



STUDY OF A ROAD WIDENING PROJECT IN HILLY REGION AND ITS IMPACT ON ENVIRONMENT: KUMAUN HIMALAYA, UTTARAKHAND

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Abstract: Roads play a very vital role in the economic and social development of any place. Present days without transport, we cannot imagine our daily life. Present-day life is completely dependent on transportation that helps to move people and things from one place to another. Roads are important not only from a social-economic point of view but also from a strategic point of view. Road construction in the hilly region is a difficult task, due to the geographical location and geological setting of the Himalayan mountainous region. Therefore, uncontrolled construction cannot be permissible. If we ignore the geographical and environmental perspective of the hilly region for construction then it can be a major cause of landslides leading towards disasters. One-line roads are useful for the economic development of any place; road widening must be avoided and by the government until and unless not necessary for the security purposes or specific area development of any part of this sensitive domain.

Index Terms- Road widening, geographical location, landslides, Himalayan.

1.0 INTRODUCTION

Roads are very essential for the development of any place. Road transport is a reliable and flexible mode of transport and the cheapest way to move things from one place to another. It connects remote hilly areas, desert areas, tribal areas, and backward areas with towns and urban centers. It is very significant for the transportation of raw materials in the Himalayan region. Uttarakhand is one of the Himalayan states that have a limited road network. Most of the state of Uttarakhand falls under the mountainous region. The Himalayan region experiences continuous slope failure due to various natural and anthropogenic reasons. Slope instability is the main issue of the region (T. Siddique et.al 2017). Anthropogenic and technogenic activities have risen to many geological and environmental problems in the recent few decades (Pushpa and Jyoti Joshi 2016). A Road network is essential for development but slope instability in the hilly region focuses on proper planning and design of road cuts on the slope. It is very important to use proper road cut techniques due to the high instability of the slope (Neeraj et.al; 2018). The environment is affected globally by many factors; highway development is one of them. Roads are important for economic development but road construction has both positive and negative effects (Shreya Handa et.al, 2019). The Uttarakhand hilly region is a highly sensitive area for landslides. The frequency of landslides in the region increases, especially during the monsoon season. Landslides are often a natural occurrence in the mountainous region of the world but anthropogenic activities are also responsible for landslides (Sajwan K.S .et.al, 2016). Landslides are one of the major threats in the Indian Himalayan region. Previous data sheets reveal that most landslides are because of rain triggers. Uttarakhand Himalayan region is highly affected by landslides during the rainy season (Abhirup Dikshit et.al, 2020).

The government has made several plans for the development of the region, which will help improve the economic condition of the local people. Among them, the national road-widening project and the Chardham road project are the main ones. One of the major income sources of the state depends on tourism. Therefore, the government believes that a road network is necessary for tourism development. Road network is important for the economic and social development of the Himalayan region but the environmental effects of road construction need deep concern too. At present, roads in the mountainous region of Uttarakhand are being widened. The Himalayan region is one of the most sensitive regions due to slope instability. The road is being widened mainly for the development of tourist destinations.

2.0 OBJECTIVES

The main objectives of the study are:

- To assess roadside landslides in the mountainous region.
- Study of the impact of road widening on the environment.

3.0 METHODOLOGY

The present study included both primary and secondary data collection. For primary data, traverses along the National highway, intensive fieldwork including field survey and observation carried out along the road cuttings, and preparation of maps were one of the major tasks. Secondary data of the region acquired from the PWD office Almora and NH office Haldwani (that are involved in the road widening process) provided the required information. These offices also provided data related to the widening of roads and details of the construction work, vegetation-cutting data, and geological data. The map of the study area was prepared using QGIS and Google earth software with the help of NRDMS, Almora. Microsoft Excel 2010 has been used to analyze and manipulate data. Identification of active landslide areas was possible by field survey with the help of GPS.

