

Landslide or Land Subsidence: A Critical Review at Joshimoth Municipal Town

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Abstract:

Hazards are an extreme event but disasters are outcome of hazards in terms of different perspective from country to country. Landslide is one of the great traumatic natural disaster but its vulnerability and risk factor vary on the basis of different socio economic condition. This study will reveal future probability of landslide in Joshimoth town.

Keywords: Hazards Disasters Land-subsidence Vulnerability Geospatial

INTRODUCTION

Hazards are sudden geophysical events triggered by natural and at the same time anthropogenic cause, which pose great threat to human being, economic asset of the country. Many of these hazardous events often turn to disaster due to its severe impact on the society and economy. Generally hazards are processes/cause and disasters are product of hazards having risk and vulnerability. The facing of natural hazards and ultimately great disaster in Uttarakhand district is very common phenomenon in terms of landslide, subsidence of land, 'Horpaban' etc. Since 1970 onwards Badrinath, Kedarnath, Joshimoth, are very much landslide prone. Recently in December 2022 sudden incidence of land subsidence in Joshimoth municipality, Chamoli district was a great shock to the inhabitants of this region. This study will throw the light of probable cause of these hazardous events, and ultimately the identification of different level of risk- zone to reduce future vulnerability in this mentioned district.

OBJECTIVES

- To understand the difference between hazards and disasters.
- To find out the causes behind the occurrence of disaster.
- To measure the vulnerability and risk of this disaster.
- To identify the different level of risk zones to mitigate the losses from this landslide.

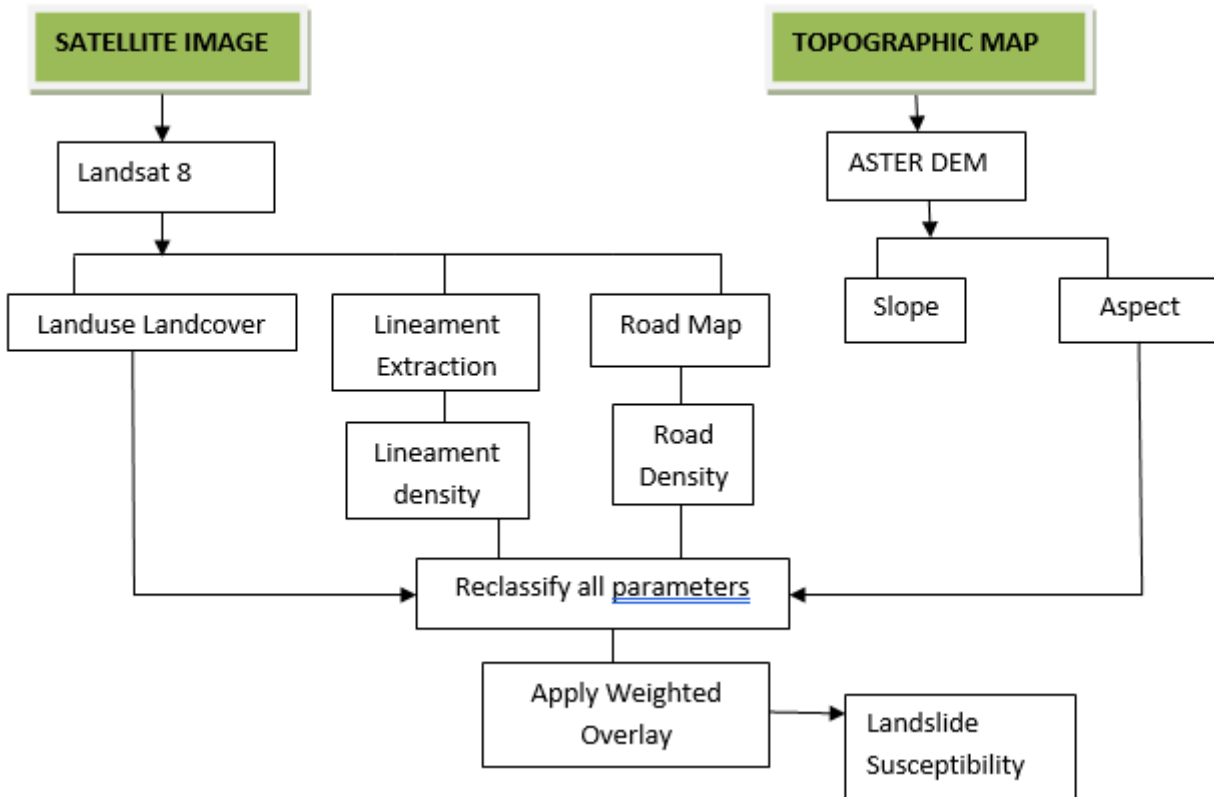
DATABASE

Two types data have been used:

