



भारत सरकार
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Geological Survey of India

मेसो-स्केल (1:10,000) कलासा क्षेत्र के एनएनई में और एसएच-66 रोड कॉरिडोर के साथ,
चिकमंगलूर जिला, कर्नाटक में भूस्खलन संवेदनशीलता मानचित्रण।
**Meso-scale (1:10,000) Landslide Susceptibility Mapping in NNE of Kalasa area and
along SH-66 road corridor, Chikmangalur District, Karnataka.**
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कार्य सत्र 2021-22 का प्रतिवेदन
Report for field season 2021-22

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Mission-IV

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मेसो-स्केल (1:10,000) कलासा क्षेत्र के एनएनई में और एसएच-66 रोड कॉरिडोर के साथ, चिकमंगलूर जिला, कर्नाटक में भूस्खलन संवेदनशीलता मानचित्रण।

MESO-SCALE (1:10,000) LANDSLIDE SUSCEPTIBILITY MAPPING IN NNE OF KALASA AREA AND ALONG SH-66 ROAD CORRIDOR, CHIKMANGALUR DISTRICT, KARNATAKA.

एम4एलएसएसएम/एनसी/एसआर/ एसयू-केजी/2021/33518

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मेसो-स्केल (1:10,000) कलासा क्षेत्र के एनएनई में और एसएच-66 रोड कॉरिडोर के साथ, चिकमंगलूर जिला, कर्नाटक में भूस्खलन संवेदनशीलता मानचित्रण।
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अचान कोन्याक, भूवैज्ञानिक

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सारांश

भूगर्भीय कारकों की अलग-अलग आवृत्ति और वर्षा की तीव्रता और भूमि उपयोग प्रथाओं के साथ पश्चिमी घाट की पहाड़ियों में ढलान अस्थिरता पर असर पड़ता है। कलासा के पास हिरेबाइल क्षेत्र में मेसोस्केल भूस्खलन की संवेदनशीलता के इस अध्ययन में भूस्खलन तंत्र के लक्षण वर्णन और संभावित भू-कारकों के कारण संबंध के मूल्यांकन के आधार पर प्रत्येक अद्वितीय भूगर्भीय स्थिति या डोमेन के लिए ढलान अस्थिरता के लिए जिम्मेदार अंतर्निहित कारक कारकों के विस्तृत पहलुओं को शामिल किया गया है। उच्च घनत्व वाले क्षेत्र अवलोकन बिंदुओं के माध्यम से भूस्खलन के साथ। अध्ययन क्षेत्र के कुल 16 किमी 2 को अलग-अलग डोमेन में वर्गीकृत किया गया है, जैसे कि अर्थ स्लाइड, मलबे की स्लाइड, रॉक स्लाइड, रॉक फॉल और स्लोप कट डोमेन। मलबे की स्लाइड और मिट्टी की स्लाइड के लिए जिन भू-कारकों पर विचार किया जाता है, उनमें भू-तकनीकी, भूमि उपयोग/भूमि आवरण, भू-आकृति, और धारा शक्ति सूचकांक शामिल हैं, जबकि रॉक स्लाइड और रॉक फॉल डोमेन रॉक मास रेटिंग और कीनेमेटिक विफलता मानचित्र के संदर्भ में भू-तकनीकी विषय पर विचार करते हैं। इन विषयगत कारकों के अलावा, ढलान नक्शा, रेगोलिथ मोटाई नक्शा, और सापेक्ष राहत मानचित्र कट ढलान डोमेन के लिए महत्वपूर्ण विषयगत परतें हैं। इन अलग-अलग विषयों की कक्षाओं को भूस्खलन संवेदनशीलता अनुमानित रेटिंग सौंपी गई है, जिन्हें प्रत्येक डोमेन के लिए कुल अनुमानित संवेदनशीलता मान (**TESV**) प्राप्त करने के लिए जोड़ा जाता है और अंत में भूस्खलन की संवेदनशीलता की अलग-अलग डिग्री में वर्गीकृत किया जाता है। क्षेत्र में भूस्खलन सूची को अद्यतन करने की प्रक्रिया में, अध्ययन क्षेत्र के भीतर विभिन्न आयामों के 42 भूस्खलन की सूची बनाई गई थी। इस क्षेत्र में मलबा और भू-स्खलन प्रमुख हैं। ओवरबर्डन का सबसे बड़ा अनुपात अपरिपक्व इंसीटू मिट्टी है, जिसके बाद परिपक्व इंसीटू मिट्टी है, जबकि कोलवियम और मिश्रित बोल्टर और मलबे के पैच को पूर्वी मल्लेश्वर पहाड़ी के मध्य ढलानों पर मैप किया गया है। सभी क्षेत्रों के लिए संयुक्त भूस्खलन संवेदनशीलता मानचित्र से पता चलता है कि **50%** क्षेत्र कम संवेदनशीलता, **23%** मध्यम और **26%** उच्च संवेदनशीलता वाले क्षेत्रों में पड़ता है। संभावित सुरक्षित आश्रय और पलायन मार्ग के साथ उच्च भूस्खलन की शुरुआत संवेदनशीलता और उच्च मलबे प्रवाह प्रभाव संभावना क्षेत्र को दिखाने के लिए एक समग्र संवेदनशीलता मानचित्र तैयार किया गया है। समग्र संवेदनशीलता मानचित्र ने कुछ ऐसे इलाकों की पहचान करने में मदद की है जहां जोखिम वाले तत्व मौजूद हैं। भूस्खलन की घटनाओं से जुड़े उच्च जोखिम वाले पहचाने गए इलाकों में चेन्नाहदलु, हेमाकी रोड, मल्लामारा हिरेबेल और बिलगाली फुट ढलान की पहाड़ियाँ शामिल हैं।

Meso-scale (1:10,000) Landslide Susceptibility Mapping in NNE of Kalasa area and along
SH-66 road corridor, Chikmangalur District, Karnataka.

M4LSSM/NC/SR/SU-KG/2021/33518

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ABSTRACT

The interaction of geologic factors with the varying frequency and intensity of precipitation and land use practices have bearing on slope instability in the Western Ghat hillslopes. In this study of mesoscale landslide susceptibility in the Hirebyle area near Kalasa the detailed aspects of inherent causative factors responsible for slope instability for each unique geologic condition or domain are incorporated based on the characterization of landslide mechanism and evaluation of causal relation of potential geo-factors with landslides through high-density field observation points. A total of 16 km² of the study area is categorized into different domains viz, earth slide, debris slide, rock slide, rock fall, and slope cut domains. The geo-factors considered for debris slide and soil slide include geotechnical, land use/land cover, landform, and stream power index while rock slide and rock fall domain consider the geotechnical theme in terms of rock mass rating and the kinematic failure map. In addition to these thematic factors, the slope map, regolith thickness map, and relative relief maps are important thematic layers considered for the cut slope domain. The classes of these different themes have been heuristically assigned Landslide Susceptibility Estimated Ratings which are added up to derive Total Estimated Susceptibility Values (TESV) for each domain and finally classify into varying degrees of landslide susceptibility. In the process of updating the landslide inventory in the field, 42 numbers of landslides of varying dimensions were inventoried within the study area. The debris and earth slides are dominant in the area. The largest proportion of overburden is immature insitu soil followed by mature insitu soil while patches of colluvium and assorted boulders and debris have been mapped on the mid slopes of the eastern Malleswara hillslope. The combined landslide susceptibility map for all the domains shows that 50% of the area falls in low susceptibility, 23% in moderate, and 26% in high susceptibility areas. A composite susceptibility map has been prepared to show high landslide initiation susceptibility and the high debris flow impact probability area along with possible safe shelter and escape route. The composite susceptibility map has helped identify a few localities where elements at risk are present. The identified localities with higher risks associated with landsliding events include the hillslopes of Chennahaddlu, Hemmaki road, Mallamara Hirebyle and Bilagali foot slopes.

1. INTRODUCTION

1.1 Background

The Western Ghats of Karnataka have faced landslide-related disasters over the years. These landslides are triggered by prolonged rainfall during the active monsoon period (June to September). During the monsoon of 2018 and 2019, several landslides have been reported in different parts of the Kalasa Hobili, Mudigere taluk of Chikmangalur District, Karnataka. resulting in the losses of property, plantation, and forest land. Macro-scale (1:50000) landslide susceptibility mapping (NLSM) has been completed for the Kalasa Hobili area and it helped to identify certain critical areas that need further study at a larger scale. In pursuance of the request from the Chikkmangalur district administration and keeping in view the presence of moderate and high susceptible zones as per the NLSM programme of FS 2017-18 (Tanvi Gupta, & Sunandan Basu, 2018) and also to minimize the risk factor associated with the landslide affected slopes, an area of 16 km² was taken up for mesoscale (1:10,000) landslide susceptibility mapping.

The current Landslide Susceptibility mapping work divides the terrain into different zones according to the relative degree of susceptibility to landslides. This categorization is done through the identification of spatial areas that are likely to be affected by landslide initiation and consequently arrive at an assessment of the damage potential of the area. This has been done based on all the relevant geo-factor themes at the pertinent scale of observation (1:10,000), determining the geotechnical properties of rocks/soils and slope stability analysis at selected stretches on a relatively larger scale (1:10,000) for direct use by the concerned State Government for landslide risk mitigation. The final output landslide susceptibility map generated in this work is important for planning large-scale developmental works as well as essential for the quantification of landslide hazards and risks. The nature, quantum, and time of work are given in Tables 1a and 1b.

