REVIEW OF WATERSHED MANAGEMENT RESEARCH ACTIVITIES IN PAKISTAN

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Abstract

This paper highlights the achievements and issues in 20th century of Watershed Management and research activities. Pakistan has been facing with energy crises for the last two decades. Hydroelectricity is the main source of cheap energy in the country. However, due to alarming rate of degradation of the mountainous watersheds and sedimentation in the reserviors, their capacity for water storage and electricity generation is decreasing rapidly. Keeping in view this critical situation, the Government has initiated schemes to control degradation of watersheds through afforestation and other technical soil conservation measures. The paper also reviews the research work and experimental trials conducted by the Pakistan Forest Institute with the aim to select the most suitable and effective measures for erosion control.

To achieve sustainable mountain development in future, emphasis has been laid on the selection of most suitable tree species, their care after planting and integration of other technical soil conservation measures with planting. Participation of the local people in watershed management activities is also suggested in the paper.

Introduction

The degradation of the mountainous watersheds has become a World Wide problem. Pakistan has some of the most important mountain ranges of the World, namely the Himalayas, the Hindu-kush and the Karakorum. A number of environmental problems have emerged in these mountains in the last few decades of the 20th century, causing adverse effect not only on the upstream ecosystems, but also in the downstream areas. The problems of degradation and severe erosion in these mountain watersheds attributable to natural factors are high intensity and erratic rainfall; extreme variations in terrain within short distances; steep stream gradients; earth tremors; mass movement/landslides and other hazards (Rafique, 1981). The natural process of erosion is then accelerated by man's activities of deforestation, improper land use, over population, grazing pressure of live stock besides rural poverty and haphazard infrastructure development (Hudson, 1980). North

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and Northwestern part of the country form the catchment areas of some major reservoirs meant for hydroelectric power generation, irrigation and domestic water supply. The capacity of these reservoirs is reducing at an alarming rate due to high rate of siltation. According to the WAPDA, (1970) an estimated quantity of 97 million tons of sediment is entering the Mangla reservoir alone, reducing its capacity by 55,000 acre-feet annually. The land in the catchment is also losing its fertility in addition to downstream problems of flood damages which lead to losses of lives, crops and properties.

The most important projects established for hydroelectric generation and irrigation purposes are Tarbela and Mangla that depend on stream flows of the rivers Indus and Jhelum, respectively. The northern watershed comprising the catchment area of these two rivers is spread over 702,336 sq.km of which 435,809 sq.km lies in Pakistan. The River Indus is the fifth largest carrier of sediment load in the World. Sediment yield over the Indus basin is estimated as 4.49 tons/ha. In the catchment area of Tarbela Dam, the rate of soil erosion is 2-4 kg/sq km/year (Ahmad, 1996).

The country's prosperity depends upon appropriate watershed management practices either biological or engineering techniques that can sustain the productivity of land and water resources of its mountain watersheds (Krosschel, 1996). Realising watershed degradation as a widespread and acute problem of the country, respective Forest Departments, Pakistan Forest Institute, Peshawar, WAPDA and other related organizations, with the help of the donor agencies, have done a lot of work to ameliorate this bad situation. These organizations have tried to address the problems in line with their own levels of awareness, technical and financial capacity. In the past, watershed management has received increasing attention not only from the Government itself, but also from international and bilateral agencies. Afforestation and other essential soil conservation measures are the only solutions to overcome the problems of erosions upto a greater extent. This paper focuses on the performance and achievements related to the rehabilitation of degraded watersheds. It intends to recommend new approaches in watershed management based on the experiences of the past.

Result and Discussions

Importance of Northern Mountain Watersheds

These watersheds include some parts of the important mountain ranges of the Himalayas, the Karakorum and the Hindu-kush. These are high, steep and rugged mountains with narrow valleys, some bearing dense natural vegetation due to favourable climatic and edaphic factors. The vegetation, however, is declining due to high population pressure for fuel and timber. These mountains constitute roughly 15% of the total geographical area of Pakistan including AJK (Ashfaque, 1998). They play an important role in national economy of the country by producing water for hydroelectricity generation and irrigation in the plains of the country. The removal of natural vegetation has become a serious threat to these watersheds. The degradation process has started at an alarming rate. Heavy grazing and deforestation has resulted in accelerated soil erosion and sedimentation. The sediment production from Tarbela/ Mangla Watersheds ranges from 20-40 tons/ha/annum (Ahmad, 1996). To combat the bad situation prevailing in watershed ecosystem, top priority has been given to, Rehabilitation activities, Research and Education during the recent past.

