NOTE ON PRELIMINARY GEOLOGICAL STUDIES OF KALI DHANK LANDSLIDE NEAR BARWAS VILLAGE ON NH-707 (PAONTA SAHIB-HATKOTI ROAD) SUB DIVISION SHILLAI, DISTRICT SIRMAUR, HIMACHAL PRADESH

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1. Introduction:

A massive debris slide occurred at Kali Dhank near Barwas village on NH-707 (Paonta Sahib-Hatkoti road), Sub Division Shillai, Tehsil Paonta Sahib, District Sirmaur, Himachal Pradesh, in morning hours of 30.07.2021. The slide zone is located at a distance of about 29km from Paonta Sahib via Sataun. Heavy rainfall was reported in the affected area on previous two days. The landslide took away a major portion of hill mass resulting in complete washout of 150m road stretch of NH 707 without any casualty or any other property damage. On the request of the District Commissioner, district Sirmaur, Himachal Pradesh, Dr G. S. TIwari, Dy Director General, State Unit Punjab, Haryana and Chandigarh sent a team of three geoscientist lead by Manoj Kumar, Director, Engineering Geology Division, Geological Survey of India, Chandigarh along with Pradap Jagan R, Geologist and Abhinav Poonia, Asst. Geologist. The field visit was undertaken on 03.08.2021 and 04.08.2021.

The observations revealed the landslide to be a debris slide presently triggered due to slope saturation but also appeared anthropogenic in view of presence of abandon quarry activities in its toe part. Further 250m below up to nala course from the toe, the hill slope is rocky. As reported by the locals, the quarry was active till 2019.

2. Location and Accessibility:

The Kali Dhank Landslide (Geographical coordinates: Latitude: N31°27'13.00" and E77°39'28.00") occurred near village Barwasa on Nh-707, is located in Paonta Sahib Tehsil of Sirmaur District of Himachal Pradesh (Fig 1 & 2). The affected area is located at a distance of about 29 km from Paonta Sahib and 70km from the district headquarter Nahan. The area can be accessed by Chandigarh –Paonta Sahib by National Highway – 07 and Paonta Sahib to Sataun towards Kafota via NH-707. The area falls in Survey of India (SoI) Toposheet No. 53F/10 and is nestled in the hilly terrain of Lesser Himalayas.

3. Climate and Rainfall:

The southern part of Himachal witnesses a sub – tropical interspersed between cold weather, hot weather and southwest monsoon. The cold weather commences in November and continues till the end of February, which is characterized by cloudless days and very cold nights with much fog and dew. May and June are usually the hottest months.

The rainfall in Himachal is highly variable due to wide latitudinal and altitudinal variations of orographic ranges. The main season of rainfall is monsoon where rainfall is generally high in foothill region and decreases beyond the highest range over the northern part of the region. After April, the rainfall gradually increases till June and thereafter sharply during July and August. The average annual rainfall in the district is 1688.7 mm. Tthe southwest monsoon season is the chief rainy season and rainfall during the southwest monsoon season constitutes to about 71% of the annual rainfall normal. July is the rainiest month (Fig.-3 & 4).

4. Geomorphology and Geology of the area :

The area forms a part of Lesser Himalaya characterized by rugged and mountainous topography that in turn is controlled by the lithology and structure where the region with limestone & dolomite exhibits steep slopes and escarpments whereas shale and phyllite form lower relief.

The landslide affected area is occupied by the rocks belonging to Krol Group represented by argillaceous and carbonate sequence overlying the Infra Krol Formation of Baliana Group comprising carbonaceous shale and quartz arenite sequence..

The Krol Group is divisible into Chambaghat Sandstone, Krol A, Krol B and Krol C formations. The Krol A (Mahi Fm) comprises flaggy lutitic limestone with shale partings. The Krol B (Mahi Fm) comprises red shale with interbands of limestone and is gradationally overlain by massive dolomite of Krol C (Jarashi Fm).

The landslide area owing to located in proximity (approx 3.5 km) of major tectonic planes like Main Boundary Thrust and Main Boundary Fault located approx 3.5 km south, exhibits fold, faulit and highly jointed nature of bedrock. The area constitutes eastern part of the Nigalidhar Syncline.

