



Analysing the impacts of widening of Shimla-Kalka national highway and incidence of landslides

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Abstract

Road is a bedrock of a thriving society, driving economic prosperity, fostering social ties, and uplifting living standards. They amplify mobility, ensure easier access, and streamline the transit of individuals, commodities, and services. The quality of roads in India can vary considerably. While some stretches of national and state highways are well-maintained and are of good quality, others may suffer from issues such as depressions, insufficient signage, and inadequate maintenance. However, efforts have been made to improve road infrastructure through initiatives aimed at enhancing road connectivity and addressing infrastructure gaps. The expansion of Highway 22 has involved widening and improving the existing road infrastructure to accommodate increasing traffic volumes, enhance safety, and improve travel efficiency. Road and infrastructure development is considered essential for the economic advancement of the nation. Roads construction and development are equilibrium factors for the development but they are overexploited practices that are making the local environment causing adverse effects not only the ecology but on the local residents also. Present paper is based on the field exploration carried out between Solan-Kaithlighat tract of NH-22 (now NH-05) from Km 106.139 to Km 129.050. It was concluded that highway expansion has resulted in the migration of local people, deforestation and exploitation of the local ecosystem, increase incidence of landslides during the construction phase as well as after the completion of the construction work.

Keywords: Highway construction, landslides, Shimla-Kalka National Highway, environmental impacts, resettlement

Introduction

Roads are often compared to lifelines for these impeccably link diverse market players, for instance, suppliers and consumers, employees and employers, and students to educational institutions. Basically, transportation corridors are the pillars of a nation's economic development for these offer avenues both for people and goods, linking cities to hamlets, confirming integrated travels. Road infrastructure is vital for trade and prosperity (Arya and Joshi, 2021) [2]. Roads are essential in rural areas, helping farming activities for these link farmers with markets, enabling the movement of crops, and granting access to vital farming resources. A robust rural road system can amplify agricultural output and strengthen rural progression. India's road network is indispensable in developing transportation, impelling economic growth, and connecting communities countrywide. There's a constant push to strengthen the quality of road network, ramp up safety measures, and advocate for greener and more efficient transportation facilities (Chalke *et al.* 2018) [3]. In this context, highway expansion is perceived as a supporter of development, boosting local commerce and inhabitants, which brings about benefits, like enhanced business activities, household incomes, and higher tax inflows for government, inspiring economy of the impacted areas (Yusupov, 2020) [6]. On contrary, there are several problems which arise during the construction of roads for road construction projects are very expensive, and face budget constraints, resulting in lower quality material being used or the project being late. Extreme weather conditions, such as heavy rainfall or snowfall hamper construction works and affect the quality of the road. Construction activities can cause traffic disruptions, causing inconvenience for commuters and traders. Road construction can have adverse environmental implications like, soil erosion, deforestation, and pollution.

Likewise, land acquisition for road construction can be a challenge, mainly in thickly populated areas, which delays and increases costs. Road construction projects require complex designing and engineering, which can be challenging in terms of cost, feasibility, and safety. On the whole, road construction is an intricate process that needs vigilant planning, implementation, and management to safeguard a successful outcome.

National Highway-22 often referred to as the NH-22 is a major highway in India which is located in the northern India, mainly connecting the states of Punjab, Himachal Pradesh, and Uttarakhand. Starting from Ambala, it extends to Shipki La Pass on the India-China border in Himachal Pradesh. The length of NH-22 is approximately 459 kilometres. NH-22 is a vital transportation corridor that serves as a lifeline for several areas in northern India which connects major cities, hill stations, and remote areas, contributing to economic activities, tourism, and trade in the region. It passes through cities and towns such as Chandigarh, Shimla, and Kinnaur. NH-22 traverses through diverse topographic landscapes, ranging from the plains of Punjab to the rugged hilly terrain of Himachal Pradesh. It provides access to various defence establishments, border towns, and military bases thereby maintaining connectivity for defence purposes. To improve road infrastructure, safety, and travel efficiency, NH-22 has undergone expansion. Efforts have been made to widen the highway, construct tunnels, and improve road conditions to lodge the increasing traffic volume and improve overall travel experience. But, looking at the other side, the construction or expansion of highways causes direct destruction of existing ecosystems and reconfiguration of local landforms. In order to analyze the impacts of expansion of NH-05 with special emphasis on displacement issues and impacts on landscapes, environment and biodiversity, present study was

undertaken. The study also analyzed people’s perceptions linked with the impacts of expansion of NH-05 and incidence of landslides.

Material and methods

Primary data collection: The primary data was collected from the respondents of the study area who are observing the erratic change which in turns is affecting the livelihood and their surroundings.

