

## EFFECT OF WATERSHED MANAGEMENT OPERATIONS ON RUN OFF AND SEDIMENT RELEASE IN HAZARA

S. Hasan Abbas and M. Hanif\*

### Summary

To study the effect of watershed management practices (mainly planting) on runoff and sediment release an experiment was conducted at two sites in Hazara. The analysis of 6 years data collected, revealed that planting coupled with closure to grazing on the slopes proved to be extremely helpful in reducing the runoff and sediment release from 30% to 1% and 239 gms/plot to 10 gms per plot respectively".

The reduction was highly significant.

### Introduction

With the construction of huge and expansive dams like Mangla on river Jhelum and Tarbela on river Indus, it was imperative to take measures to minimise the quantity of sediment entering the reservoirs. Biological treatment i.e. vegetation establishment of the denuded watersheds is the only long term effective measure for conserving soil and water.

Watershed improvement projects are being implemented for reducing sediment yield mainly by planting up the catchment areas. Planting of bare watersheds with Chir (*Pinus roxburghii*) followed by partial closure to grazing was first taken up by the NWFP Forest Department in Kaghan valley of Hazara civil division under a pilot project in late sixties. The hill near village Mangli in Balakot (Mangla catchment) was taken up for planting chir in 1971-72. The area was owned by the local people of the village with some cultivated land at the base and at the top of the hill. Therefore the area in the middle was available for planting.

Since the planting was done on private lands, some of the owners agreed to get their lands planted up with forest trees while others did not. Hence the plantations were patchy. Consequently, for evaluating the effect of these plantations on water and sediment yields, the conduct of a comprehensive comparative watershed study was not possible. A small scale plot study was, therefore, resorted to at two sites viz Balakot (Mangla catchment) and Batagram (Tarbela catchment).

At Balakot, the study was laid out by putting 2X2 m plots (1/2500 ha) with 3 treatments to be tested and 5 replications. The treatments consisted of:-

- (a) Chir and grasses cover closed to grazing

\* The authors are Research Scientists at Pakistan Forest Institute, Peshawar.



- (b) Natural vegetation (grasses, herbs etc) cover closed to grazing.
- (c) Control with natural vegetation cover open to grazing.

The plots on upper, right and left sides were demarcated by blue pine planks treated with coal tar and creosote. The planks were buried to a depth of 16-20 cm in the ground and only 10-14 cm exposed above the ground. The runoff from the plots was led into a galvanised iron sheet bucket through a cemented outlet in the downslope side of the plot. The bucket was placed inside an empty coal tar (44 gallons) drum. The plots under chir/grass and only grass covers were fenced with the wooden posts and barbed wire to exclude grazing. In the control plots, situated in open at about 200 m distance from the treated plots; fencing was done around the runoff collecting drums only. Ordinary rain gauges, one each at the treated and control plots were provided. The drum and the bucket were covered with G.I. Sheet to prevent direct precipitation entering the bucket and to minimise the evaporation loss from the runoff collected in the bucket,

A similar study was also laid out at Batagram (Tarbela catechment) near chapar gram nursery. The number of treatments here were four with 3 similar to those at Balakot and the 4th additional under Robinia and grasses cover. Number of replications were the same. Thus the study consisted of 20 plots. The control plots here too, were situated in an open place (devoid of trees), at about 100 metres from treated plots.

The extent of the coverage of plots by vegetation at both the sites was measured to be ranging from 48 to 95% in different plots at the time of layout-

#### Data collection and Analysis

After each rainstorm, the rainfall was recorded at the experimental and control plots separately. The runoff from individual plots, collected in the buckets, was measured in litres and then average runoff was computed for each set of five plots under the same treatment. It was later converted into millimetres and was then expressed as percentage of rainfall. Samples from runoff (well Shaken in the Bucket) were taken in bottles and were carried to PFI for laboratory analysis to determine the sediment contents.

The information on runoff and sediment of individual rainstorms in a particular month were summed up to get the monthly record and the same from April of one year to March of next year was summed up to obtain the annual record. Summary of the same is presented in Table I and Table 2 for both the experimental sites.