1.2 Objective

The objectives of the current study are:

- i. To generate a mesoscale (1:10,000) landslide susceptibility zonation map.
- ii. To identify causative factors related to landslides.
- iii. To suggest generic mitigation measures for unstable slopes.
- iv. To update the existing landslide inventory

Table 1.1 Nature and quantum of work

Nature of Work	Target FS 2021-22	Total Achievement (in sq.km) 2021-2022
1. Detailed pre-field landslide inventory map including ground deformation, creeps etc. and identification of failure domains		
2. Preparation of pre-field thematic geofactor maps		
a. Land use/ Land cover map	16 km ²	16
b. Drainage map		16
c. Geomorphology/Landform map		16
d. Slope Morphometry		16
e. Slope forming material Map		16
f. Stream Power Index Map		16
g. Landslide domain Map		16
h. Overburden thickness map		16
i. Slope Facet Map		16
3. Field-based studies		
a. Validation and updation of all thematic maps and landslide inventory in the field.	16 km ²	16
b. Data collection for preparation of Geotechnical map		16
c. Geotechnical field sample collection for determination of geotechnical parameters*	32 nos.	32
4. Post-field studies and modelling		
a. Updation and finalization of thematic maps and landslide inventory in the GIS platform.	16 km ²	16
b. Preparation of Geotechnical map #		16
5. Preparation of landslide susceptibility map in GIS platform.	16 km ²	16
6. Collection of Rainfall data	As per availability	

Table 1.2 Man days spent on the project

Sl. No	Supervisory officer/Officers	Field initiation date	Total field days
1.	R Sajeed, Director (G)	14/11/2021	06
2.	Achan Konyak, Geologist	18/10/2021	90
3.	E Mohan Raj, Geologist	15/09/2021	110

1.3 Study area

The study area is about 13 km away from Kalasa Hobili of Mudigere Taluk, Chikkamangalur district of Karnataka (Fig.1). The study area includes parts of Hirebyle, Bigali, and Hemmaki villages. The study area is bounded by latitude N 12° 10' 40.8" to N 12° 13' 51.6" and longitude E 75° 47' 24" to E 75° 51' 0" which falls in Toposheet No. 48 O/8. The area can be accessed from Bengaluru via NH-75 via Hassan and Mudigere. The area is well connected by state highways such as SH – 106 (Hornadu – Kothighere stretch), and SH – 66 (Magundi-Kudremukh stretch).

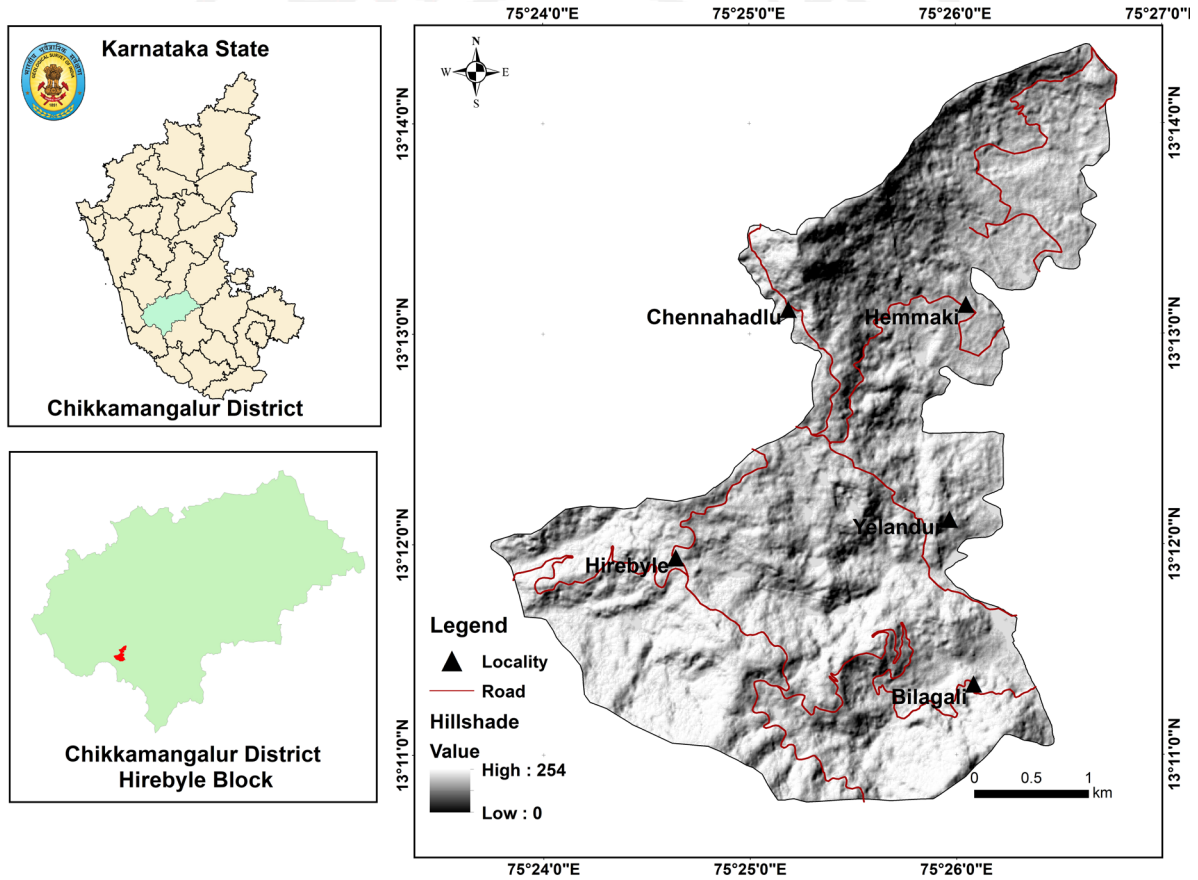


Fig. 1 Location map of the study area

1.4 Physiography

The physiography of the study area represents a mountainous region that forms part of the Western Ghats. The area exhibits lowly to moderately dissected topography with NW-SE linear ridges and valleys. The highest elevation in the area is 1302 m above the mean sea level at Malleshwara hilltop and the lowest elevation is 772 m above the mean sea level around the SE of the Hemmaki. The relative relief of the area is about 530 m. The drainage in the study area exhibits a radial pattern and shows up to the 5th-order stream.

1.5 Previous work on landslide studies

Earlier workers attempted Landslide inventory mapping along the Kottighera-Kalasa road corridor, Mudigere Taluk, Karnataka (Maruthi and Mishra, 2009) where about 24 landslides were recorded along the whole stretch. As per the report, most of the landslides in this stretch were shallow debris slides confined to the road corridor aggravated by slope cuts for road construction. The study area was covered under Macro Scale (1:50,000) Landslide Susceptibility Mapping (NLSM) Programme during FS 2017-18 (Tanvi Gupta and Sunandan Basu, 2018). As per the landslide susceptibility map of 1:50,000 scale, the northern parts of the area show considerable patches of high and moderate susceptibility zones, while the northeastern and northern side of the area mostly falls under the low susceptibility zone. In 2019, post-disaster landslide studies (Kapil and Kamal, 2019) were carried out after reports of landslide incidences in localities of the Hirebyle area, Mudigere as per the request of the district authority. As per the report, the landslides were triggered by the prolonged rainfall in August 2019 and the anthropogenic interference on the natural slope was the primary causative factor.

These slope stability studies are taken up to cater to site-specific needs as and when landslides occur which include preliminary post-disaster studies and their inventory and also coordinating activity related to landslide hazard mitigation with district authorities. The above studies carried out by different authors are done on different scales along selected stretches of road and also specific areas when the need arises owing to landslide incidences.

1.6 Acknowledgements

The timely completion and smooth execution of the project for FS 2021-22 are attributed to the concerted efforts of several individuals at various levels. The authors are grateful to Addl. Director General and HOD, GSI, SR, Hyderabad for intimating the state and district administration about the work to be carried out in the area. Sincere thanks are due to the Deputy Director General, SU-KG for approving all the logistics for the smooth execution of the project. The authors are grateful to Shri R. Sajeev, Director, for the overall supervision and for providing all possible logistic support and technical inputs both in the field and at headquarters. The authors would like to put on record the help, guidance, and support rendered by experts from GHRM Cell, GSI, Kolkata, especially Sh. Sumit Kumar, Sr. Geologist for running the debris flow impact probability model for the area. The authors are grateful to the colleagues of the Engineering Geology and Landslide division of Bangalore for the help rendered through mutual discussions and technical inputs in various forms.

2. GEOLOGY

2.1 Regional geology

Geologically, the Western Ghat area of Karnataka is occupied by rocks belonging to the Sargur Group, Peninsular Gneiss-I of PGC, and Charnockite Group, which are intruded by granites, pegmatites, and dolerite dykes. The Sargur Group comprises garnet-sillimanite schist, kyanite-bearing gneiss and amphibolites. The high-grade metapelites such as fuchsite quartzite, kyanite-sillimanite schist, and kyanite gneiss occur as narrow and discontinuous bands. The stratigraphic succession of the study area is given below in Table 2.1, (Misc. pub. No 30, Part VII, GSI, 2009).

Table 2.1 Generalized stratigraphic succession of Western Karnataka.