- Toposheet number: NH 44-6. SERIES 502
- Geological Map of Uttarakhand
- Satellite data: Landsat 8 and ASTER DEM

Secondary data have been collected from Times of India(December 2022) and Anandabazaar Patrika.

METHODOLOGY



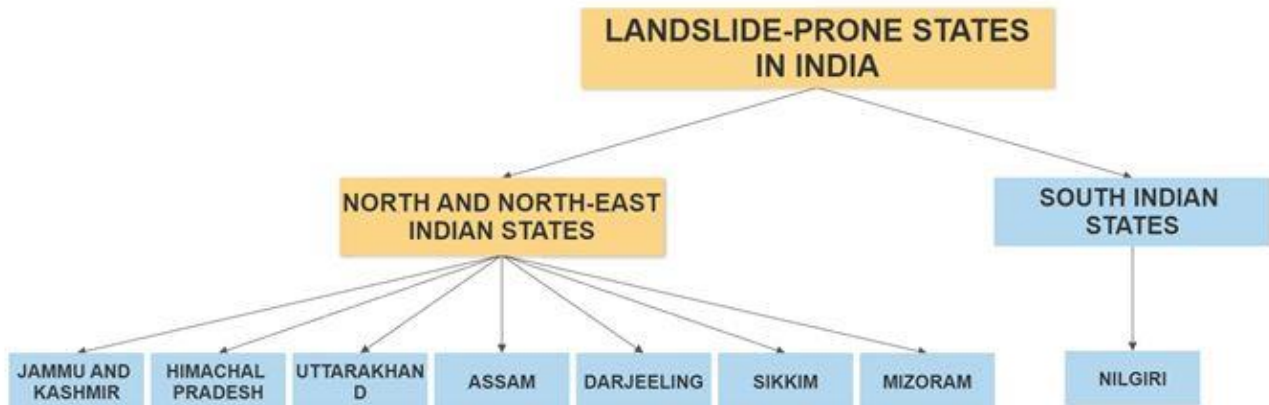
INDIAN CASE OF HAZARDS

In India there are mainly four locations which are hazard-prone:

- Peninsular location
- Himalayan mountainous belt
- Western drought prone area (i.e. Rajasthan)
- Time of Monsoon arrival at different states

Percentage of occurrence of hazards in India

- 5-10% area per year fall under any type of hazards.
- Six types of hazards appear every year in more than one place e.g. Flood, drought, cyclone, landslide, snowfall, change in river course.
- 12% of total Indian Territory is flood-prone.
- 60% of total Indian Territory is earthquake-prone.
- 68% of total Indian Territory are drought-prone.
- 8% of total Indian Territory have cyclonic tendency.
- 6% of total Indian Territory is landslide-prone.



STUDY AREA

Joshimoth is a temple and strategic municipal town in Chamoli district of Uttarakhand state. It is situated on Himalayan foothill zone and is flanked by two tributaries of Ganges: Rishi Ganga & Dhoul Ganga River.

EARLY HISTORY REGARDING OCCURENCE OF LANDSLIDE:

- Land subsidence and occurrence of crack was first identified in 1976. (From MC Mishra Committee's report).
 - Glacial avalanches known as Chamoli disaster led to flash flood on February 2021 leading to death of 200 people including worker of Topobon Vishnugad hydropower plant's tunnel
 - July 2021, heavy downpour, cloudburst, rock fall, debris fall, avalanche occurred leading to sinking of mountainous area and built-up area.
In this case 300 people died, 61 missing, 160 injured, 1048 farm animal lost, 6729 houses fully damaged, 18.5 hectares of agricultural field washed away.
 - December 2022, again subsidence and crack in built up area was identified with heavy snowfall.
- These devastating evidences in terms of loss of human beings, animal life and economic asset seem to be turned into large scale disaster.
Now it's time to identify the probable cause behind this occurrence:

UNIVERSAL CAUSE OF LAND SLIDE/ LAND SUBSIDENCE:

In general the incidence of landslide in mountainous area depends upon two factors:

1. Internal strength of slope
2. External stress from surrounding :

The water availability at slope sometimes increases internal strength of rock or very often eroding the base level creating voids in lower part of the slope. The incidence of Joshimoth falls under the example of base level erosion by increasing water availability at sloppy land.