4.0 STUDY AREA

The study area comes under two districts Almora and Nainital. NH 109 passes through Kakrighat and Khairna. These places are included under the Kosi watershed area. The road widened at various stages on National Highway 109 (previously called NH 87) and its impact on the geomorphology environment of the selected area is a major concern of the present study. This road widening project is working in several phases. Its first phase was started along the highway (10 km.) between the places named Kakrighat and Khairna (Fig.1). Kakrighat is a small village located in the Almora district. Khairna is a semi-urban center located in the Nainital district. The study area includes the road extension between 29°33' North latitude to 79° 32' East longitudes and 29° 30' North latitude to 79° 29' East longitudes. The entire Kumaun region connects Haldwani mandi via NH 109. Previously, NH 109 was NH 87. After the renumbering of National Highways in 2010, is now known as NH 109 which connects Nainital, Ranibagh, Haldwani, and Rampur towns and is very important from a strategic and economic point of view. NH 109 connects Udham Singh Nagar- Nainital- Almora to the Chamoli district of Uttarakhand. There are many tourist spots between Udham Singh Nagar and Chamoli. The total length of NH 109 is 284 km. We can call this route the backbone of Kumaun region.

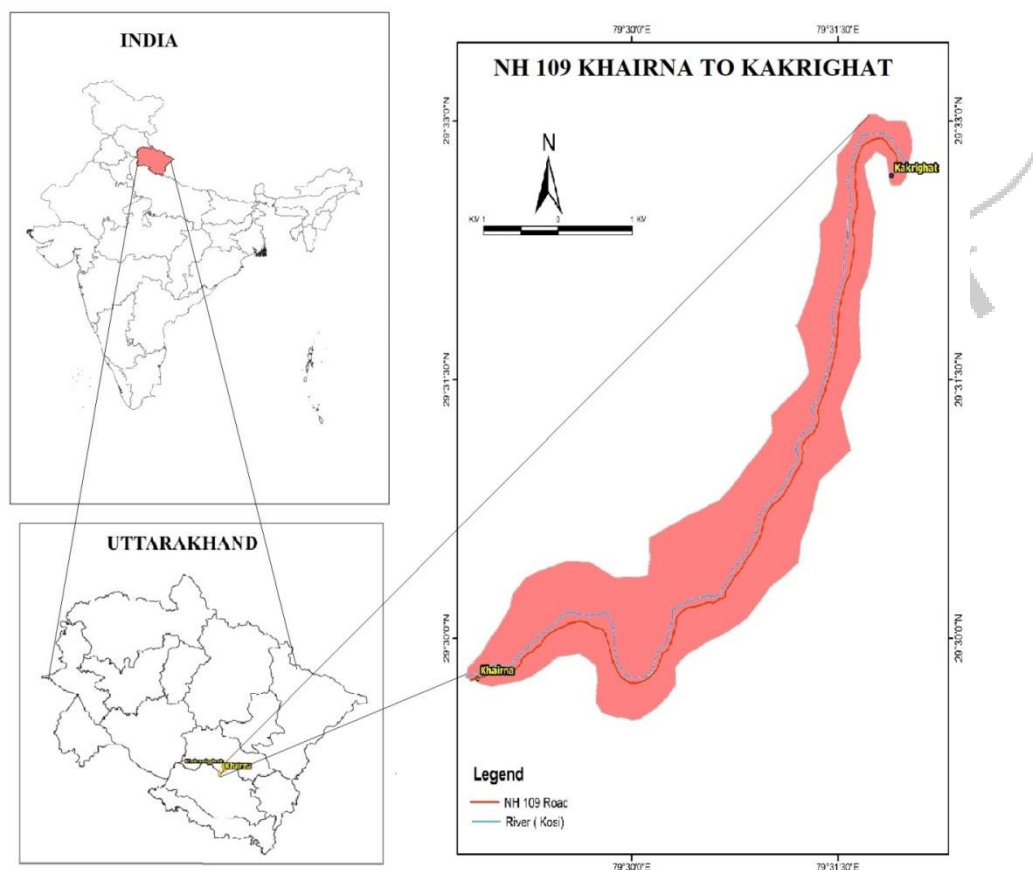


Figure 1: Location map of the study area, viz., NH 109 Khairna to Kakrighat

5.0 REGIONAL GEOLOGY

Road project NH 109 extends over the southeast tip of the Krol belt in the Himalayas. Khairna and Kakrighat lies in the Kumaun lesser Himalayas. The Himalayan landscapes are controlled by the geology and tectonics of the region. Thus the investigation of geology and geomorphology must be more essential before the construction of any place especially in the mountain region of the Himalayas. The lesser Himalayan mountain ranges near the foothills are made up of rocks of the Krol-Nagthat group. This group of rocks is Pre-Cambrian age to the middle paleozoic age. The formation of Nagathats has been found in Khairna and neighboring areas (R.A. Chansarkar, 1974). The Nagathats formation is found in Khairna, Garampani, and neighboring areas. The Ramgarh thrust is located in the north and northeast part of the Nagathats formation. Quartzites Nagathats and slaty phyllites, limestones with slate and granites are rock types found in

Nagthats and Ramgarh thrusts (C.P. Shah, 1973). Nagthat and Ramgarh rock formations exist in this area between Khairna and Kakrighat. Most rocks have layers of debris and soil (Fig.2, Plate 1). The gradient of the highway design is moderate to steep.

