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Watershed characteristics of Shiwalik torrents at Sabhawala in Doon Valley

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Abstract

In the foothills of Shiwalik Himalaya, torrents are the prominent seasonal land features and characterized by high sediment ladder flash flow during monsoon period. These torrents have low banks and thus the flow frequently over tops the banks and causes floods in foot hill region to agricultural plain area. In present study, morphological, water and soil characteristics were studied with special references to torrential behavior and flow mechanics of torrent at Sabhawala watershed in Doon Valley of Garhwal Himalaya. The torrent gradient had varied from 1-75 to 2-62 % with flow velocity was 0.30 - 0.95 ms^{-1}, occurred in Sabhawala watershed. Different forms of soil texture of torrent were observed and pH slightly alkaline consisting organic matter (%) as 0.24-0.95 in different zones of torrent The present study will provide resource based data for remedial measurement of torrent in other watersheds of Himalayan region.

Keywords: *Doon valley, Stream order, Torrents, Watershed*

Introduction

The Himalayan region is particularly sensitive to natural land disturbing activities. Steep slopes, high rainfall and weak geology of the Himalayas accentuate the land degradation and soil erosion process at much faster rate than in the plains due to fragile ecosystem (Das, 1986). In the head water reaches the sediment and flushed them with high velocity currents and reached the relatively flat foothills alongwith debris. Sediment starts accumulating on the river bed causing change of river course and flooding its bank. These rivers with flash flows and high sediment loads are known as torrents. This is the most common problem in, Himalayas spread over the northern states of India. In the foothills of Shivalik Himalaya, torrents are the prominent land features. The torrents are seasonal in nature and characterized by high sediment ladder flash flow during monsoon period. These torrents have low banks and thus the flow frequently over tops the banks and cause floods The problem of torrent menace has been rising in Himalayas with the rise in population pressure and related mismanagement of upstream watersheds (Singh *et al.*, 1990). Torrents are causing vast area submergence and damage to life, property and infrastructure almost every year.

Moreover, the torrents have meandering nature *i.e.* they often change their course and cause damage of adjoining land, life and property. Torrent effected states include Uttarakhand, Punjab, Haryana, Jammu & Kashmir, Himachal Pradesh, Assam and the north eastern states (Juyal *et al.*, 2005). To effectively tackle the menace of torrents through appropriate soil and water conservation measures, it is necessary to systematically study the mechanism and behaviour of torrents through geomorphological characterization and analysis of watershed physiographic features. The physio-logical features of a watershed help in inter-comparison of watersheds for the purpose of deciding priority areas in developmental planning and execution. In the present study the torrential behaviour of watersheds originating from outer Himalayas and Shiwalik ranges has been studied and compared through morphometric analysis.

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Materials and Method

Study area

Uttarakhand is a state located in the Northern part of India. It extends from 28º 43' N to 31º 27' N longitude and 77º 34' E to 81º 02' E la borders China (Tibet) on the North, Ne East and the Indian states of Uttar Prad South, Haryana to the West and Himachal Pradesh to the North West. Uttarakhand has a total geographic area of 53,483 km² out of which 93% is mountainous and 64% is covered by forest. Most of the northern parts of the state are part of Greater Himalayan ranges, covered by high Himalayan peaks and glaciers, while the lower foothills are densely forest. Climate in the Shivaliks is hot in summer and cold in winter. The temperature in summer goes more than 45° C and while in winter it goes sometimes below 0° C. Rainfall is quite favorable in this area and is more than 1100 mm per annum. However its main concentration is in monsoon season (about 80% of the total precipitation).

Methodology

A lot of torrential watersheds originating from Shiwalik Himalaya foothill regions have been identified and delineated on the topo sheets received from Survey of India on the scale of 1 :50000. These maps were exploded to the scale of 1:10000 for the purpose of finding out various morphological characteristics and selecting the watersheds only third and fourth order streams were considered for systematic analysis. All the watersheds drain caused natural hazards in forest as well as agricultural plain basin and lastly drained into Asan river, a tributary of Yamuna river. In analytical observations of watersheds, various morphological characteristics of the watersheds such as area, perimeter, and maximum length of flow, average width, form factor, average slope and drainage density and physico-chemical analysis as followed by APHA (1998) and Khanna and Bhutiani (2004). Soil analysis as organic carbon, moisture content, pH and available NPK were determined by Anderson and Ingram (1993), Walkley and Black (1934) and Eno (1960).