But there are many reasons behind this base level erosion. Geologists have identified seven factors of landslides:

- a) Slide: Movement of rock parallel to bedding plane or slope.
- b) Creeping: Gradual movement of slope.
- c) Topple:

- d) Fall: Either due to gravitational force or land subsidence due to erosion of base level by extraction of mineral or underground water.
- e) Flow:
- f) Torrent:
- g) Slump: This movement also occurs due to base level erosion.

PROBABLE CAUSE BEHIND JOSHIMOTH

1. LOCATION

Joshimoth is located on geologically and geographically sensitive area. This town is not standing on stable mainland but remains of landslides and avalanche-mass and also big unsettled boulders made up of sandy clay material, micaceous, gneissic rocky parts which have low bearing capacity.

Actually Joshimoth is landslide prone town. There are few common features in landslide area:

- Sloppy land
- Pressure of water/ vapour in soil or rock voids
- Base-level erosion
- Existence of weak zone below the strongest part
- Seismic prone in nature
- Torrential rainfall in rainy season

2. EVIDENCE OF GEOMORPHIC ACTIVITIES:

This area is very much prone to weathering and mass wasting especially solifluction, rock fall, debris fall etc. Besides in this hilly zone, deep undercutting of two tributaries of River Ganga make this region's rock very poor and cohesive.

3. GEOLOGY

There is a tectonic zone, just southern boundary of this town, called main Central Thrust Zone. The older rock forming the basement of crustal profile has moved because of compression resulting from northward movement and subsequent collision of Indian and Eurasian plate. So there is a lot of stress and pressure which is sometimes accommodated by faulting, thrusting and tectonic movement in this entire bed.

4. SEISMIC ACTIVITY

This entire belt falls in zone 5 of seismic belt- highest category of earthquake prone region.

5. SLOPE

The natural slope (angle of repose) of this town is very steep, bulging and convex in nature, already unstable and creeping down.

Not only natural causes are responsible but there are so many **ANTHROPOGENIC causes** (Deforestation followed by agriculture, urbanisation, and construction work) behind this hazardous event. These man-made activities turned these natural hazards into disaster or sometimes large scale calamities.

- a) Drainage & Sewerage: Soaking pits, open rain lead to water seepage. After surface run off, water percolates and moves through pores, fractures and joints. This underground water movement is triggered by water pressure of soil pores due to creation of more fracture, ultimately leading to collapse of land----- land subsidence.
- b) Construction activities: It is a tourist spot and cantonment area. So, rampant construction work for making hotel, lodge, and home stay are continuous process. At the same time for the tourism industry, road construction by cutting hilly areas and continuous movement of different vehicle for tourist and strategic purpose make the physiographic more unstable.

In a broad sense, climatic change(in terms of sudden flash flood, ‘Harpaban’, cloud-burst rainfall) are main outstanding factors for these binding calamities.

PROCEDURE OF DISASTER MANAGEMENT:

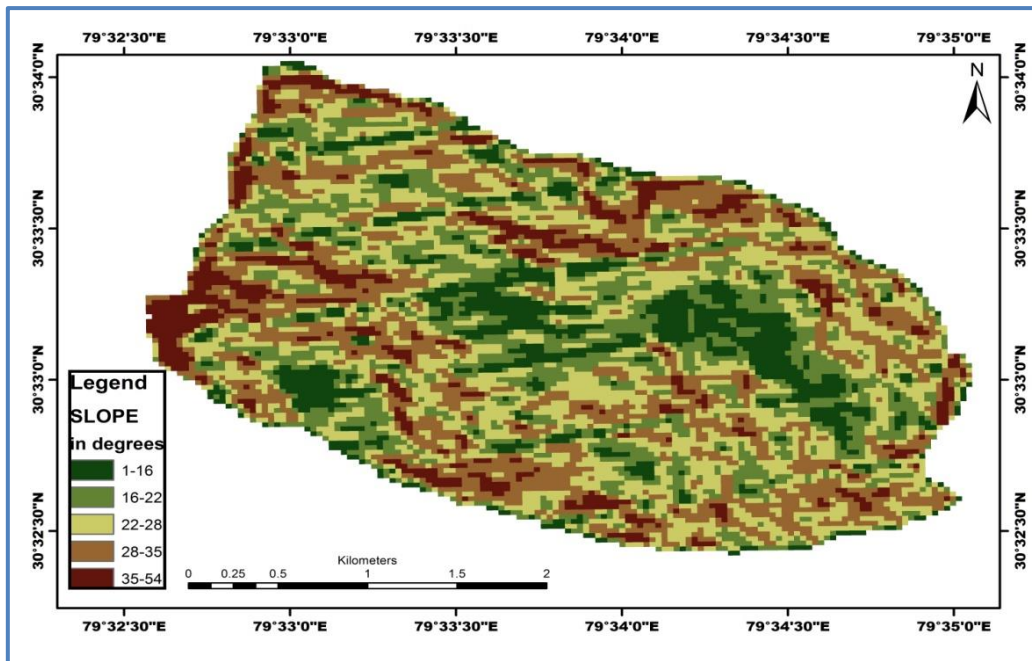
There are two steps:-

1. Pre disaster protection:-
 - a) Risk Assessment
 - b) Mitigation
 - c) Preparedness
 - d) Emergency Plan
2. Post disaster protection:-
 - a) Immediate Action:
 - Rehabilitation/ Relocation/ Evacuation
 - Provide relief in terms of food , water, clothing, temporary shelter etc..
 - b) Long-term measures:
 - Learning from incidences by increasing awareness

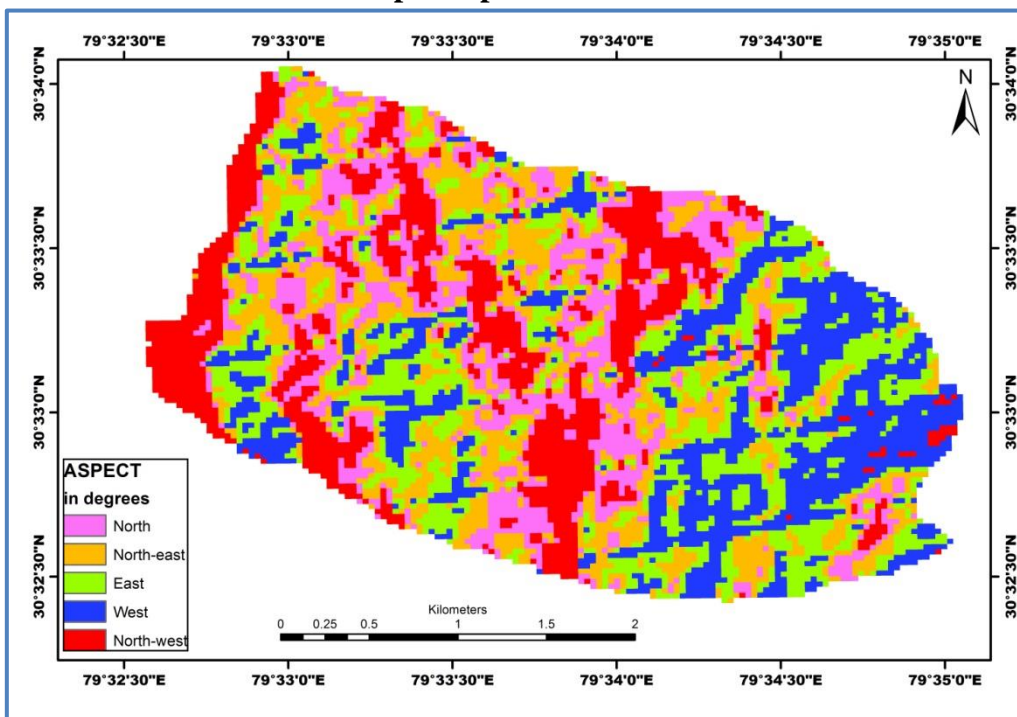
For this purpose, from the perspective of Joshimoth town, zoning of landslide prone area from satellite image, slope map, lineament, LULC, ultimately landslide probability zonation map on the basis of LSV(Landslide Susceptibility Value) is very necessary.