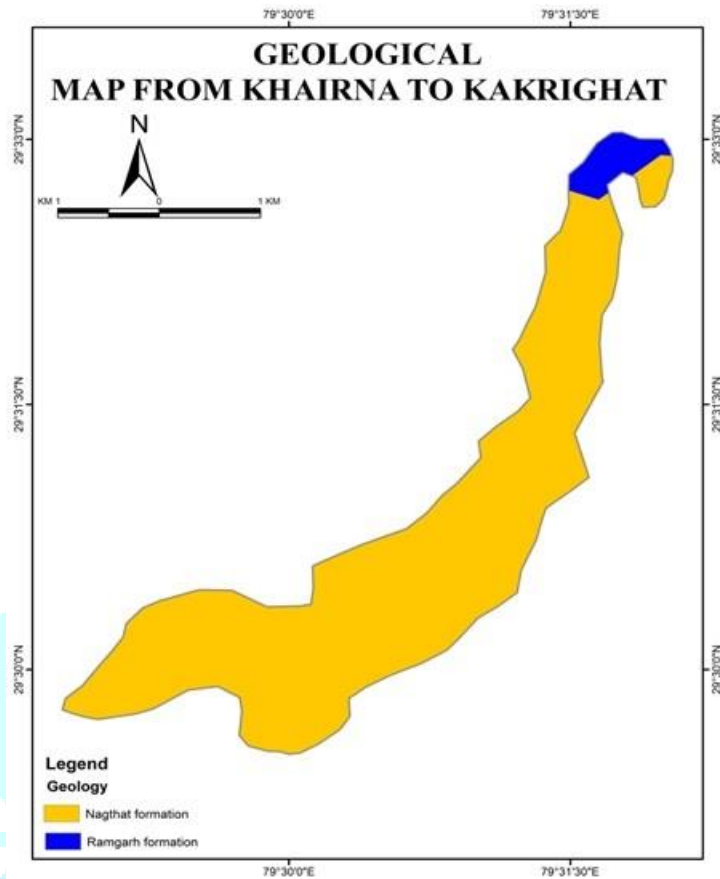


Figure 2: Geological map from Khairna to Kakrighat



Plate 1: Fine layers of soil and Talus cone near Jaurasi (source: field survey)

6.0 FIRST PHASE OF ROAD WIDENING FROM KAKRIGHAT TO KHAIRNA

The road widening project was the first phase working from Kakrighat to Khairna. The first phase of widening the road in NH 109 was approved only a short distance from the road (10 km). The project is a part of the construction work by the Engineering Procurement and Construction Board. A budget of 32 crores 17 lakh has been received in this phase. It is the first weighting project at Uttarakhand. It is based on traffic conditions of 15 years. Presently, the second phase of road widening has also started from Kakrighat to Kwarab, a very important roadway that connects the entire Kumaun region with the country.

6.1 PROPOSED WORK IN ROAD WIDENING

6.1.1 Road width- Earlier the width of the road was 7 to 8 meters. It is presently converting into two lines. Now the width is increased up to 12 meters where the road is made of seven meters and drains on the other side.

6.1.2 Road Planning- The project is designed for a traffic condition of 15 years. About 2500 vehicles pass through this road every day. 10 lakhs MSC vehicles pass through this road every year.

6.1.3 Construction of Minor Bridges- Three minor bridges constructed along the road included in this project lie near Chhara, Chamria, and Jaurasi. Stones and other materials used in the structure and sub-structure are mostly part of the material mobilized during the widening process. The width of these bridges is 6.20 to 5.25 meters. Details about these bridges are mentioned in (Fig.3, Table 1, and Plate 2).