5. The landslide incidence:

The Kali Dhank landslide basically deep circular failure of slope debris, is located nearly 7km from Sataun and nearly 30km from Paonta Sahib in Lesser Himalayan terrain of Sirmaur Himalayas . Area exhibits generally steep to very steep slopes characteristic to that of a limestone terrain. The debris slide is located in a slope depression of a major spur and appears to have occurred due to weakened slope debris in due course of limestone quarry activities, now abandon, near its toe and subsequent slope saturation by heavy rain. The landslide occurred in the morning hours of 30th July, 2021 resulting in washout of 150m stretch of NH-707. The slide area exposed limestone and shale of Krol A and Krol B respectively of Krol Group. The bed rock mostly comprising rocks of Krol A, are folded, faulted and highly fractured with 30-40 hill-ward (northerly) dips.

The landslide 200m in length, 200 in width and nearly 100m in height is now exposed with steep slope with frequent exposure of bedrock. The landslide was multiple and retrogressive in nature with its toe terminating in mid hill part from where the nala course is further 250m below (Fig.-5).

The landslide has resulted in complete washout of nearly 150 stretch of NH-707 causing disruption of communication of hilly terrain with foothill areas and thus severely affected the socio-economic activities in the area.

6. The present and future menace:

The limestone terrain generally exhibits steep valley slopes and likewise the Kali Dhank area. In view of presence of frequent exposure of bed rocks baring the axial depression, as well as in uphill area, the landslide expected to remain stable if uphill masses are dealt carefully and scientifically. Also, prima facie, the Barwas village establishment in further uphill area, appears to be on stable ground/ slope, however, the uphill mass including the village establishments must to put to frequent observations for any ground signatures of slope instability such as development of tension cracks, land sinking, tilting of tree, sudden appearance or disappearance of any nala etc.

The downstream shoulder of landslide near road level appears a slumped mass and has also recorded a minor slope failure with its toe at road level. The new road alignment must avoid this distress rock mass stretch (Fig.-6). Near toe there existed some cavernous feature along the contact zone flaggy limestone and underlying dark limestone causing the damage of rock line during debris slide (Fig.-7)..

7. Conclusion:

1. The Kali Dhank debris slide in eastern part of Nigalidhar Syncline of Sirmaur Lesser Himalaya lies in proximity of major thrusts like MBF & MBT (Giri Thrust) located approx. 3.5km south.

2. The slide area exposed folded, faulted/sheared bed rock comprising highly fractured flaggy limestone-shale and dark limestone of Krol A overlain by red shale (Krol B).

3. The debris slide is located in a slope depression and drained by seasonal nala.

4. The landslide is natural as well as geogenic in nature, in view of presence of fractured bed rock, incohesive slope debris resting over the steep slope that may have weakened in due course of quarry activities near its toe, now abandoned, and finally failed up on slope saturation by heavy rainfall.

8. Recommendation:

1. The 150m stretch of NH-707 constructed over debris material washed away. The restoration of the same the has been suggested by realigning the NH-707, partly by hill mass cutting and partly by filling in order to restore emergency services and socioeconomic activities in the area. The road alignment may be achieved in the competent rock strata in order to avoid the slope instability.

2. In view of frequent exposure of bedrock in the slide zone, further widening of the road may be exercised by way of muck/ debris filling using bedrock as hold fast and with adequate toe support..

3. The benching in uphill debris mass as well as in rock mass, may be carried out very carefully, scientifically along with their simultaneous effective stabilization.

4. The up-slope hill mass and village establishments must be put to frequent observations with regards to any ground signature of instability such as developments of tension crack, joint openings/ widening, land sinking, development of crack in building, collapse of soil along slope or nala, tilting of trees, sudden appearance or disappearance of surface stream or reduction in water volume etc.

5. Altering the geometry of the steep slope by flattening and benching along with draining out any ingressing nala or rain water.

6. Use of soil nailing, grouting, wire mesh draping, biotechnical slope stabilization measures (plantation of suitable trees with deep rooted species, application of geo-jute/ geo-mats etc) in the slope debris mass of the uphill and downhill (road/ dump filling).

7. Provision of check dams along runout path.
8. The breast and retaining structures along the road must be provided with adequate filter and drainage, in particular, when constructed in debris filled mass.

9. Installation of sign boards/ banners at appropriately identified vulnerable locations for cautioning to the commuters.