Table 1 Comparative results of rainfall, runoff and sediment in Balakot

## A. Runoff (% of Rainfall)

Period	Rainfall (mm)		Closed to grazing		Open to grazing
	Treated	Control	Chir+NV	NV	NV
August, 79 to March, 1980	194	194	7	12	12
April, 80 to March, 1981	409	459	4	4	8
April, 81 to March, 1982	950	1025	2	3	4
April, 82 to March, 1983	772	883	0.9	2.8	3.3
April, 83 to February, 1984	346	375	0.4	1.6	2.9
March, 84 to February, 1985	607	672	0.9	1.5	2.5
Total	3278	3608	1.9	3.2	4.4

B. Sediment (gm/2 x 2 m<sup>2</sup> plot)

August, 79 to March, 1980	194	194	102	126	196
April, 80 to March, 1981	409	459	25.8	35.4	72.7
April, 81 to March, 1982	950	1025	7.4	11.8	40.0
April, 82 to March, 1983	772	883	12.8	31.4	107.6
April, 83 to February, 1984	346	375	2.8	4.0	60.1
March, 84 to February, 1985	607	672	3.8	8.6	33.9
Total	3278	3608	154.6	217.2	510.3
Sediment (tonnes/ha/yr)			0.07	0.10	0.23

NV = Natural Vegetation i.e. grasses, Shrubs, Forbs etc.

Table 2 Comparative results of rainfall, runoff and sediment in Batagram

## A. Runoff (% of Rainfall)

Period	Rainfall (mm)		Closed to grazing			Open to grazing
	Treated	Control	Robinia + NV	Chir+ NV	NV	Control NV
Sep., 79 to Mar., 1980	128	128	25	30	30	31
Apr., 80 to Mar., 1981	590	649	8	9	10	14
Apr., 81 to Mar., 1982	749	762	1	2	2	3
Apr., 82 to Jan., 1983	483	563	1.7	2.3	2.7	3.9
Feb., 83 to Feb., 1984	415	391	2.9	2.9	2.6	3.3
Mar., 84 to Feb., 1985	598	574	1.2	1.3	1.7	3.6
Total	2963	3067	3.9	4.6	4.9	6.8

B. Sediment (gms/2 x 2 m<sup>2</sup> plot)

Sep., 79 to Mar., 1980	128	128	239	254	265	341
Apr., 80 to Mar., 1981	590	649	80	101	172	332
Apr., 81 to Mar., 1982	749	762	12	16	24	48
Apr., 82 to Jan., 1983	483	563	14	19	23	92
Feb., 83 to Feb., 1984	415	391	2	2	2	3
Mar., 84 to Feb., 1985	598	574	10	11	13	33
Total	2963	3067	357	403	499	849
Sediment (tonnes/ha/Yr)			0.16	0.18	0.23	0.39

NV = Natural vegetation i.e. grasses, shrubs, forbs etc.

## Results and Discussions

The study remained in operation since August, 1979 to March, 1986 about 5½ years) at Balakot and Batagram. During this period, the vegetation had completely covered the plots. In most of the cases the branches of trees had extended beyond the plot boundaries.

*At Balakot* :—The runoff from chir cover plots was 7% of the total rain received during 1st year (August, 1979 to March, 1980) where as from N.V. cover and control plots it was



12% each. The average sediment release per plot for this period was 102 gms, 126 gms and 196 gms respectively. These quantities were higher as compared to those for the subsequent years because the plots layout was fresh and soil was disturbed. Reduction in runoff and sediment started in 1980-81. In 1984-85, the runoff from chir cover, N.V. cover and control plots respectively was 0.9%, 1.5% and 2.5%. Similarly the average sediment from these plots in the same order was 3.8, 8.6 and 33.9 gm/plot. Total rainfall received during the study was 3273 mm in the treated plots and 3608 mm in the untreated plots. An average runoff yielded by the chir, N.V. and control plots was 1.9%, 3.2% and 4.4% of precipitation and average sediment/plot in the same order was 154.6 gms, 217.2 gms and 510.3 gms or 0.07, 0.10 and 0.23 tonnes/ha/year.

**At Batagram :**—The total precipitation received during the study period was 2963 mm in treated area and 3067 mm in untreated area. The runoff received against it from Robinia cover, Chir cover, N.V. cover and control plots was 3.9%, 4.6%, 4.9% and 6.8% respectively. A reduction in quantity of runoff from 1979-80 to 1984-85 was observed from 25% to 1.2% under Robinia cover 30% to 1.3% under chir cover, 30% to 1.7% under N.V. cover and 31% to 3.6% in control plots.

In case of sediment release, the average sediment/plot for the study period from Robinia, chir, N.V. and control plots was 357 gms, 403 gms, 499 gms and 849 gms or 0.16, 0.18, 0.23 and 0.39 tonnes/hectare/year. A reduction in sediment release from 1979-80 to 1983-84 from the plots in above order was 239 gms to 2 gms, 254 grams to 2 gms, 265 grams to 2 gms and 341 gms to 3 gms respectively. During 1984-85, the quantity of sediment, however, remained 10, 11, 13 and 33 gms/plot in the above order due to some high intensity rain storms.

