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GEOMORPHIC LANDSCAPES ALONGSIDE EAST DHAULIGANGA RIVER, HIGHER HIMALAYAS

Chandani Arya[1],

Department of Geography, S.S.J.Campus Almora, Kumaun University Nainital (Uttarakhand) 263601

Dikshita Pande[2], Jyoti Joshi[3],

Department of Geography, S.S.J University Almora (Uttarakhand) 263601

Abstract

Kumaon Himalaya in Uttarakhand are blessed with varying mountain landscapes. A mélange of geomorphological features can be observed along the Himalayan mountains. The present study is focused upon the higher Himalayan landscapes and landforms within the East Dhauliganga river basin. The river originates from east Panchachuli glacier and forms a tributary of Kaliganga at Tawaghat in Pithoragarh district. The study area lies closer to Main Central Thrust (MCT) and is therefore, a tectonically active zone. A complex combination of tectonic, glacial, fluvial, pluvial and anthropogenic activities can be seen throughout the basin. The melting of snow from the glacier contribute to the hydrological stability of the river system. In contemporary times, we see a huge challenge in sustaining the environs of upper reaches of mountains. Rapid change in landscape and landforms poses a greater threat in near future, and has also affected the sustainability of the region.

KEYWORDS- *landscapes, landforms, glacier, river*

1.0 INTRODUCTION

Landscapes evolve in a systematic fashion through time (Thornbury, 1984). The mighty Himalayas are the epitome of beautiful scenic landscapes. The northward movement of Indian subcontinent and its subduction under Eurasian plate makes Himalaya as one of the most active orogeny of the world. The orogenesis of Himalayas started about 50 million years ago and still continues (Dwivedi et al., 2021). This has resulted in formation of various geomorphic landforms and landscapes. Due to tectonic and other geomorphic activities, the higher Kumaon Himalaya is a vulnerable region.

The Himalayas uplifted from a great geosyncline called Tethys Sea. The upheaval took place in four major phases (Valdiya, 1984). Consequently, fault lines occurred between each phase. Main Central Thrust (MCT) separates Greater and Lower Himalayas (Singh, 2016), Main Boundary Fault (MBF) occurred between Lower Himalayas and Shiwaliks, and Himalayan Frontal Fault (HFF) between Shiwaliks and Indo-Gangetic Basin (Pathak et al., 2015). Higher Himalayas are abode to innumerable glaciers, and thus is source of mighty rivers like Indus, Ganga, Brahmputra etc. The glaciated area covers about 1,12,000 km². Snow and glacial melt contribute about 2 to 50% of flow of rivers in the region which provides 8.6 million m³ of freshwater annually (Chauhan et al., 2011).

Thornbury has defined geomorphic processes as those actions that alter the landforms of the Earth through physical and chemical changes or internal and external forces. Bloom (1992) described landforms as constructional like fault scarps, volcanic cones, glacial moraines, river deltas and destructional or erosional. Steep slopes, high altitudes, structural weaknesses, heavy rainfall and increasing anthropogenic activities collectively create potential ground for disasters. The area also lies in the high seismic zone V (Valdiya, 1979). Here an attempt has been made to show various landscapes and landforms along Dhauliganga river which flows through higher Himalaya.

2.0 OBJECTIVES:

The main objectives of the present study are as follows-

I. Study and analysis of geomorphic landscapes and landforms in the study area.

II. Study of anthropogenic activities in the study area.

3.0 METHODOLOGY:

For the purpose of study of geomorphic landscapes and landforms, the Eastern Dhauliganga river has been selected. The study is entirely based on the observational method. For the completion of this research paper, both primary and secondary data have been used. Arc GIS software and Google Earth software has been used for mapping of study area.

4.0 STUDY AREA:

East Dhauliganga river flows in Pithoragarh district, Uttarakhand, India which lies in the higher Himalayas and active tectonic zone. It is located between the latitude 29°57’28”N to 30°13’25”N and longitude 80°29’41”E to 80°36’3”E (Fig.1). The East Dhauliganga river originates from Govan Khana glacier at the base of Panchachuli peaks. The river is fed by various other streams like Lissar Yangti and Darma Yangti. It generally follows the south easterly direction, and its water drain into Kaliganga river at Tawaghat, which is the largest river of Kumaon both in terms of volume and catchment area (Pathak et al.). Most of the river course have steep slopes and is covered with glacial moraines landscape. For most of its course Dhauliganga is a rattling stream flowing in gorges between steep slopes. Active tectonic activities largely influence the rivers and both faulting and

regional surface deformation affects fluvial systems. (Keller et.al, 1996). The present study focuses on different geomorphic features. Descriptions of these features along the river path are discussed further in the paper.

