

**NOTE ON PRELIMINARY STUDIES OF BATSERI LANDSLIDE (ROCKFALL
ON OPPOSITE BANK OF BATSERI) ON SANGLA-CHITKUL ROAD,
TEHSIL SANGLA, DISTRICT KINNAUR, HIMACHAL PRADESH**

By

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Introduction:

A massive rock fall incidence occurred on the opposite bank of Batseri village, on Sangla-Chitkul road, district Kinnaur, Himachal Pradesh, around 13:10 hrs on 25th July 2021. The incidence resulted in boulder hit smashing of a mini bus along with death of nine tourists and casualty of three others, including a local resident. The massive rock fall was reported to have continued for nearly another one and half minutes also resulted in severe damage to Sangla-Chitkul and Sangla-Batseri link roads, collapse of the Batseri Bailey bridge on Baspa River, a public facility construction and stumping of several mature trees along the trajectory. The live incidence of rock fall and damages was released on various multi-media soon after the ill-fated incidence that indicated continuation of the episode for nearly 75 seconds with severe intensity and stray incidences even after hours. Taking into consideration of the gravity of the landslide incidence, the authors of this note on the invitation of the Dy Commissioner & the Chairman, DDMA, Kinnaur, carried out the preliminary assessment from 27th to 30th July 2021.

The authors could carry out the active field work between 28th and 30th July 2021 under the constraints posed by monsoon. The activities included uphill trekking to observe source and trajectory of the rock fall zone (El 3400m) and to Batseri village (opposite bank of the Baspa River) to take the perspective view of the rock fall zone (as most of the time the crown portion was covered with dense clouds), meeting with local inhabitants and village Pradhan and concluding discussions with the Deputy Commissioner, Superintendent of Police, Kinnaur and other local authorities. The authors of this note briefed them about the status of the rock fall zone and suggested several precautionary measures including the restricted movement along the road during monsoon.

Location and Accessibility:

The study area (Batseri village) falls in Sangla tehsil (Sangla valley) of Kalpa Division of, district Kinnaur, Himachal Pradesh and falls in the Survey of India toposheet No.53E/7. The Batseri village is located 47km from Reckong Peo (district HQ) and is approachable by all-weather road via Karcham-Sangla. The study area is also well connected from Chandigarh via Simla-Rampur-Karcham NH-22 (Fig.1). The Batseri village area located at EL \pm 2800 m along left bank of Baspa river on Sangla-Chitkul road which is also a strategically important road. Chitkul village which is 24km from Batseri village, is the last village in Indian part bordering China.