6.1.4 Constructions of Concrete Blockers- There are three major hazard zones on this road project where there is always the possibility of landslides. Which was also affected by the 2010 disaster. Concrete blockers are to be constructed in a hazardous area (Plate 4, Fig.3). These hazardous places are mentioned in (Table 3).

6.1.5 Construction of Culverts- In this road project, several culverts have been built between Khairna to Kakrighat. They are constructed by stone. The details of the culvert are mentioned in Fig. 4 and Plate 3 that the data was provided by NH Office Haldwani.



Plate 2: Minor bridges (source: field survey)

Table: 1 Details of minor bridges (source: NH office Haldwani)

S. N.	B ridge location	Salient details of existing bridge				Adequacy
		Type of Structure				
		Foundation	Sub-structure	Super structure	No. of spans With span Length(m)	
1	Chhara	open	Stone masonry	RCC solid slab	1x8.50	adequate
2	Chamria	open	Stone masonry	RCC solid slab	1x9.55	adequate
3	Jaurasi	open	Stone masonry	RCC solid slab	1x9.55	adequate

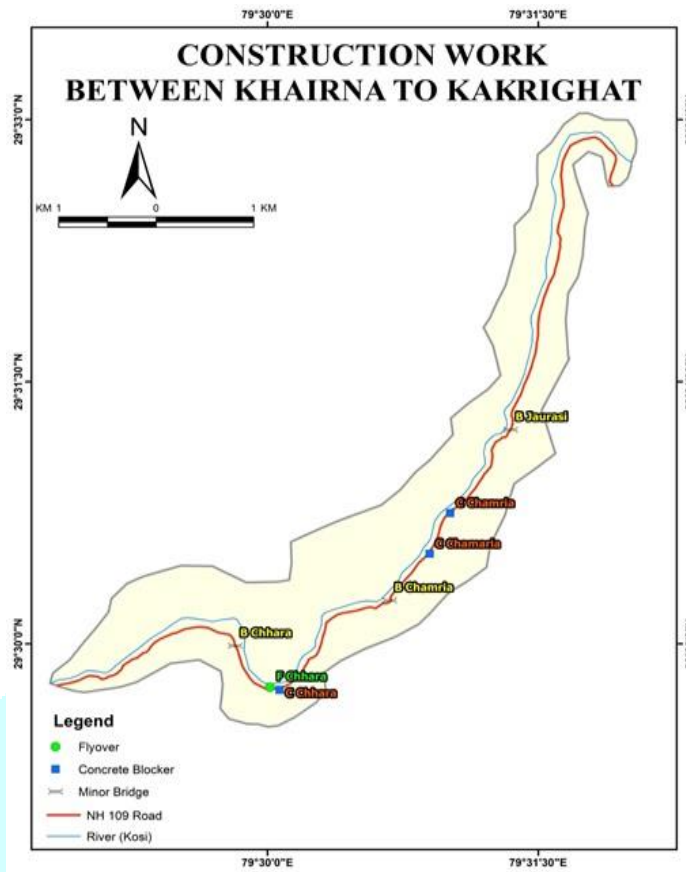


Figure 3: Construction work along NH 109 between Khairna to Kakrighat (source: field survey)

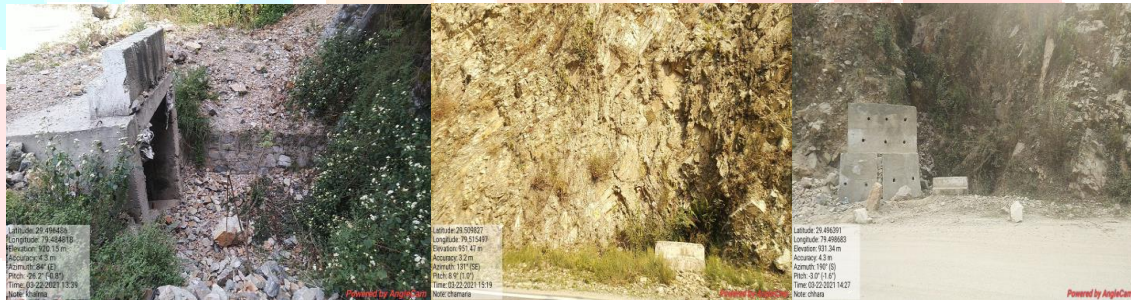


Plate 3: Roadside culverts (source: field survey)