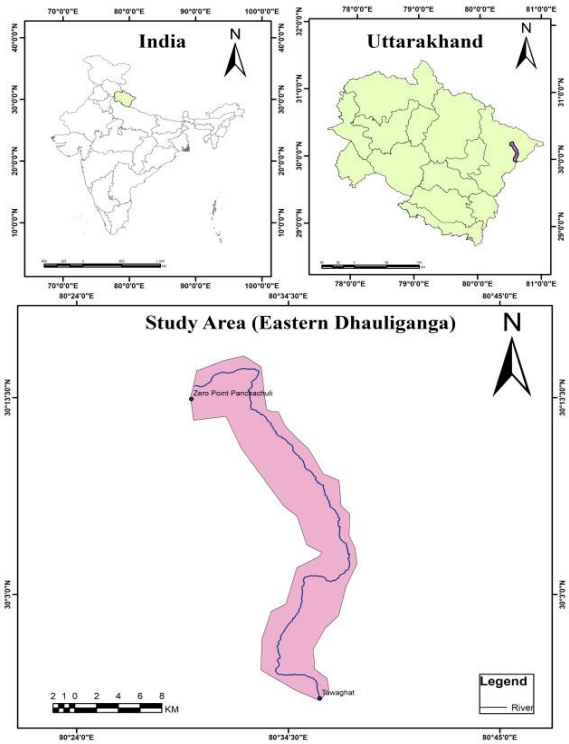

Fig.1: Location Map of Study Area

5.0 RESULTS AND DISCUSSION:

Geomorphic landforms are features of Earth's surface. Landscape features which can be observed in their entirety and are consistent of their form can be defined as landforms. Geomorphic processes are slow in nature and a result of interaction of geologic structures and processes. They differ in intensity from place to place and depends upon climate, vegetation and altitude (Thornbury, 1984). Various geomorphic landscape/ landform features discussed in the paper are as shown in (Fig.2):

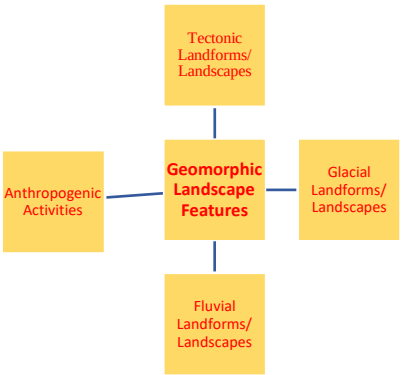

Fig.2: Geomorphic Landscape Features

5.1 TECTONIC LANDFORMS/ LANDSCAPES:

As the region is tectonically active therefore its imprint can be seen in the landscape features. The advent of Great Himalayas takes on north of Sobla where Main Central Thrust, also called as, Vaikrita Thrust can be noticed. The main composition of these rocks is from garnet to sillimanite grade gneiss, mica garnet schists, migmatites and so on. Fragments detached from Tethyan rocks like boulders of conglomerates and sandstones are also visible. High grade metamorphic rock structure of Greater Himalayas can be seen enroute (Plate-1,2).

Plate-1: Interbedded sedimentary rock layer *(Source:Field Survey)*

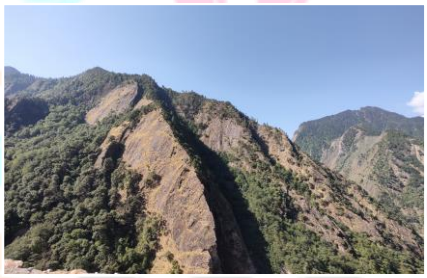

Plate-2: Steep scarp *(Source :Field Survey)*

5.2 GLACIAL LANDFORMS/LANDSCAPES: -

The geomorphic landscapes carved by the glacier add to the beauty of the region (Saha, 2021). Various glacial landforms can be seen as one moves higher in altitude. The change in vegetation pattern was easily noticeable with change in altitude. Fields of lush green meadow or bugyals provide one of the most scenic landscapes to the region (Plate- 4). Receding tree line becomes an important feature. Shrubs like rhododendron and short height trees like Bhojpatra, blue pine trees etc. (Plate- 3) were common at the base of glacier. The snout of the glacier which is the source of Dhauliganga river could be marked. Glacier till, debris, Moraines, Outwash Plains, Horns are striking features alongside upper Dhauliganga river (Plate-5).

Plate-3: Rhododendron (Source: Field Survey)

Plate- 4: Jhabbus grazing at the bugyal (Source: Field Survey)

Plate-5: Glacial landscape and features *(Source: Field Survey)*

5.3 FLUVIAL LANDFORMS AND LANDSCAPES: -

The higher Himalayan region is the source of many glacial rivers, and the Eastern Dhauliganga river is one of them. Rivers, in general, have a natural tendency to cut off their bank. Erosion through river depends on the slope, velocity and sediment load of the river (Singh, 2015). Various fluvial landform features can be observed in the river course, which are as follows-

5.3.1. V-Shaped Valley: The V-shaped valley is the most common feature in the higher mountains. It can be observed in this region due to steep gradients and vertical erosion of the fast-flowing river. In the upper course of the river, vertical erosion is more dominant and the down-cutting processes have continuously cut the floor below. This valley is very narrow with a steep slope and looks like the English letter 'V' which has been cut off by the stream over time (Plate- 6). This is the young stage of the river where the velocity of the water is very high.