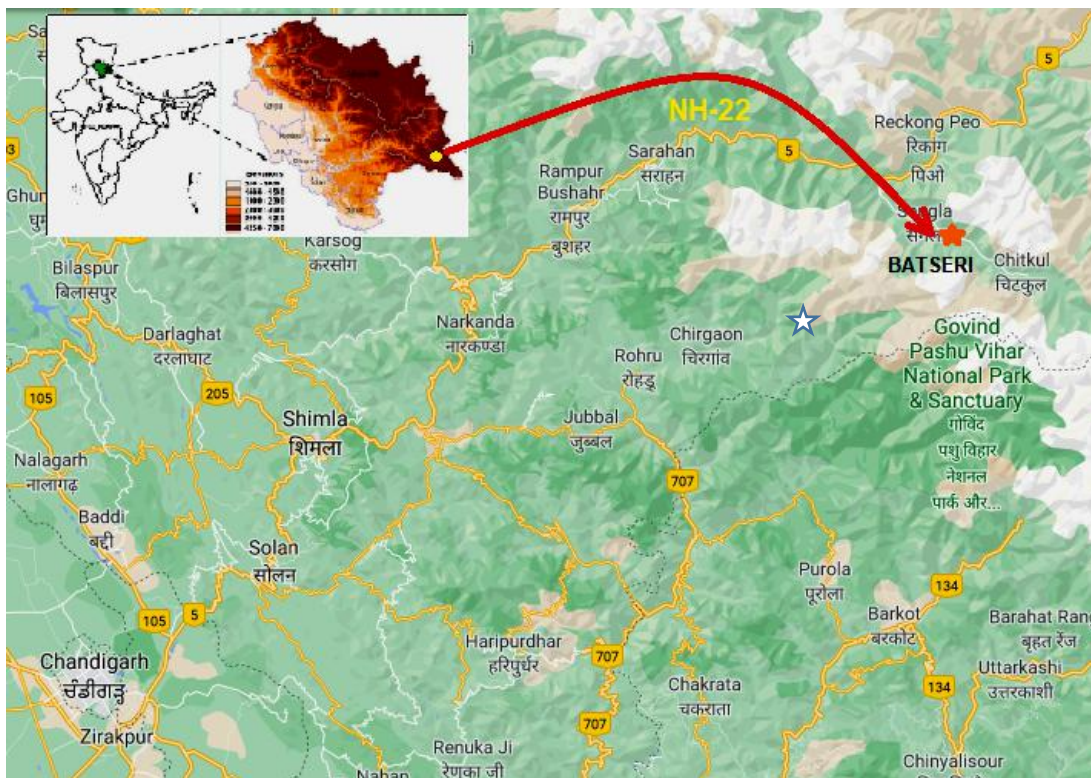


Fig.1: Location map showing Batseri Landslide area.

Climate:

Overall, the climate of Sangla valley is quite pleasant throughout the year, although the winters tend to be a bit harsh (sometimes dropping down to -10°C in the night). Summers are hot but the heat is not really scorching. The temperature during summers ranges from 8 to 30 degrees Celsius. Monsoon season in the valley brings a lesser amount of rainfall. Temperatures during monsoon range from 12°C - 20°C and sometimes get even colder due to continuous rainfall. The district is one of the driest part of Himachal Pradesh recording less than 50mm to 100mm

of rainfall. The district receives 30-40% of annual rainfall during SW monsoon season (Fig.-2).