F-test carried out for both the experiments showed that the reduction in annual runoff and sediment from 1979-80 to 1984-85 was highly significant. The treatments arranged in descending order of preference are given below.

**Balakot :** Chir cover, N.V. cover, closed to grazing and N.V. cover-open to grazing.

**Batagram:** Robinia cover, Chir cover, N.V. cover closed to grazing and N.V. cover open to grazing.

Runoff and sediment were also plotted against period on a square paper for both the experimental sites. The graphs depicted that from 1982-83 onward, the trend of runoff and sediment release had almost been stabilized. It was observed that the control plots at both the sites were also keeping the trend of treated plots which was beyond expectations. That was most probably due to the fact that the control plots were not subjected to the destructive type of grazing. The local people living around did not own sheep which while grazing, pull out the grasses with roots from the ground. They owned cows which graze over the grasses leaving their roots intact with the earth and even this grazing was not frequent. Thus the control plots had full grass cover over the ground which reduced the runoff and sediment release from the plots.



## Conclusions

The study has demonstrated that runoff and soil loss from the bare areas open to grazing is higher as compared to that from vegetated areas closed to grazing. It would have been still higher, had the control plots been subjected to destructive grazing or with steeper slopes and other adverse climatic physiographic and biotic interferences.

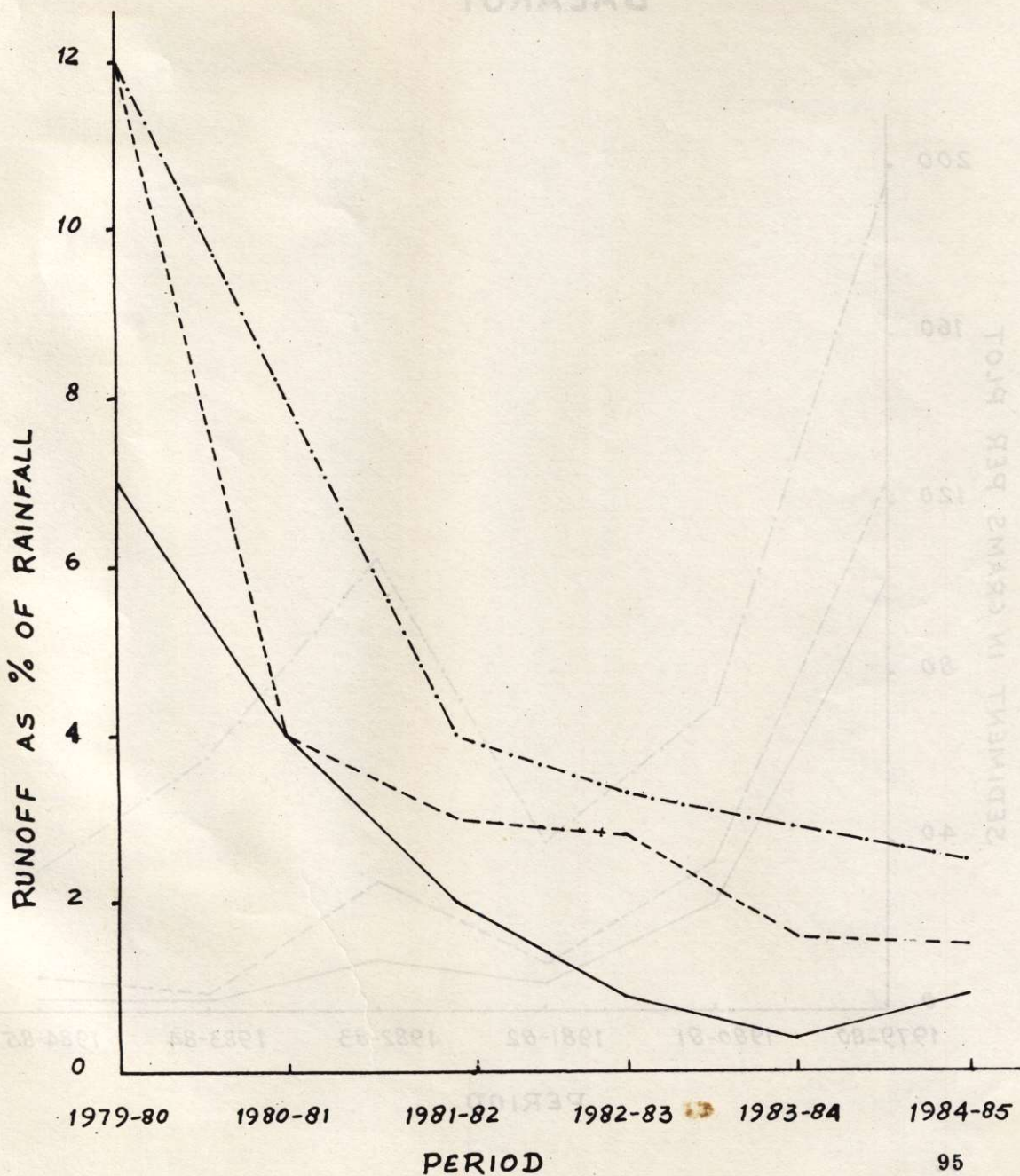
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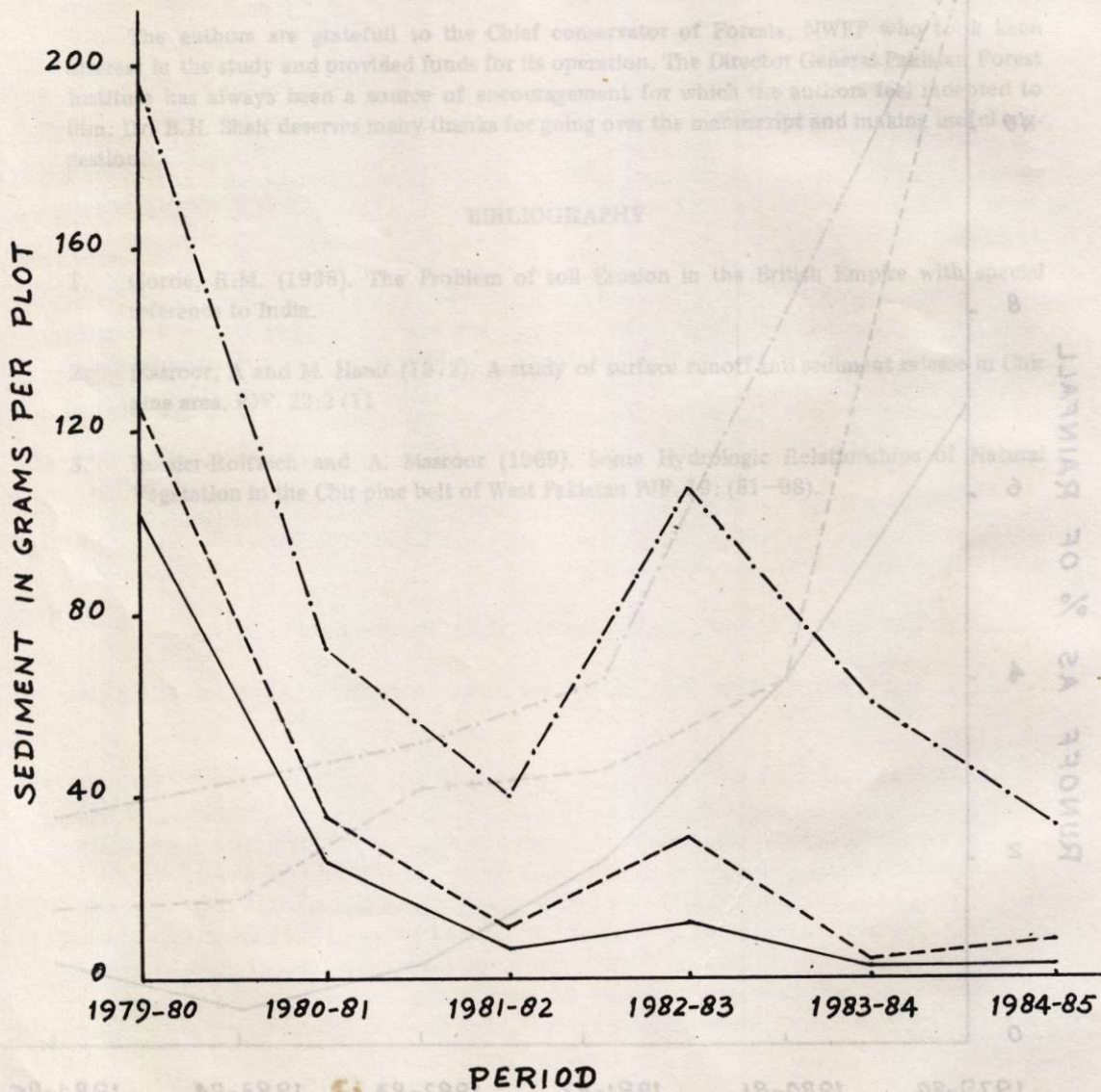
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# RUNOFF AT BALAKOT





## SEDIMENT RELEASE AT BALAKOT





# RUNOFF AT BATAGRAM