Study area is located in the Solan district of the Indian state of Himachal Pradesh. There are total 13 villages in the alignment of Solan-Kaithlighat tract of NH-22 (now NH-05) from Km 106.139 to Km 129.050 out of which five villages were selected. Information was sought from National Highway Project (NH-05) with regard to:

- a. Salient Features of project
- b. Status of Land Acquisition
- c. Status of flora and fauna
- d. Rehabilitation and Resettlement Plane
- e. Environmental Impacts

Focussed group discussion: The primary data was collected from the residents of the selected villages by using the Focussed Group Discussion method.

Secondary data: Various national and international journals, books, monographs, reports of government were also consulted for the purpose. Secondary information was also collected from NHAI (National Highway Authority of India) to correlate the information gathered from the field. The data collected from different sources has been tabulated and analysed using suitable statistical tool.

Profile of study area: The present study was carried out is between Solan and Kaithlighat, which is part of the section from Solan (km 106.000) to Dhalli (km 156.507) of NH-05. Study area is located in the Solan district of Himachal Pradesh. The project envisions connecting high-traffic density stretches, state capitals and tourism centres to the NHDP Phase III. This section passes through districts Solan and Shimla of Himachal Pradesh. The length of the stretch selected for study is 25 km. This stretch is a part of tourist route and connects Kalka, Shimla, Parvanoo, Ambala, Chandigarh, etc. Shimla, being the state capital and Solan being an important town of Himachal Pradesh is an important hub of many industries, and bulk trading apple market.

This road is responsible for to and fro movement of heavy traffic from Shimla and other parts of the State which necessitated the widening of the existing road and is likely to enhance the economic competence of the area. There are total 13 villages in the alignment of Solan-Kaithlighat tract of NH-05 from Km 106.139 to Km 129.050 out of which five villages were selected. The name of the villages is tabulated in table 1:

Table 1: List of villages in the alignment of Solan-Kaithlighat tract of NH-05

Tehsils	Villages
Solan	Salogra Solan, Ber Khas, Ber Ki Ser, Dadhog, Padag, Jarai, Kotho, Daunsi, Kathog, Salogra, Mansar, Mathiya
Kandaghat	Sanech, Padotha, Ded, Dolag, Sirinagar

Out of 13 villages of Solan tehsil and five villages of Kandaghat tehsil, the study was carried out in Salogra, Mansar, Ber Khas, and Ber Ki Ser villages from Solan tehsil and Ded and Dolag villages from Kandaghat tehsil.

Solan is situated in the southern part of the state, about 46 kilometres from the state capital, Shimla. Due to its thriving mushroom cultivation industry, Solan is often known as the ‘Mushroom City of India’. Solan is known for its pleasant climate, picturesque surroundings, and lush greenery. It is located at an average elevation of around 1,600 meters above the mean sea level. Solan serves as an important educational and industrial hub of Himachal Pradesh. It is home to several educational institutions; while Kandaghat is a small town located in the Solan district. It is situated in the Shiwalik range of the Himalayas, at an average elevation of about 1,427 meters (4,682 feet) above the mean sea level. Kandaghat is known for its scenic beauty and pleasant climate. Kandaghat is well-connected by road and rail. It lies adjacent to the Kalka-Shimla railway line, a UNESCO World Heritage site famous for its scenic beauty. The physiographic details with regard to the study area were gathered from the secondary sources.

Topography: The topography of selected stretch is undulating and hilly. The elevation of selected stretch ranges from 1493 mts. to 2250 mts. from the mean sea level.

Direct influence area: The direct project influence area has been considered the Right of Way (RoW) of proposed project and 500 mts. on either side from the edge of the road. The Proposed Right of Way (ROW) of project road is 45 mts. in the entire stretch of project road.

Indirect influence area: The indirect influence extends from boundary of the direct area of influence and up to 15 kms from the boundary of RoW of project road.

Geomorphology: Owing to its location in the Shiwalik range of the Himalayas, Solan district exhibits diverse geomorphological features. Key aspects of the geomorphology of Solan district includes:

Shiwalik hills: Solan district is situated in the Shiwalik Hills, which are the southernmost range of the Himalayas. The hills are characterized by gently sloping terrain and are composed of sedimentary rocks, including sandstone, shale, and clay.

Ridge systems: The multiple ridges that run parallel to each other form distinct landscapes. These ridges are often covered with dense forests and provide stunning views of surrounding areas.

Plateaus and plateau escarpments: Solan district is known for its plateaus, characterized by relatively flat landforms at higher elevations. These plateaus are often interspersed with steep escarpments, creating a striking contrast in the topography.

