TECHNICAL SESSIONS - II

MEASUREMENT TECHNIQUES AND NETWORK DESIGN FOR MOUNTAINOUS AREAS

General Report
by
J.S.Rawat

In recent years mountain hydrology has received a lot of attention from researchers and environmentalists. Several workers agree that there remains a shortage of reliable scientific data on the Mountain hydrology, controlled primarily by the geological, pedological, vegetational, landuse pattern and meteorological conditions, the energy balance in mountains is manifest in the hydrological cycle. Without appropriate measurement technique and network design strategy, a thorough understanding of these controlling geographical factors and the operating hydrological cycle, it is not possible to develop a holostic model of water resource management especially in mountains. To cope with this problem appropriate measurement techniques of individual hydrological parameters and network design are needed. In this regard following four papers have been received for this technical session. These are:

1. Some Remarks to Precipitation Measurements in Mountains by Ladisav Halka.
2. Reasons and Limitations of Transportation Measurement in Mountainous Areas by Molnar. L., Meszaros, I., Konicek, A.
3. Automated Estimation of Snow Cover Parameters and Meteorological Quantities in Mountainous Regions for Hydrological Purposes by L.A. Konaev.
4. Estimation of Surface Runoff Components in Himalayas Based on Environmental Isotopes. by V.N. Nijampurkar and D.K.Rao
5. Discharge measurements of River Teesta during lean season using Tracer Dilution Techniques by Bhisham Kumar, S.V. Navada and Rajan Vatsa.
6. Instrumentation and measurement techniques for the study of water equivalence of snow and snow pack and glacier studies using Isotope Technique.
7. Capabilities of an Advanced Data Acquistion System for Mountainous region.

These papers describe the instrumentation and applications and limitations of measurements of hydrological input parameters such as precipitation and hydrological output (or response) such as transpiration, surface runoff and snow cover parameters. Let as come to individual papers:

Paper -1 The author has presented distribution of precipitation in an experimental catchment of Jalovecky Creek encompassing an area of 42 sq. km. The experimental catchment is typical for the highest part of the Corpathians mountain range and it consists of two distinctly different physiographic domain, viz, mountain (800-2178 m) and foothill (570-800 m).The paper summarises results for the period 1987-91 and suggests that the seasonal variations of the precipitation gradient with altitude are pronounced. precipitation provides the basic input data for water related studies. The distribution of precipitation in mountains is usually described by means of precipitation gradient that expresses changes of precipitation with altitude. The author has suggested that generally, the vertical gradient is used by hydrologists for estimation of areal precipitation, but the increase of precipitation with altitude is limited by the mean height of clouds and decreasing of vapour pressure with the altitude. The author has further suggested that (i) the decreasing of precipitation with altitude can take place in mountains above certain level; and (ii) due to the deformations of the wind field caused by topography, local gradients usually differ from the general gradient in particular catchment.

In view of these points the author has built-up a new precipitation network by developing regression models for three pronounced seasons, viz., winter, summer and autumn.

By using three years data (1989-91) of the experimental catchment (Jalovecky Creek), the author has proved seasonal changes of vertical precipitation gradient which requires further discussions. Annual precipitation gradient for this catchment, as author has calculated stands 86 mm/100 m but seasonal gradient varies in betwen 8 mm/100 m (winter) and 48 mm/100 m (summer),

For more accurate definition of particular seasons, the author has rightly suggested that longer data series are necessary and has pointed out similar pattern of monthly precipitation can be used for transformation of cumulative rainfall measurements. The author deserve all praise for his excellent paper on precipitation network in mountain.

Paper 2 In this paper the authors have presented the method of measurement of the transpiration its application and also limitations in moutainous environment. The authors have suggested that the actual distribution of potential evapotranspiration could be calculated by heat balance considering the elevation and exposition of the slopes. For the measurement of transpiration the heat balance method by Cermak et al. (1973, 1987) and Kucera, et al. (1977) and modified for mountainous conditions by Raso (1989) has been used by the authors. The measuring device consists of a power generator, two series of needle thermometers (8 sensors for one measured tree), electrodes (5 electrodes for one tree) and recording instrument.

The authors have rightly pointed out that the most needed assumption for further utilization of trnspiration measurements in the representativeness of the measured tree. They have suggested that even well selected representative trees do not serve a sufficient information about the areal distribution, therefore, to extrapotate the point measurement of transpiration additional data such as the global and reflected radiations are needed. Authors have diagramatically illustrated all these data together with resulted transpiration. Regression analysis of meteorological data and transpiration for one vegetational season (1980) done by the authors reveals that the hourly meteorological data are more closely related to the diurnal variation of transpiration and confirms the dominant importance of air temperature over tree canopy against that collected over the ground. Second group of statistical data used on daily total presented by the authors shows that the net radiation over the canopy is the most related parameter to transpiration.

Authors have also used multiregression linear analysis for diurnal estimation of transpiration by using net radiation and air temperature over canopy. Diagramatically illustrated comparision between measured and calculated values of transpiration (using multiple regression equation) varies from good to bad. But no explanation is made for this variation. Authors have pointed out that the use of presented model for long term seasonal calculations is limited and have suggested that the areal distribution and digitized terrain modelling methods. Authors deserve all parise for their excellent paper.

Paper -3 The author has described problems in detail concerning (i) setting up of automated system for the collection of snow cover parameters and meteorological quantities, (ii) processing and interpretation, and (iii) possibilities of these systems application for hydrological problem solution.

