



RESEARCH ARTICLE

GEO-ENVIRONMENTAL HAZARDS AROUND BHATWARI AREA, DISTRICT
UTTARKASHI GARHWAL HIMALAYA UTTARAKHAND

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ARTICLE INFO

Article History:

Received 27th January, 2011
Received in revised form
24th February, 2011
Accepted 12th March, 2011
Published online 17th April, 2011

Key word:

Geo-environment,
Geomorphology,
Drainag,
Hotspring,
Hydrological,
Anthropological,
Hazard.

ABSTRACT

The area of investigation lies in lesser and central Himalaya between Maneri and Gangnani area in the Bhagirathi valley, District Uttarkashi. Geologically the area is divided into two group of rocks viz. Garhwal group and Central crystallines separated by Main Central Thrust which is exposed near Sainj i.e. 20 kms from Uttarkashi along Uttarkashi Gangotri road. The rocks of Garhwal group are represented by quartzites, sericite quartzite's and talc chlorite schist intruded by metabasics, whereas the Central crystallines are constituted by gneisses, schists, migmatites and amphibolites. Various geomorphological features like ridges, slopes, glacial lakes, hot springs, waterfalls, terraces and landslides were analyzed in the field and then plotted on the base map. These features are result of exogenetic forces formed mainly by fluvial, fluvio-glacial and glacial processes. Studies show that running water is responsible for erosion and denudation in low reaches in the valley side whereas the high land area and upper reaches in the valley side slope have been degraded by glacial or in part by fluvio-glacial. Geo-factor of human activities like construction of roads, tunnels, bridges and buildings and Geo –factors of environment like landslide soil erosion and rock fall are responsible for Geo-environmental hazards in the area. Attempt has been made to study three types of hazards viz. geomorphological, hydrological and anthropogenic hazards.

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INTRODUCTION

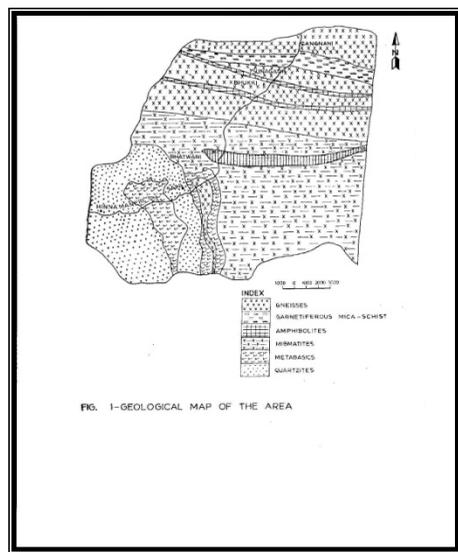
The study area is situated in the north of Uttarkashi along Bhagirathi river from Maneri to Gangnani, lying between the latitude 30°40'–30° 55' N and 78°30'–78°45' longitudinally. The national highway joins Rishikesh with Gangotri connecting number of pilgrim centers.

The highway has strategic importance As it touches Sino-Indian border, thus frequently used by defense personnel's. This road along with many branched road are breached in rainy season land sliding. Many defense installations, settlements engineering structures, forests, cultivated soil and lives etc are destroyed due to avalanches, floods, landslides and other phenomenon that are created after heavy and torrential rains or snowfalls.

Due to varying lithology and variable microclimatic ingredient different type of landforms assemblages were produced at different places. Thus geo-environmental factors are responsible for the formation of these landforms. In the upper reaches glacial and fluvio-glacial processes and in lower reaches fluvial processes are dominated. The forces due to gravity and human impacts are also equally important.

GEOLOGY OF THE AREA

The geology of the area has been worked out by Heim and Gansser (1939) Gairola (1976), Valdiya (1980, 1983). Detailed study on stratigraphy and tectonics of lesser Himalayan region of Uttarkashi was made by Jain (1971). The geology of upper Bhagirathi valley and Yamuna valley was studied by Kumar and Aggarwal (1973). The petrological and metamorphism of the rocks of upper Bhagirathi valley has been studied by Dave and Gupta (1982). Pant (1975) recognized fossil valley in Maneri and Bhukki area. Regional geology and structure of the area was worked out by Saklani (1986). Geomorphological observations were made by Prasad and Rawat (1982) and Naithani (1992).