Slopes and terraces: Solan district exhibits a variety of slopes, ranging from gentle slopes to steep inclines. Terraces can also be found in some areas, formed due to the erosional and depositional processes of rivers over the years. The geomorphology of Solan district showcases the

dynamic interplay of various geological processes, including weathering, erosion, and tectonic activity. It contributes to the scenic beauty and natural diversity of the region, attracting tourists and providing a unique environment for flora, fauna, and human settlements.

Landslides: Given its hilly terrain, Solan district is prone to landslides, especially during heavy rainfall. These landslides shape the landscape and influence the land use pattern of the region.

Weather and climate: Solan district experiences a pleasant climate throughout the year. Summers are mild and pleasant when the temperature ranges from 25°C to 35°C (77°F to 95°F). During the monsoon season, Solan receives moderate to heavy rainfall. The temperature ranges from 20°C to 30°C (68°F to 86°F) during the monsoon months. Solan district receives moderate to heavy rainfall during the

monsoon season (July to September). The rainfall replenishes the water bodies and helps recharge groundwater aquifers. The variation in rainfall patterns can affect the hydrological balance in the region. Autumn brings a pleasant climate has temperature ranging from 15°C to 25°C (59°F to 77°F). Winters in Solan are cold with temperatures ranging from 0°C to 15°C (32°F to 59°F).

Background of the four-laning project

The Ministry of Road Transport and Highways on behalf of Govt. of India is engaged in the development of National Highways through the Govt. body represented by National Highways Authority to develop the National Highways under NHDP. As a part of this venture, the National Highways Authority of India (NAHI) has decided to undertake four-laning of Shimla-Kalka. District-wise length and general information of four-laning project of NH-22 is given in the table 2.

Table 2: District-wise length of four-laning project and trees felled

Name of district	Length (km)	Trees felled
Solan	23.007	Approx. 20000
Shimla	27.500	Felling marked of over 21,000 trees
Total	50.507	

Source: NAHI

Project road starting from Solan (Km 106.000) and terminating near Dhalli (Km 156.507), runs through Solan district and ends at Shimla District. The road that existed had two-lane configuration with three minor bridges and 185 culverts. The four-laning project will have 11 major bridges 8 minor bridges and 256 culverts, besides four tunnels.

The existing road passes through six major settlements, some of which didn't had sufficient RoW to be widen to four-lane facility; hence, bypass for Kandaghat and Shogi, Shimla and Dhalli were proposed to avoid these crowded settlements and non-stop movement of traffic. Realignment has been proposed for geometric improvement and to protect/ save ecologically sensitive locations. The options of concentric widening and left or right side widening were considered to utilize the existing right-of- way (RoW) to possible extent and minimize additional land acquisition. NHAH is executing the four-laning of NH-05 from Parwanoo to Shimla (including Shimla Bypass). The length

of this project is 89.71 km with estimated cost of Rs. 2739 Cr.

Implementation of project: NHAH is the implementing agency of the expansion work. Before initiating the project-related works environmental impact assessment was carried out whose scope was decided based on the past experience of consultants of similar projects and Terms of Reference (ToR) of consultants. The EIA study was undertaken to meet the requirements of National and State Level statutory undertakers. The EIA also complied with the TOR approved by the MoEF. To meet the challenges faced by the existing road suitable options for improvement were proposed. The implementing agency tried to monitor the issues by setting-up- Air Monitoring Station, Noise Monitoring Stations, Water Monitoring Station, Soil Monitoring and Trees on ROW. The details of land acquired and compensation granted in the study area were obtained from the implementing agency and presented in the table 3.

Table 3: Details of the land acquired and compensation granted in the study area

#	Name of village	Name of panchayat	Compensation granted	Land acquired in hectare	Structures affected
1.	Ber Khas (Solan)	Basal	31,54,55,549/-	0-78-42	34 no.
2.	Ber ki Ser (Solan)	Padag	61,65,120/-	0-03-78	Nil
3.	Salogra (Solan)	Salogra	38,40,000/-	0-06-00	Nil
4.	Mansar (Solan)	Salogra	5,04,000/-	0-02-63	To be announced
5.	Dedghat (Kandaghat)	Mahi	1,18,64,263/-	0-15-28	-
6.	Dolag (Kandaghat)	Sirinagar	20,88,50,400/-	3-22-30	To be announced

Source: NAHI

Results and discussion

During the field visit the information was gathered with regard to the floral and faunal diversity of selected stretch

and the list of the same was prepared and the IUCN status was also explored and presented in table 4 and 5.

