

## ROLE OF HYDROLOGY IN WATERSHED MANAGEMENT- IMPORTANCE OF TRAINING

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### ABSTRACT

*The demand for trained technical manpower in watershed management programmes has tremendously increased over the years. Hydrological inputs form an integral component of all developmental programmes aimed at judicious and efficient management of land and water resources involving design of soil and water conservation structures, water resource development, erosion control in the catchments of River Valley Projects, treatment of flood prone and drought prone areas and command area development etc. Though the allocation of funds for watershed based soil conservation programmes has increased manifold, the programmes invariably suffer for want of adequately trained manpower at supervisory, assistant and specialist levels. This paper briefly reviews and discusses the role of hydrology in watershed management programmes, the need and status of training programmes at various levels in India and future thrust for strengthening the training Institutions to meet the increasing demand of technical and skilled manpower for successful planning and execution of these programmes.*

### INTRODUCTION

Hydrology has a pivotal role to play in integrated management of land and water resources to maximise production on sustained basis. Watershed as a planning unit is accepted for all developmental programmes in the country. The Government has initiated many projects in soil and water conservation both in hilly and plain regions, flood and drought prone areas on the watershed management concept. The country has been delineated into 6 water resource regions, 35 basins, 112 catchments, 500 sub-catchments and 3237 watersheds following 5 stage delineation approach (AISLUS, 1990). However, from soil conservation point of view, these macro watersheds need to be further subdivided into meso and micro watersheds for effective planning and execution of various programmes in the country.

The hydrological investigations form an integral component of watershed management for the assessment, development, utilization and management of the water resources so that, the erosion hazards are minimized and land productivity is maintained. The requisite knowledge of hydrological components is essential to prevent recurrence of floods and droughts, design of soil and water conservation structures and judicious management of water resources particularly in rainfed areas to maximise production.

Of the estimated 175 m.ha degraded land in the country, about 150 m. ha is subject to erosion by water and wind resulting into loss of productivity. The demand for food, fuelwood and fodder are estimated to increase to 240 m tonnes, 225 m cubic meter and 850 m tonnes respectively by the year 2000 AD owing to population pressures. The rainfed areas account for about 70 percent of the total arable land in the country but contribute only 42 percent to the total food production. The major factor for the low produc-

tivity is the non-availability of water during crucial periods of plant growth. Though, the country receives about 1170 mm mean annual precipitation the bulk (about 75%) is received during four months from June to September. It fluctuates both aerially and temporally and vary from as low as 10cm in Western Rajasthan to as high as 1142 cm in Cherrapunji. The uneven and erratic distribution of rainfall necessitates proper analysis of hydrological data in a given region to meet the ever increasing demand of water scarcity areas and to achieve the target of 240 million tonnes of food production by 2000 A.D.

Flood prone area in the country is estimated as 40 million hectares. Annually, an average area of 8 million hectares including 3.7 million hectares of crop land is affected by floods. The worst affected States are Assam, Bihar, Orissa, U.P. and West Bengal. To break the vicious circle of recurring floods and drought and to restore the degraded lands to their original productivity levels, it is necessary to utilize the natural resources of land and water on watershed basis, attenuate the flood peaks and conserve water through appropriate soil conservation technology.

The design of soil conservation structures principally consists of three components, viz; Hydrologic, hydraulic and structural. The hydrologic design primarily aims at estimation of peak rate and volume of runoff under a given rainfall, topographic, soil and land use conditions and forms the basis of successful design.

