatment of extreme events. Development of technologies to address these aspects is greatly influenced by availability of data and land use change. Methods of analysis for gauged watersheds are usually not applicable to ungauged watersheds. Papers presented, at this seminar discuss methods for both the gauged and data scarce watersheds. These methods must take into account the effect of changing a land use. In some parts of the world it is found that a 100 year flood is now encountered on an average in 25 years, this same flood may be equalled or exceeded once in 20 years or less in future. In addition, even more alarming is going to be the effect of global climatic change or the so called 'green house effect'. How do we cope with this issue is likely to be a major question to be faced by hydrologists.

1. Probable Maximum Precipitation (PMP) and Probable Maximum Flood (PMF)

Determination of probable maximum precipitation values is required to derive probable maximum floods which can be considered as upper bounds to flood estimates obtained from flood frequency analysis. This seminar had some presentations which discussed extreme rainfalls and the philosophy of PMP in the United States. Some of the important questions that warrant immediate attention are :

i) A better definition of PMP, based on meteorological dynamics, that can be expected under the most favourable conditions for generation of maximum rainfall.

ii) Depth-area-duration relationships need to be developed for different regions,

iii) Methodologies need to be formulated for conversion of PMP to PMF taking into account antecedent basin conditions and physiography.

2. Flood Frequency Analysis

Estimates of different duration floods form the basis of hydrologic design of a wide spectrum of hydraulic works and environmental systems. These estimates are obtained using either point-frequency analysis or regional frequency analysis. The bulk of literature on flood frequency analysis is devoted to point frequency analysis. It is no surprise that in this seminar a similar pattern is perceptible. However, recent years have witnessed considerable activity on regional flood frequency analysis. In several papers presented in this seminar, important issues relative

to identifying the best fitting probability distribution, the best plotting postion formulae, objective detection of outlier and inliers, and the sample size were discussed. Some of the important questions remain yet to be resolved are :

1. Development of a physically based method for specifying the probability distribution underlying the observed flood series.

2. Objective treatment of outliers and inliers and their impact on flood frequency estimates, and on eventual hydraulic design and damage assessment.

3. Establishment of a uniform procedure for flood frequency estimates.

Regional flood frequency analysis is particularly useful in data scarce regions. The papers presented at the seminar discussed index method and regression analysis based on basin characteristics, and hydrometeorological homogeneity. Some of the outstanding issues that need to be addressed are :

1. Development of criteria for demarcation of meteorologically & hydrologically homogeneous regions.

2. Quantification of the effect of changing land use on flood frequency estimates.

3. Quant fication of the reliability of flood frequency estimates.

3. Flood Damage Assessment and Flood Zoning

Flood management includes all planning and actions needed to determine, implement and revise plans for the best use of flood plains and their water resources for the welfare of people. Its main objective is to strike a favourable balance between the benefits obtainable from the use of flood plains and the potential damages arising from such use. For modifying the flood various structural measures like reservoirs, embankments etc are adopted, while for reducing the susceptibility to damage and impact of flooding various non-structural measures like forecasting and warning, flood plain zoning, flood insurance etc. are adopted. Flood damaga assessment studies are essential in order to understand the severity of flood problem and to compare benefits and costs of a flood management measure, such as flood plain zoning. Such measures ensure that flood plain land uses are compatible with degree of hazard involved.

Some of the important issues that require immediate attention and study are :—

(i) Development of procedures for use of remotely sensed data alongwith other conventional data and watershed models in flood damage and flood zoning studies.

(ii) Development of systematic methodologies for flood damage assessment.

(iii) Methodologies for assessment of environmental impact of floods both for short and long periods.

(iv) Carrying out systematic flood zoning studies for selected river reaches.

4. Low Flows & Droughts

Relatively much less effort has been directed towards modelling droughts, event though their accumulated impact may be far greater than other natural calamities such as floods. Droughts may last long over large areas and cause much suffering. It is fitting that this seminar close to deal with this somewhat neglected but important area. In several papers presented in the seminar important aspects related to low flows and drought covered were classification of droughts, stochastic analysis and some lessons to be learnt from the severe droughts experienced in the world. The various hydrological characteristics of low flow as well as their application were also discussed. Some important questions that need to be addressed are :

1. Development of drought duration, magnitude, and frequency analysis. Areal coverage and time interval between droughts also need to be investigated.
2. Development of regional curves for low flow characteristics for data scarce regions.
3. Development of improved low flow forecasting procedures.
4. Development of monthly, seasonal and annual flow duration curves to assess the impact of drought on flow regimes.
5. Development of relationship between rainfall, riverflow and ground water recharge.
6. Development of indices for hydrolcgic assessment of severity of drought.

5. Flow Forecasting

Flow foreasting is one of the most important hydrologic tools for water resources planning, development and management. The papers presented in this seminar covered mathematical modelling techniques, and also data acquisition techniques with a view to real time forecasting. Some of the outstanding issues in this area are :

1. Development of adequate hydrological data networks, data acquisition and data transmission for river basins.
2. Testing and evaluation of reliability of existing mathematical models before new models are developed.
3. Linking flow forecasting to frequency analysis, for both aspects to streamflow. This link will help develop continue approach to streamflow synthesis.
4. Presentation of modelling methods and results for practical use by field personnel, planners, managers and administrators.

Observation

1. Dam Safety

Based on the notes on dam safety distributed to the participants in the seminar, the following issues are considered important :

1. Consideration of the differential hazard potential (with and without dam) design in the selection of dam.

2. For the energy dissipation, a more frequent floods may be considered for the hydraulic design.

3. The downstream channel capacity should be a guiding factor in release of flow from the dam, with a view to minimising the manmade flood downstream. However, this must not be at the cost of the safety of the dam.

2 Snow Hydrology

The role of snow hydrology in water resources development is well documented in developed countries. In recognition of this role a workshop was organised in Nov. 1988 at Manali in Himachal Pradesh. During the workshop, various aspects of snow hydrology relating to instrumentation, network design. snowpack simulation modelling, models to forecast streamflow for melting snowpack, glaciers effects on streamflow, induced snowmelt, remote sensing, were discussed. Some of the important issues that were considered appropriate for consideration by that seminar are as follows :

1, Instrumention for measurement of snowpack should be initiated for operational application. Method of measurement should be continually reviewed to include new technologies such as remote sensing etc.

2. Techniques should be developed to define the probable volumes of snowmelt and glacied melt runoff during the whole season for short term and long forecast.

3. An attempt should be made to match, couple and integrate remote sensing results with ground truths to evolve a suitable methodology for estimation/forecasting snow water yield.