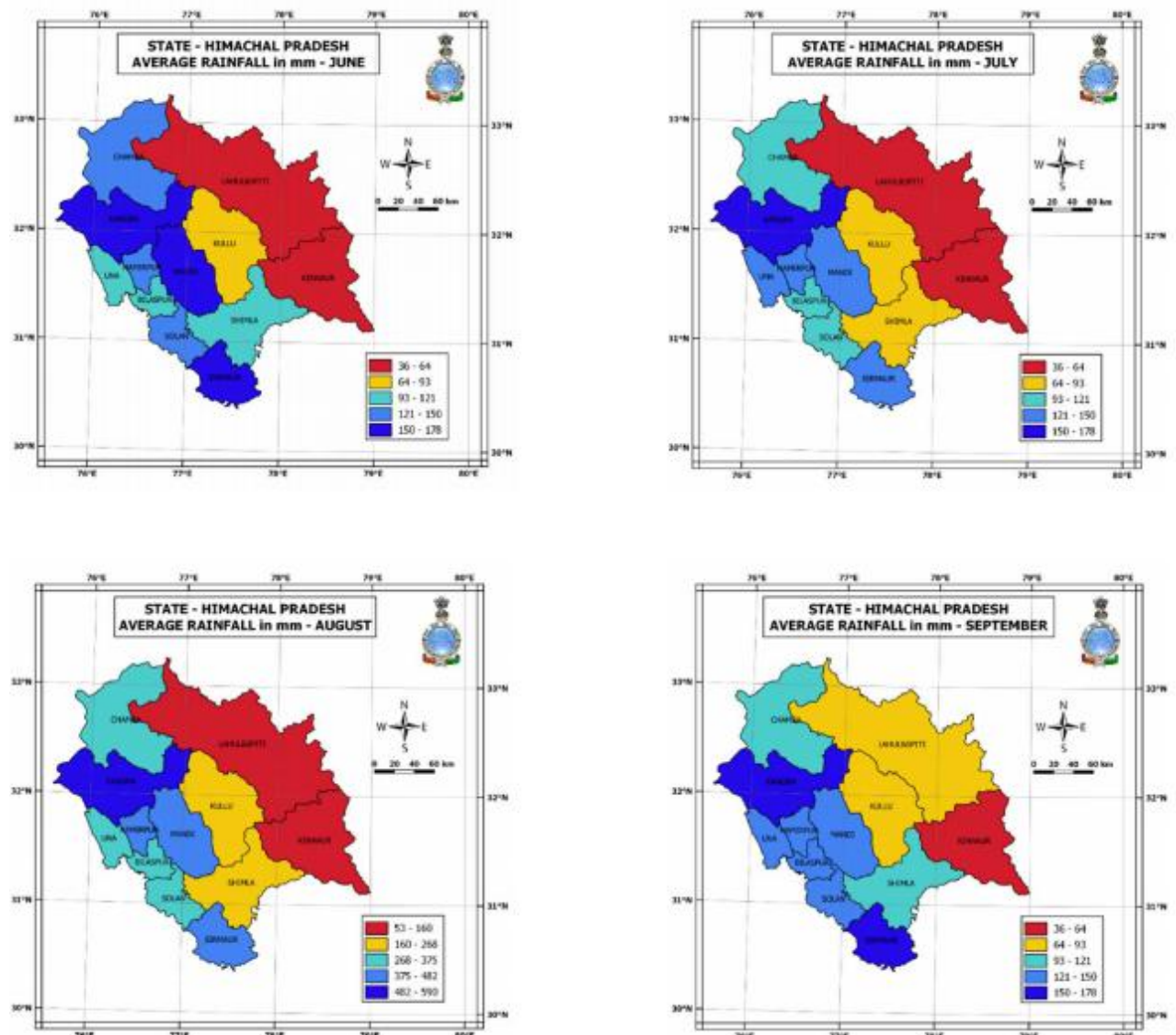


Fig.-2: Mean rainfall pattern over districts of Himachal Pradesh shows Kinnaur to be the driest district (Source: Met Monograph No.: ESSO/IMD/HS/Rainfall Variability/10(2020)/34 of IMD),

Geology, Geomorphology and Seismicity settings of the study area:

Kinnaur Himalaya forms part of the northwestern Himalayas where its number of subsidiary valleys lie between the Zanskar Mountain range, Great Himalayan range and Dhauladhar range including the Sangla valley. The Baspa River valley (Sangla valley) exhibits variable morphology which is broad U-shaped in the upstream 65 km stretch (source to Sangla) and deeply incised narrow V-shaped in

the downstream stretch (Sangla to Karcham). The Pleistocene-Late Quaternary landforms are ubiquitous in the valley. Owing to the general disposition of the Baspa valley along WNW-ESE direction, the right valley slopes are steeper with frequent talus/ scree aprons composed of loose to semi loose slope debris mass, whereas the left valley slopes are gentler and manifested with flatter debris cone or colluvium. The major habitations, agricultural fields and forest are mostly located along left valley slope. The right valley slopes are highly dissected landmass with sparse vegetation (Fig.-3 & 4).

Kinnaur in Higher Himalayas is the northwestern part of the young fold mountains of Himalayas which is seismically still very active. The district falls in seismic zone IV and V High damage risk zone (MSK VIII) and very High damage risk zone (MSK IX or more) (Source: BMTPC Vulnerability Atlas for Himachal Pradesh). A strong earthquake (Kinnaur Earthquake) rocked the Indo-China border on January 19, 1975. It had a magnitude of 6.8 and caused massive damages in **parts of Kinnaur and** Lahaul and Spiti districts. The study area also lies near to the regional-tectonic features in the Himalayas like the Main Central Thrust (MCT). In general, the Baspa Valley including the Batseri village in Sangla Tehsil, Kinnaur district, Himachal Pradesh, exhibit a very fragile geo- environment condition.

Field assessment of landslide incidence area:

The rockfall area is located on the right valley wall of Baspa River, opposite to Batseri village, constitutes a steep sun-facing hill slope comprising major scarp on uphill side and a major bouldery talus cone downhill ward, derived from Sub-Recent to Recent fluvio-glacial weathering and erosion activity .

The rockfall, in fact a rock slide occurred in upper part of a major escarpment represented by tectonized and highly jointed Raksham Granite intrusive in to Khari gneiss of Vaikrita Fm. The overlying granitic rock mass have been severely affected by deep fluvio-glacial weathering and erosion due to frost wedging action of seasonal snow transforming them in a distress rock mass. Thus the escarpment represent a natural source area of rock fall or slide and down slope area a depositional site represented by talus/scree cones (Fig.: 5 & 6). The presence of semi-loose to loose slope boulders, absence of vegetation along linear track, stray cases of rock fall in the zone etc are indicative of the rock fall and debris cone to

be active in recent geological past (Fig.-5, 6 & 7) . However, this natural process turned in to a tragedy in wake of loss of lives, infrastructure and property that came in the trajectory zone. Therefore, the incidence at the Batseri village can precisely be describe as a rock fall hit zone. The steep and upstream bouldery slope of the major talus cone supplemented the rock fall by downstream end, possibly facilitated the spread of boulder by adding more boulder flux resulting in loss of nine lives, severe damage to Sangla –Chitkul & Batseri link road and a bailey bridge. As on date of visit, the Sangla –Chitkul road and surrounding landmass was totally destabilized and can be reclaimed only after proper ground stabilization applications (Fig. 6-12).