5.3.2. Waterfalls: The waterfalls are one of the most magnificent landforms found along the eastern Dhauliganga river. Formed by erosional processes in which water flows over hard rocks and cut soft rocks vertically. Several waterfalls were seen along the river. It was observed that most of the waterfalls are snow-fed. Plate-7 shows snow-fed waterfalls at Kanchyoti village.

Plate-6: V-Shaped Valley

Plate-7: Kanchyoti waterfall (30˚01'06"N 80˚34'15"E)

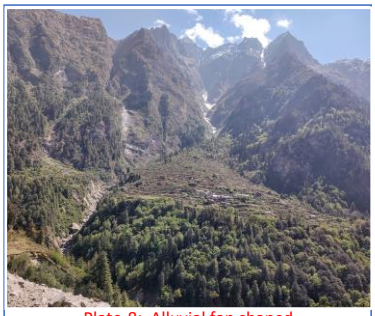

Plate-8: Alluvial fan shaped Chal Village (30˚10'43"N 80˚34'55"E)

(Source: Field Survey)

5.3.3. Alluvial Fan: Alluvial fan is the deposit of sand, gravel and sediments. These were commonly observed along the river banks at many places in the study area. A landform similar to alluvial fan was observed at Chal village (Plate-8) in the higher altitudes, where both settlement and terrace cultivation could be seen.

5.3.4. Potholes: A river pothole is a bowl-shaped geomorphic feature found in the river valley. Generally, the width is lesser than its depth. The presence of potholes at 40-50 metres from present river level indicated towards active channel incision in the past.

5.4 ANTHROPOGENIC ACTIVITIES

The study area is highly vulnerable due to tectonic activities and landslides. The area is connected to the border line of Nepal and China, due to which the road network is very essential. The road construction in this area has cut steep slopes leading to many landslides along the road (Plate-10, Fig.3). In some places, road cutting affects the ice sheets especially where the sheets intersect the road line. Further with the construction of roads tourists and other local activities like grazing and gathering have exponentially increased which have adversely affected the landscape and environment (Plate-9,11). According to Disaster Mitigation and Management Center, Government of Uttarakhand (DMMC) the study area lies in the Zone V of Earthquake prone area. As the region lies in close proximity to MCT, therefore it becomes a very fragile zone. Hence the geology does not permit heavy construction, and too much human interference.

Plate -9: Cattle Rearing
(Source: Field Survey)

Plate -10: Road construction
(Source: Field Survey)

Plate-11: Tourism Activities
(Source:Field Survey)

Landslides are the most common phenomenon. Both natural and anthropogenic landslides can be observed on either side of the river bank (Plate-12,13). During rainy season it increases manifold as a result, frequent road blockages occur. Major landslides along the river are shown in the following (Table-1).