Watershed Rehabilitation Activities

Realizing the importance of northern mountainous watersheds, the NWFP Forest Department started watershed management activities as early as 1964-65 on pilot basis and on regular basis since 1972-73. Till 1982-83 two phases of WFP-385 and one phase of Tarbela Mangla Watershed Management (Phase-I) have been completed. Under these projects, afforestation of multipurpose tree species have been carried out over an area of 1,30,819 acres and soil conservation work on 1,60,231 acres. In Phase-II, of Tarbela-Mangla watershed management project, the targets are to cover an area of 1,50,000 acres.

Research

Pakistan Forest Institute has conducted various experiments during the past years, a brief summary of same is given as under:

Evaluation of hydrologic performance of soil conservation measure on comparative watershed in the subtropical scrub zone

The objective of the project was to evaluate the effect of watershed improvement treatments on runoff, erosion and production of wood and forage. The location for this experimental work was Missa Keswal, in between Rawalpindi and Jhelum. The study area was located in the catchment of Kanshi River, a tributary of the lower river Jhelum that contributed silt to Mangla reservoir. The experimental activities were conducted in two phases and ultimately it was proved that there was a decrease of 44% and 58% in runoff and sediment yield, respectively, due to bio-technical measures adopted in experimental area.

Watershed management practices in hilly areas (Temperate zone) of Pakistan

This experimental work started in 1986 in the watershed area of Fazagat (Swat). The objective of the project was to determine the effect of different soil conservation techniques on runoff and sediment yield. For this purpose five contiguous sub-watersheds were selected. It was found that the maximum yield of sediment (295 kg/ha/yr) from the catchment under grass cover and open to grazing while it was minimum (58 kg/ha/yr) for the catchment under mix plantation combined with light soil conservation measures.

Evaluation of the effect of different land uses (Temperate zone)

An other comparative study of watershed treatment was done in Chikar, AJK. The objective of the project was to evaluate the effect of different land uses on water and sediment yield. Land uses included Forest, Agro-forestry, Grazing and pure agricultural operation on the land. The project work was started in 1988 and was continued till 1995. It was observed that runoff was 43% and 29% from agriculture land and mixture of trees and agriculture respectively, while it was 28% under forest land use.

Evaluation of soil conservation measures in forested area (sub-tropical zone)

To study the effect of soil conservation measures on sediment yield, the experiment was initiated in 1987 at Chattar Class AJK. Three similar watersheds for this purpose were selected and it was found that maximum sediment yield of 1.80 tons/ha/year was for untreated catchment. It was 1.08 tons/ha/year. for the catchment treated with soil conservation

measures, while the minimum yield of 0.52 tons/ha/year was recorded for the catchment treated with mechanical soil conservation measures combined with vegetation measures.

Mountain slope development (Temperate zone)

An experimental trial was conducted to study the effect of Mountain slope development by the establishment of forage tree species and grasses. The study was laid out at Kund (Siran Forest Division, NWFP). Four small catchments were selected and the following soil conservation treatments were given.

SW1 Bench terraces with reverse slope and sown with red and white clovers and grasses. Check dams in the streams and grazing excluded.

SW2 Earthen contour bunds with level bench of one metre in width at vertical interval of 2m. Sown with clovers and grasses. NPK fertilizer was applied. Area was closed to grazing.

SW3 Staggered individual basins of 2m width and 3m length. Line to line distance of basins was 4m. Sown with clovers and grasses check dams in the streams and closed to grazing.

SW4 Kept untreated and open to grazing.

The results showed that the maximum sediment was from SW4 (open to grazing) and minimum from SW1 from the catchment treated with terraces and sown with clover and grasses.

The effect of different forest management systems (Sub-Tropical Zone)

To study the effect of different forest management systems such as shelterwood with natural regeneration vs shelterwood supplemented with planting. The work of this experiment has been done in Shinkiari. The result showed that the yield of runoff and sediment was at the ratio of 100:115 and 100:121 respectively.