The salient feature of the disastrous rock fall has been enumerated below-

- 1) The rock slide/fall occurred from the upper part of a major escarpment.
- 2) The runout distance of the rock fall extends approx. a distance of 700m and maximum spread of 400m in the valley part.
- 2) The general slope direction varies from N205° to N245° and slope angle varies from N35° to 45° in upper part and steep > 45° in valley portion below the road.
- 3) The rock mass exhibited three set of joints including the foliation joints which are:
- Foliation joint- 35°/N70°E to E; Valley parallel joint- 78°/S30°W; Valley across joint- 60°/S80°W; one random joint-75°/N40°W.
- 4) The failure mechanism appears to be planar/ translational failure from heavily jointed major escarpment composed of Raksham Granite.
- 5) The type of movement involved is Downhill spreading Rockfall (Rolling in upper part & bouncing in downhill part due to steeper slope).
- 7) The geoscientific causes worked out be rock slide occurred in tectonised and highly fractured contact of Kharo gneiss and overlying Raksham Granite (Vaikrita Gp) subjected to seasonal fluvio-glacial and rain water related weathering and erosion.

The Future Menace:

The observations along the upslope revealed presence of lot of loose granite bouldery material precariously disposed on the slope (Fig. 8 & 9). In view of the

steep gradient of the upstream part of debris cone that behaved as trajectory for present landslide , the recurrence of rock fall incidence cannot be ruled out. In this effect and in view of rainy season still remaining ahead or in case of any seismic jolt, the area should be kept under close monitoring. It is also suggested that till monsoon the restricted vehicular movement should be allowed under proper surveillance. The above pursuit of safety may also be followed in other villages/ habitats, in particular for those living along right bank of Baspa River.

Conclusion:

1. The Baspa valley with elevations from 1830m (Karcham) to 3275m (Chitkul) and Batseri village with elevation approx. 2700m, constitutes a high altitude area. Manifested with Pleistocene to Sub-Recent glacial landforms and fluvio-glacial deposits.
2. Sun-facing hill slopes are steeper, highly dissected, barren to sparsely forested and covered with loose to semi compact slope material scree aprons composed of small to boulder size rock fragments. Sun-shadow side are generally gentler and with colluviums/ debris cone, thick soil cover, agriculture, forest and village settlements.
3. In view of immature topography and active fluvio-glacial processes, the Baspa valley area possesses a fragile geo-environment condition. The area including Batseri locality has already been identified as High landslide susceptibility zone by Geological Survey of India (GSI, 2018-2019).
4. The Baspa valley in recent years, has witnessed a remarkable jump in increase of infrastructural development and tourist influx. In view of the inherent natural processes of seasonal fluvio-glacial weathering and erosion, the area warrants a comprehensive strategy to minimize the associated hazard and risk.
5. The landslide area exposes highly tectonised contact between Kharo gneiss and intrusive (overlying) Raksham Granite of Vaikrita Gp. The incidence has been identified as rock fall caused by rock slide from uphill escarpment. The hill mass composed of granitoid rocks are naturally amenable to deep weathering and erosion with the release of larger boulders.

Recommendations:

It is recommended that for implementation of site specific remedial and protective measures, the available live video of incidence may also be analysed. The various recommendations deduced are as per below-

1. Removal of precariously disposed rock mass/ boulder from the source/trajectory area.
2. The application of wire mesh rock bolt etc in the vulnerable part of

escarpment/ source area.

3. Near immediate vicinity of foot slope of the escarpment, provision of suitable catch ditch and catch fence.
4. Upslope loose boulders stabilization by using draping wire mesh and crate wall cum catcher ditch at different level along the debris trajectory.
5. Suitable afforestation/ plantation/ biotechnical stabilisation of the slope material, in particular in the trajectory area
6. Concrete/ masonry retaining structure all along the road stretch cut in terrace/debris cone material with adequate drainage holes.
7. Provision of rock fall shelter in risky stretch of the road. Rock deflector to protect important infrastructure such as bridge etc.
8. During rainy season, the traffic movements under strict onsite and offsite slope monitoring.
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 development of infrastructure, any slope modification etc must take in to consideration the geoscientific evaluation of inherent risk & hazards in that locality/ spot. Meso-scale (1:10,000 scale) landslide susceptibility mapping along Sangla valley (Karcham-Sangla- Chitkul sector) may also be carried out.