Plate 4: Concrete blocker (source: field survey)

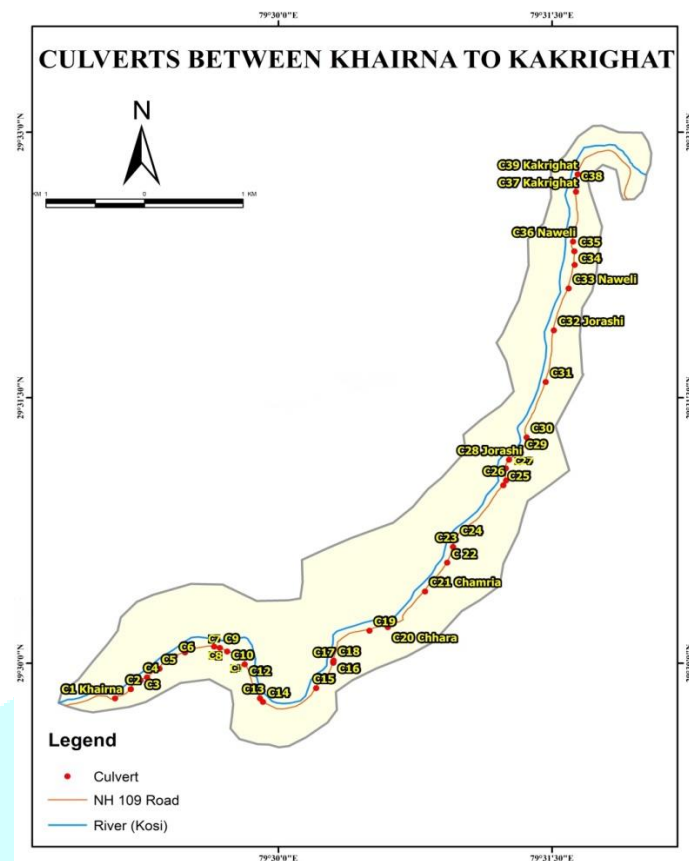


Figure 4: Culverts between Khairna to Kakrighat (*source: field survey*)

6.1.6 Flyover- A Flyover is being constructed at Chhara near the major landslide area, where landslides occur every year. According to construction workers, the length of this flyover is 360 meters (Fig.3, Plate 5).

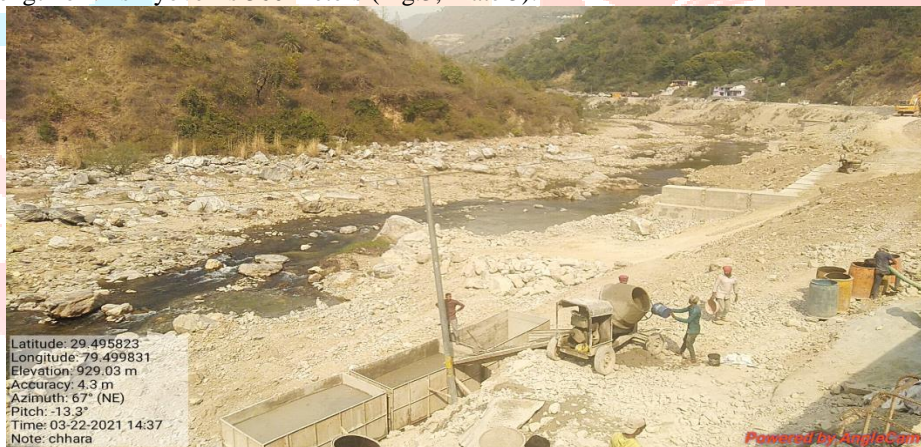


Plate 5: Construction of flyover near Chhara (*source: field survey*)