Results and Discussion

The characteristics of Sabhawala watershed and geomorphic catchment of the Shiwalik torrent ranges had been characterized by narrow width and high gradient at the upper reaches of its upstream of forest area and wide spreading beds in downstream catchment basin area towards riverine plain region. In the present study, torrent was measured as 200 meter length span. In each zone comprised, the total length was 2.4 km and the total average gradient (%) was recorded 2.19 %. In Zone A and B the torrent width was ranged in 36-75 meter and 21-33 meter having the bank height ranged 1.5 -2.0 meter and 2.5-2.8 meter along with the gradient (%) was 1.75 to 2.62 respectively (Table 1). In water characteristics, the flow velocity (m s^{-1}) was recorded in the range of 0.95, 0.85, 0.65 and 0.30 in Zone A B C and D respectively. The torrent water discharge Q (m^3s^{-1}) was calculated as 18.00, 27.54, 21.06 and 24.00 in the zone A, B, C and D respectively. The turbidity (NTU) was measured in range 3780 to 5200 in torrent water sampling zones (Table 2).The largest component comprising the mixture of particles creating turbidity in rivers is caused by erosion of materials from the contributing watershed. Turbidity may be created from a wide variety of eroded materials, including clay, silt or mineral particles from soils or from natural organic matter created by the decay of vegetation. Particles may capture and hide or mask, other inorganic and organic constituents that are present in the watershed. In the riparian area, there is variation in landform, soil, topography, land use and hydrology (Yadav and Bhushan, 2002). Therefore, these factor influence erodibility of the soil, which is of practical interest in conservation planning. However there are certain limitation (slope and topography) associated with this kind of field study in the riparian areas as against its in-situ determination of soil characteristics.In the physico-chemical characteristics of soil in the torrent area, the soil texture (sil) was recorded common in Zone A, B and C, having the pH range 6.25, 7.40 and 7.50 respectively. The Zone D has sicl soil texture with maximum pH value as 7.80.

Table 1: Morphological characteristics of torrent channel at Sabhawala watershed.

S.No.	Zones	Subzones	Torrent length (m)	Torrent width (m)	Torrent bank height (m)	Torrent gradient (%)
1	**A**	a	200	75	1.5	1.75
		b	200	41	1.7	
		c	200	36	2.0	
2	**B**	a	200	33	2.5	2.62
		b	200	28	2.7	
		c	200	21	2.8	
3	**C**	a	200	5	3.0	1.75
		b	200	5	3.0	
		c	200	100	0.5	
4	**D**	a	200	200	0.25	2.62
		b	200	-	-	
		c	200	-	-	
			Total length= 2.4 km			**Average= 2.19**

Table 2 : Water characteristics of the torrent channel at Sabhawala watershed during rainy season

S. No	Zones	Flow velocity V (m s^{-1})	Hydraulic measures and Discharge Q (m^3 s^{-1})				Turbidity (NTU) Mean value
			W	D	A	Q	
1	A	0.95	50	0.60	30.0	18.00	3780
2	B	0.85	27	1.20	32.4	27.54	4045
3	C	0.65	36	0.90	32.4	21.06	4460
4	D	0.30	200	0.40	80.0	24.00	5200

V= Flow velocity (m s^{-1}), W=width of torrential water, D= depth of water during torrential flow, A=Total area (M3), Q= Discharge (m^3s^{-1}),

Table 3: **Physico-chemical characteristics of soil in the Sabhawala watershed**

S No	Zones	Soil texture	pH	Water holding capacity (%)	Organic matter (%)	Available Nutrient (kg/ha)		
						N	P	K
1	A	Sil	6.25	7.56	0.95	215	32	162
2	B	Sil	7.40	10.66	0.24	70	5	78
3	C	Sil	7.50	17.85	0.27	96	11	88
4	D	Sicl	7.80	20.70	0.32	102	18	154

The water holding capacity (%) was measured in range 7.56 to 20.70. The organic matter (%) was calculated in range of 0.24 to 0.95 with maximum at Zone A. The available nutrients (kg/ha) N, P, K were found maximum as 215, 32 and 162 respectively at zone A. Minimum value of N, P, K as 70, 05 and 78 respectively at zone B (Table 3). Selection of appropriate location for growing sorghum by employing water holding capacity, soil depth and organic carbon in combination with land form was found useful in Maharastra (Sharma *et al.*, 1997). Steep slope and high relative relief in Sabhawala watershed were led to the low availability of agricultural land. Due to the population pressure on cultivated land there has been resulted in large scale encroachment on the forest land for extension of agriculture land and thus deforestation had denuded the forest cover

and caused many steep torrential streams from the upper forest heights. The research data revealed that morphological, water and soil characterstics of torrent in forest, agricultural area and habitation region play vital contribution as base data for engineering and bioengineering treatment measures to rehabilitate the watersheds in Shiwalik as well as in other Himalayan region.

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