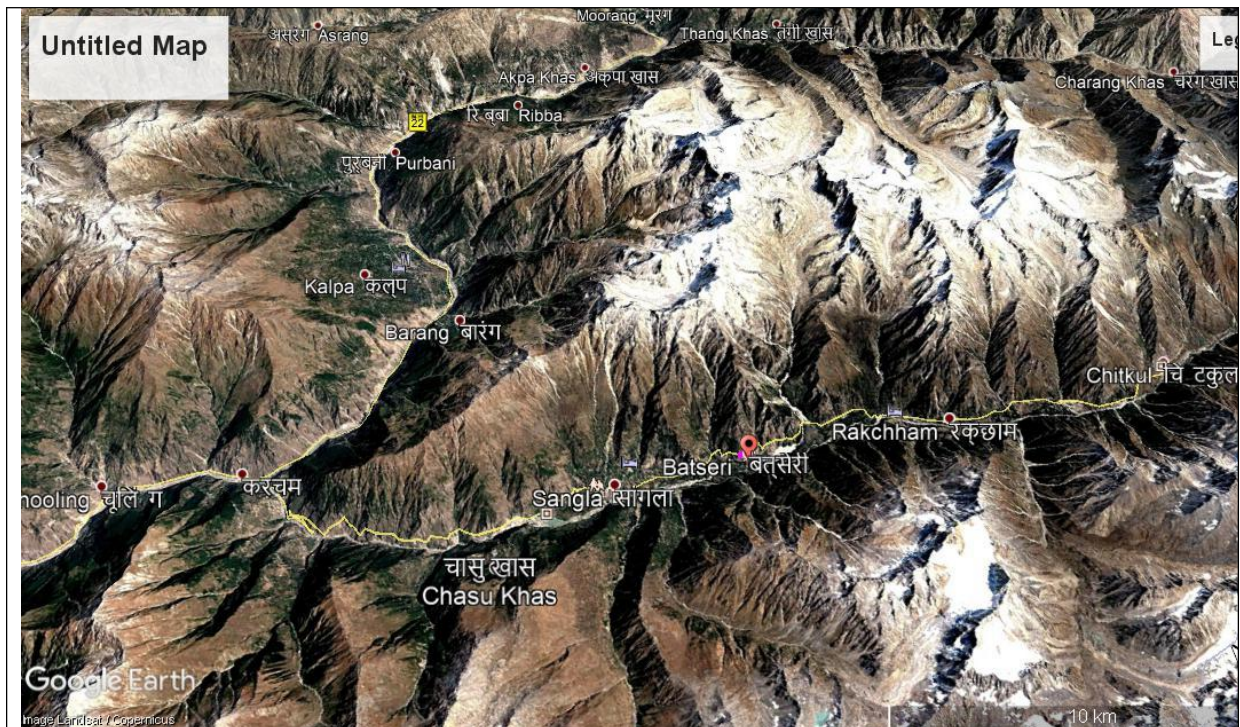


Fig-3: Geomorphic location of Batseri village ($N 31^{\circ} 24' 40.98''$, $E 78^{\circ} 18' 22.15''$), Kinnaur district, HP. (Source: Google earth)

