AUTOMATION IN HYDROLOGICAL MONITORING OF SMALL WATERSHEDS

Y. P. YADAV * AND G. HONORE **

* *Deputy Commissioner (HYD), Dept of Agriculture & Cooperation, Ministry of Agriculture, Govt of India, and Project Coordinator, Indo-German Bilateral Project, New Delhi-110 001*

** *German Project Coordinator, Indo-German Bilateral Project, New Delhi.*

The effectiveness of soil and water conservation measures in checking soil erosion as well as moderation of flood plains is an important factor to be considered by engineers, hydrologists, forecasters, soil scientists, etc. The time series data on rainfall, run-off and sedimentation is required in order to estimate the trend. Hydrologic and sediment monitoring of small watersheds has been envisaged to identify priority watersheds contributing high volume of sediment and to develop appropriate methodology for predicting run-off and sediment discharge and also to determine the effectiveness of soil conservation measures. The paper describes the steps taken to modernise the observation network for measurement of these parameters in the catchments of River Valley Projects (RVP) and the Flood Prone Rivers (FPR) under an Indo-German Bilateral Project at the Dept. of Agriculture and Cooperation, Ministry of Agriculture, Govt of India.

Importance of hydrology in the field of water projects hardly needs any emphasis to be elaborated. The sedimentation problem in the country has reached an alarming situation in some or the River Valley Projects. Water flowing into artificial reservoirs carry sediments which reduce their storage capacity and, therefore, their effective life. It has been found that the rate of siltation, in some of the reservoirs is on an average more than four times the rate which was assumed at the time these projects were designed.

There is no denying the fact that hydrological monitoring has been neglected in the past in India. Some institutions, e.g. ICAR, have been carrying out hydrological experiments whereas RDSO, Lucknow has been estimating floods in small watersheds where the data will be

used for construction of railway bridges. The Central Water Commission has altogether different objectives on this subject and hence has been measuring flood discharges of big rivers, either for forecast or for construction of dams, barrages etc.

From the hydrological point of view, small watersheds are sensitive to high intensity rainfall of short duration, whereas large watersheds have pronounced channel flow effect or basin storage effect. In order to cope with the problem of soil erosion, at the source, a programme of watershed management was launched giving high priority to treatment of lands which deliver the highest amount of sediment to reservoirs during the Third Five-Year Plan. The Soil and Water Conservation Division of the Ministry of Agriculture has adopted programmes on checking soil erosion in River Valley Projects (RVP)/ Flood Prone Rivers (FPR), ravine reclamation etc., by the small integrated watershed management approach. The basic unit of implementing these schemes are watersheds having treatable areas varying from 2000 to 4000 hectares.

Centrally sponsored schemes of the Soil Conservation Programme in the catchment areas of River Valley Projects (RVP) is under implementation from the Third Five Year Plan onwards. During 1980-81, another Centrally Sponsored Scheme on Integrated Watershed Management Programme in the catchments of Flood Prone Rivers (FPR) was started. Objectives of RVP\FPR Schemes are to control erosion (in RVP) and moderation of flood peak (in FPR) during monsoons in particular. These two schemes are spread over almost all the states except the North-Eastern States. Assumed sediment rate at the time of design and observed for RVP/FPR schemes are given as folows:

These schemes were launched in the Third Five Year Plan in 13 catchments. Eight catchments were added during the Fourth Five Year Plan and 10 during the Fifth Five Year Plan. Till 1987-88, a total area of 2.76 million hectares has been treated at a cost of Rs. 3982.3 million. Till now only 12.5 percent priority areas have been treated.

As an estimate, 1572 million tonnes of eroded material are washed away into the sea while 480 million tonnes are getting deposited in various reservoirs of India. The estimate also shows that soil loss rate is on an average 16.35 tonnes per hectare per year.

RVP Catchments	Sediment Rate ha. m/100 sq. km./per year	
	Assumed	Observed
Sutlej	4.29	6.00 (1975)
Beas	4.29	15.10 (1975)
Ramganga	4.29	17.30 (1973)
Pohru	–	7.71
Giri-Bhata	–	11.60
Teesta	–	98.20
Gomti	–	3.56 (1973)
Pagladia	–	31.40
Dantiwada	3.61	6.22 (1974)
Sukhna Lake	–	98.50 (1971)
Sone	4.76	6.25 (1972)
Hirakud	2.52	9.53 (1976)
		3.53 (1977)
Rengali-Mandira	–	7.76
Mayurakshi	3.61	20.09 (1975)
Kangsabati	3.27	6.73 (1972)
Maithon	1.62	13.02 (1971)
Panchet	2.47	9.92 (1974)
Mashkund	3.90	2.19 (1978)
Chambal	3.61	5.29 (1976)
Matatila	1.43	3.50 (1972)
Ukai	1.47	4.96 (1967)
Tawa	3.61	8.10 (1973)
Nizamsagar	0.29	6.57 (1967)
Tungabhadra	4.29	6.11 (1972)
Ghod	3.61	15.51 (1970)
Mahi	1.29	8.99 (1973)

Source-Tech. Series 4/H & S/1990, Min. of Agriculture, New Delhi.