Table 4: List of flora distributed in the study area

#	Botanical name	Common name	IUCN status
1.	<i>Acer rubrum</i>	Red Maple	LC
2.	<i>Aesculus indica</i>	Indian Horse Chestnut	DD
3.	<i>Albizia stipulate</i>	Boivin's Albizia	-
4.	<i>Barleria cristata</i>	Philippine Violet	-
5.	<i>Brugmansia suaveolens</i>	Night Bells	-
6.	<i>Cannabis sativa</i>	Cannabis	-
7.	<i>Celtis australis</i>	European Nettle Tree	-
8.	<i>Centaurea cyanus</i>	Cornflower	-
9.	<i>Cupressus sempervirens</i>	Mediterranean Cypress	LC
10.	<i>Dalbergia sissoo</i>	Indian Rosewood	VU
11.	<i>Erigeron karvinskianus</i>	Mexican Fleabane	-
12.	<i>Erigeron strigosus</i>	Daisy Fleabane	-
13.	<i>Eucalyptus globules</i>	Blue Gum	LC
14.	<i>Euphorbia heterophylla</i>	Painted Spurge	-
15.	<i>Ficus auriculata</i>	Roxburgh Fig	-
16.	<i>Ficus palmate</i>	Fig	-
17.	<i>Galinsoga parviflora</i>	Gallant Soldier	-
18.	<i>Grevillea robusta</i>	Silky Oak	LC
19.	<i>Grewia optiva</i>	Bhimal	-
20.	<i>Ipomoea purpurea</i>	Common Morning-Glory	-
21.	<i>Jacaranda mimosifolia</i>	Jacaranda or Blue Jacaranda	-
22.	<i>Lantana camara</i>	Common Lantana	-
23.	<i>Leucaena leucocephala</i>	White Leadtree	LC
24.	<i>Melia azaderach</i>	Chinaberry Tree	LC
25.	<i>Myrica esculenta</i>	Box Myrtle or Bayberry	-
26.	<i>Pinus roxburghii</i>	Chir Pine	LC
27.	<i>Pistacia integerrima</i>	Karkatshringi	-
28.	<i>Populus deltoids</i>	Eastern Cottonwood	LC
29.	<i>Prunus armeniaca</i>	Apricot	-
30.	<i>Prunus cerasoides</i>	Wild Himalayan Cherry	-
31.	<i>Punica granatum</i>	Pomegranate	-
32.	<i>Pyrus pashia</i>	Wild Himalayan Pear	-
33.	<i>Quercus leucotrichophora</i>	Banj Oak	-
34.	<i>Robinea pseudoacacia</i>	Black locust	-
35.	<i>Tagetes patula</i>	French Marigold	-
36.	<i>Thuja orientalis</i>	Oriental Arborvitae	LC
37.	<i>Toona ciliate</i>	Red Cedar	-
38.	<i>Zantedeschia aethiopica</i>	Calla Lily	-

Source: Field data [Least concern (LC), Vulnerable (VU), Data deficient (DD)]

Table 5: List of faunal distributed in the study area

#	Common name	Scientific name	IUCN status
1.	Ashy Drongo	<i>Dicrurus leucophaeus</i>	LC
2.	Black Bulbul	<i>Hypsipetes leucocephalus</i>	LC
3.	Brown-fronted Woodpecker	<i>Dendrocoptes auriceps</i>	LC
4.	Cinereous Tit	<i>Parus cinereus</i>	LC
5.	Common Crow Butterfly	<i>Euploea core</i>	LC
6.	Common Punch Butterfly	<i>Dodona durga</i>	LC
7.	Common Silverline	<i>Cigaritis vulcanus</i>	LC
8.	Crimson Sunbird	<i>Aethopyga siparaja</i>	LC
9.	Domestic Cat	<i>Felis catus</i>	LC
10.	Domestic Dog	<i>Canis familiaris</i>	LC
11.	Fulvous-breasted Woodpecker	<i>Dendrocopos macei</i>	LC
12.	Gray Treepie	<i>Dendrocitta formosae</i>	LC
13.	Gray-breasted Prinia	<i>Prinia hodgsonii</i>	LC
14.	Great Barbet	<i>Psilopogon virens</i>	LC
15.	Grey Bushchat	<i>Saxicola ferreus</i>	LC
16.	Grey-hooded Warbler	<i>Phylloscopus xanthoschistos</i>	LC
17.	Himalayan Bulbul	<i>Pycnonotus leucogenys</i>	LC
18.	Himalayan Gray Langur	<i>Semnopithecus schistaceus</i>	LC
19.	House Sparrow	<i>Passer domesticus</i>	LC
20.	Indian Red Admiral butterfly	<i>Vanessa indica</i>	LC
21.	Indian White-Eye	<i>Zosterops palpebrosus</i>	LC
22.	Jungle Babbler	<i>Argya striata</i>	LC
23.	Kashmir Rock Agama	<i>Laudakia tuberculata</i>	LC