10. Widespread advance communication/warning to the dwellers/visitors regarding heavy rainfall etc.

11. Widespread Landslide Awareness Program in landslide vulnerable areas.

12. The Lesser Himalayan terrain in Sirmaur exhibits a fragile geoenvironmental conditions with regards to the slope stability. These areas have already been demarcated as “High” Landslide Susceptibility Zones by GSI (Fig.-8). In view of continued road widening along NH-707 located all through on steep slope or for development of any other infrastructure or quarry involving slope modification, dumping site selection etc, must take in to consideration the geoscientic evaluation of inherent risk & hazards specific to that locality/ spot. Therefore, such road corridors are also recommended for Meso-scale (1:10,000 scale) landslide susceptibility mapping.

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Fig.-1: Location map showing location of Barwas Landslide on NH-707

Fig.-2: Schematic diagram of Kali Dhank Landslide on Google Image

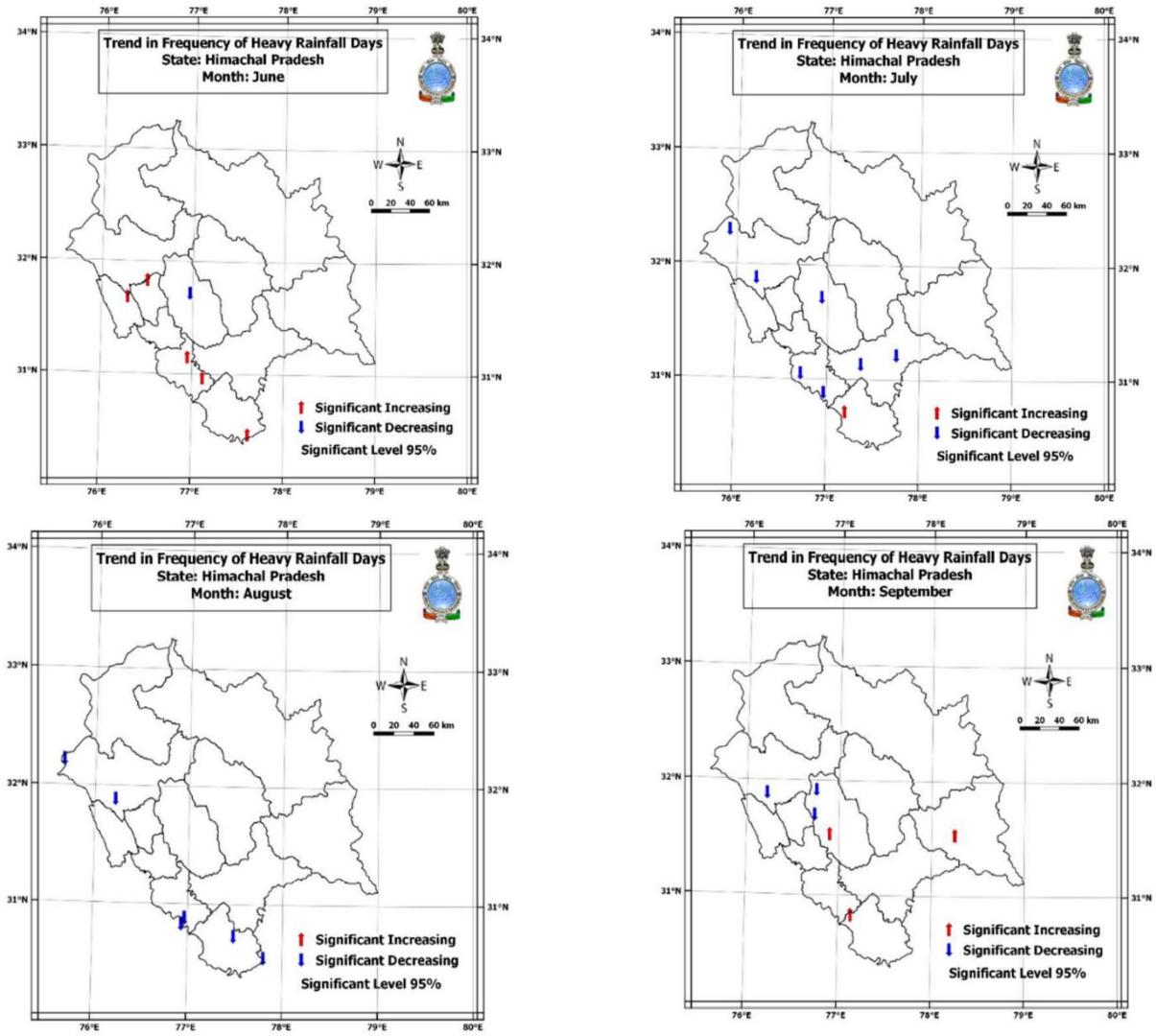

Fig.-3: During the period June to September there is a significantly increasing trend in heavy rainfall days in Sirmaur district. (Source: Met Monograph No.: ESSO/IMD/HS/Rainfall Variability/10(2020)/34 of IMD)

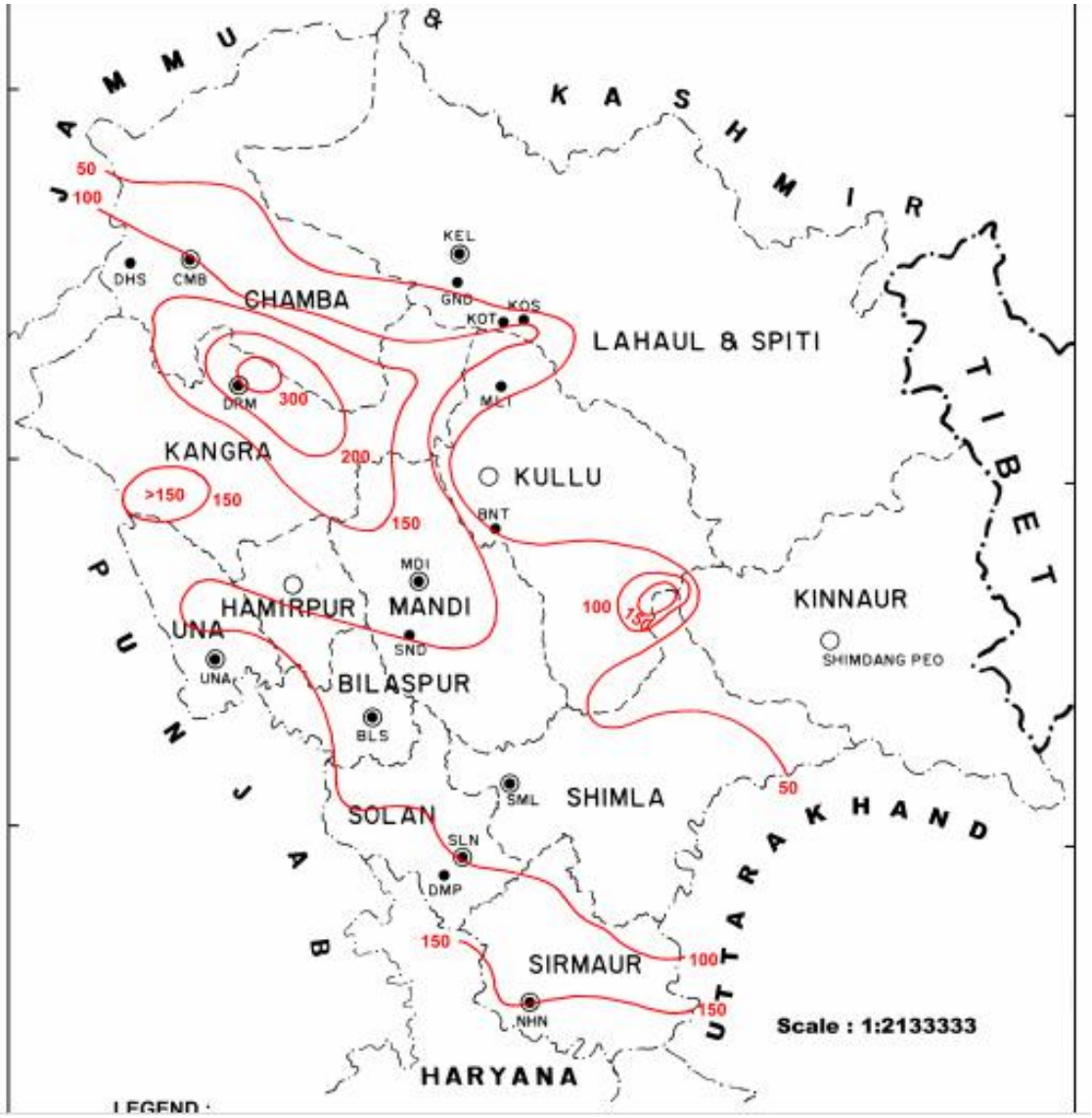

Fig.- 4: Rainfall in Himachal Pradesh during monsoon (July-September)