Eon/Era/Epoch	Suite/Assemblage Supergroup	Group /Formation		Lithology
Paleoproterozoic 2530-2450ma	Intrusive (Closepet granite etc.)			Alkali granite, monzogranite/adamellite to granodiorite
~~~~~ Intrusive ~~~~~				
Late Archaean to Paleoproterozoic To Late Archaean 2900-2600 ma	Dharwar Supergroup	Chitradurga Group 2700-2600 ma	Ranebennur Subgroup	Greywacke/BIF/ polymict conglomerate/ volcanics (Mardihalli, Bellara, Medur)
			Vanivilas Subgroup	Polymict conglomerate, cross bedded quartzite, pelite, stromatolitic carbonates, biogenic chert, BIF & manganese formations (Ingaldhal volcanics-tholeiitic basalt rhyolite suite (Tekkalvatti, Jagar))
		Bababudan Group 2900-2800 ma		BIF & carbonaceous phyllite, basalt-dacite suite (Locally pillowed) with minor ultramafics/ alternations of amygdular basalts/cross-bedded quartzites, pelite/minor BIF/basal quartz pebble conglomerate
Late Archaean <3000 ma	Peninsular Gneiss-I			Tonalite- trondhjemitegranodiorite
Middle Archaean 3000 ma		Charnockite Group		Metamorphic equivalents of earlier formed rocks
Middle Archaean				Ultramafic-mafic

>3000 ma		Sargur Group	intrusive complex (Holenarsipur-Nuggihalli)/ serpentinitised komatiites, komatiitic and thoeliitic amphibolites, chert, BIF/garnet-biotite schist (with kyanite, sillimanite and staurolite)/local marble and calc-silicate/fuchsite quartzite with chromite and baryte layers
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## 2.2 Geology of the area

As per the 1:50,000 geological map, the area exposes rocks of Peninsular Gneisses-I of Peninsular Gneissic Complex, Bababudan Group of rocks belonging to Kudremukh of Archaean age and younger intrusive of Paleoproterozoic age. The Peninsular Gneissic Complex-I in the area is represented by Granite gneiss, Bababudan Group is represented by metabasalt, meta ultramafic, banded magnetite quartzite, and amphibolite and younger intrusive are represented by dolerite dyke. The general trend of the litho units is NNW to SSE in direction.

The granite gneiss exposed in the area is light-coloured with quartz, feldspars, and some amount of biotite. The rock is medium to coarse-grained, exhibiting massive characteristics in most exposures (Fig. 2.1a) but also more deformed and well-foliated in a few localised places. A small patch of meta-ultramafic rock with NW-SE trend is observed in the southwestern corner of the study area at the fringe of the Goomankhan tea estate. The rock is extremely hard and massive and characterized by coarse-grained light to dark green mineral grains (Fig. 2.1b).

The exposure of amphibolite in the study area is considerable (Fig. 2.1c) and the value addition on the geological map has been done by updating and extending the amphibolite outcrop on the map in areas around Chennahadlu and Malleswara gudde and north of Hemmaki which were earlier marked as granite gneiss in 50k geological map. The amphibolite exhibits a salt and pepper texture, medium to fine-grained, comprises of hornblende and plagioclase with minor amounts of quartz and biotite, highly foliated and sometimes garnets crystals are found within the amphibolites.

Several patches of the outcrop of banded magnetite quartzite (Fig. 2.1d) are observed on the higher reaches of hillslopes and accordingly updated on the geological map. Thin alternate bandings of quartz and magnetite are observed to have been tightly folded or sheared in some places.



A schistose rock unit is observed in Gumminkad characterized by a preponderance of micaceous and flaky minerals including sericite and chlorite (Fig. 2.1.e). Specks of magnetite are also observed over the micaceous layers. The foliation of the unit is following the regional trend of NNW-SSE but steeply dips (50°) towards the southwest.

The younger intrusive in the form of dolerites are observed in the Malleswara Gudda (Fig. 2.1f). The rock is fine to medium-grained, rich in pyroxene and plagioclase, and extremely hard in nature. The outcrop is bouldery following the NW-SE trend.

	
Fig. 2.1a Granite gneiss	Fig. 2.1b Meta-ultramafic
	
Fig. 2.1c Amphibolite	Fig. 2.1d Banded Magnetite Quartzite
	
Fig. 2.1e Mica-schist	Fig. 2.1f Dolerite

Fig. 2.1 Field photos of litho-units of the Hirebyle, Kalasa area

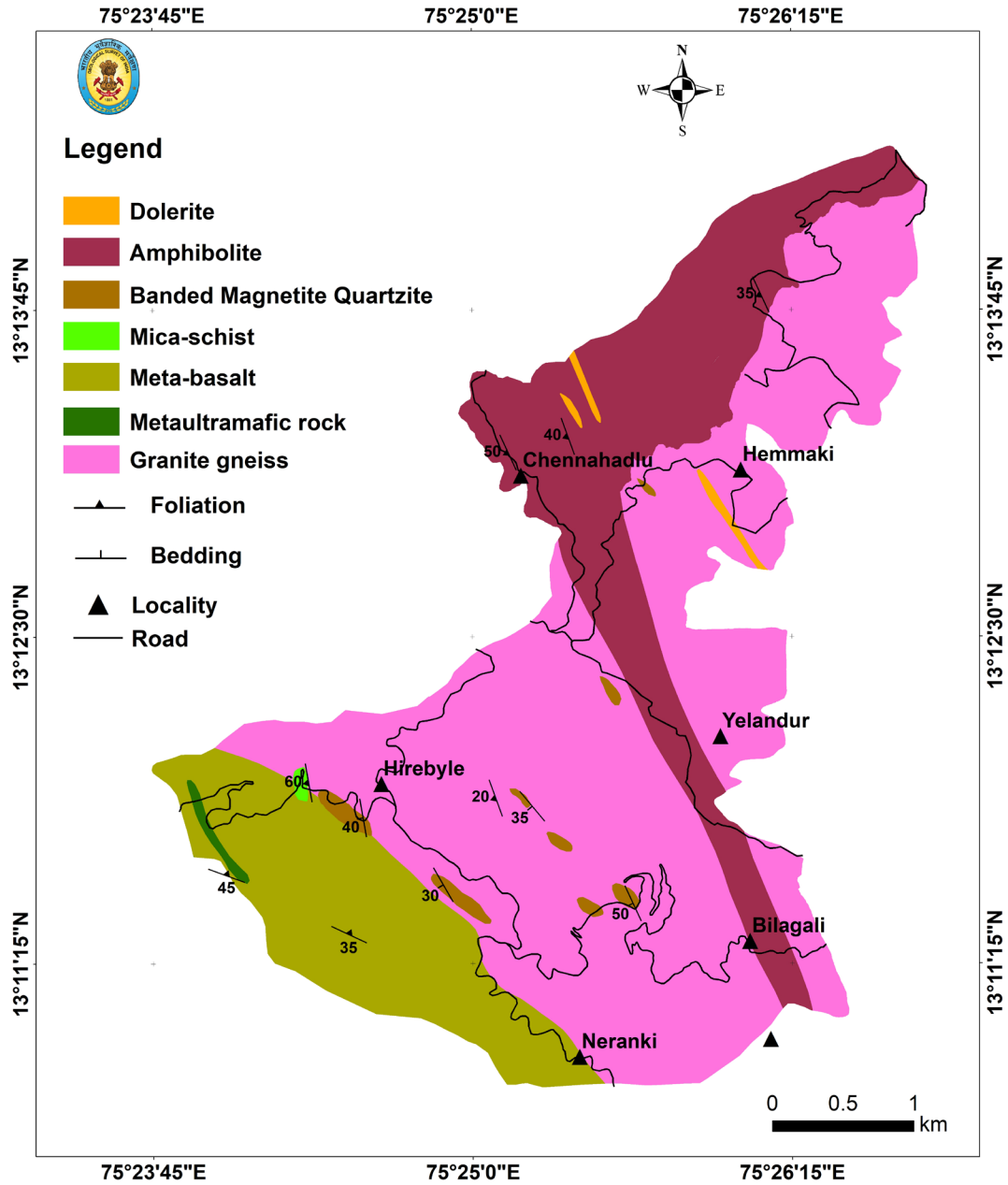


Fig. 2.2 Geological map on 1:10,000 scale of the Hirebyle, Kalasa area (Updated after GSI legacy 50k map)



### 3. METHODOLOGY

In the current study, the broad guidelines outlined in Standard Operating Procedure (SOP) GSI, 2021 have been followed.

#### 3.1 Input data and maps

CartoDEM 10 m spatial resolution procured from the National Remote sensing Centre (NRSC), Hyderabad is used to generate the topographic base map for the area. The CartoDEM is also used to prepare the relevant pre-field DEM derivative thematic maps for the entire Area of Interest (AOI). For landslide inventory and categorical maps, the multi-temporal high resolution google earth imagery is used to identify both the old and new landslide scars and other cultural features to be incorporated into the base map. The previous landslide hazard zonation work and reports including the post-disaster studies serve as baseline information for the current work. The geological legacy map of GSI (1:50,000) is the primary base map to obtain the lithological and structural information in the area.