24.	Plum-headed Parakeet	<i>Psittacula cyanocephala</i>	LC
25.	Red-billed Blue-Magpie	<i>Urocissa erythroryncha</i>	LC
26.	Red-billed Leiothrix	<i>Leiothrix lutea</i>	LC
27.	Red-vented Bulbul	<i>Pycnonotus cafer</i>	LC
28.	Rhesus Macaque	<i>Macaca mulatta</i>	LC
29.	Russet Sparrow	<i>Passer cinnamomeus</i>	LC
30.	Seven spotted lady beetle	<i>Coccinella septempunctata</i>	LC
31.	Slaty-headed Parakeet	<i>Psittacula himalayana</i>	LC
32.	Spotted Dove	<i>Spilopelia chinensis</i>	LC
33.	Verditer Flycatcher	<i>Eumyias thalassinus</i>	LC
34.	Yellow Coster Butterfly	<i>Telchinia issoria</i>	LC
35.	Yellow legged hornet	<i>Vespa velutina</i>	LC

Source: Field data

Impact analysis: The impact analysis of the project was carried out by gathering the people's perceptions through Focussed Group Discussion (FGDs) and field observations. The Focussed Group Discussions were carried out in six project affected villages to know the issues raised by the people with regard to social and environmental aspects linked with the project activities where the people openly discussed about the implementation of the project and its impact on their day-to-day life. Respondents were from the age 18- to 70-year-old and their opinions were recorded. In nutshell, following inference was drawn from the study area.

- People were first informed about the need to move through a series of official communications from NHAI. They started with field surveys to assess the impact of the highway expansion on their lands. Following the surveys, NHAI dispatched letters detailing the project's potential impact on the property and further informed about the need for relocation, wherever required. The notice was sent by the Department of Land and Revenue of the State Government.
- Only few people were aware that public hearing was organized by NHAI which provided them with an opportunity to raise questions about the project's impact on their lives and environment. This process allowed community engagement and input in the decision-making process.
- People's point of view about the expansion of national highway was mixed. While they recognize the importance of infrastructure development and improved connectivity, they feel that their needs and concerns as a community were not addressed adequately during the implementation. The impact on our livelihoods and environment has been a cause for concern.
- Before and during the highway expansion, people encountered several problems. Firstly, the project disrupted the conventional way of life and farming activities, which has been the main source of livelihood for generations. The construction activities caused environmental disturbances, including deforestation and soil erosion, which affected the fragile ecosystem.
- Regarding compensation, many people were not satisfied. Those received compensation for their land, but did not get the real value. Locals felt that they were not treated fairly during the entire procedure. The compensation offered and the support provided during resettlement often was small and not up to their expectations and the actual impact they had on their lives. They believe that there should have been more consideration for cultural and social bonding with the

land. Furthermore, the offered compensation might not fulfil the emotional and cultural ties they had with their land. For those who received compensation to construct a new house, opined that the new settlement might be more positive. However, those who could barely afford the land and housing they previously had find it challenging to adapt to new living conditions. The main difference is the financial strain and potential downgrade in the quality of living.

- The feelings about the new neighbourhood for those who shifted to new location were mixed varying with the financial condition of each family. Those who were financially well-off and received sufficient compensation, find it easier to adapt to their new surroundings, while those who had to struggle financially, have a more challenging time for acclimatization. The difference lies in the financial constancy and living conditions of each family, which has not been taken in account by the project proponent.
- In their new location, the cost of living varies. Some of them had extra land available, so it cost less to live there. However, others had to purchase land for housing, which is more expensive when compared to previous houses. What costs more or less depends on each of the individual circumstances. For some of them, the cost of lodging was low due to the extra land they had. However, for those who had to buy new land, the expenses were higher. On a positive note, they believe that conveyance is likely to become easy which might benefit them in future.
- The impact of highway expansion on livelihoods varies because some people who had established local shops and businesses and were asked to move were affected negatively due to the disruption and potential loss of customers.
- As far as environmental impacts are concerned, in fragile mountainous terrain the cutting of the mountains during construction, people have been witnessing significant changes during and after the construction, which they believe will continue to impact them in future as well.

During construction

1. **Increased landslide risk:** The cutting of mountains and construction activities amplified the risk of landslides in the region. People noticed an increase in soil erosion and instability in hilly patches.
2. **Noise and dust pollution:** Construction activities increase the noise and dust level, affecting their daily lives and local environment.

