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Snow Hydrology Project (UNDP) in Yamuna Basin - An Overview

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Hydrology is concerned with the study, understanding and evaluation of all the components of the hydrological cycle, quantitative evaluation of all factors that influence each of these components which requires adequate knowledge of the relevant factors relating to the science of the meteorology, hydraulics, thermodynamics, geology, soil mechanics and plant physiology.

Optimum water resources development would be facilitated by (i) evaluation of water stored in the snow pack (ii) its relation to the hydrologic balance, evaluation of rate of snow melt, and effect of snow-pack on runoff.

Snow supplies at least one third of the water used for irrigation in the world. In the northern region of India, the Himalayas (literally the abode of snow) play a very significant role in the country's economic life. The people of India have increasingly realized the tremendous value of the potential resources of the himalayas more particularly in respect of the water and hydroelectric resources which are of primary importance from the point of view of the economic growth in agriculture and industry. Despite the hazards it creates in the form of avalanche & disruption of transport system etc. Improved understanding and management of this valuable resources, is now recognized throughout the world as essential in the optimum production of food, in the design of rural and urban facilities and in the conservation of environmental standards while ensuring water resources development programmes including flood management, multipurpose beneficial use etc.

A good percentage of the Himalayan water is derived from the snows and glaciers which constitute a vast reservoir. Winter precipitation which occurs in the form of snow, in this part of the country, goes on accumulating till summer starts. As summer advances, the accumulations melt and release water into the streams. It forms the most important component in the spring runoff in Northern and North Eastern part of the country, as the origin of all major rivers is in the Himalayas. Hence a proper understanding of the likely snow contribution is a valuable asset in planning and development as well as judicious operation of water resources development schemes.

An appraisal of this source of water and its seasonal forecast would, therefore, constitute an inescapable need in the rational management of the national natural resources.

EARLY ATTEMPTS ON SNOW SURVEYS IN INDIA

The fact that most of the major river systems in the Northern part of India originate from the great Himalayas and as such there is considerable contribution of snow melt runoff in the flows of many of these rivers during spring season was

Water Commission took some pioneering steps in regard to snow surveys in the late forties and early fifties.

A meeting was held in August 1946 between the Central Waterways Irrigation and Navigation Commission (now Central Water Commission) and the India Meteorological Department to consider and lay down a general policy for collection of hydrological data in which snow surveying was discussed. It was decided to invite Dr. J. E. Church, the then Meteorologist, Agricultural Experiment Station, Reno, Nevada, U.S.A. and later President of the International Commission on Snow and Glaciers to visit India and initiate snow surveys and stream flow forecasting in the Himalayas and also to impart necessary training to Indian personnel in this science. Accordingly a formal invitation was sent by CWINC to Dr. Church who initially proposed the Satluj river basin to layout a system of snow surveys but as there was no past precipitation and river flow data available for any site above snowline in that basin, it was decided that the first snow surveys might be started in the Kosi and then Tista basins. Dr. Church arrived in India in March 1947.

U.N.D.P. PROJECT

During the last three to four decades, increasing demands upon the water resources of the country have resulted in the construction of many projects for the control of our river systems, thus bring about a need for a better understanding of the natural processes which govern their flow. In August 1979, the Govt. of India approved a pilot Project for the "Improvement of River and Flood Forecasting System in India" with the assistance of World Meteorological Organization WMO/United Nations Development Programme (UNDP) . As a part of this scheme a research project dealing with snow Hydrology was also included. This marked tne restart of CWC's active role in snow surveys after a long gap.

Accordingly, a Snow Hydrology Division to carry out the development of Snow Hydrology was sanctioned by the Govt. in May 1984. A small sub basin, called Sundli Nala, in the Upper Yamuna basin was selected as an experimental watershed for the surveys.

The snow Hydrology pilot project aims at imparting training to CWC personnel on snow data collection procedures, their installation and maintenance, and to develop snow melt runoff models for short range (flood) and long range (seasonal) river forecasting with the help of modern equipment and high speed computer.

Once sufficient experience is gained from the pilot project, the system could be interfaced with existing flood forecasting services for real time forecasting from snow melt. It could also be extended to other watersheds in due course.

Water equivalents should be as close as possible to the average actual water equivalent of the snow cover over the basin. For this snow course survey is to be done.

The ideal locations for snow courses in mountainous areas are:

1. At elevations and exposures where there is little or no melting prior to the peak accumulation.

2. At sites sufficiently accessible to ensure continuity of surveys.

3. At a gently sloping terrain, as flat areas may have poor drainage, and sampling difficulty increases with slope.

4. In forested areas where the sites can be located in open spaces sufficiently large so that snow falls to the ground without being intercepted by the trees.