#### 3.2 Selection of mapping unit

The term mapping unit refers to that part of the topographical surface considered to have similar geo-factor attributes significantly different from the immediate or adjacent units and thereby having definite polygonal boundaries (Guzzetti *et al.*, 1999). The selection of a suitable mapping unit is the prerequisite of landslide susceptibility mapping. In the current study, a pixel (10 m) from CartoDEM is used for the 1: 10,000 scale because the same is easy to generate, integrate and retrieve, easy for spatial analysis, statistical/mathematical calculations, and minimum generalization. There are various mapping units adopted for landslide hazard mapping depending on the scale of the study and the type of landslide processes involved. In the current study, a slope facet is adopted only for the slope-cut domain which is again pixelated for seamless map generation. A slope facet represents that part of the slope which has a similar slope inclination and azimuth. The facet base map is manually prepared using a topographic map and the drainage map is generated through CartoDEM 10 m resolution (Fig. 3.1).

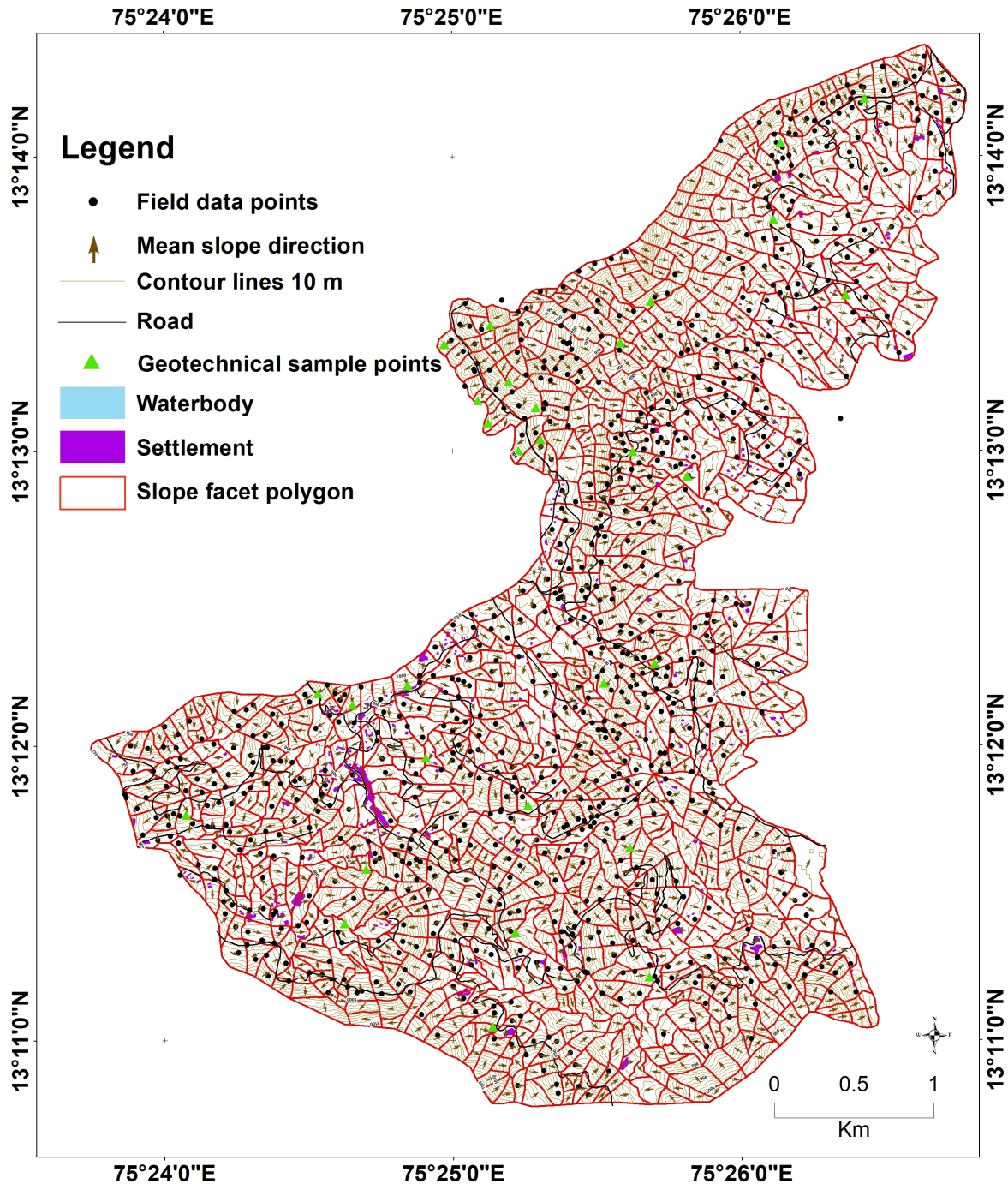


Fig. 3.1 Facet map with field data points and geotechnical sample points

### 3.3 Categorization of the study area into domains

The causative factors of each landslide and the failure mechanisms involved are different for each geological terrain. Therefore, it is reasonable to categorize the hillslopes into domains based on the dominant type and processes involved in the initiation of landslides (Cruden *et al*, 1996). Each domain in the study area represents similar or unique geologic or physiographic conditions that control the landslides in the area. The hillslopes have been



categorized into the following domains: earth slide, debris slide, rockslide, rockfall, and slope cut domains.

The earth slide domain dominantly has mature soil which can either be insitu or transported while the debris slide domain has hillslopes that are covered by immature soil, colluvium, and other assorted boulders. The rocky areas have been categorized into the rock slide domain which can have both planar and wedge failure mechanisms and the rockfall domain where the slope angles are greater than 45°. Therefore, landslide inventory and characterization of landslide mechanism and evaluation of causal relation of potential geo-factors with landslides through high-density field observation points become a primary exercise to categorize the hillslopes into different domains.

In addition, any areas having water bodies, reservoirs, flatlands, etc. where obvious landslides cannot be initiated are categorized as the “No Landslide” domain. However, this does not mean that the areas marked as no landslide domain are completely devoid of landslide risks since such areas can also be along the impact path of the landslides initiated on the upslopes.

### **3.4 Selection of geo-factors for domain**

The most relevant underlying factors in the initiation of landslides in each domain are taken into account in the current study. Since the heuristic method is employed in the current study, a reasonable assumption of the main causes of landslides in the area of interest is taken into account in selecting the most relevant geo-factors (Ghosh *et al.*, 2011). Such geo-factors for landslide susceptibility analysis depend on the scale of analysis, the characteristics of the study area and deductive knowledge of the main causes of landslides (Guzzetti *et al.*, 1999; Glade and Crozier, 2005; Van Westen *et al.*, 2008). In the current study, the geo-factors considered for earth slide and debris slide include slope angle and relative relief, land use, landform, stream power index, and overburden geotechnical character. For the rock slide and rock fall domain, the geo-factors considered are the rock mass rating and kinematic failure map.

### **3.5 Ratings of the classes of geo-factors**

Each geo-factor theme is divided into classes which are assigned ratings based on the relative contributory role for landslide initiation. This knowledge-driven rating is as termed Landslide Susceptibility Estimated Rating (LSER). Every theme will have the maximum weight assigned (Table 3.1). In the current study, this heuristic method used to assign LSER for each class of the geo-factors caters to the needs of the terrain-specific condition.

The modes of slope failure in rocky slopes and overburden-covered slopes are different. The same pre-disposing factors will have a varying contributory role in the initiation of landslides in both types of slopes. In this context, the ratings/weights to different geo-factor classes are assigned after a proper field assessment of the classes and examining the landslide incidences in the given area.

The ratings are similar to the broad schema outlined by the Bureau of Indian Standards (IS-14496, Part 2), 1998, and Ghoshal *et al.*, 2013 which are also knowledge-based ratings. However, in the current study, the classes and thematic geo-factors incorporated are different and based on the observations of the authors as appropriate to the terrain of the study. The LSER for the classes of any thematic geo-factor and the maximum LSER or weight assigned for any thematic geo-factor ranges from positive non-integer to “1” for each domain so that the Total Estimated Susceptibility Values (TESV) for each domain adds up to integer 1. This TESV is subdivided into low, moderate, and high susceptible zones using either the natural breaks or the manual breaks in Arcmap 10.8 to fit the real field conditions (Fig. 3.2).

Table 3.1 Maximum weight assigned to the geo-factor themes (SOP, GSI, 2021)

<b>Rock Slide</b>	
Geo-factors	Weights
1. Geotechnical map (GT)	0.6
2. Kinematic failure (KF)	0.4
Total Estimated Susceptibility Values (TESV)	1.0
<b>Rockfall</b>	
Geo-factors	Weights
1. Geotechnical map (GT)	0.6
2. Toppling failure (TF)	0.4
Total Estimated Susceptibility Values (TESV)	1.0
<b>Debris slide</b>	
Geo-factors	Weights
1. Geotechnical map (GT)	0.5