3. **Disrupted transportation:** Roads were frequently blocked due to construction activities, making it challenging for people to move within the area.

After construction

1. **Landslide incidents:** Landslide incidents have become more frequent and severe, posing a constant threat to life and property.
2. **Environmental damage:** The construction has left scars on the landscape, with exposed rocky terrain and damaged ecosystems.
3. **Improved connectivity:** On a positive note, improved road connectivity has made it easier for people to access essential services, markets, and medical facilities.

Present situation

1. **Continued landslide threat:** The region is experiencing continuous landslides, and people are living with the on-going threats of natural calamities.
2. **Environmental challenges:** The environmental impact of the construction activities can still be felt, affecting their farming and local ecosystems.
3. **Mixed benefits:** While improved connectivity has brought benefits, it has come at the cost of increased environmental insubstantiality and risks.
 - Overall, the construction in the mountainous region has brought a combination of positive and negative changes, with long-lasting consequences for local community and environment.
 - Health problems were felt during the construction phase. Many people experienced respiratory problems due to dust and air pollution. Some also reported stress-related issues caused by the uncertainty and disruptions brought about by the construction and resettlement.
 - Proper measures were taken by the project implementing agency to some extent, but there were shortcomings. While implementing agency made efforts to mitigate pollution and ensure safety, people believe that these measures were insufficient. It's a mixed perception, and opinions vary on whether the implementing agency has done a fair job in addressing health concerns and environmental impacts.
 - The construction activities affected the agriculture and cropping patterns in the area. The construction has led to the loss of agricultural land and disrupted traditional farming practices. Additionally, changes in land use and increased construction activities have altered the local microclimate, which impacts the crop yields.
 - The project has had an impact on natural water resources as well. Construction activities have caused soil erosion and water pollution, affecting the quality and availability of water in the area. People are apprehensive that changes in the land use is likely to affect the natural flow of water, possibly aggravating the situations like flooding or reduced access to clean water sources. These impacts have raised concerns about the long-term sustainability of region's water resources.

- The project has had an impact on forest resources and dependence on them. The construction has led to deforestation, which has affected the customary and conventional dependence on forests for firewood, medicinal plants, and fodder for livestock. This has disrupted the way of life and added to existing socioeconomic challenges.
- The project has had implications for biodiversity in the area. Deforestation and habitat disruption caused by the construction has resulted in the displacement of local wildlife and threatened the local biodiversity. People believe that it is important to consider the long-term consequences of these changes on the ecosystem and the potential impacts on both flora and fauna in the region.
- The project has certainly affected the local environment. The construction activities, such as excavation and landslides have disrupted the natural landscape and led to soil erosion. Noise and dust pollution have also been prominent issues, negatively impacting environment's tranquillity and overall quality. Restoration measures have been taken by the implementing agency, but the satisfaction level of people with the same is mixed. Some of the restoration efforts included afforestation activities to compensate for the trees cut down during the construction, erosion control measures, and efforts to mitigate dust and noise pollution. However, people were not very satisfied because in many instances, there was negligent dumping of excavated muck in the forest areas, which has and likely to have future environmental implications and controverted the intended restoration efforts of the implementing agency.

In nutshell, most respondents indicated that:

- They were disoriented as to how they were initially informed
- They were informed through notification that came via public notice, that's how they got to know that it was time to move on
- They were not aware of the public hearing process and were concerned about their alternate facility or land before the project implementation
- Adequate time was not given for settlement and they felt pressure to resettle
- They were not satisfied with the NAHI, and specified that the implementing agency didn't helped much in the resettlement and they were not satisfied with the compensation for the dismantled structures
- Their livelihood has been affected because it has shattered their old shops or businesses which was running steadily before the construction phase
- Though the new shops, restaurants, cottages have been opened during the resettlement for the businesses and tourism-related activities yet, it is too early to predict its implications
- During the construction phase there was more risky incidences like landslides occurred at the phenomenal rate
- During the construction phase, continuous annoying noise resulted in disturbances and dust problem affected the general health
- Orchard and farm lands have been degraded during the expansion of National Highway due to cutting of trees and stripping the mountains

- Natural drainage has been affected during the construction
- Migration and settling process was the main concern because of which they felt pressure and trauma

Key Field Observations vis-à-vis Associated Risks are listed as:

Slope cutting at 90 degree angle: Unstable leading to more landslides.