Geologically the area is comprises of two different type of rocks viz. Garhwal group and Central crystallines separated by main Central thrust which

passes near Sainj and exposed along Kumalti gad and Dogadda gad. The trend of thrust in this area is NW-SE with dip varying from 25° to 65° due NE. The rocks of Garhwal group are represented by white cream colored quartzites, epidiorites; sericite quartzite's and talc chlorite schist along the thrust. These rocks have been intruded by metabasics. The rocks of Central crystallines included migmatites, schists, gneisses and amphibolites etc. Litho tectonic succession of the area is as follow Table-1 and geological map of the area has been depicted in

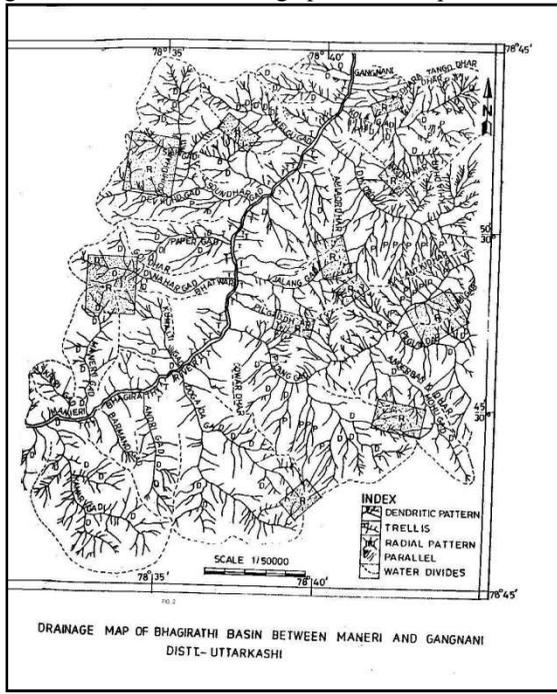
Table 1. Lithotectonic succession of the area

	Augen gneisses
	Banded gneisses with bands of garnetiferous mica schist
	Migmatites
Central crystallines	Augen gneisses
	Quartz muscovite schist's
	Mylonitic migmatites
	Augen Gneisses
	----- Main ----- Central -----Thrust
	Talc –chlorite schist
	Sericite quartzites
Garhwal group	Epidiorites
	White cream colored quartzites

DRAINAGE PATTERN

River Bhagirathi originates from Gangotri glacier at Gaumakh on the western slope of Chaukhamba at the elevation of 3800 mtrs. The rivers Bhagirathi initially has N-W course and has carved out deep gorges at many places. Many tributaries join Bhagirathi at right angle. The overall drainage pattern of the area is dendretic and most of the tributaries meet the major stream at varying angles. Irregular branch configuration appears to be very prominent. The development of this pattern in this area may be due to regional initial slopes that gradually roll downwards to main stream, from its either bank comprising rocks of uniform resistance. Some streams are elongate and join the primary stream at right angle, so trellis type of pattern has also been developed at some places particularly along the valley. At some places stream also exhibit radial pattern particularly at summit surfaces. The parallel pattern developed due to

presence of subparallel topographic features viz. glacial landforms. Drainage pattern is depicted in



erosion, while the trellis as well as radial pattern indicate tilting, folding and faulting topography.

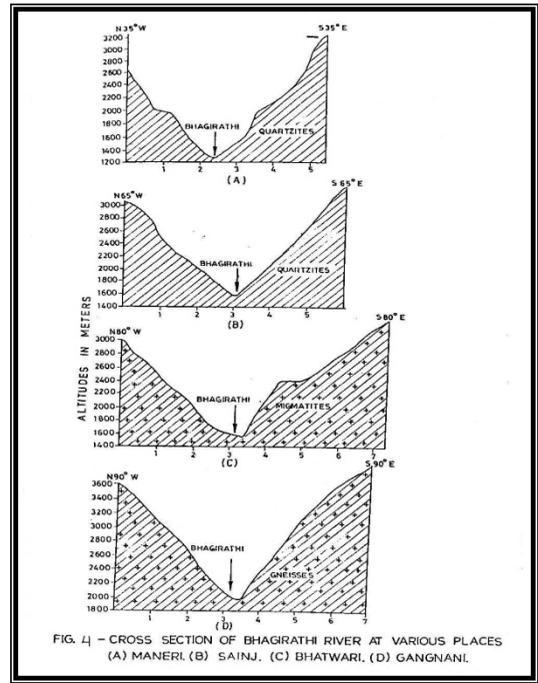
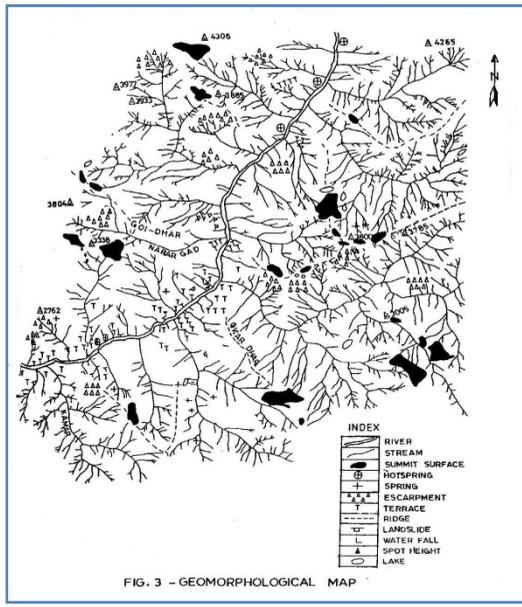


FIG. 4 – CROSS SECTION OF BHAGIRATHI RIVER AT VARIOUS PLACES (A) MANERI, (B) SAINJ, (C) BHATWARI, (D) GANGNANI.



