INAUGURAL ADDRESS

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It is pleasure for me to have this opportunity to meet experts in hydrological science from India and different parts of world who have assembled here on this occasion. I am glad to note that this symposium is organised by National Institute of Hydrology and sponsored by UNESCO. Unesco's leading role in development of hydrology under International Hydrological Decade and subsequent programs is well known. National Institute of Hydrology was established in 1978 by Government of India as a UNDP assisted project. It is appropriate that this symposium is being held in Shimla, in the foot-hills of Himalaya and I am sure that this will provide much needed focus on hydrological problems of mountainous areas. I would like to take this opportunity to share some of my ideas and thoughts on hydrology and water resources development in mountains areas in India.

The Himalayas are the main source of supply for the rivers in the Indo-Gangetic plains both during monsoon season from rainfall and during the winter period from snow melt. The river Indus from which our country derived its name, the river Ganges which is worshipped by millions in our country, and also the mighty river Brahmaputra, all originate from the Himalayas. The intense heavy rainfall in mountainous areas to high flows in rivers causing problems of floods in the lower reaches, often sumberging standing crops and property and disrupting communications. The problem of floods varies from basin to basin and so also the magnitude of damages caused by floods. The recent floods in Jammu and Kashmir, Punjab and Himachal Pradesh are still fresh in our memory. The hydrology of mountainous areas, therefore, have an important bearing on our capability and preparedness for dealing with floods. Another important aspect of mountainous areas of our country particularly in the Himalayas is their being abode of large number of glaciers and snow covered areas. The physical aspects of snow and glaciers make them a much different process in comparison to normal rainfall runoff process. The problem is further aggravated due to relatively sparse network of observation stations and data base. Though India has made significant progress after independence in the application of new technologies of computer, electronics, and remote sensing applications in hydrological problems, their potential is yet to be fully utilised for dealing with problems of mountainous areas.

India has about 93.06 million hectare of mountainous area. There has been a long felt need to carry out systematic studies for the different problems typical of the mountainous regions. During the Eighth Five Year Plan special emphasis has been laid on the development of hill areas.

For all round development of the hill regions, it is necessary that a realistic assessment of the water resources of these regions is made and the utilization of the available water resources are judiciously managed. Unlike the heavy rainfall in the West Bengal and hills of Meghalaya, rainfall and snow in Himalayas is more evenly distributed during the year. While planning water resources development of the hilly regions it is essential that a systems approach is followed, so that the available waters could be appropriately used for different demands, such as drinking water, irrigation, hydropower generation, recreation, etc.

The information available from the mountainous regions is limited because of lack of proper hydrological network. Also some of the instruments which could operate in the plain regions do not work in the hilly regions because of low temperature, snow fall and rapid flows with boulder and sediment. It is, therefore, necessary to develop instrumentation suitable for use in high altitude regions preferably unattended for atleast three months.

We have to make efforts to improve the data base by establishing proper network for rain, snow, flow and other hydro-meteorological observations. But at the same time, suitable technologies have also to be developed for decision making under limited and inadequate data situations.

Mountainous areas pose problem not only due to high variability of climatic conditions, but also due to variability of physiographical conditions, leading to significant differences and variations in hydrological behaviour of mountainous catchments. Further complexities are also added due to presence of snow, glaciers and forests. Several agencies like Central Water Commission, India Meteorological Department, Bhakra Beas Management Board, Snow and Avalanche Study Establishment, and State Irrigation Departments are collecting information of meteorological and hydrological variables. However, the flow of information from one agency to another is impaired because of lack of standard storage media like computer tapes or computer disks, lack of standard format, etc. It is, therefore, imperative that a data bank is developed wherein all the available information could be pooled in and is made available to the users for studies and research.

Efforts are also needed for fully understanding the role of geomorphological factors in hydrological behaviour in hilly and mountainous areas. These have to be suitably incorporated in hydrological relationships and models. For this purpose, representative and experimental watershed studies have also to be carried out for small and medium watersheds representing major ecological and climatic zones for integrated and intensive hydrological studies.

The floods are caused by intense heavy rainfall, snowmelt or combinations of the two, which is some time made worse because of natural or man made obstructions due to construction of weirs and barrages, land slides, avalanches, etc. Sometimes floods are also caused by failure of dams. This problem is particularly serious in mountainous areas due to high velocities of flows resulting in flash floods. This makes it very difficult to forecast such floods sufficiently in advance. It is, therefore, increasingly necessary that sophisticated techniques of short term quantitative precipitation forecasting are used alongwith modern techniques of data observation and transmission including radar and satellite.

It would be desirable that these and other related issues of floods are carefully examined particularly with respect to floods in mountainous areas and suitable suggestions made. In the Indian context, the flood phenomenon has also to be looked into in the social point of view. Some of our mountainous areas are also potential earthquake zones. A combination of earthquakes, avalanches and dam breaks could cause catastrophic situation. Though such occurrence could be rare, there is need for proper understanding of these phenomenon and their like occurrence.