7.0 EFFECT OF ROAD WIDENING ON VEGETATION

Vegetation is one of the most essential elements of the environment. Most of the forested areas have lost their significance and at places existence due to urbanization and uncontrolled construction. While on the one side, the environmental protection agency is planning a green highway to sustain ecology, and on the other side in the hilly region of Uttarakhand, much vegetation has been affected in the highway widening project. Deforestation is a major contributor to landslides. After the Indo-China war in 1972, highways were strategically constructed throughout Uttarakhand. In which many forests were affected due to the availability of road transport (Ravi Chopra, 2014). According to the data of NH Office Haldwani, the road widening project between Khairna to Kakrighat affected 4.2 hectares of forest area and 0.78 hectares of naap land. In which 0.79 hectares of reserved forest has been affected, 1.6 hectares of state forest has been affected and 1.77 hectares of civil forest/panchayat forest has been affected in road widening from Khairna to Kakrighat. A total of 4.2 hectares of the forest area has been affected by road widening (Table 2). The forest department received a budget of 69.5 lakhs to cut 4.2 hectares of forest area. The forest department had also appealed for 23583.0 lakh funds for the dumping zone from Khairna to Kakrighat. Approximately 1577 trees have affected under 10 km area between Khairna to Kakrighat. The forests damaged due to road widening can cause disasters. However, there is a provision for doubletree planting in the area of tree felling. During road construction work it is necessary to compensate for cutting down the forest on the roadside. It is mandatory to get permission from the forest department to cut the trees required for road construction. Compensation for the loss of trees in road construction is necessary as per the rules of the forest Department. These are just in the form of documents. This highway project extends from Jyolikot to Karnprayag. In which many flora along the road will be affected (Plate 6). This effective forest area falls under Almora and Nainital districts.



Plate 6: Effect of road widening on vegetation (source: field survey)

Table:2 Affected forest area (source: NH Office Haldwani)

S.N.	Forest Type	Affected forest area(Hectares)
1	Reserved Forest	0.79
2	State Forest	1.64
3	Civil Forest/ Panchayat	1.77
Total		4.2

8.0 IMPACT OF ROAD WIDENING ON THE RIVER

The Kosi River runs through this road widening area From Khairna to Kakrighat. The road passes by the banks of the Kosi River. The debris of the road widening has entered the river from the slope of the road, blocking the flow of the river. During the rainy season, all the loose debris gets into the river. This process interrupts the flow of the river at various places. Whereas the rule is that, the mobilization of the debris must be to the dumping zone, which should be 100 meters away from the construction area. However, the debris, which is released near the slope of the road, is dangerous (Plate 7).



Plate 7: Debris dumped near the slope of the road, which is blocking the river (source: field survey)

9.0 IMPACTS OF ROAD WIDENING ON SLOPE

There is a steep and moderate slope between Kakrighat to Khairna in NH 109. The slope cuts to widen the road move the grip rocks and soil has become loose, due to which the rocks are falling on the side of the road. This process increases new minor landslide areas in the future, it may convert into a high-risk area. Similarly, the hill slope in Kakrighat cut up to 80 meters, affecting the hill slope. Heavy boulders fall in this area anytime. Somewhere the cutting of slope becomes a cause of landslide by humans that will lead to environmental problems in future.

We all know that the road is very important for economic development. The places where there is no road connectivity are still backward. As we can say that road acts as arteries in the economic development of any area but road construction in the Himalayan region has affected the environment and geology of the region. The Himalayan region is sensitive. The explosions that are used to break rocks during the process of road construction in the Himalayan region make the rock layers loose, which causes landslides. This increases the tendency of rocks to fall. Uttarakhand receives heavy rainfall during the monsoon season, which increases the landslides. If landslides are to be assessed, one can find most of the landslides occurring on the roadsides. Landslides in the mountainous region inhibit transportation. Though Landslides occur due to both; anthropogenic and natural causes. Nevertheless, the main reason for the roadside landslide is anthropogenic. New landslide areas have emerged along the roads due to the road-widening project. NH-58 and NH-109 widening projects are prime examples of this. Khairna region has already been a very sensitive area. Before the road widening work, there were three landslide sites between Khairna and Kakrighat area. The location of these landslides is near Khairna, Chhara, and Chamaria, (Fig.5, Table 3, and Plate 8). After the widening of the road, several new minor and major landslides have emerged from Khairna to Kakrighat. New landslides have emerged near Khairna, Jaurasi, Chamria, and Chhara (Fig. 6, Table 4, Plate 9). The geological survey is important to the area before road construction, which is ignored more often is responsible for the degradation of landscapes.