The automatic device which the author has described for hydrometeorological data, consists of nine sensors (air temperature, humidity, wind direction wind speed, sunshine duration, precipitation, surface temeprature of snow, stratified snow surface temperature and snow depth). The author has suggested that snow depth measurements are also possible using ultrasonic device for registration of ultrasonic wave pass from signals transmitter to the snow surface. When it is necessary the sensor can be used for estimation of water level in streams.

The author has rightly suggested that the important task of automatization is optimization of observational points selection, their location in a sufficient number. Regarding the sensors location the author has suggested that it is limited by zones of maximum snow accumulation where they are most likely to be drifted out by snow. Regarding a whole, terristrial distribution of automatic devices the author has suggested that it should be determined by space-time regularities of analyzed parameters which requires organization and carrying out of special research.

Emphasising again on the location of the sensor the author has clearly pointed out that parameter taken for estimation requires specific approach depending on aim and possible application. For example, according to the author the problem of optimum location of points for air temeprature in mountainous may be solved by relief characteristics.

Regarding data collection and processing author has specifically raised some useful points such as (i) when observing snow pack temperature, it is necessary to take strong distortion effect of direct solar radiation leading to thermal sensors melting out into account; (ii) for snow temperature observation, determination of absolute height and location orientation effect is very important for substantiated optimum location of points and for this purpose the author has suggested that it is the most rational to make correction analysis between reference site and sites located on different slopes; (iii) for estimation of optimum composition of snow stakes network, the author has suggested that it is necessary to determine snow accumulation differences on different slopes and heights together with correlational analysis of available data. The author has diagramatically illustrated the regularities of height distribution of snow depth in western Tien Shan Mountain.

This piece of work will draw a big valuable response from planners for different uses of high mountains such as tourism, sports, construction, designing of small and big dams, aviation, irrigation and agriculture etc. We must congratulate Sri Kanaev for this innovative paper.

Paper -4 The authors have attempted a very important and applied aspect of the Himalayan hydrology, i.e., contribution of glacier melt water in lakes or streams which is almost unestimated. For this purpose authors have employed a lake of the Chhota Shingri glacier in Lahul Spiti Valley in Himachal Pradesh as a natural laboratory. Based on the Cosmogenic Silicon - 32 radioactivities technique, the authors have deduced that contribution made by the snow and glacier ice melt for the study area stand at 55% and 45% in August 1987 and 1988, respectively.

The authors have also propsoed a massive future plan to extrapolate such studies in different Himalayan basins from Sikkim to Himachal Pradesh by using Stable Isotopes, Tritium Silicon-32 and electrolytic conductance.

Paper 5 Accurate knowledge of minimum as well as maximum flows of stresms has wide implications in water resources development and conservations. Unfortunately, both the informations of the mountainous streams are poorly indentified. In this paper the authors have introduced a technique for accurate measurement of water discharge. The authors have noticed that the accurate measurement of water discharge is not possible with help of conventional techniques, which needs further discussions.

For accurate discharge measurement, the authors have suggested dilution technique. The authors have used this technique in the Teesta River in Sikkam. The experiment was carried out by the authors during the lean season, using Bromine-82 land Tritium as radiotracers and iodide as chemical tracer.

Regarding the importance of this technique the author have highlighted that since the low flow observations are mainly important for estimating the firm power draft for hydroelectric project, it is very important to have accurate lean flow data.

The authors deserve all praise for thier valuable paper which have wide implication for water resource development.

Paper 6 In this paper the authors have described the importance of study on the formation of snow cover and measurement of its water. According to the authors, information on the snow cover is required to evaluate (1) the rate of stream flow during snow melt (2) the amount of water available for reservoirs and irrigation and (3) to forecast natural disasters (Flooding, mudflows, Landslides and snow avalanches.

The authors have pointed out that hydrology of snow and ice are mostly directed to water balance studies. There require knowledge of accertion and melting of snow covers, transition from snow to ice, water movement and storage in glaciers etc and have suggested that Isotope methods have been proved useful for solving there problems.

The authors may like to discuss the instrumental Isotope techniques (used by them) for the measurement of glacier hydrology parameters based on Isotope contents - primarily 2H 3H 18 0.

Paper 7 Interruption of hydrological parameters and lack of other environmental parameters of a particular site generally creats problem in hydrological analysis under mountainous terrian having complex environment. In this paper the authors have described in detail about an advanced data acquisition system which can solve above problem. According to the authors the system is

(1) Capable of collection data on hydrometeorological parameters through 12 analogue, 2 pulse and a digital input/output channel, with provision of expanding upto 192 channels.
(2) The system uses data logger, portable computer and telemetry device.
(3) The system in used for the monitoring of rainfall, soil temperature, air temperature, snow layout, snow weight, solar radiation, wind speed and wind direction.

Use of this advance data acquisition system specially in the mountains requires appropriate site selection and optimum distribution of this automated device which need discussion for its application in mountains.

Keeping in view the theme of the symposium following issues are suggested for discussion, which emerge from the papers received :

(i). Measurement strategy to define difference between local and general precipitation gradient.
(ii). Measurement problems of longer hydrometeorological data series in mountains.
(iii) Application and limitations of point measurements of hydrological parameters in mountains.
(iv). Optimum distribution of sophisticated automated measuring devices in mountains.