Deforestation: 3 saplings for 1 tree to be grown, but no measures taken yet

Drainage: Lack proper drainage

Cutting continued in monsoon season: Prompt rock fall which harms the roads more intensely

Retaining walls: Stepwise structuring of retaining walls is lacking

Natural water sources: Proper channel/route not provided leading to damage of retaining walls

Dumping zone: Proper dumping site lacking

Existing road's condition: Bumpy, uneven, irregular, or poorly maintained road surfaces

Traffic management: Poor

Dust pollution: Intense leading to poor visibility especially for drivers

Buildings and structures adjacent to roads: Cracks in structures, due to drilling and cutting of slopes

Tunnel: Lacks proper planning for construction of tunnel near Kandaghat

Thus, project has affected the local environment in terms of the cutting and stripping of the land, the loss of trees causing landslides, erosions and rock fall, which can be more catastrophic leading to further degradation of land and property. Though the four lanes between Kalka-Shimla has been viewing the repercussions of monsoons every year but amidst heavy rains and cloudburst in the state in 2023, Solan district witnessed a huge portion of Kalka-Shimla highway flyover collapse disrupting the traffic with vehicles on the edge of the caved sinkhole. Kalka-Shimla Highway 22 flyover joins a four-way tunnel which was shut many times for traffic. Restoration is underway. Following heavy rains, landslides shattered numerous parts of Parwanoo-Solan stretch of the Kalka-Shimla NH-22. According to the geologists:

To meet the need for broadening the road, the National Highway Authority of India (NHAI) could have considered the alignment or constructed tunnels to minimize the impact. The slope must be less than 60 degrees, whereas the vertical cutting close to 90 degrees has most consequences. The highway's slopes in the entire stretch continue to shower stones, disrupting the traffic on one lane of the highway at regular intervals. After the repeated incidences of landslides and road blockages the National Highway Authority of India (NHAI) has decided to change the criteria for road

construction to maintain the stability of the mountains, ensuring safer travel for commuters. Considering the varied nature of the hills, the new criteria will be tailored to suit the distinct features of the state. Now, according to the revised criteria, to create four-lane roads, mountains will no longer be cut at 90-degree angle. Moreover, a technical team will analyse the feasibility and scope of road construction in hilly areas.

One of the primary aims of this modification is to protect the mountains from further damage and prevent the occurrence of cracks and landslides. The previous practice of cutting hills at steep angles had led to catastrophic aftermaths and road instability has become a recurring issue. The four-lane project has emphasized on the significance of conserving the natural terrain while escalating road infrastructure. The need for new way outs became more apparent, and the NHAI is now actively reconnoitring alternate methods. NHAI hopes to strike a balance between road expansion and environmental conservation because from now onwards, focus will be on constructing tunnels rather than extensive cutting of mountains.

The natural settings in the state, including uneven steep gradients, weak rock structure and intense rainfall, are main causes for slope failure. However, extensive construction and broadening activities to enable hydro-power projects and transportation facilities have considerably added to the vulnerability. The Kalka-Shimla NH-05 is tectonically active, characterized by steep slopes, high relief, and very fragile landscape. Many sites along this NH-05 have become slide prone, posing risk to commuters. Landslides in and around Shimla and Solan town are consequent of increasing urban spaces, changing natural slopes. A few sites have unconsolidated bedrock material and scanty vegetation. The construction activities have added to the glitches of landslides incidence, thus travelling has become risky affair. Though landslide is a natural phenomenon, increased anthropogenic activities are responsible for spike in landslides across the state. The susceptibility in these geographically young and unsteady steep slopes has increased due to anthropogenic activities, viz. road construction and widening, communication facilities, expansion of suburbs and other related developmental actions, deforestation and changes in land use and cropping patterns. Slope failure has shown increasing tendencies and there is upsurge in annual and decadal frequency of landslides. The intense rainfall, mainly during the monsoons, is one of the main initiating causes for such occurrences. In 2007, environmentalist opposed construction of four-lanes of Shimla-Kalka NH-05 which was justified by affirming that the project will destabilise the fragile hills and result in new catastrophes. The issue was by *Kasuali Bachao Andolan* for no environment impact assessment (EIA) and public hearing was undertaken before declaring the four-lane project of NH-05. It was predicted that widening of the Shimla-Kalka National Highway would bring down the entire Kasauli Hill, threatening the live and property. Issues were raised with regard to the construction activity in and around Kasauli town that violated the orders of HP High Court for there were encroachments on government land new constructions and projects were banned. The environmentalist also condemned the role of Town and Country Planning Department, which legalized the compounding of illegal land transfers and was violation of Land Tenancy Act 1972 and Section 118. NHAI initiated