Table 3: Old landslide area (source: field survey and Google earth software)

S.N.	Landslide Symbols	Location	Area (square meters)	Map Length (Meter)	Ground Length
1	L1	Khairna	2035	49.92	57.31
2	L2	Chhara	1,03,402	376.23	496.53
3	L3	Chamria	5535	154.17	205.13

Table 4: New landslide area (source: field survey and Google earth software)

S.N.	Landslide Symbols	Location	Area (square meters)	Map Length (Meter)	Ground Length
1	L1	Kakarighat	1508	32.18	43.35
2	L2	Kakarighat	5405	53.38	73.41
3	L3	Jaurasi	427	14.07	21.67
4	L4	Jaurasi	2207	26.4	31.91
5	L5	Chamria	3163	63.09	97.54
6	L6	Chamria	8714	229.36	296.69
7	L7	Chamria	5535	154.17	205.13
8	L8	Chhara	67.4	5.73	9.26



Plate 9: New landslide area (source: field survey)

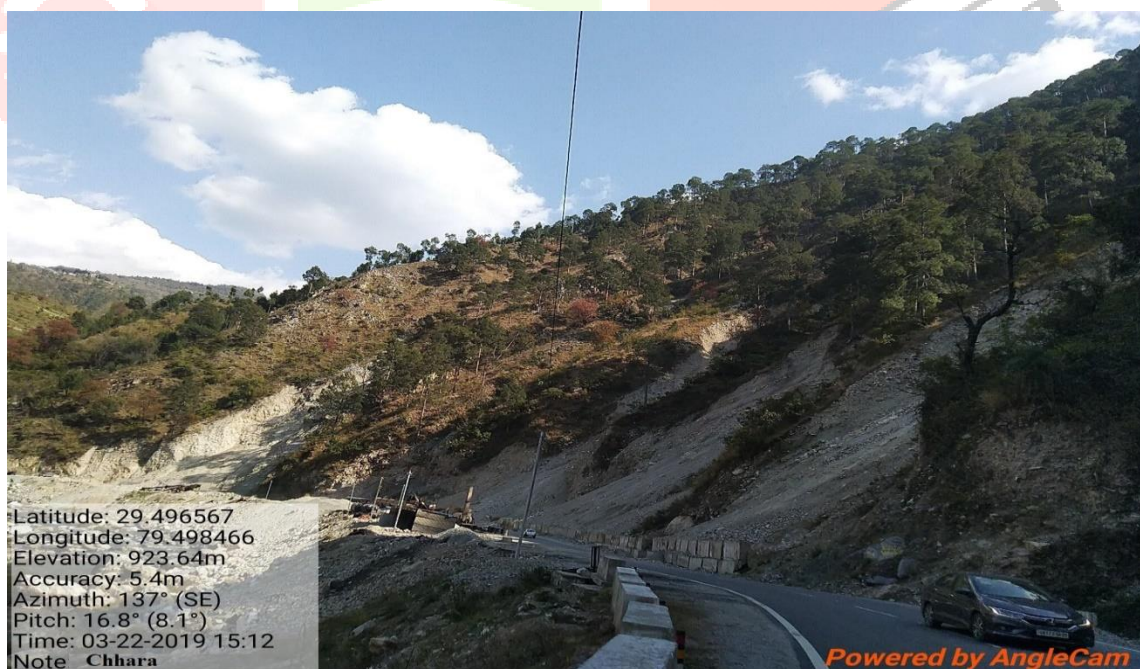


Plate 8: Old landslide area near Chhara (source: field survey)