The effect of different land uses in foot hill areas (sub-tropical zone)

To determine the effect of different land uses on sediment yield, a small study was laid out at Pabbi forest near Kharian. For this purpose, 15

plots of 300 sq.m and each having 5% slope were selected. The treatments given were agriculture without soil conservation measure, agriculture crops with soil conservation measures with tree cover and perennial grasses and cultivated fallows. The analysed data showed that maximum (44.5%) hydrological response was recorded for the cultivated fallow plots and minimum hydrological response (38%) for plots planted up with *E. camaldulensis* and *L.leucocephala*.

The effect of rehabilitation work (Sub-Tropical Zone)

At Bhugar Mang, District Mansehra an experiment was laid out to study the effect of Rehabilitation work on mountain ecosystem. For this purpose, two similar watersheds were selected. One watershed was treated with soil conservation techniques and sloping Agriculture Land Technology (SALT), while the other was kept as untreated. From data analysed it was found that hydrological responses were 26% and 29% from treated and untreated watersheds respectively. Soil loss from treated watershed was 21.3 tons/ha/ year while it was 25.1 tons/ha/year from untreated watershed.

Education

Development of Watershed Management Research and Education at Pakistan Forest Institute, Peshawar.

The FAO/UNDP sponsored development project was initiated in 1982 and was terminated on 30th June, 1991. The main objective of the Project was to establish a nucleus for education and research in Watershed Management; at PFI. In .this connection the following achievements have been done.

M.Sc. forestry students received M.Sc. forestry degree with specialization in Watershed Management which was introduced in 1985

- Foreign training in watershed management was given to PFI researchers.
- Comprehensive research programme in watershed management was conducted.
- Technical support to the World Food Programme and to other

FAO activities in the field of watershed management was provided.

– Assisted Federal Ministry of Food and Agriculture in evaluating and co-ordinating watershed development activities throughout Pakistan with particular emphasis in the northern region.

Conclusions

Watershed management is closely related with the management of forest, soil and water of a particular hydrological area. Trees play an important role to control the losses of soil fertility and erosion through decrease in total streamflow, proper distribution of stream discharge and improvement of its water quality. In an overall picture, forest has to be seen as a kind of living filter interposed in hydrological cycle between precipitation and streamflow. It has been observed that the commencement of soil conservation activities performed on degraded lands by respective forest departments and related agencies, has checked siltation and improved water quality. Though adequate amount of afforestation and soil conservation work has not been done so far on required mountain watershed, yet the occurance of frequent floods has been reduced to a great extent. All the research works and experimental trials conducted by watershed management branch of PFI indicates that soil erosion can be brought to its minimum limit if range and waste lands are converted into forest land use. Still a large area in mountain watershed needs plantation and other soil conservation techniques to overcome the problems of siltation in our major reservoirs meant for irrigation and hydroelectric power production which are indispensable needs of present day life.

Recommendations

It is imperative that an awareness of this situation be created at all levels, from decision maker down to the farmer, from land use planners and those responsible for technical and financial assistance, to scientist and research workers. To save the country's precious resources of land and water, a sound technical based conservation programme needs to be established. A comprehensive inventory of the watershed is required to categorise the existing true condition of the whole land resource. Priority of rehabilitation work must be given to the area which is very much prone to erosion. If possible, afforestation work should be supplemented with

engineering techniques of soil conservation in watersheds having susceptible soil condition and steep slopes. The most appropriate species must be recommended according to the soil and environmental condition.

Mere plantation and soil conservation work are not sufficient for rehabilitation but aftercare and maintenance is also essential for positive effect. There is an acute shortage of professionals in watershed management. The Government is required to encourage research and training activities in the country related to this discipline. Higher financial out lay for research, trainings and rehabilitation work is needed to cover the whole watershed. Coordination of all the concerned government and semi-government agencies is desirable. The government is also required to create a socio-economic environment to encourage the community to devote to the conservation of the country's soil capital. The social attitude of the official concerned towards the local communities must be favourable to increase the participation of the inhabitants in plantation activities. In the present day life, watershed management should not be considered as synonymous to soil conservation only, but poverty alleviation of the upland population or land user is also essential.

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