2. Landform (LF)	0.3
3. Stream Power Index (SPI)	0.1
4. LULC	0.1
Total Estimated Susceptibility Values (TESV)	1.0
<b>Earth slide</b>	
Geo-factors	Weights
1. Geotechnical map (GT)	0.5
2. Landform (LF)	0.3
3. Stream Power Index (SPI)	0.1
4. LULC	0.1
Total Estimated Susceptibility Values (TESV)	1.0
<b>Cut-slope failure</b>	
Geo-factors	Weights
1. Regolith thickness (RT)	0.3
2. Relative Relief (RR)	0.3
3. Geotechnical map (GT)	0.4
Total Estimated Susceptibility Values (TESV)	1.0

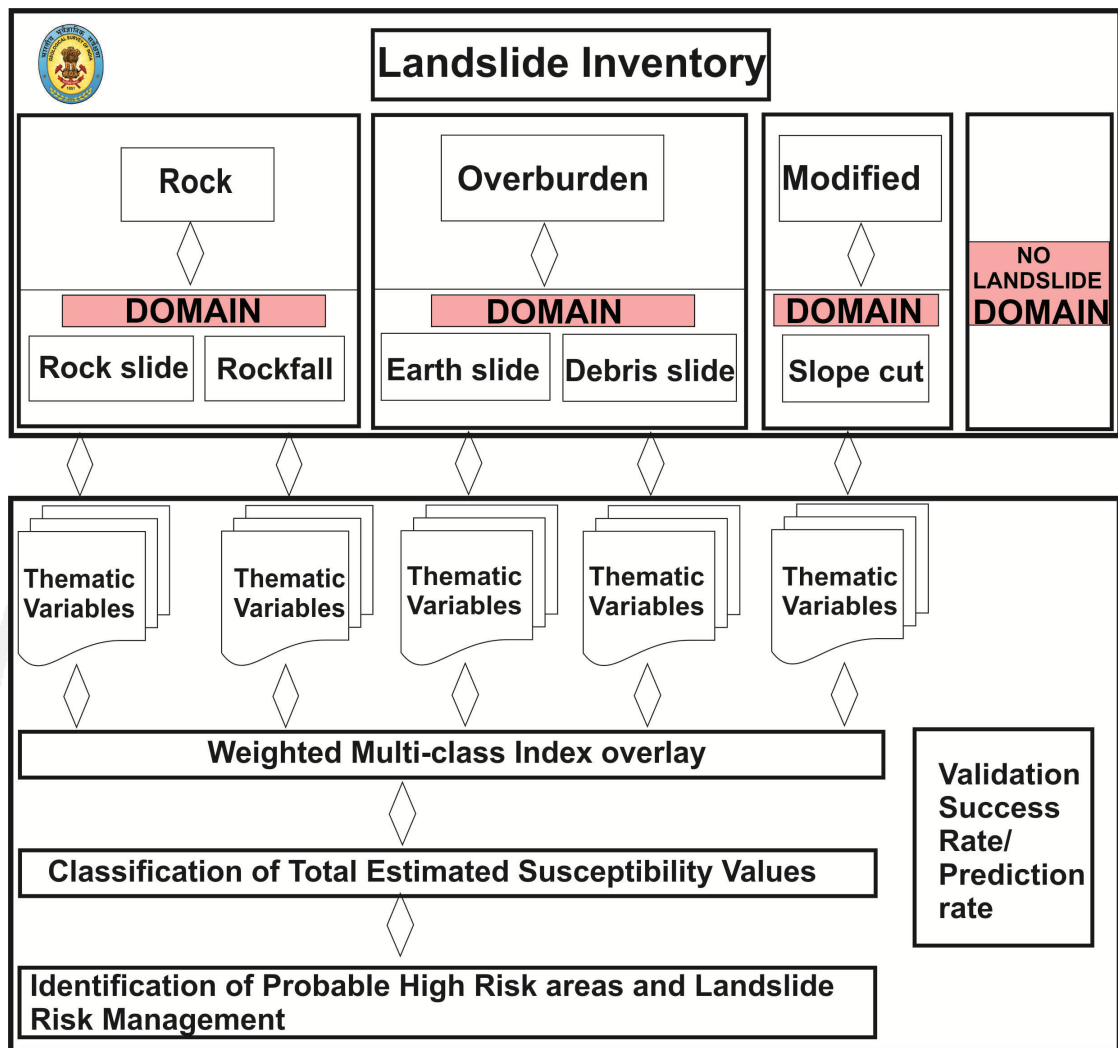


Fig. 3.2 Simplified flow chart of methodology (After SOP, GSI, 2021)

## 4. CAUSATIVE GEO-FACTORS

Landslides are caused by different geo-factors which have varying degrees of influence on slope stability. No one theme or factor can be singularly attributed to the initiation of slope failures because it is the combination of various geo-environmental factors that act together to initiate landslides on any given slope. These include both predisposing and triggering factors (Guzzetti *et al.*, 1996). While some factors are more important than others in any given place, there is a change in various parameters from one place to another. In other words, the influence of the geo-factors will have spatial variation. In addition to this, there can be temporal variation as most landslides are triggered by a heavy downpour during monsoon which is the case in the Kalasa area and the Western Ghats in general. For each theme, the possible factor classes are considered for the preparation of geo-factor databases for the GIS-based analysis of susceptibility to land sliding. Slope stability, irrespective of the scale at which it is viewed and analyzed, is known to be influenced by causative factors such as slope morphometry, nature of slope-forming material, degree of weathering of the rock mass, relationships between the slope inclination and attitude of discontinuities in the rock mass, land use/land cover and hydrological conditions.

The categorical geo-factor themes included in the study are land use/land cover, slope-forming material, and overburden thickness maps. The geomorphon and stream power index maps are DEM derivatives representing continuous data which are prepared using CartoDEM as source data employing different geoprocessing techniques in the ArcGIS platform. The failure mechanisms in rocky slopes are different from those in overburden-covered areas and the influence of geo-factors on slope instability varies for different domains. So judicious selection of thematic geo-factors has been done for each domain pertinent to the scale and relevance of the study. Thereafter, knowledge-based assigning of ratings (LSER) is done to the classes of selected geo-factors based on their observed contributory role in landslide initiation to compute 'Total Estimated Susceptibility Values (TESV).

### 4.1 Landslide inventory

In the current study, landslide data are obtained initially from the previous reports and multi-temporal google earth imagery. Thereafter, the landslides are field validated and new data on landslide initiation points are inventoried in the field.

Historic data on landslide occurrences is a critical component of landslide susceptibility studies as it gives insight into the frequency and spatial distribution of landslides. As a result, a landslide inventory map having both the historical and present landslide locations are important for future spatial prediction and subsequent hazard analysis.



In the process of updating the landslide inventory (*Annexure-III*) in the field, 42 number landslides of varying dimensions were inventoried within the localities of Hirebyale, Chennahaddlu, Hemmaki, Hattla and Yelandur. The landslides were inventoried following Varnes' classification (Varnes, D. J., 1978). There are 32 debris slides and 8 earth slides and 2 rock slides inventoried in the area. Out of the 42 landslides in the database, 5 are shallow rotational earth or debris slides while 37 are shallow translational slides with a depth of less than 4 m. The landslides are of varied dimensions and observed spatially associated both with the natural slopes and the cut slope domain (Fig. 4.1). The landslides on the natural slopes are confined to the moderate to steep slopes of the upper reaches of the Malleswara Gudda and Hemmaki area. Debris flows are observed here along the first and second-order stream channels. The debris flow along the channelized path reached a distance of about 300-400 m downstream.

The cut slope domain hillslopes have undergone substantial slope profile modification primarily because of the increased construction of settlements in the Chennahaddlu area. Here the average length of the landslides in the cut slope domain is 20 m with a maximum run-out distance of about 40-50 m. The Chennahaddlu-Hemmaki road sector also comes under cut slope domain and several landslides have affected the sector.

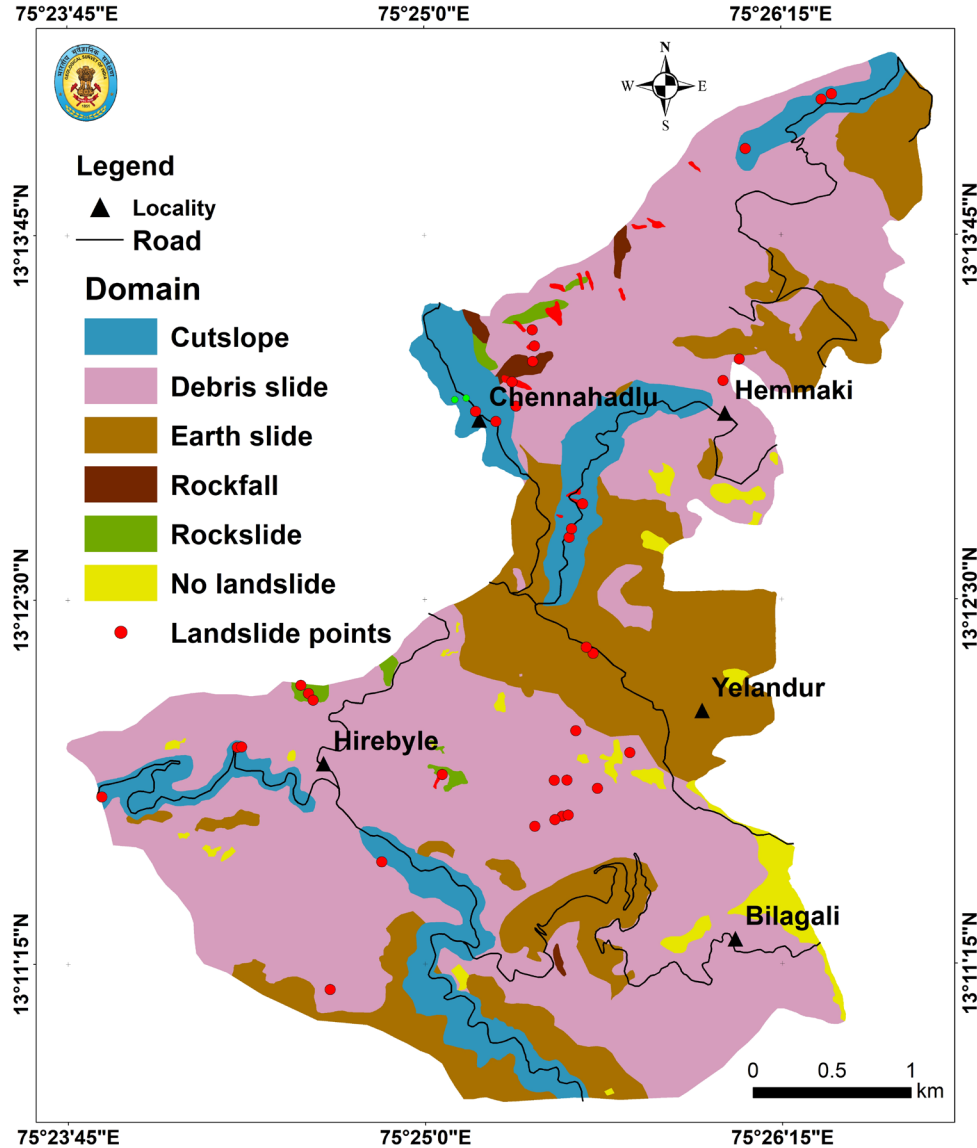


Fig. 4.1 Landslide distribution on the domain map

## 4.2 Rainfall as the triggering factor

In Hirebyle and Chennahadlu localities, landslide events of variable magnitude are mainly triggered by incessant monsoon rain between June and September. The available landslide data documented in the course of field investigation suggest direct temporal relation of landslide initiation with prolonged rainfall. This is particularly true for the landslides that were initiated during the monsoon of 2018 and 2019. While some of the major landslides have the dates recorded but most of the inventoried smaller landslides do not have exact initiation dates. The rainfall of the 2018 monsoon did not show much deviation from normal for the study area. However, major landslide events were reportedly triggered in August 2019 when the rainfall has a 128% deviation from the normal as observed during the month (Fig. 4.2).