LANDSLIDE SUSCEPTIBILITY ZONATION AND ANALYSIS

To determine the landslide occurrence in the region, slope angle, slope, aspect, land use, lineament, and road density were taken into consideration. A 30m resolution Digital Elevation Model (DEM) that was acquired from the EarthData website (ASTER DEM) was used to create maps for, slope angle (5 classes), and aspect (5 classes).The angle of slope varies from 1° to 54° and the aspect of the map mostly is in the north and north west facing direction.

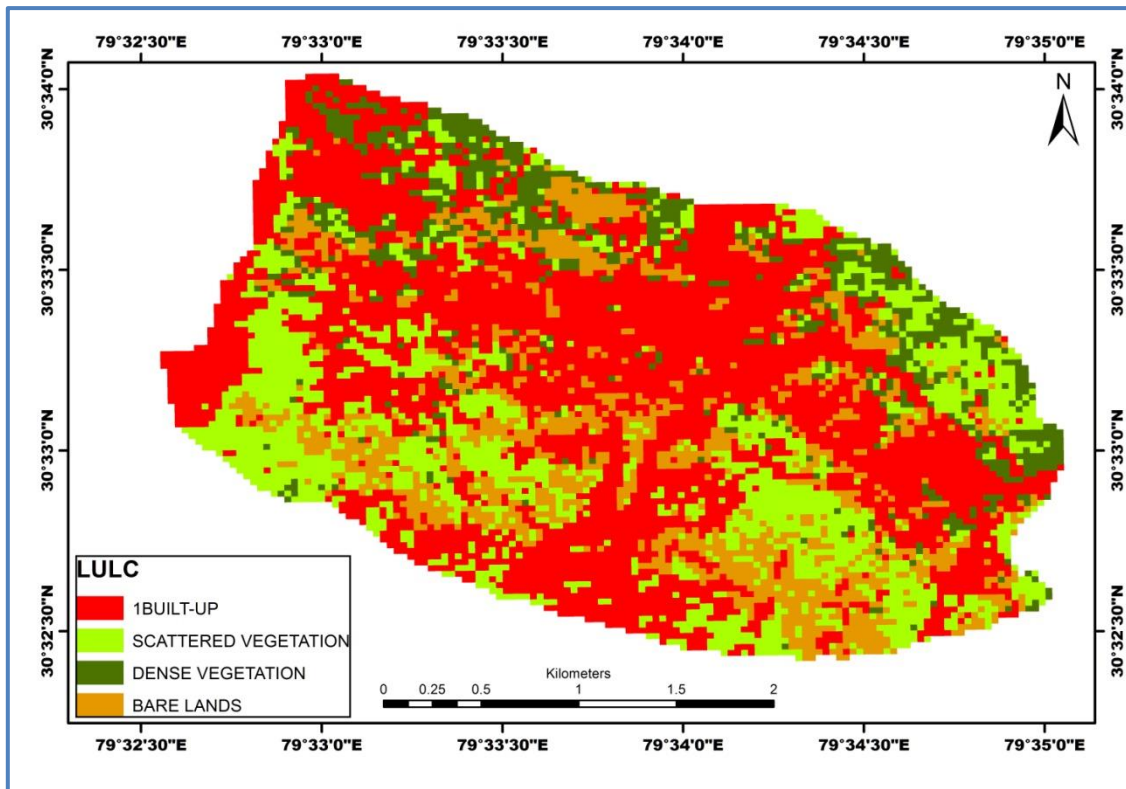


Slope Map of Joshimath



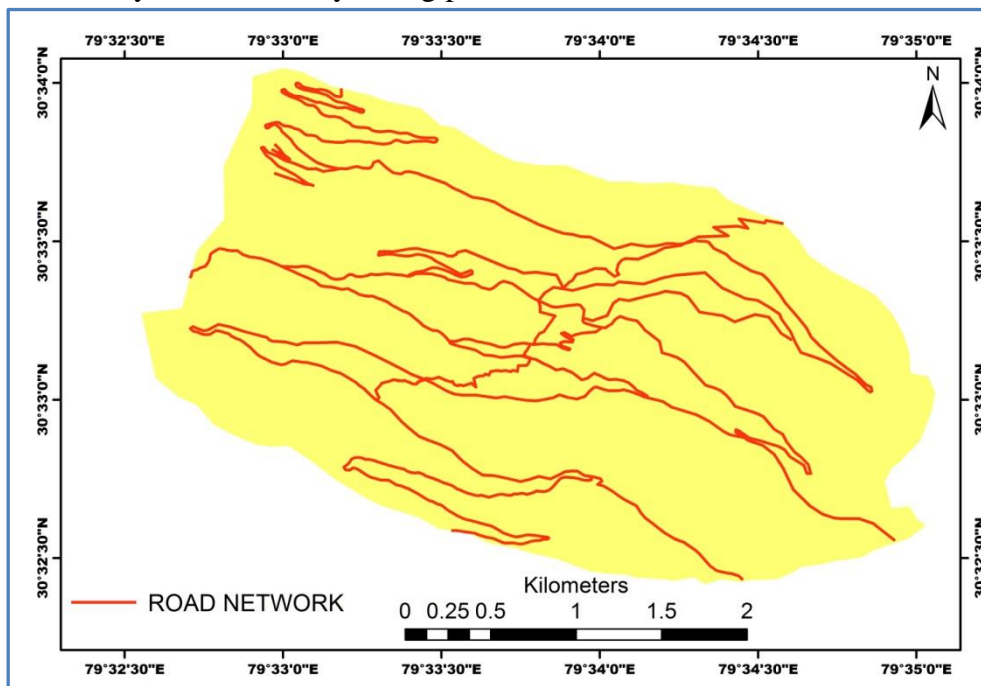
Aspect Map

The land use map of the region was created using supervised classification of Landsat 8. Landuse Lancover map has 4 classes, namely Built-up area, Scattered vegetation, dense vegetation and bare lands. The road network was digitized manually and road density was computed using line density technique in ArcGis. The road construction in these landslide prone zones significantly alter the structure and thus the strength of the slope , so density of roads stands as a crucial factor for landslide susceptibility mapping.

