EFFECT OF DIFFERENT LAND USES ON SURFACE RUNOFF AND SEDIMENT YIELD IN MOIST TEMPERATE ZONE

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Abstract

An experiment was conducted to evaluate the hydrologic response and sediment yield under different land uses such as agriculture, rangeland, forests and mixed forest, horticulture and agriculture in moist temperate zone at Chikar, Azad Jammu and Kashmir (AJK). In this study four sub-catchments were selected. Nine year's (1988-1996) average data showed that both the hydrologic response (16%) and sediment concentration (158 kg/ha) were minimum i.e. for the subcatchment under forest and was maximum,i.e hydrologic response(26%) and sediment yield (332 kg/ha) for the catchment under agricultural use. The response from mixed landuse of forest and agriculture was 18% and sediment concentration was 215 kg/ha. For rang land hydrologic response was (21%) and sediment concentration was 340 kg/ha.

Introduction

The economy of Pakistan is mostly based on agricultural crops, The management of these crops requires the existence of proper and regular irrigation system. The world's biggest canal irrigation system in this country is being regulated from the two big reservoirs such as Mangla and Tarbela. Due to huge siltation rate, the storage capacity of these reservoirs is decreasing. The Indus carries the highest sediment loads especially during floods (Khan 1968). No study was conducted in the past to evaluate the surface runoff and sediment yield under various land uses in the upstream catchments in the moist temperate zone of Mangla and Tarbela.

This study was established with the collaboration of Forest Department of AJK and FAO/UNDP/Pak/78/036 project in 1987 near Chikar. The main objective of the study was to evaluate the surface runoff and sediment yield under various land uses in the moist temperate zone of AJK.

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Materials and Methods

1. Study site

The study area included four small sub-watersheds located at Bandi Bakelan, near Chikar on Muzaffarabad-Chikar road in AJK. The geological formations of the study area consist of sand stone, lime stone, clay and shale in cyclic deposition and soil formed by the disintegration of these rock materials. The colour of the soil varies from dark red to reddish brown and the texture is from silty clay to silt.

The important tree species in the area were *Pinus wallichiana*, *Juglan regia*, *Prunus* spp. and *Quarcus* spp. Important shrubs were *Barberis lycium*, *Indigofera pulchella* and *Punica granatum* while Important grasses were *Heteropogon contortus*, *Sorghum helepense*, *Aristida cylindrica* and *Chrysopogon aucheri*.

For appropriate result achievements, four separate sub-watersheds, were selected from watershed experimental area on the basis of their different land uses. In which the First Sub-watershed (SWR) was under natural grasses and shrubs and was open for grazing. The second subwatershed (SWF), had a small portion of agriculture but was almost covered with Forest trees plantation and was closed to grazing. The third subwatershed (SWM), was consisting of mixed plantation of Forest trees and Agricultural crops and was closed for grazing while the Fourth subwatershed (SWA), was under pure agriculture land use (Anon, 1988). Further detail of the watershed area regarding its physical and topographical features and including the treatment of different land uses are given in Table 1.

Table 1. Different land uses, physiucal and topogrphical features of the subwatersheds at Chikar (AJK)

Subwatershed	Land use	Area (ha)	Elevation (m)	Aspect	Totel length of channels (m)
SWR	Range/grazing	9.0	1300-1572	Eastern	120
SWF	Forest	32.1	1570-1950	North-Western	445
SWM	Agriculture + Forest	22.8	1430-1790	Northern	617
SWA	Agriculture	23.5	1390-1730	Western	582

2. Procedures

At the outlet of each subcatchment modified San Dimas flumes of one metre height and 0.9 metre width were constructed for the measurement of surface runoff and sediment concentration. Stilling wells were provided for fixing automatic stage recorders. Ordinary rainguages were also placed in each subcatchment for recording rainfall data.

Total rainfall and runoff data were recorded for each storm event as well as for the whole year. Water samples containing sediments were collected at different specified stages of the comming runoff. Sediment load determination for each individual rainfall and then for the whole year was determined using laboratory facilities at PFI Peshawar.

Results and Discussions

The data collected for runoff and sediment yield during the period 1988-96 were processed and analyzed,which is given in Table 2. The result showed that maximum of hydrologic response and sediment yield (26% & 332 kg/ha/yr) were recorded from the subwatershed (SWA) under agriculture, while it was minimum (16%,158 kg/ha/yr)from the subwatershed (SWF) under forest land use. The hydrologic response and sediment yield for SWR and SWM was 21% and 340 kg/ha/yr and 18% and 215 kg/ha/yr.respectively.

Table 2. Hydrological response and sediment yield in subwatersheds under different land use at Chikar (AJK).

Subwatershed/ Year		1988	1989	1990	1991	1992	1993	1994	1995	1996	Average
SWR	A	29	30	32	36	08	13	15	15	13	21
	B	426	379	400	319	332	298	302	302	300	340
SWF	A	24	28	28	27	07	09	09	09	08	16
	B	207	242	210	126	102	138	132	132	131	158
SWM	A	29	29	30	29	08	09	09	09	08	18
	B	272	240	223	164	147	152	135	302	300	215
SWA	A	41	43	40	38	11	14	16	16	14	26
	B	380	361	370	317	313	301	317	317	311	332

A= Hydrological response %
B= Sediment yield kg/ha/year

The Analysis of variance (ANOVA) was carried out for four watersheds having different treatments (Table 1 and 2). The analysis results for both hydrological response and sediment yield are tabulated as under.

Table 3. ANOVA for Hydrological Response and sediment yield.

Soyurce		DF	SS	MS	F.Value	Probibility 7F
Treatment	A	3	472.08	157.36	25.58	0.0001
	B	3	215833.44	71944.50	55.31	0.0001
Year	A	8	3990.56	498.82	81/07	0.0001
	B	8	50314.00	6289.25	4.84	0.0012
Error	A	24	147.67	6.15		
	B	24	31217.56	1300.73		
Total	A	35	297365.004610.31			
	B	35				

A. Hydrological resonse % B. Sediment yield KG/ha/yr.

Table 4. Results of analysis of variance

	Hydrological Response	Sediment yield
R2	0.970	0.90
CV	12.18	13.81
Mean	20.36	261.17
Alpha	0.05	0.05
Critical value of T	2.06	2.06
L.S.D.	3.62	35.09

The results clearly indicated that treatment as wwll as years are highly significant. In order to findout differences between means of treatments, the LSD tests for hydrological response and sediment yield were also carried out which

were 3.62 and 35.09 respectivelly.

From all the values of ANOVA it could be inferred that Hydrological Response and Sediment yield in case of Agriculture (SWA) and Range Management (SWR) land uses were not significant, while forestry (SWF) and mixed land use (SWM) were highly significant mutually as well as with other land uses.

Conclusion

It may be concluded from the study that forest landuse is the best which not only produce less surface runoff but also decrease a considerable amount of sediment yield in the moist temperate catchments of Tarbela and Mungla reservoirs. Mixed plantation of Forest Trees and partial agriculture has also given good response for erosion control and is to be considered as the second best land use.

References

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