The nodal agency for implementing the RVP/FPR scemes is the Soil and Water Conservation Division of the Ministry of Agriculture. The

work components, in checking erosion from any watershed, are by construction of bench terraces, graded bunds, drop structures and levelling of undulating agriculture fields and afforestation, including horitculture plantation etc.

The effectiveness of soil and water conservation measures in checking soil erosion as well as moderation of flood peaks, is an important factor to be considered by engineers, hydrologists, foresters, soil scientists etc, all directly involved in these activities. The time series data on rainfall, run-off and sedimentation is required in order to estimate the trend. Hydrologic and sediment monitoring of small watersheds has been envisaged to (i) identify priority watershed contributing high volume of sediment, (ii) develop appropriate methodology for predicting run-off and sediment discharge, and (iii) determine the effectiveness of soil conservation measures.

Presently, Silt Monitoring Stations set up in one out of five watersheds in a catchment have self-recording or non-recording raingauges, a weir to measure discharges or velocity-area method being used for the same purpose and sediment samples are collected mechanically, brough to the lab and analysed.

Hydrology being a tool to understand hydrological responses of any area invited the attention of the ministry and an in-built provision of 3 percent of total allocation in RVP\FPR projects have been made, exclusively, for hydrological activities. Although it took about half a decade to impress upon the states about its usefulness, some states have set up silt monitoring stations. It may take some more years to achieve 100 percent target of gauging all watersheds before starting soil conservation activities.

Rainfall, water stage in streams\rivers and also sediment flow are the main components which require to be observed. Raingauges as well as stage level recorders being used in RVP and FPR schemes are still of the conventional type i.e. mechanical. Past experience in recording rainfall by either non-recording or self-recording raingauges have hardly been encouraging. Either the clock used in self-recording raingauges stops working or ink from the recording pen spreads over the chart giving inaccurate readings. The clocks used in water stage level recorder have equally discouraging performance.

Estimation of suspended sediment in stream\rivers are being done mechanically either by collecting water samples through the Punjab type bottle or ordinary bucket. The units used in publication of results also vary from state to state.

One most important factor above all is the human factor utilised in operation of hydrological instruments. During heavy rains, field workers hardly bother to change the raingauge chart at the stipulated time. Any suspended silt sample may not be collected during extreme conditions of rain or flash flood.

Based on past experience with conventional type instruments and to cope with the human or mechanical factors, automation is the only alternative, if the country is seriously planning to strengthen the field of hydrology. Probably, with the foregoing problems in view, the ministry agreed to implement the Indo-German Bilateral Project on Watershed Management.

One of the aims of the project is to improve hydrological monitoring of small watersheds. For this purpose, 25 watersheds have been equipped with imported hydrological instruments consisting of:

- Rain fall recorder
- Water level recorder
- Wind speed sensor
- Temperature and humidity sensor
- Solar radiation sensor

Data collection is done manually (sediment concentration and flow velocities) and automatically using data logger, which are linked to various instruments. Data is retrieved on-site using laptop computers and processed by self developed HYDRIS database in the IGBP office in New Delhi. Battery recharge is done by solar panels, since the instruments are installed in remote areas in nine different states viz. Rajasthan, Himachal Pradesh, Uttar Pradesh, Bihar, Gujarat, Madhya Pradesh, Orissa, Tamil Nadu.

The performance of the instruments, after the 4th year of operation, has been altogether satisfactory. Problems still exist in data retrieval and computer handling by field level officers. Therefore, an intensive training programme in maintenance and operation of hydrological

stations is ongoing since the begining of this project.

Up to now sediment was collected manually which very often caused problems due to inaccurate handling by observers. In order to improve data collection, manufacturing of indigenous hydrological instruments has been promoted by this project too.

So far, one set of instruments have been manufactured on prototype basis consisting of:

- Water level recorder (float type)
- Rain fall sensor (Tipping bucket)
- Turbidity recorder (Scattered infra-red)

Data is collected by data-logger and stored in a RAM card, which is easy to handle and to transport. Data retrievel as such is done in the office later on. The testing of these instruments has been performed in a laboratory at the University of Roorkee and the measurements were found to be accurate. Currently the instruments are field tested and in the next stage the turbidity values will have be correlated to the actual sediment concentration. Once operational, these instruments will allow a faster and more accurate monitoring and evaluation of erosion control in India.