5. At a site where possible future major changes in ground cover or timber stands is avoidable.

6. At a site having protection from strong wind movement etc.

Thus, the criteria for suitable snow course locations are the same as those for setting precipitation gauges for measurement of snowfall. In most places, the best snow courses for forecasting purposes are the most difficult to reach because most of the snow zones are not readily accessible. A snow course is of no value unless it can be measured on schedule. Accessibility, therefore, is an essential criterion in site selection. Locations near roads at high elevations are preferred if other requirements can be met to a satisfactory level.

METHODOLOGY FOR CALCULATION OF RUNOFF FROM SNOWMELT

The derivation of snowmelt runoff is a complex problem. Unlike rainfall, snowmelt is not generally measured quantitatively, but estimated indirectly from observations of meteorological parameters by a rational approach. Snowmelt is a function of energy transfer to the snow pack. The natural known sources of heat responsible for melting snow are following:

1. Absorbed solar radiation
2. Net long wave radiation (terrestrial)
3. Convective and advective transfer from the air (sensible heat transfer)
4. Latent heat of condensation from the air
5. Conduction of heat from then soil and surroundings
6. Heat content of precipitation

In application, however, few of these sources of energy are directly evaluated for a watershed.

Crops of Engineers, U.S. Army has developed generalized equation where some of the above mentioned parameters are lumped together into the following live components of melt.

1. Short wave radiation melt
2. Long wave radiation melt
3. Convection and condensation melt
4. Rain melt
5. Ground melt

A number of computerized hydrological watershed models which are being successfully utilized in applied hydrological

engineering river, forecasting and river management activities in the developed countries are available. Two such models developed by the Corps of Engineers, U.S. Army, mentioned below, are proposed to be utilized for calculation of snowmelt runoff, after sufficient data is observed in few years.

1. SSARR Model
2. HEC-1 F Model

Both these models are capable of computing snow melt runoff.

SNOW HYDROLOGY OBSERVATORY

As indicated earlier, the ultimate objective of the project is to determine snowmelt runoff on short and long range basis and the snow melt is a function of energy transfer to the snow pack. Hence to measure some of the concerned important meteorological parameters such as wind flow, net radiation, air temperature, humidity, atmospheric pressure, evaporation, precipitation, (snow and rain) etc. the following instruments have been obtained with the assistance of UNDP/WMO under the pilot scheme in addition to snow samplers, snow shoes, snow mobiles etc.

1. Net radiometer
2. Microbarograph
3. High altitude barometer
4. Dual channel recording wind system (Anemometer)
5. Dipping bucket precipitation gauge (heating type)
6. Thermograph
7. Evaporation recorder
8. Stainless steel snow pillows with pressure transducer
9. Hygrothermograph

The location of the site is shown in the Index Map in Figure 1.

DISCHARGE MEASUREMENTS

A V-notch was constructed across the Sundli Nala and daily discharge were measured using the formula applicable. However, after working for about two years the downstream portion of the V-Notch got damaged and consequently the V-Notch never functioned as a V-Notch. Hence the measurement is now being done by "Area Velocity Method" using pygmy current meter.

DIFFICULTIES IN THE EXECUTION OF THE PROJECT

Difficulties that are being encountered in the execution of the project are too many. The slope of the area is very steep and it is very difficult to reach various locations in the snowfall especially during the snowing period. Also there are thick jungle growth in the area which adds to the difficulties in approachability. The roads are cut off during the winter period and the officers and staff are to live in the area under sub zero conditions for many days. The required protection materials of good quality are not available in India. If one gets lost on the way during snow surveys, it is very difficult to trace him due to want of communication facilities.

NEED IN INDIA

The major portion of the snow falls during the month of December to February. All the snows that falls into the catchment practically get melted by end of February and thereafter there is practically no contribution from snowmelt. However, there is contribution from glaciers. Even in the advanced world, the assessment of contribution from glacier is in a preliminary stage.

India is worst affected in water supply from mid April to end of June. So what is required in Indian condition is to develop a model based on snowfall and the rainfall of the particular year and of the previous years and develop a model for forecasts the availability of water at specific points at least on a biweekly basis. It is proposed to attempt to develop such a model in due course of time.

PROGRESS ACHIEVED

Data of various parameters at various locations have been collected from 1984 onwards. The model has been developed and is under testing. It will take some more time to perfect the model.

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The views expressed in this paper are of author and CWC is in no way concerned with this.