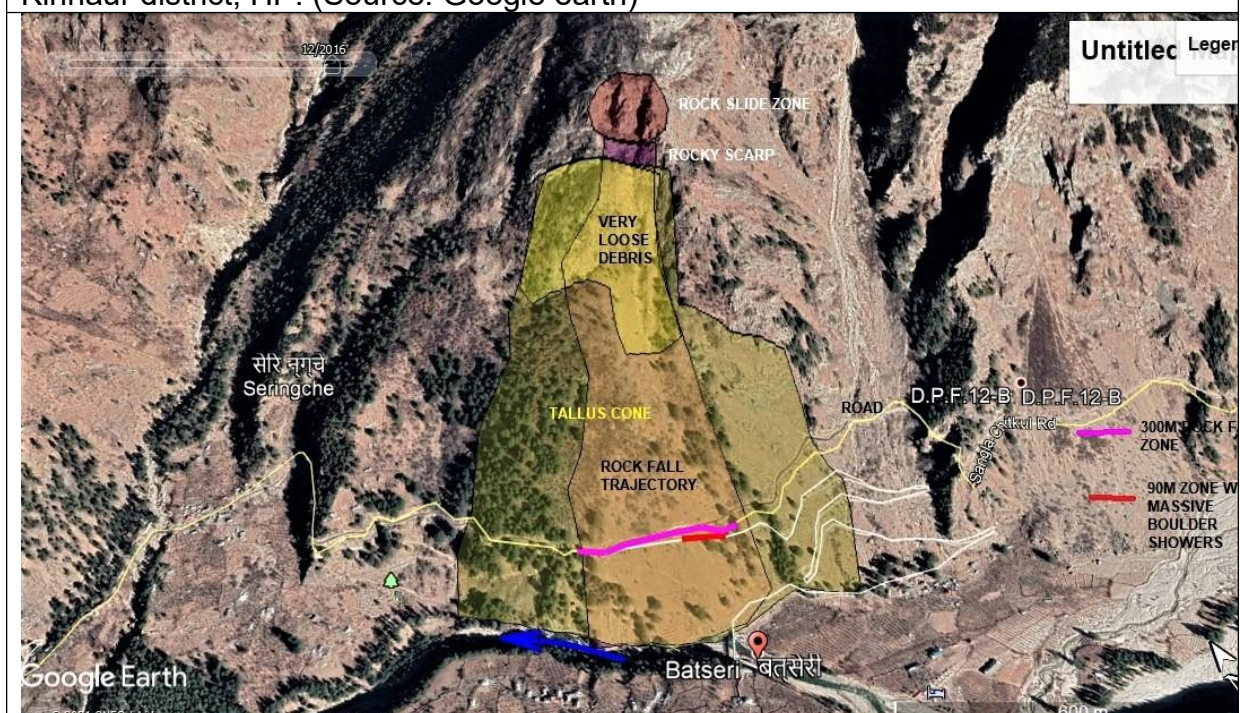


Fig-4: Geomorphic location of Batseri landslide (Rock fall) ($N 31^{\circ} 24' 40.98''$, $E 78^{\circ} 18' 22.15''$), Kinnaur district, HP. (Source: Google earth)