the construction of four-lane highway without consulting authorities or holding public hearings violating environmental norms which is causing massive loss to the natural ecosystem, human lives, assets, and economic loss to the people owing to their helplessness to carry their farming produce to the market. NH-05 is a part of the Himalayas, which are basically sedimentary rocks, are still undergoing tectonic moments. Instead of cutting the mountain in slopes, they could have been cut perpendicularly because conventionally roads in hilly areas were built by cutting hills in a terraced manner to reduce the ecological loss. Increased emphasis on tourism and rapid development by ignoring environmental impact assessment studies have added to the existing problems. The consequences of such road widening are apparent even during normal rain, as it leads to slips and slides, intensifying the extent of the damage during heavy downpour or floods. Many locals and tourists complain that shooting stones pose a threat on Kalka-Shimla road and driving on the Solan-Kandaghat section of the National Highway-5 has become unsafe for drivers as shooting stones and rubbles often fall on the highway after continuous rain. Signages have been instituted to inform the drivers especially driving at night about the risky spots with loose strata from the excavated hills. NHAI, which is completing the four-laning of the highway, has been ensuring that labour and machinery is positioned at risky sites for fast road clearance for there are few susceptible spots on the Solan-Kandaghat stretch where the lanes facing the hill side get obstructed after the rain. Ever since the four-laning work started in 2015, the district administration is on tenterhooks during the monsoons. The stretch from Solan to Kandaghat and Kaithlight has become a cause for concern owing to the fragile landscape. There are at least a dozen sanctioned four-laning projects which must be reviewed for these are likely to cause large-scale land acquisition, displacement of families, cutting of

hills and deforestation, continuous landslides and filling up of valleys, pollution of water sources. More than 17000 trees were cut during the construction of NH-05 and pollution levels of towns in between, viz. Dharampur, Solan, Kandaghat, Shoghi, Kaithlight- have increased exponentially. Arevalo *et al.* (2020) [1] described the impact of highway construction. Researchers observed that such projects besides many benefits, affect the local environment. When the construction works were carried out many residents had to migrate from their native place. Similar observations were made during the present study. Kahlon *et al.* (2014) [4] described the occurrence of landslides in the Himachal Pradesh as a major threat mainly in the monsoon season which has increased due to anthropogenic activity such as road construction, expansion of settlements and other allied developmental activities, deforestation and changes in agriculture pattern. As of the present study when the construction phase was carried out, stripping and cutting of the land was done to widen the road, thus increasing the incidences of landslides and erosion activity which is more significant in the monsoon season. Rock fall, debris flow and blockage of the road create traffic problems. Walls constructed along the roadside are affected by the landslides and has resulted debris flow on the road or roadside. Thousands of trees were cut down including the commercially and ecologically important trees to expand the highway affecting the local environment Similarly, Kumar *et al.* (2011) [5] described the Indian highways in the mountainous terrain suffer from more landslides event due to rainfall and the sliding event became more recurrent resulting in repeated restoration which further result in direct and indirect losses. Therefore planned construction is suggested including the hazard and risk management plan, construction and maintenance of the road for risk-free road development.



Fig 1

Concluding remarks

The highway expansion project by NHAI and the subsequent land acquisition by the state government led to significant changes in the lives and environment of the affected communities. While infrastructure development and improved connectivity are undeniable benefits, the associated costs to the local populace, both culturally and economically, were significant. Many challenges arose from the construction project. From environmental disturbances, like deforestation and soil erosion, to disruptions in daily life from noise and dust pollution, the community experienced significant inconvenience. In addition, there was a disruption to the traditional way of life and livelihood of the locals, with some businesses suffering due to displacement. The compensation and resettlement assistance provided to the affected people were not consistent across the board. Many felt it did not adequately reflect the true value of their lost properties or the potential income from agriculture. The emotional and cultural ties to the land were also seemingly undervalued in the compensation process. The new settlements and neighbourhoods had mixed reviews, largely based on the financial position of each family. Many experienced increased costs in their new locations, while others found living expenses to be reduced. There was a consensus that the project affected agriculture, cropping patterns, natural water resources, forest resources, local environment, and biodiversity. These impacts varied in severity but were felt throughout the community. It is important that new technologies must be applied to address the challenges of creaking mountains which could be a significant step in confirming sustainable and resistant infrastructure. It is not that there the problems don't arise in construction activities, but these could be planned in advance and alleviated concurrently in an inclusive and technical manner. No road, tunnel, bridge or highway anywhere in the world can be completed without the active involvement of a geological department.

To sum, while the national highway construction project brought about infrastructure development and improved connectivity, it was at the expense of the local community and the environment. The efforts made to mitigate damages and compensate those affected were inconsistent and, in many cases, viewed as inadequate. The entire project underlines the importance of striking a balance between development and the well-being of communities and the environment. Summarizing this research, road widening project was a necessity but let's not deny the fact that people have been affected by this expansion and destruction!

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