#### **NEED FOR TRAINED MANPOWER**

The science of hydrology deals with all waters on the earth, in the atmosphere and underground, their occurrence, distribution, properties and their reaction with the environment including their relation with human beings. The demand for trained technical manpower in the field of soil and water conservation particularly with reference to hydrological inputs has tremendously increased over the years. The soil conservation programmes in the catchments of River Valley Projects and Flood Prone Rivers are being executed through integrated watershed management approach with the main objectives of reducing high rate of siltation in the reservoirs, minimising the flood damages, mitigating the

droughts, augmenting the groundwater reserves, development of the degraded lands, enhancing the land productivity and increasing the employment generation. Normally the staff engaged in watershed management programmes do not have necessary training and field experience in designing and executing various soil conservation measures involving hydrologic analysis. Consequently, many ill-designed structures fail leading to severe land degradation problems. Training in hydrologic and sediment monitoring instruments is also necessary to evaluate various programmes on watershed basis in terms of their economics, efficacy and performance under field conditions.

The Govt. of India which has rightly laid emphasis on integrated management of land and water resources on watershed basis has allocated during the current financial year (1994-95), a sum of Rs.800 crores for soil and water conservation works and Rs. 1200 crores for watershed management works. Hence, for effective implementation of soil conservation works, the trained manpower at various levels, viz; supervisory, technicians and specialists is essential.

#### **HISTORY OF TRAINING IN WATERSHED MANAGEMENT**

To tackle the problems of soil and water conservation and to impart training to the manpower engaged in various soil conservation programmes, the Govt. of India, established a chain of Soil Conservation Research Demonstration and Training Centres in different agro-climatic regions of the country during 1954-55. These Centres were transferred to Indian Council of Agricultural Research (ICAR) on October 1, 1967 and on April 1, 1974, Dehradun Centre of the above chain was upgraded to the status of full fledged Institute with other Centres attached to it.

One of the major objectives of the Central Soil & Water Conservation Research & Training Institute (CS&WCR&TI) is to impart training in soil and water conservation to in-service gazetted officers and graduate assistants of State Governments, other agencies and foreign candidates sponsored by International agencies. The training in soil and water conservation started in 1955-56 at Dehradun for gazetted officers and at Research Centres Kota (Rajasthan), Bellary

(Karnataka), Ootacamund (Tamil Nadu) and Directorate of Soil Conservation under Damodar Valley Corporation at Hazaribagh (Bihar) for graduate assistants.

The concept of watershed management has become the crucial component of training programme in Soil and Water Conservation since late seventies after the tremendous success achieved in three model watersheds of the Institute at Fakot (U.P), Sukhomajri (Haryana) and Chitradurga (Karnataka). Thereafter, the Govt. of India initiated a number of developmental programmes on watershed basis and identified 47 model watersheds in the country. Out of this, management plans for 21 watersheds were prepared by CS&WCR&TI and executed in collaboration with various State agencies.

To cope with the increasing demand of trained manpower, especially at supervisory level, Bellary Centre was also assigned to train the gazetted officers in 1989-90. With increase in response for the officer's course, Kota Centre was further included to train Gazetted officers.

Realising the importance of hydrologic training, the Ministry of Agriculture also joined hand to sponsor special training courses on hydrologic and sediment monitoring for 10 days duration for Officers and Assistants during the year 1977- 78. Besides this, the University of Roorkee has also started a post graduate course in hydrology with specialization in watershed management in collaboration with UNESCO.

### **HYDROLOGIC COMPONENT IN TRAINING COURSES**

During the initial years of establishment of Soil Conservation Research Demonstration and Training Centres in 1954- 55, the duration of the training course was 1 year. Since the demand of trained manpower was high, the State Govts. expressed their inability to spare their officers for such long periods and hence the duration of the courses was curtailed initially to nine months and finally in 1970 to 5.5 months. Since then, the Institute is conducting two regular courses of 5.5 months each during each year at Dehradun, Bellary, Kota, Ootacamund and D.V.C. Hazaribagh.

Watershed management integrates techni-

cal input from various disciplines such as hydrology and engineering, soils, conservation forestry, conservation agronomy, economics, extension etc. The hydrology and engineering discipline forms a major component of the regular training courses which alone accounts for more than 35 percent of the course covered during 5.5 months both for officers and graduate level courses. The topics pertinent to hydrological aspects which are covered in the training programmes are briefly summarised below.