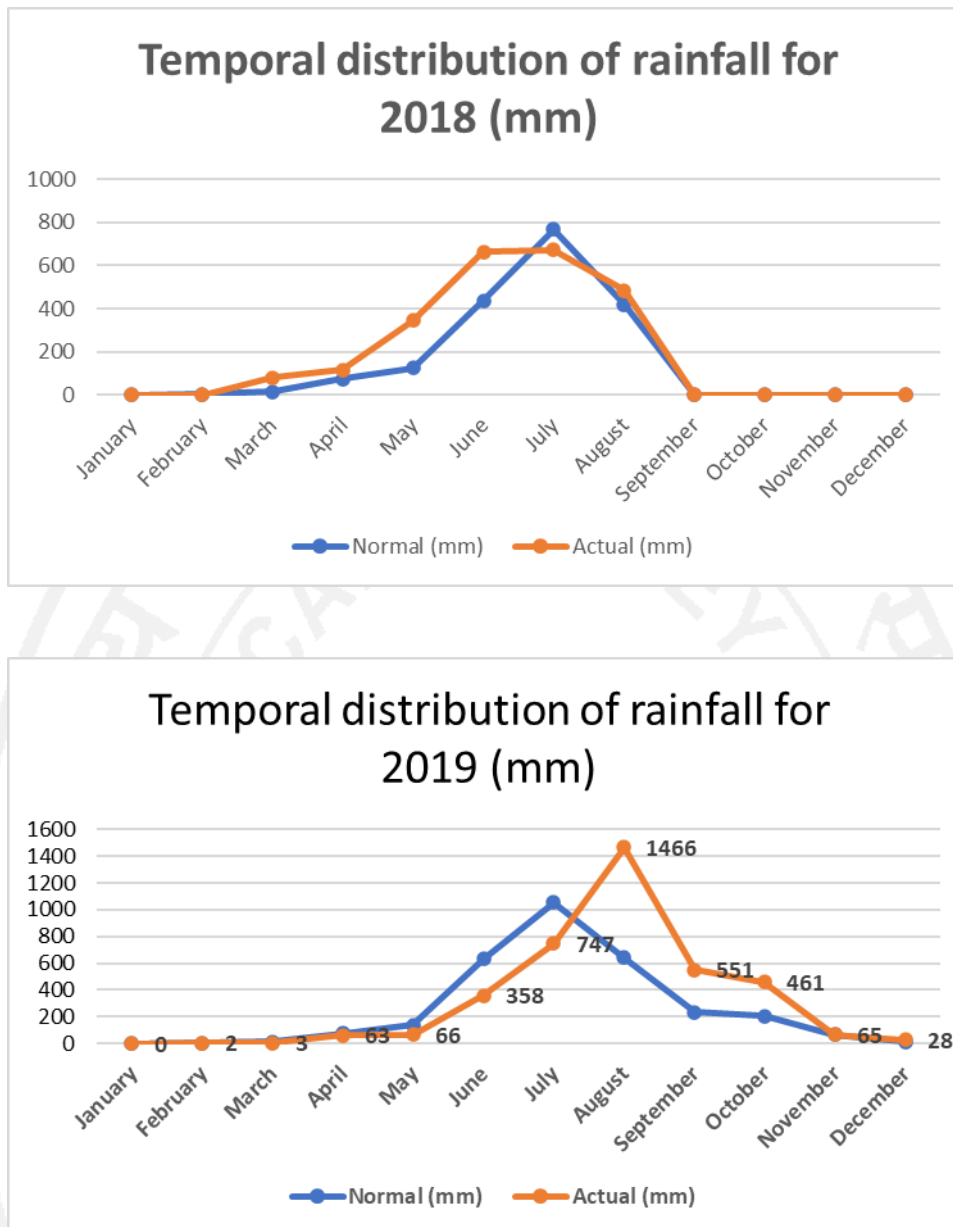


Fig 4.2 Rainfall data departure from normal for SW monsoon of 2018 and 2019 (KSNDMC)

### 4.3 Geo-factors in earth and debris slide domains

In soil and debris slide domains, the common thematic geo-factors considered are land use/land cover, stream power index, landform, and geotechnical maps. The thematic maps were field validated in all the accessible areas and The data points have been plotted on the facet map and accordingly updated the different classes. The facet map itself has been modified in several places.

#### 4.3.1 Land use / Landcover

The land use/land cover map of the study area is a categorical geo-factor map prepared using high-resolution open-source google earth imagery. The imagery data for the area is taken from 2019 in the preparation of the LULC map. In the pre-field LULC map, the

maximum area is observed to be thick vegetation followed by several patches of plantation. But the types of plantations could not be classified from the google earth imagery. The digitized files are saved as .kml and the features are converted into polygons in ArcGIS to be exported to Google Earth through the layer to .kml conversion for assigning names as per its LULC class.

The pre-field LULC map prepared through google earth imagery is field validated in all accessible and all necessary modifications and value addition in the boundary and name of the LULC classes are incorporated. The Kalasa and Hirebyle areas are part of the Western Ghats characterized by thick mixed vegetation.

A substantial modification is done in the pre-field LULC map through the incorporation of coffee plantations within the mixed vegetation. Land use in terms of coffee plantations covers about 12 km² of the hillslopes. Coffee is not cultivated as a monoculture or under the canopy of one single tree species but grown under a diversity of native shade trees. The other major class added after field validation includes coffee plantation with silver oak. In several parts of the hillslopes around the eastern flanks of Yelandur and Hattla, the native trees are replaced by *Grevillea robusta* commonly known as the silver oak tree which is updated in the field-based map (Fig. 4.3). The Goomankhan tea estate of about 1 sq. km is in the southwest part of the study area. A few areas near Guminkad hillslopes, acacia trees, and areca nut plantations are updated. The patches of agricultural area are confined to the low-lying valley and many of these patches are either left fallow or abandoned at the time of validation.

The land use theme has been observed to have a significant influence on the slope instability of the study area particularly along the cut slope domain in the Chennahaddlu and Hemmaki road stretch. Field study in the area reveals that extensive slope cutting has played a vital role in the initiation of several landslides along these hillslope stretches. The upslope of such excavation becomes unstable due to the removal of the natural toe buttress of the overlying overburden. The landslide susceptibility estimated ratings (LSER) for the classes LULC are given in Table 4.1.

Table 4.1: Landslide Susceptibility Estimated Rating (LSER) for LULC classes

Earth and Debris slide domains	Land use/Land cover (LULC)	
	<i>Geo-factor classes</i>	LSER
	Waterbody	0
	Acacia	0.6
	Barren	1
	Cemetery	0.1
	Coffee and areca nut	0.3
	Coffee with mixed vegetation	0.3
	Coffee with silver oak	0.5
	Cultivation	0.2
	Flatground	0.1
	Mixed vegetation	0.6
	Settlement	0.5
	Sparse vegetation	0.8
	Tea and silver oak	0.3

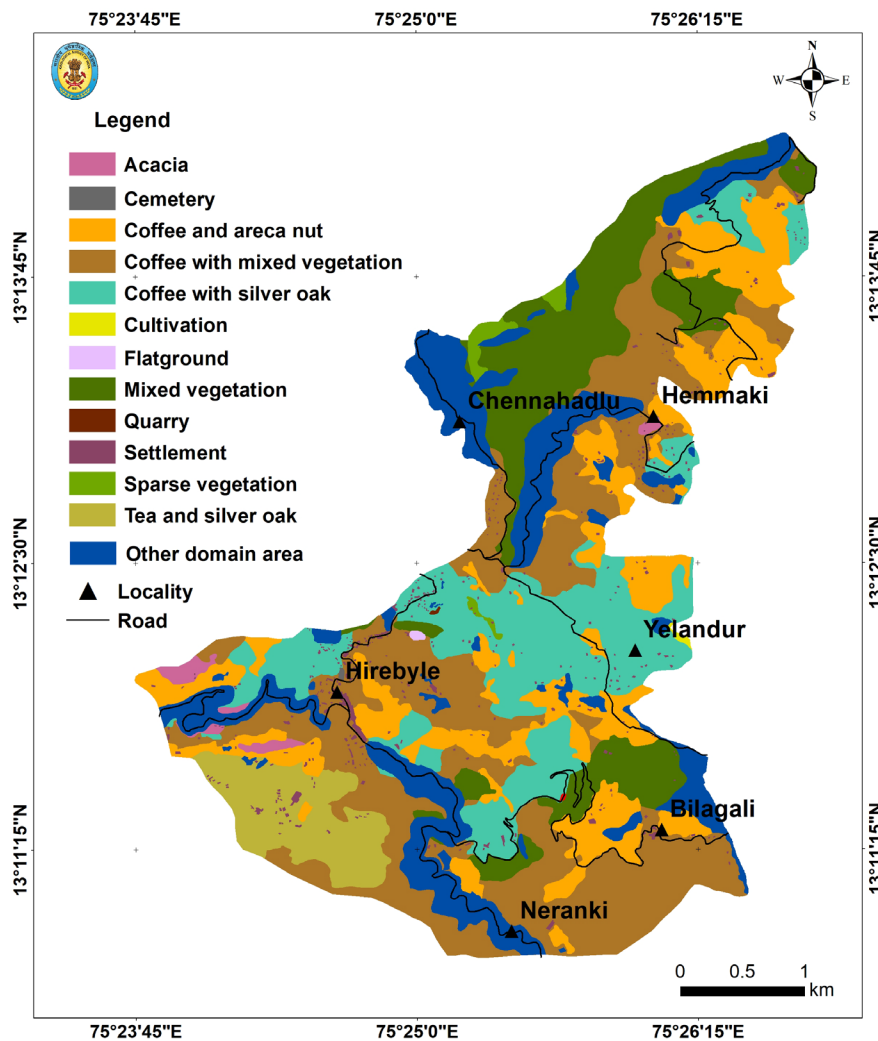


Fig. 4.3 Land use / Land cover map of earth and debris slide domains



### 4.3.2 Stream Power Index

In the current study, stream power index (SPI) is included for earth slide and debris slide domains. The SPI is a secondary terrain attribute that accounts for the local slope gradient and the catchment area. The proportionate discharge or erosive power of the drainage is considered for the drainages in the area using the two parameters. The stream power index geo-factor is even more important for the debris domain because a few debris slides inventoried on the upper reaches of Malleshwara Gudda have been observed to confine to the flanks of first and second-order streams which have aggravated debris flow during the peak monsoon.

Stream power index is expressed as  $SPI = A_s \times \tan \sigma$  where,  $A_s$  is the specific catchment area represented by the flow accumulation raster and  $\sigma$  is the slope gradient in degrees (Conforti *et al.*, 2011; Shit *et al.*, 2015; Gajbhiye and Konyak, 2020). It is generated using the primary terrain attributes which include the slope, flow direction, and flow accumulation through the map algebra tool in ArcGIS.

The SPI map (Fig 4.4) is an estimate of the active hydrogeological condition based on the two parameters considered. In addition, it may be noted that in the SPI map, the authors have not taken into account the ephemeral or perennial condition of the drainages. In the current study, the stream power index will adequately reflect slope erosion processes along with the erosive power of running water directly influencing slope instability.