Fig.-5: Perspectivre view of the Dhank landslide, Simaur district, H.P.

Fig.-6: Damage and complete wash out of *150m stretch of the* NH-707 (View towards Sataun)

Fig.-7: Uphill view of the landslide shows dislodged large oxidis bed rock blocks possibly derived from the toe part.

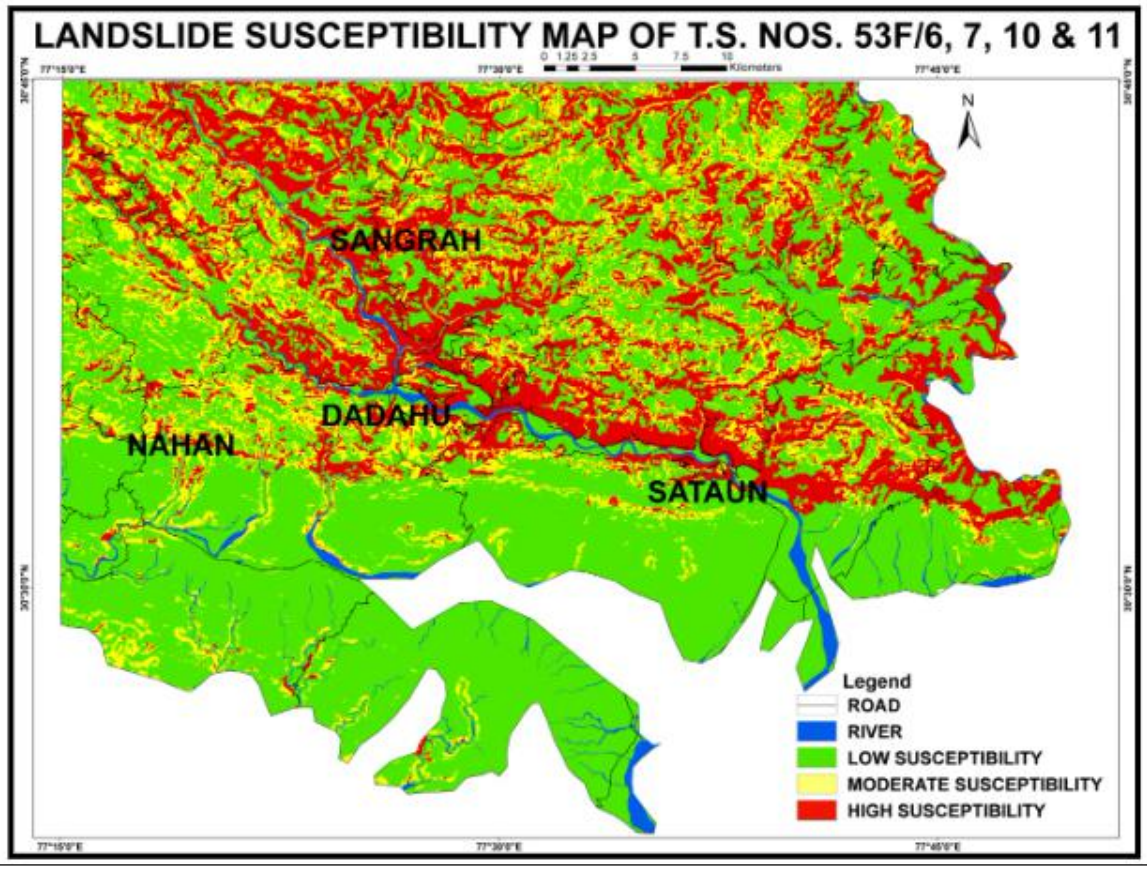

Fig.-8: Landslide Susceptibility of Sirmaur distt., H.P.