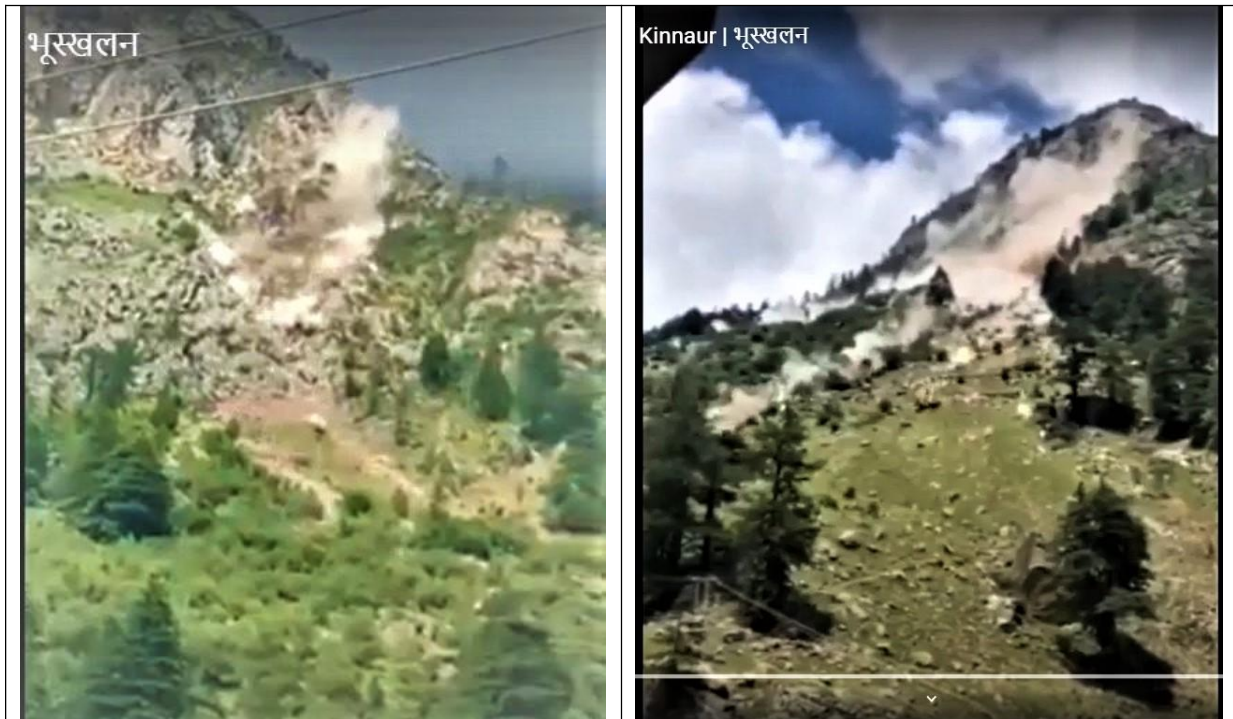


Fig.-5a: The photo clips from live video showing source and spread of rock fall

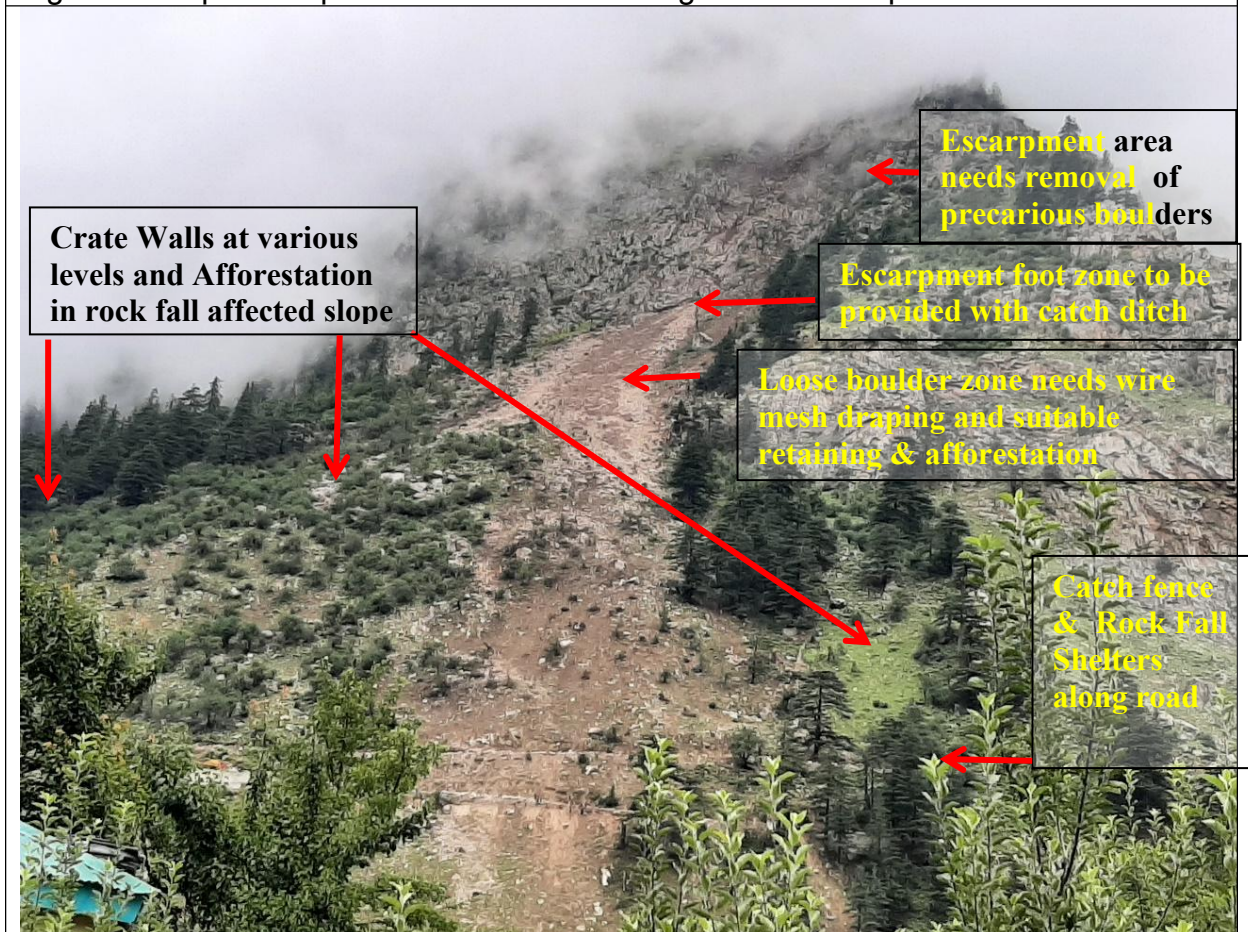


Fig.-5b: The perspective view of Batseri landslide debris fall affected slopes with tentative remedial and protection measures after live video analysis.