GEOMORPHOLOGY

The study of landforms, the distinctive geometric configuration of earth surface Strahler (1968) which also influence the pattern of human activity is called geomorphology. Initial type landforms are those which are result of internal forces which later on modified by the external forces. Study area form the very difficult terrain characterized by rugged topography and steep escarpment. The ridges are initial type of landforms and are major water divide which generally follow the main Himalayan trend. Such ridged are Kalanti ki dhar, Lingu -dhar. Summit surfaces observed at Bhu-top, Chakru-top and Deo-kund which generally remains snow covered from October to April. The rocks are generally subjected to glacial and fluvio-glacial erosion. Geomorphological map of the area has been depicted in Fig 3.

the Fig 2. In general dendritic pattern suggest homogeneity in texture and their resistance to

(1) Glacial Lakes

The lakes of glacial origin are located above 2500 meters in the zone of ablation. The depression formed by the quarrying action of glacier which later on filled by water. In summer it receives water from melting of ice while in rainy season water increases from surroundings. Such four lakes were observed in Bhu-top area, one at Deo-kund and another at Khariatal. The Khariatal lake is about 250 mtrs in length and 200 mtrs in width and having 1.5mtrs depth at corner. The lake is oval in shape and surrounded by beautiful bugiyals. This lake is located between Parvati and Jolly peaks in a vast glacial trough. Due to its beauty the area is also known as Ramnikadesh by old people of area. If the proper attention will be paid the area may become future tourist resorts. The other lake is located near Siaba village; it may have tectonic origin because Main Central Thrust is passing near Siaba village.

(2) Moraines

Moraines are glacial deposits of heterogeneous composition associated with rock fragments and clay. The moraines are characterized by striations, grooves and chatter marks. Some villages are located on such morainic deposits. The soils of these morainic deposits are very fertile especially for Malta, Apple and potatoes.

(3) Valley development

Valley development is the result of erosion work of glacier and river. It is accompanied by the process of valley deepening, widening and lengthening. River Bhagirathi flow through the country rocks quartzites, gneises metabasics forming deep George at Bhukki and U shape valley at Uttarkashi. In the upper reaches the valley is U shape while at low reaches it is V shape indicate that valley was previously occupied by glacier and later river carved out V shape valley. Valley cross section shows straight slope at valley side due to uniform rate of erosion and uniform nature of rocks. The convex slope is due to the sub surface soil water movement and soil creep generally exhibited by summit surface like Bhu-top and Chakru-top. Concave type of slope is due to deposition of

material at low reaches. Fig-4 shows valley cross section of Bhagirathi River at some places.

(4) Escarpment

Escarpments are associated with ridges shows steep slope at one side and gentle on the other side. Such type of features observed at Kalantiki dhar and Bhetatipri.

(4) Waterfalls

Waterfalls are common in the present study area. Such waterfalls has been observed at Helgu gad, Kamar gad, Maneri gad and Kola gad having height about 55mtrs, 24 mtrs 10 mtrs and 32 meters respectively. Rocks around the waterfalls are hard quartzites metabasics, gneisses amphibolites. These waterfalls may be used for micro-power generations.

(6) Hot springs

Five hot springs have been located from Maneri to Gangnani area all hot spring s lies along NE-SW lineament and observed at Gangnani, Sunagarh Bhukki and Maneri. The temperature of hot springs noted as 54, 48, 46 and 36 respectively from Gangnani to Maneri. These hot springs contain K, Na, Cu, Cd, Mn and Zn. There is a possibility of much hot water in the NE direction and these hot springs may be source of thermal power energy.

(7) River terraces

These are flat surfaces along the valley side of stream marking the former valley floor. River terraces are observed at Hinna, Bhatwari Maneri and Sainj. The four terraces are of fluvial origin while old terrace is of glacial origin. The flood of 1978 in Bhagirathi valley has been washed away the youngest terrace of Gangnani and Bhatwari area.