One more important feature of most of the Himalayan catchments is that some portions of the catchment of higher elevations remain always under permanent snowcover, whereas lower parts of the catchment come under snow cover temporarily during the winter months of November to February. Due to temperature rise from March onwards, the temporary snow starts melting gradually from lower elevations. In the later parts

of the snowmelt season, the effect of rain also comes into play. During monsoon months of July to September rainfall becomes much predominant, with some contributions coming from remaining temporary snowcover, besides melt water from permanent snow covered areas and glaciers. Besides the rugged topography and limited physical accessibility, the Himalayan basins are also faced with problem of limited data availability. This calls for use of modern techniques of data collection- and transmission including use of remote sensing satellites, for providing reliable data base for hydrological studies and analysis.

I understand that Central Water Commission has taken up systematic studies of a snow covered catchment in Yamuna basin, and it is also actively involved in Chota Shigri glacier expeditions alongwith scientists of National Institute of Hydrology and other organisations. These are steps in right direction for providing better understanding of hydrology of snow covered areas. A significant volume of runoff in the Himalayan rivers is contributed by snowmelt and glacial melt runoff. It is therefore, essential to develop appropriate methodologies for the estimation of spring season flow. I am happy to note that some efforts have already been made in this direction, but further work should be continued to develop forecasting capabilities. Our ability to predict rainfall and snowmelt runoff from mountainous areas has considerable economic importance in optimal operation of multipurpose reservoirs and control of floods. Suitable regional approaches would have to be evolved. I hope that this matter would be discussed in detail in the technical sessions.

While carrying out hydrological studies of small and medium watersheds, one should not forget about global nature of atmospheric processes. Various interactions of atmosphere and land surface processes would have to be already understood, then only some reasonably accurate forecasting of precipitation and consequent runoff is possible.

There is very much concern about greenhouse effect and global warning. Hydrologists and water resources engineers would also have to look into its influence on hydrological parameters. In the context of mountainous areas the study of such effects on melting of snow and glaciers would be much relevance.

Other important aspects include effect of afforestation/deforestation, effect of urbanisation, etc. on hydrological regime of river basins. The introduction of super computers for use in weather forecasting and use of satellites for land use characterization would make it possible for significant progress in this area in the country. Our scientists and engineers should be always receptive to new ideas and new technologies. I am sure that the deliberations at this symposium would lead to useful suggestions in this direction.

The study of erosion and sediment yield are particularly important for mountainous areas. These processes have considerable economic significance due to reduced soil depth leading to declining crop productivity and downstream transport of eroded sediment giving rise to raising of river beds, decrease in reservoir capacities and salutation of harbours. With increasing pressure of growing population, deforestation, and various human activities lead to increased erosion in mountainous watersheds. Suitable methodologies should be evolved for an integrated approach in watershed resources development and management. Hydrologists have to play a crucial role in this effort.

Snow, glaciers, springs, alluvial cones and high altitude lakes are reservoirs of water and study of the hydrology of these sources of water would help in harnessing the water resources especially in drought prone areas. It is not only essential to estimate the quantity but also to monitor the quality of water available from various sources in the mountainous

regions to meet the growing demand of water and to take appropriate measures to make it fit for human consumption. I understand that this aspect has been included in Symposium themes and would be discussed in the technical sessions. I am happy to learn that the National Institute of Hydrology has set up a Regional Centre in the Western Himalayan Region at Jammu for study of these problems. The advent of computer technology and introduction of personal computers have revolutionised the hydrological analysis and has made computerised analysis possible at a very small cost.

I am glad to not that hydrologists and engineers in India are aware of these problems and scientific developments taking place in other parts of the world for dealing with them. I understand that satellite information in increasingly being used for snow cover estimation for its use in snow melt runoff prediction models. I am happy to learn that the National Institute of Hydrology in cooperation with Central and State Government departments is taking steps to set up a National Snow Monitoring System for the Himalayas.

There is a tendency in academic and research organizations to work in isolation and developing sophisticated techniques while the field practices at large continue to remain at conventional level. To narrow down the gap between R&D effort and field practice, it is desirable that suitably trained man power are available in States for carrying out various hydrological and other studies needed for optimal planning and utilization of water resources. While working at national level for development of indigenous scientific capabilities and technologies, one can not keep aloof from similar developments elsewhere. In a way each mountain system is unique and solutions to its hydrological problems have to be found locally. It is also essential that the solutions to the hydrological problems of the different regions are found through increasing emphasis on hydrological research and studies at the regional level. Scientific cooperation and exchange of ideas is also very much desirable for dealing with sustainable development of the water resources of the mountainous regions. This international symposium should provide an opportunity for exchange of ideas and information among the scientists, academicians, field engineers and international experts. I have no doubt that this would lead to consolidation of useful information base and methodologies for dealing with multifarious and complex hydrological problems of the mountainous areas. I look forward to the recommendations of the deliberations at this symposium.

With these words, I am happy to inaugurate this symposium, and wish fruitful discussions and best success.

JAI HIND