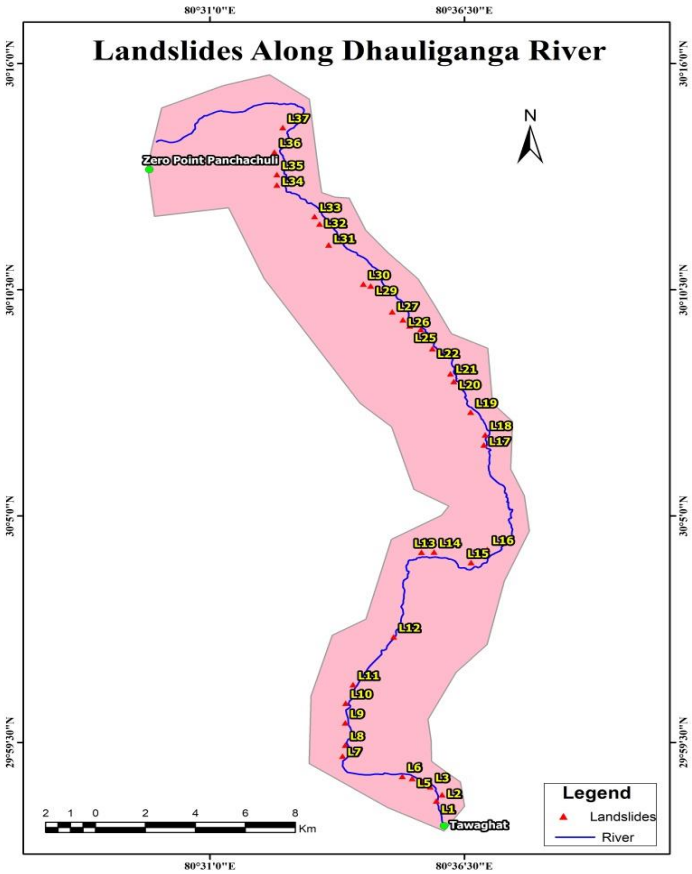

Fig.3: Landslide zones

Table-1: Landslides location *(Source: Field survey)*

S.no.	Nearby Area	Landslide Location		S.no.	Nearby Area	Landslide Location	
1	Khela (L1)	29°58'4.50"N	80°35'53.75"E	20	Sela (L20)	30° 8'16.08"N	80°36'16.47"E
2	Khela (L2)	29°58'13.41"N	80°36'1.29"E	21	Sela (L21)	30° 8'27.45"N	80°36'12.04"E
3	Khela (L3)	29°58'24.94"N	80°35'45.96"E	22	Sela (L22)	30° 9'3.89"N	80°35'48.57"E
4	Khela (L4)	29°58'31.35"N	80°35'35.34"E	23	Sela (L23)	30° 9'19.48"N	80°35'41.11"E
5	Khela (L5)	29°58'37.28"N	80°35'22.29"E	24	Sela (L24)	30° 9'32.02"N	80°35'33.69"E
6	Khela (L6)	29°58'40.33"N	80°35'9.65"E	25	Sela (L25)	30° 9'37.33"N	80°35'19.22"E
7	Chhirkila (L7)	29°59'9.81"N	80°33'52.03"E	26	Sela (L26)	30° 9'45.99"N	80°35'10.39"E
8	Chhirkila (L8)	29°59'25.85"N	80°33'55.58"E	27	Sela (L27)	30° 9'57.66"N	80°34'56.36"E
9	Khet (L9)	29°59'58.26"N	80°33'55.48"E	28	Sela (L28)	30°10'27.52"N	80°34'44.39"E
10	Khet (L10)	30° 0'26.98"N	80°33'56.08"E	29	Nagling (L29)	30°10'35.39"N	80°34'28.52"E
11	Khet (L11)	30° 0'54.10"N	80°34'5.64"E	30	Nagling (L30)	30°10'38.11"N	80°34'19.04"E
12	Kanchoti (L12)	30° 2'3.72"N	80°34'58.38"E	31	Baling (L31)	30°11'35.13"N	80°33'33.98"E
13	Sobla (L13)	30° 4'7.05"N	80°35'34.37"E	32	Baling (L32)	30°12'5.76"N	80°33'22.22"E

14	Sobla (L14)	30° 4'7.50"N	80°35'50.80"E	33	Baling (L33)	30°12'16.78"N	80°33'15.63"E
15	Sobla (L15)	30° 3'52.18"N	80°36'38.77"E	34	Baling (L34)	30°13'2.74"N	80°32'26.79"E
16	Dar (L16)	30° 4'11.23"N	80°36'59.87"E	35	Baling (L35)	30°13'17.92"N	80°32'26.91"E
17	Bauling (L17)	30° 6'43.62"N	80°36'55.46"E	36	Baling (L36)	30°13'50.79"N	80°32'23.45"E
18	Bauling (L18)	30° 6'58.47"N	80°36'57.17"E	37	Dugtu (L37)	30°14'26.55"N	80°32'34.33"E
19	Bauling (L19)	30° 7'31.50"N	80°36'38.40"E				

Plate- 12: Landslide along the road *(Source: Field survey)*

a.

b.

Plate- 13: a. and b. shows natural landslides *(Source: Field Survey)*

6.0 CONCLUSION:

Higher Himalayas being of recent origin are highly unstable because of various processes that work simultaneously here. The area is geodynamically and tectonically very active falling under zone V in earthquake zone. Faults, upliftment, steep scarps, waterfalls and terraces of different levels are frequently observed. Glaciers and rivers are important elements which play crucial role in the geomorphology of concerned region. Glacial landforms add to the beauty of the glacial landscape. Rivers are at their younger stage, therefore, have high incision rate. Dhauliganga , the major stream of the area is of glacial origin; known as Darma at upper reaches. V-shaped valleys, gorges, waterfalls formed by vertical erosion are common landforms of the region. At places, alluvial deposits can also be observed. Heavy precipitation and steep slopes are prominent factors of natural landslides. Increasing human interference in the recent years like road and dam construction, also become the major cause of man-induced landslides. However, the importance of road in the economic and

strategic importance of the region cannot be ignored. The region must be studied both in term of geologically and geomorphologically for construction of roads and other infrastructure projects. Due to vulnerability of the region eco-tourism should be promoted here.

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