GEOMORPHOLOGICAL HAZARDS

National highway joining Rishikesh to Gangotri is frequently blocked by landslide during rainy season; such landslides were located at Bhatuksaura, Malla, Bhatwari and Tiara. Some of

the landslides are aligned along the Main Central Thrust as near Siaba and Lata. The landslide of Lata and Siaba are due to the tectonic activity as the rocks near the thrusts are quartzites grading into talc-chlorite schist's with gauze material. These chlorite=schist and gauze material when soaked in water are easily disintegrated form lubricating material which initiate the sliding. Such phenomenons are common near Kumalti gad and Dogadda gad and in such a way cultivated area near Dogadda gad and Kumalti gad.

Near Bhatuksaura and Malla the landslide were encountered along the road where the road about 500 mtr in two patches had been subjected to subsidence. The road was constructed over Mylonitic migmatites and morainic deposits, Above the roads Mylonitic migmatites and unconsolidated material slump down during rainy seasons causes landsliding. The Tiara village and Hurri gaon were located on morainic deposits exhibiting moderate slope, Whenever these area subjected to vibration the ground morains sliding down. Opposite of Bhatwari there are loose debris material slumping down due to the toe cutting of Bhagirathi River. During the rainy season area receive greater precipitation water increases in the streams as well as in Bhagirathi causes the soil erosion depend on slope condition, bed rock character and topography of the area.

HYDROLOGICAL HAZARD

Climatic factors are also responsible for environmental degradation. Higher intensity of rainfall and cloud burst phenomenon is common in the middle Himalayan region. The sheet erosion and gully erosion increases and streams as well as river flow with high velocity also increase the soil erosion. Due to increase in water level new seasonal springs emerges causes erosion. The main tributaries of Bhagirathi River in the investigated area are Helgu gad, Montru gad, Saundhar gad, Pilang gad Nahar gad, Paper gad, Kumalti gad, Dogadda gad Maneri gad and Kamar gad. Most of the tributaries has source in glacial area so they receive continuous supply of water throughout the year. They are in youthful stage of their development and erosion processes are hydraulic, abrasion and attrition. In rainy seasons

when these streams get higher precipitation due to toe cutting several landslides takes place and cultivated area washed away by these streams even due to heavy landslide it blocked the stream and small lake were formed by Kannoldiya gad. Cloudburst is also common phenomenon in middle Himalaya. It was noticed that during last 10years maximum loss of life and property was caused by cloudburst. Wherever the valley is funnel shaped and larger condensation of clouds a heavy torrential rain occurs in a small area. Such cloud burst phenomenon was occurred in Paper gad and Dhanpati gad area.

ANTHROPOGENIC HAZARDS

The accelerated pace of erosion in this geodynamically sensitive region coupled within supportably big growth in human and livestock. Population has brought certain irreversible changes endangering life support system even for the flora and fauna. Over exploitation of forests destruction of slope stability by indiscriminate and ruthless excavation of roads, tunnels, dams etc. Landslides become common and rate of erosion increases higher than it was in past. The sediments are filling channels and chocking the streams .The springs are drying up or becoming seasonal. Road construction has caused both directly and indirectly a massive destruction of forests, slope stability. Vibrations generated by the explosive during road construction, open the fissures of rocks and weaken the existing rocks. Such types of hazards are noticed near Malla, Aungi and Chadheti.

Diversion tunnel was constructed from Maneri to Uttarkashi and power station set-up at Uttarkashi. Jamak village is located just above tunnel, opposite of Maneri. The village triggered due to the explosive used during the construction. Jamak – Gangori fault is passes along Bhagirathi river trending NE-SW direction. Earthquake of Uttarkashi (1991, 6.2 intensity) destroyed Jamak village and maximum loss of life and property was observed. Similarly the Hurri gaon was located on morainic deposits over vertically dipping Banded gneisses and biotite schists. Due to the construction of tunnel for Lohri Nag pala project the cracks appeared on the houses of Hurri gaon due to vibration caused by explosives.

DISCUSSIONS AND CONCLUSION

From the geo-environmental study of investigated area following conclusions were made:-

- (1) Near the thrust landslides of Siaba and Lata were observed, the Main Central Thrust is the structural feature in the area, and Lake of Siaba is also due to Main Central Thrust.
- (2) Various landforms are result of glacial, glacio-fluvial and fluvial processes. Valley is generally "U- shape" in upper part and "V shape" in the lower which suggests that previously glaciated valley was carved out by river in later stage.
- (3) Five levels of terraces indicate neo-tectonic activity in the area.
- (4) Hot springs and their temperature increasing towards NE indicate much hot water in NE direction which may be used as thermal energy.
- (5) The lake of Khariatal located in vast outwash plain, surrounded by bugiyals with colored flower is best eye soothing scene, if proper attention will be paid, it may be future tourist resort.
- (6) Hydrological hazard is mainly by torrential rain in rainy season, stream and by cloudburst.
- (7) An anthropogenic hazard is mainly by construction of roads, tunnels and buildings.

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