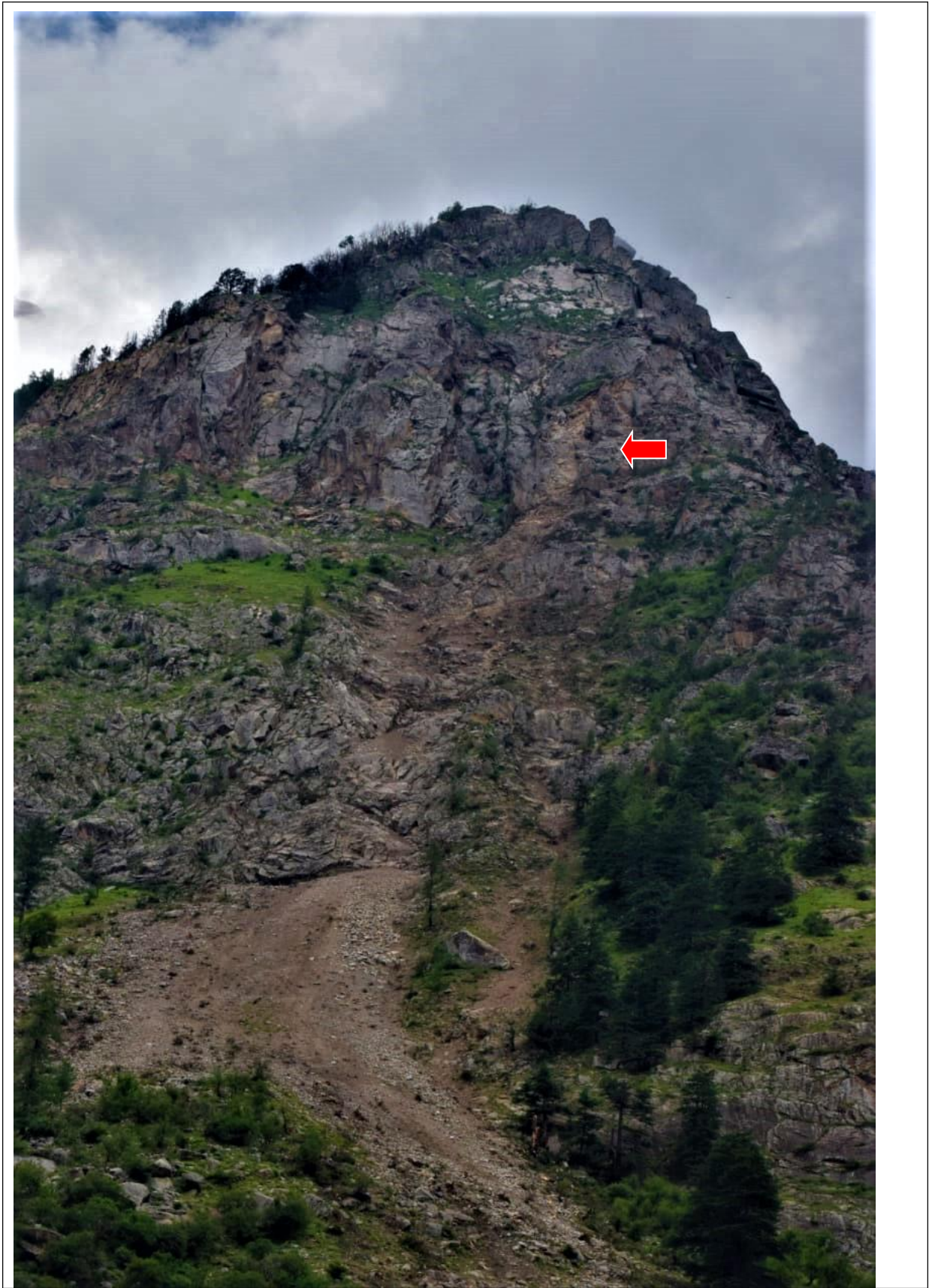


Fig.-6: An uphill view of escarpment area with rock slide scars.



Fig.-7: The perspective view of trajectory of the rock fall before and after rock fall. The zone is with near absence of any vegetation, indicative of active natural processes along the slope



Fig.-8: Loose boulders in escarpment foot slope needs wire mesh draping and retaining .



Fig.-9: A tree holding a large (>2m dia) boulder of an earlier episode of rock fall.



Fig.-10: Down hill view of damaged link road and bailey bridge to Batseri village



Fig.-11: Severely damaged Sangla- Chitkul road due to rock fall of 25th July 2021



Fig.-12: The image showing the boulder trajectory to Bailey Bridge and subsequent collapse.

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