S. No.	Topic	Lecture hours
1.	Hydrologic cycle and its importance in soil conservation.	2
2.	Rainfall, aerial and temporal distribution, measurement, average depth computation, analysis and intensity duration-frequency relationship.	8
3.	Factors affecting runoff, computation of peak rate and volume of runoff, measurement of runoff through weirs, flumes, orifices and channels etc.	8
4.	Rainfall-runoff relationships, water budgeting, infiltration, evaporation and ground water flow.	4
5.	Hydrologic design of contour bunds, graded bunds, bench terraces, conservation bench terraces, conservation ditches and other measures on arable lands.	12
6.	Hydrologic design of drop, drop inlet and chute spillways.	12
7.	Design of dugout and embankment type farm ponds.	8
8.	Design of land slide, mine spoil road side erosion and torrent control structures such as check dams, spurs, cross barriers etc.	8

The theory lectures are supplemented with

field practicals and assignments to make the training programme more practical oriented. To acquire working knowledge in various aspects of watershed development, the trainees are assigned independent watersheds in groups for about two weeks wherein they prepare integrated management plans incorporating engineering, forestry and agronomical measures such that the plan is economically viable. In addition, the trainees are assigned special projects of 2 weeks duration on location specific problems which include land slide control, mine spoil control, ravine reclamation and Shiwalik problems. In assistant level courses, more emphasis is given on field surveys and execution works, though the course outline is broadly the same as that for officer's courses. They are sufficiently exposed to the practical aspects and monitoring and collection of relevant data but planning and design aspects are not covered in greater details.

On specific demand from the sponsoring organizations and International agencies, the Institute also organises short courses of one week to 8 weeks duration for middle (technician) and supervisory level officers. For example, two short courses on rainwater harvesting and conservation were organized at Bellary Centre under USAID programme. The training programme has acquired International status after successful completion of two short courses in soil and water conservation sponsored by Commonwealth Secretariat London during 1989 and 1992. The course conducted during January 15 to March 10, 1992 for Southern Africa Development Cooperation Conference Countries has been very well received and appreciated. The main objective of these short and refresher courses is to create awareness and apprise the senior level technical staff, policy makers, administrators, bankers and conservationists about the latest technical knowledge and skills in the field of hydrology, soil conservation and watershed management.

The short courses organised by the Ministry of Agriculture cover the following topics which are supplemental with practicals and field visits.

1. Rainfall intensity, distribution and location of stations.
2. Mechanics of stream flow, calculation of cross-sectional area and velocity measurement.

3. Mechanics of sediment movement, point sampling and depth integrated sampling.
4. Field and laboratory equipments & analysis of sediment data.
5. Instruments required for sediment observation.
6. Analysis of water turbidity index.
7. Reservoir sedimentation survey methodology.
8. Analysis of data, rainfall-runoff relationship, sediment load movement, unit rate of movement, gross rate of movement.

### **STATUS OF TRAINING PROGRAMMES IN INDIA**

#### **Regular Courses**

The CS&WCR&TI, Dehradun has been the pioneering organization in the country to impart training to the gazetted officers and assistants in the field of soil and water conservation with special emphasis on watershed management since 1955-56.

The Institute has the privilege of training 1876 officers in regular courses till March, 1993 with Dehradun as leading Centre (1727) followed by Bellary (127) and Kota (22). It includes 44 officers from foreign countries sponsored by International Agencies like Colombo Plan, F.A.O., USAID, SCAAP, SADCC, SIDA, SRTC etc. Kota Centre has so far organised two training courses for graduate assistants only. Among Indian States, maximum number of officers have been sponsored by U.P. followed by M.P., Bihar, Punjab, Rajasthan and other States.

In Graduate Assistant level courses, a total of 5098 technical officials have been trained till March, 1993. Out of which DVC Hazaribagh trained a maximum number of 1560 followed by Ootacamund (1463), Kota (1378) and Bellary (697). Since last few years, the demand for assistant level training courses has declined due to the fact that many state Govts. have initiated their own technician level training programmes.