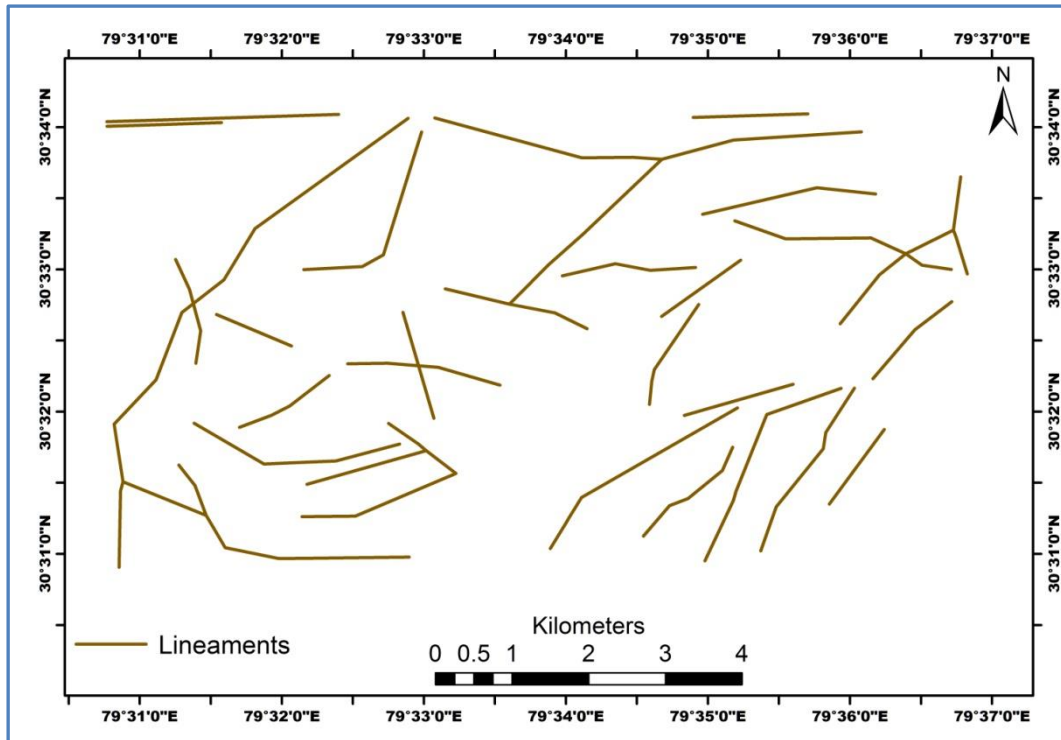


Land-use land-cover map of Joshimath

The landuse development in Joshimath is increasing at an alarming rate, decrease in vegetative cover and increase in built-up are one of the major cause of gradual sinking of the land. The road density is also increasing drastically posing a threat to the region. The roads are denser in the central part of the map and so is the built-up area, making the said area highly susceptible to landslide as the slope strength gets weaker due to heavy human activity taking place.

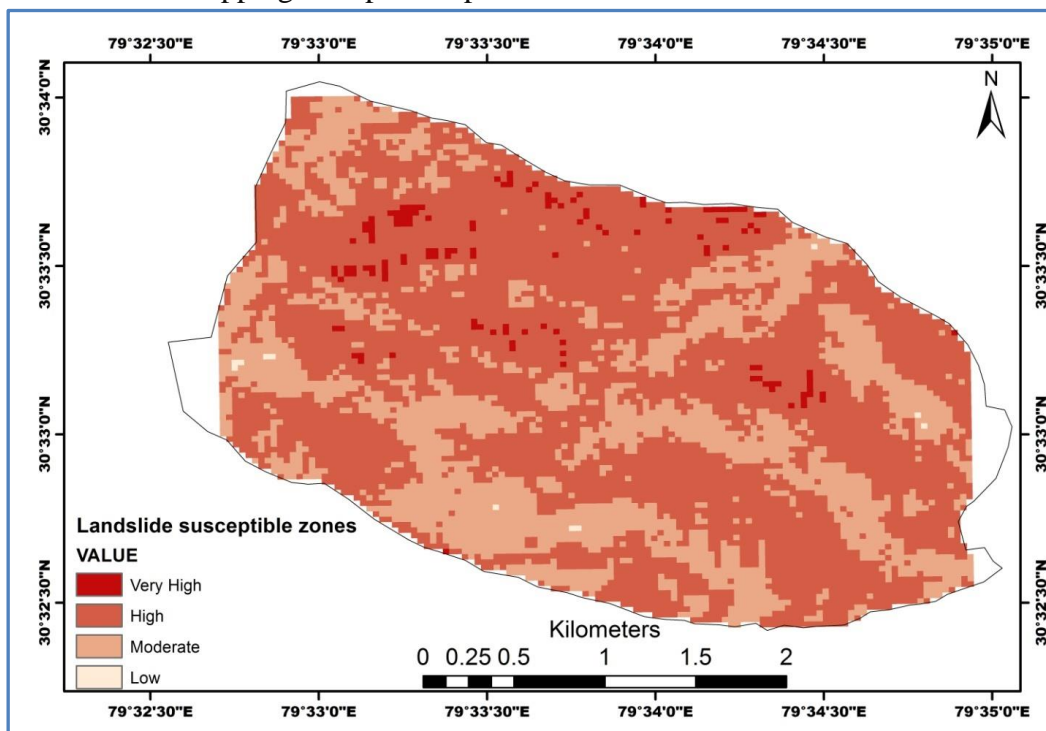


The Lineaments are yet another important factor for landslide susceptibility mapping. They represent the weak, exposed planes where the strength of the slope's material is being diminished, leading to



Lineament Map of the study area

Slope failure. However lineaments and landslide susceptible areas are correlated. Area with high landslide susceptibility was seen in area with high builtup and roads rather than areas with dense lineaments, so lineament mapping is important prior to construction of roads and settlement.



Landslide susceptible zone map

The area with darker shades are highly vulnerable to landslides, these areas have dense, rich human activities taking place, altering the natural landscape drastically.

CONCLUSION:

On the basis of this map, technologists, geologists and urban planner have to sit together to take necessary future plan for diminishing the probable loss from this disaster in near future.

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