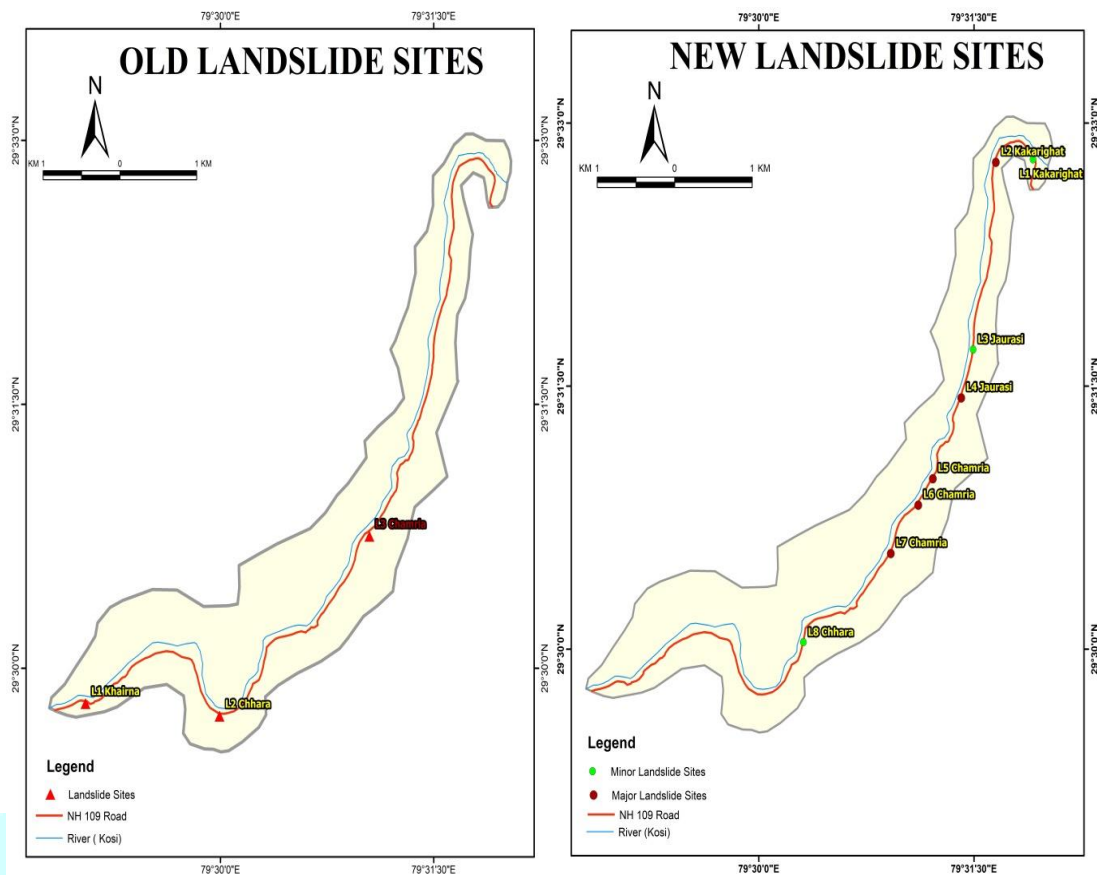


Figure 5: Old landslide sites (source: field survey)

Figure 6: New landslide sites (source: field survey)

10.0 IMPACT OF ROAD WIDENING ON HUMAN LIFE

The road widening project severely affects human activities, especially in the hilly region. Due to road widening, there landslides are increasing on the side of the road, which are the cause of the accidents. The site has several locations with risky areas where bolder flow is common. Debris flow during the rainy season is also a common phenomenon in the study area. In 2017, about 10 people lost their lives in road accidents in the study area. A bus was badly damaged due to the boulder flow which killed 8 people (Plate 10). In July 2017, 2 bikers were buried in the debris due to the landslide. Khairna to Kakrighat road is completely risky due to the landslides. The road becomes more dangerous during the rainy season.



Plate 10: Bus badly damaged due to boulder flow (source: field survey)

CONCLUSION AND SUGGESTIONS

Roads are helpful for economic development but if we analyze the widening of the road in the hilly region, deep observations show that most of the process is unfavorable to the environment. Road widening has invited many environmental problems in the study area. The entire debris of the road cut was being dumped on the slopes of the river which affecting the flow of the river. Various anthropogenic activities for infrastructure and development create many environmental issues in the hilly region of Uttarakhand. Landslide activities intensify mainly during the rainy season in the Himalayan region. Natural and human activities cause landslides, but most of the landslides are due to anthropogenic activities on the roadside. The slope has to be cut along the roadside due to road widening which increases the erosion

process and sometimes is the major cause of the landslide. Highway widening activities also have an impact on the vegetation along the steep slopes. Vegetation roots hold the soil, which helps reduce soil erosion but the loss of vegetation increases soil erosion. Vegetation protects the soil from the rain splashes that fall directly on the soil layers and increase soil erosion.

Uncontrolled construction always leads to disasters. The hilly region is very vulnerable to earthquakes, landslides, erosion, and cloudbursts, etc. Development is essential for human beings but environmental harassment has invited many environmental issues which are impacting human life. Therefore, the need of the hour is to also care and rethink seriously to sustain the precious gift of nature i.e., the Himalayan mountain system, and make balance in between natural processes and human development.

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