## Short Courses

Till March, 1993, 53 officer level short courses have been organized at Dehradun, Kota, Bellary, Ootacamund, Vasad and Chandigarh Centres of the Institute mainly on themes covering hydrological and watershed management aspects. The maximum number of short courses (33) have been conducted at Dehradun in which 494 officers from various organizations including participants from foreign countries have been trained on various themes in the field of soil and water conservation. In addition, the Institute has conducted 19 assistant level short courses at Dehradun, Chandigarh and Ootacamund in which 355 participants from different States as well as from foreign countries have been trained till March, 1993.

The Ministry of Agriculture, has also trained about 350 officers and 400 assistants through short courses of 10 days duration till March, 1993.

## FUTURE THRUST AND RECOMMENDATIONS

From the foregoing discussions, it is clear that in the foreseeable future, the need for trained manpower will increase manifold in view of the major thrust on watershed management programmes in the country. Many State Agencies, Voluntary organizations and International agencies have expressed their keen desire to train their officers through short courses on various topics involving hydrological aspects. The Ministries of Agriculture, Environment and Forest and World Bank have allocated huge funds for watershed development programmes in many States like Punjab, Haryana, H.P., J&K and U.P. Unfortunately, most of the staff engaged in these programmes does not possess the requisite knowledge and skills for planning and implementation of soil and water conservation measures. Proposals have, however, been received from the States to conduct short courses for their senior and middle level officers for duration varying from one to 3 weeks. Since watershed management is a multi-disciplinary approach, all the line departments, viz; soil conservation, agric. engg., civil engg., agriculture, forest, animal husbandary, extension and economics are required to work in close coordination to ensure their active involvement in conserva-

tion and efficient management of land and water resources and restoring the eco-system. Of late, these departments have realised the importance of trained technical manpower so that all these programmes are technically sound and economically viable. Needless to say, the involvement of local people is of utmost importance for their socio-economic upliftment.

By the end of VII plan, 1876 officers and 5098 assistants have been trained in regular courses in addition to 900 officers and 355 assistants trained through short courses. In view of the fact that many developmental programmes have been initiated on watershed basis involving huge funds, it is estimated that about 700 officers and 2000 assistants need to be trained during VIII Plan which works out to 140 officers and 400 assistants per year. In addition, about 90 trainees from foreign countries are also expected to participate in short/regular courses during VIII Plan. To accommodate the demand for trained manpower, it is necessary to strengthen the training programmes in the country in general and at CS&WCR&TI, Dehradun and its Research Centres in particular.

The following recommendations are made to meet the increasing requirements of technical personnel and make training programmes more effective.

1. Watershed management concept should form an integral component of all training programmes in Soil and Water Conservation in the country.
2. The training institutions should be fully equipped with all the relevant facilities including hydrological and sediment monitoring instruments/equipments and emphasise should be more on practical and field aspects wherein the participants may acquire working skills and knowledge in planning and executing soil conservation measures.
3. Since the trainees come from different States and Organisations, literature pertaining to different agro-climatic regions must be compiled and made available in the training libraries. Brochures and hand-outs on different topics covering hydrolog-

ical and other aspects with worked out examples will be of great practical use under field conditions.

4. Training programmes for extension workers/trainers in watershed management may be taken up.
5. The expertise of the trained officials should be effectively utilized by placing them in proper line departments after training. The officials who perform excellently well during training courses should be encouraged through incentives like advance increments and out of turn promotions.
6. The Institutes like CS&WCR&TI, should offer short courses of one week to 3 weeks duration regularly on specific areas of interest and circulate the details to various sponsoring agencies in the beginning of each year to ensure their active participation.
7. Education and training of local people residing in the watershed particularly women should be undertaken continuously for efficient management of land and water resources.

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