In the current study area, the maximum relative relief is 521m with 1st and 2nd order streams draining the larger area of the southeastern part of Malleshwara Hillslope and also the southwestern slopes of the study area. The slope gradient here is moderate to steep and therefore represents high erosion area. On the other hand, the 3rd or 4th order stream is confined to the lower reaches of the hillslopes near Hemmaki, Hattla, and Bilagali and has a larger catchment area. The very high erosion propensity is confined to these higher-order stream orders with large catchment areas. The landslide susceptibility estimated ratings (LSER) for the classes SPI are given in Table 4.2.

Table 4.2 Landslide Susceptibility Estimated Rating of stream power index

<b>Earth and Debris slide domains</b>	<b>Stream power Index (SPI)</b>	
	<b><i>Geo-factor classes</i></b>	<b><i>LSER</i></b>
	<0 (very low erosion)	0.2
	0-1 (low erosion)	0.4
	1-2 (moderate erosion)	0.6
	2-5 (High erosion)	0.8
	>5 (Very High erosion)	1.0

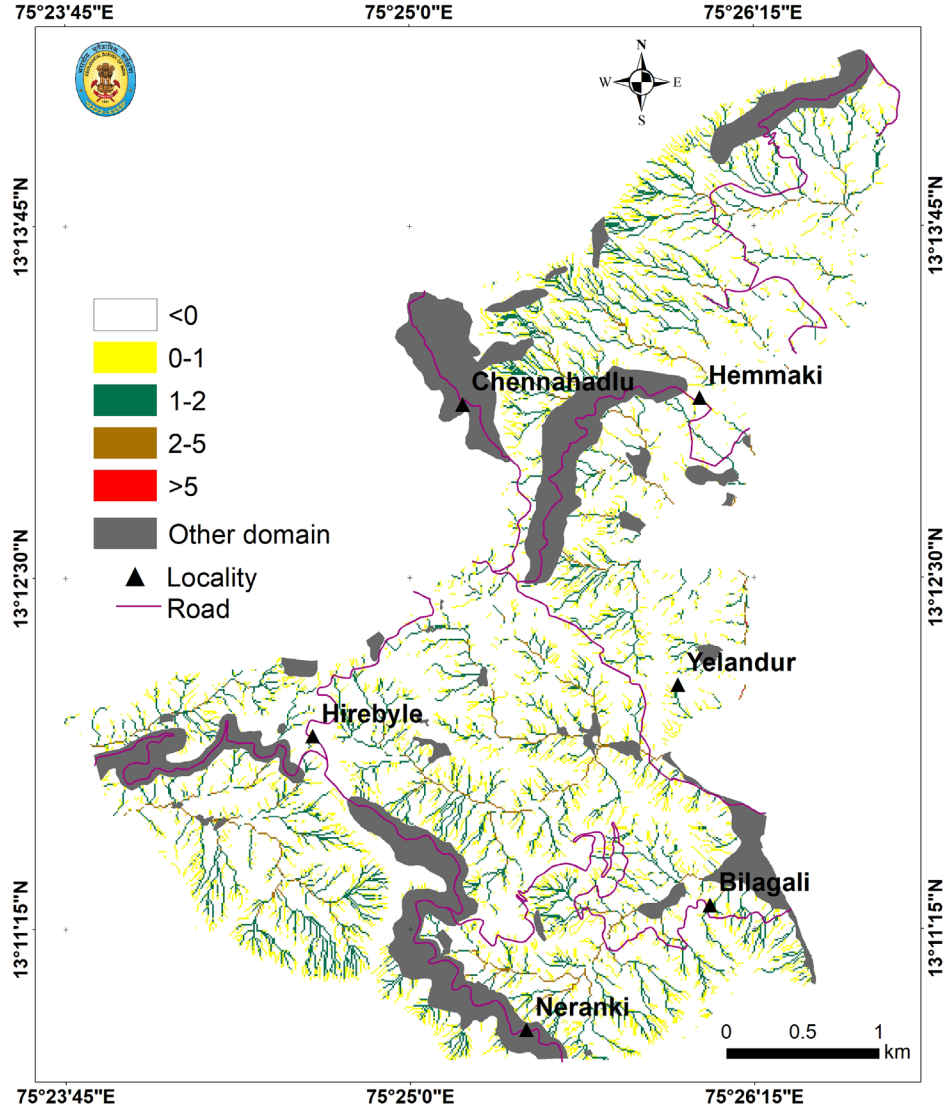


Fig. 4.4 Stream power index map of earth and debris slide domains

#### 4.3.3. Landform

The landform map is an important geo-factor map and it is prepared based on the concept of geomorphologic phenotype which classifies the terrain into discrete units at the slope or basin scale. Since the current work is carried out at the slope scale it is suitable to use the DEM-derived landform/geomorphon map wherein the elementary terrain units are classified based on the morphology of surface or geomorphometric variables. Geomorphons constitute a comprehensive set of most common terrain units that are independent of the size, relief, and orientation of the actual landform (Jasiewicz and Stepinski, 2013). For the study area, the most frequent and commonly recognizable geomorphons considered are summit, ridge, shoulder, spur, slope, hollow, footslope, valley, and depression (Fig. 4.5). These classifications and processing of geomorphon are carried out in the GrassGIS platform. Geomorphon represents terrain units with attributes which is the result of the evolution of

geomorphological processes. Therefore, every terrain unit is rated based on its causal relation with landslides, and the LSER is given in Table 4.3.

In the study area, out of 10 common discrete landform units, slope shows preponderance covering an area of about 43%, followed by spur at 22% and hollow covering an area of 19%. The N-S and NW-SE trending linear ridges are observed on all prominent hilltops of the area.

Table 4.3 Landslide susceptibility estimated rating of Landform

<b>Earth and Debris slide domains</b>	<b>Landform map</b>	
	<i>Geo-factor classes</i>	<i>LSER</i>
	Flat	0.2
	Summit	0.2
	Ridge, Spur & Depression	0.3
	Shoulder	0.8
	Slope	0.5
	Hollow	1
	Footslope	0.6
	Valley	0.2

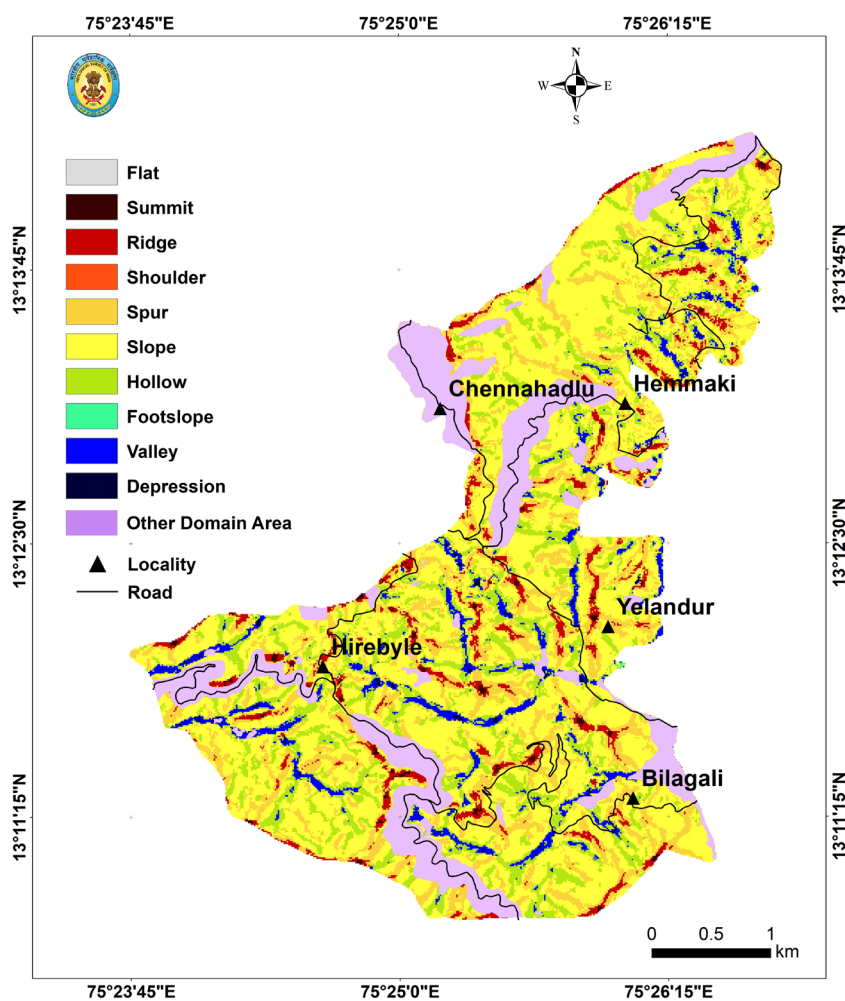


Fig. 4.5 Landform map of earth and debris slide domains

#### 4.3.4 Geotechnical

In the earth slide and the debris slide domain, the geotechnical map is the most important geo-factor used in the model which uses the cohesion and the internal friction angle. These geotechnical parameters depend on the type of overburden material. The slopes in the study area are characterized by varied slope-forming material that includes bare rock at the steeper slope of Malleswhara Gudda, patches of colluvium, and assorted boulders and debris at the mid slopes of Malleswhara Gudda, and thick immature soil spread pervasively along gentler slopes which have been updated after field checking. These heterogeneous materials will have variations in the porosity and permeability influencing the overall stability condition of the slopes. In the current study, the scheme of classification of overburden material has been adapted from Ghoshal *et al.*, 2013 based on the genesis and their relative susceptibility to initiation of landslides. However, the type of slope-forming material (SFM) is not directly used for assigning ratings. Instead, the samples of these SFM are collected to determine the geotechnical parameters which are then used to assign ratings based on the matrix of cohesion and the internal friction angle (Table 4.4).

The cohesion (C) and internal angle friction ( $\phi$ ) are important geotechnical parameters that determine the shear strength of the material and the ability to resist sliding. In the current study, a matrix of classes of both C and  $\phi$  is used for assigning ratings in line with the classes defined by Ghoshal *et al.*, 2013. The sampling points were selected to adequately represent all variants of the material. An attempt is made to sample following the profile elevation of the slope to acquire possible variation in material deposits due to kinematic sieving (Makse, 1999). A total of 32 numbers of soil samples were collected to determine shear parameters. The results show considerable variation in the cohesion parameter and but limited variation in the friction angle. The lab results reveal that the cohesion ranges from 20.59 kN/m² to 49.03 kN/m² while the angle of internal friction ranges from 22.4 to 28.1 degrees. As per the Cohesion (C)-Friction angle ( $\phi$ ) matrix of Ghoshal *et al.*, it is found that all the samples fall only in the two categories of “Good” and “Fair” class which is reduced to just one class on employing the relation of peak friction angle and the slope. The workers have therefore employed the simplistic relationship between shear strength in terms of peak friction angle (PFA) and the slope angle for the component of internal friction angle which helped to significantly classify the geotechnical results (Table 4.5) and thereby helped to classify the slopes based on susceptibility (Roopnarine *et. al.*, 2013). The facet map is then used to demarcate and polygonise the data and generate the geotechnical map (Fig 4.6).

Table 4.4 Landslide susceptibility estimated rating of shear parameter

Earth and Debris slide domains	Geotechnical map	
	<i>Geo-factor classes</i>	<i>LSER</i>
	Very good	0.2
	Good	0.4
	Fair	0.6
	Bad	0.8
	Very bad	1.0

Table 4.5 Geotechnical class as per the cohesion and internal friction angle matrix adjusted based on Peak friction angle minus slope (After Roopnarine R. *et. al.* 2013)

Cohesion (C)	Angle of Internal Friction ( $\phi$ ) (PFA-S)			
	>20°	10°-20°	5°-10°	≤5°
<15 kN/m ²	Fair	Fair	Bad	Very Bad
15-25 kN/m ²	Good	Fair	Bad	Bad
25-35 kN/m ²	Good	Good	Fair	Bad
>35 kN/m ²	Very Good	Good	Good	Fair



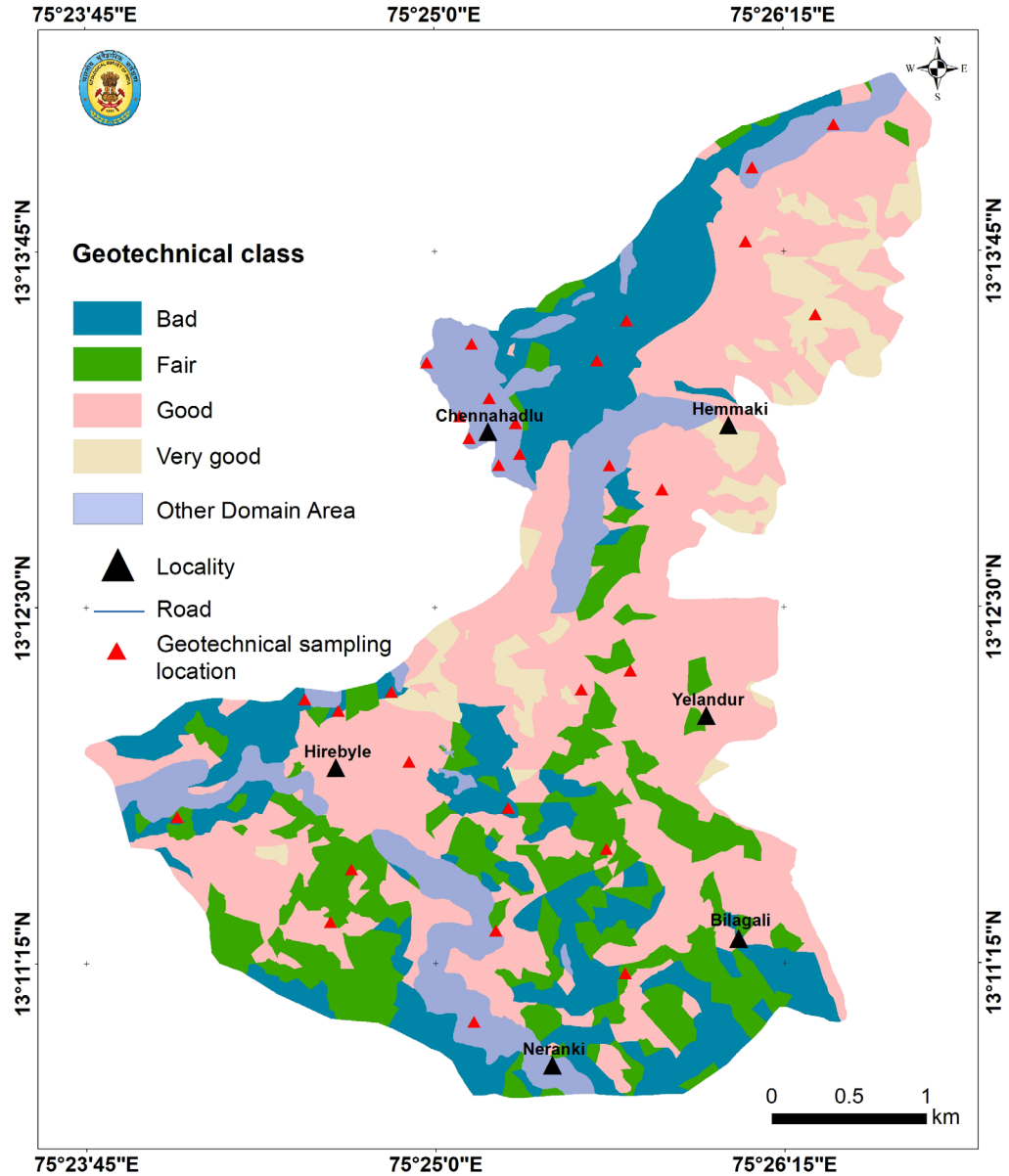


Fig. 4.6 Geotechnical map of the earth and debris domain

#### 4.4 Geo-factors in the rock slide and rock fall domain

The rock mass rating (RMR) map and kinematic failure map are two important thematic maps considered in the current study.

##### 4.4.1 Rock mass Rating

The geomechanical characteristic of the rock mass is an important geo-factor that determines the rock slope stability. In the current study, the rock mass quality is studied using the rock mass rating (RMR_{basic}) schema provided by Bieniawski, 1989 (Fig 4.7 ). The rock mass rating (RMR_{basic}) includes the following parameters for each structural unit:

i. Uniaxial compressive strength of intact rock material: The uniaxial compressive strength is derived using the Schmidt Rebound Hammer through non-destructive in situ tests of rock exposures.

ii. Rock quality designation (RQD): The rock quality designation is derived using the empirical equation  $(RQD)=115-3.3J_v$ , where  $J_v$  is the volumetric joint count (number of joints in  $1m^3$ ).

iii. Joint or discontinuity spacing: The joint spacing of the most vulnerable joint set is taken into account in the field.

iv. Joint condition: The joint condition is described using five parameters which include joint persistence, aperture, the roughness of the surface, type of infilling, and degree of weathering of the joint surface.

v. Groundwater condition: The hydrogeological conditions of the jointed rock mass is qualitatively described in terms of dry, damp, wet, dripping, and flowing. The condition of groundwater can change with the season and under adverse meteoric events. The qualitative observations on groundwater considered in the current study are based solely on the time/season of the fieldwork.

In the study area, minimal rock exposures are observed near the Iddur road, Hattla, and the steep slopes of Malleswara hillslopes. Since each rock exposure was accessible, the  $RMR_{basic}$  data for each rock exposure is calculated separately without using Inverse Distance Weighted interpolation (Annexure IV). The LSER assigned for the classes of  $RMR_{basic}$  is given in Table 4.6.

Table 4.6 Landslide susceptibility estimated rating of rock mass rating

<b>Rockslide and rockfall domains</b>	<b>Rock mass rating</b>		
	<b>Class</b>	<b>RMR value</b>	<b>LSER</b>
	Very good (I)	>80	0.2
	Good (II)	61-80	0.4
	Fair (III)	41-60	0.6
	Poor (IV)	21-40	0.8
	Very poor (V)	$\leq 20$	1

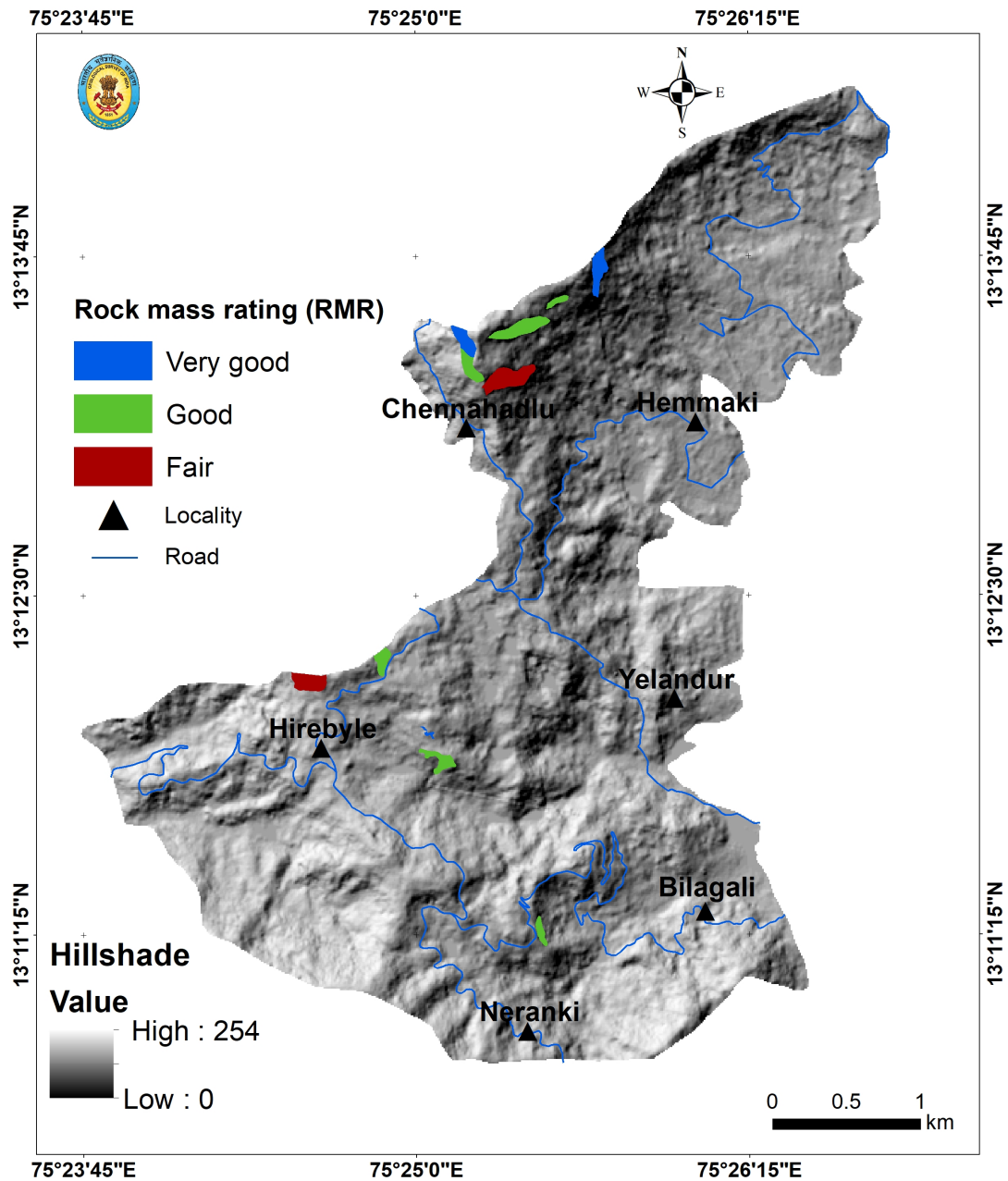


Fig. 4.7 Rock mass rating map of rockfall and rock slide domains of the study area

#### 4.4.2. Kinematic failure

The Kinematic Failure (KF) map is an important thematic map for the rocky slopes which is prepared by considering the geometrical relation of discontinuities and the slope (Fig. 4.11). The structures in rocks are primary and secondary discontinuities which include bedding planes, joints, foliations, faults, and thrusts (Bureau of Indian Standards - IS 14496 Part 2: 1998) and serve as an important pre-disposing factor for stability. Therefore, the characterization of structural setting is a basic aspect of landslide susceptibility assessment

and the evaluation of the geo-structural conditions can enable the assessment of slope stability where both first-time and reactivated slope failures are anticipated (Grelle *et al.*, 2011). The structural data for the rocky exposures are taken to establish a mutual geometrical relation with the existing slope angle. The mean vector of dip amount/plunge and dip direction/trend for each rock exposure sector is derived by plotting in the stereonet software to establish the geometrical relation of the discontinuities with the slope morphometry (Ghosh and Carranza, 2010; Ghosh *et al.*, 2010). In the present study, for friction angle, the lowest value in the corresponding range values of rock mass quality class as given by Bieniawski, 1989 is used assuming the worst-case scenario for stability conditions.

For planar failure to occur the necessary structural conditions needed to be satisfied is  $\phi < \text{DIP} < S$  (Hoek, E., and Bray, J. W., 1977).

Where  $\phi$  = Angle of internal friction of the rock

DIP = Dip amount/plunge of joint

S = Slope angle

For the wedge failure, the trend and plunge of the line of intersection of the discontinuities are considered with respect to the slope and friction angle. However, the existence of two intersecting great circles on the stereonet does not necessarily mean that a wedge failure will occur. The factors that influence the stability of the wedge include the direction of sliding relative to the slope face, the dip of the planes relative to the friction angle, external forces such as ground water, and whether the planes are located so that they actually intersect behind the face (Hoek, E., and Bray, J. W., 1977).

For the rockfall domain, the slopes greater than 45° are considered which includes the escarpment areas of Malleswara Hillslope. In these slopes, pervasive joint sets have formed detached blocks of rocks. The condition required to be satisfied in the rockfall is

$$S \geq \phi + (90^\circ - \text{DIP}) \text{ (SOP, GSI 2021, Hoek, E., and Bray, J. W., 1977)}$$

Where  $\phi$  = angle of friction of the rock

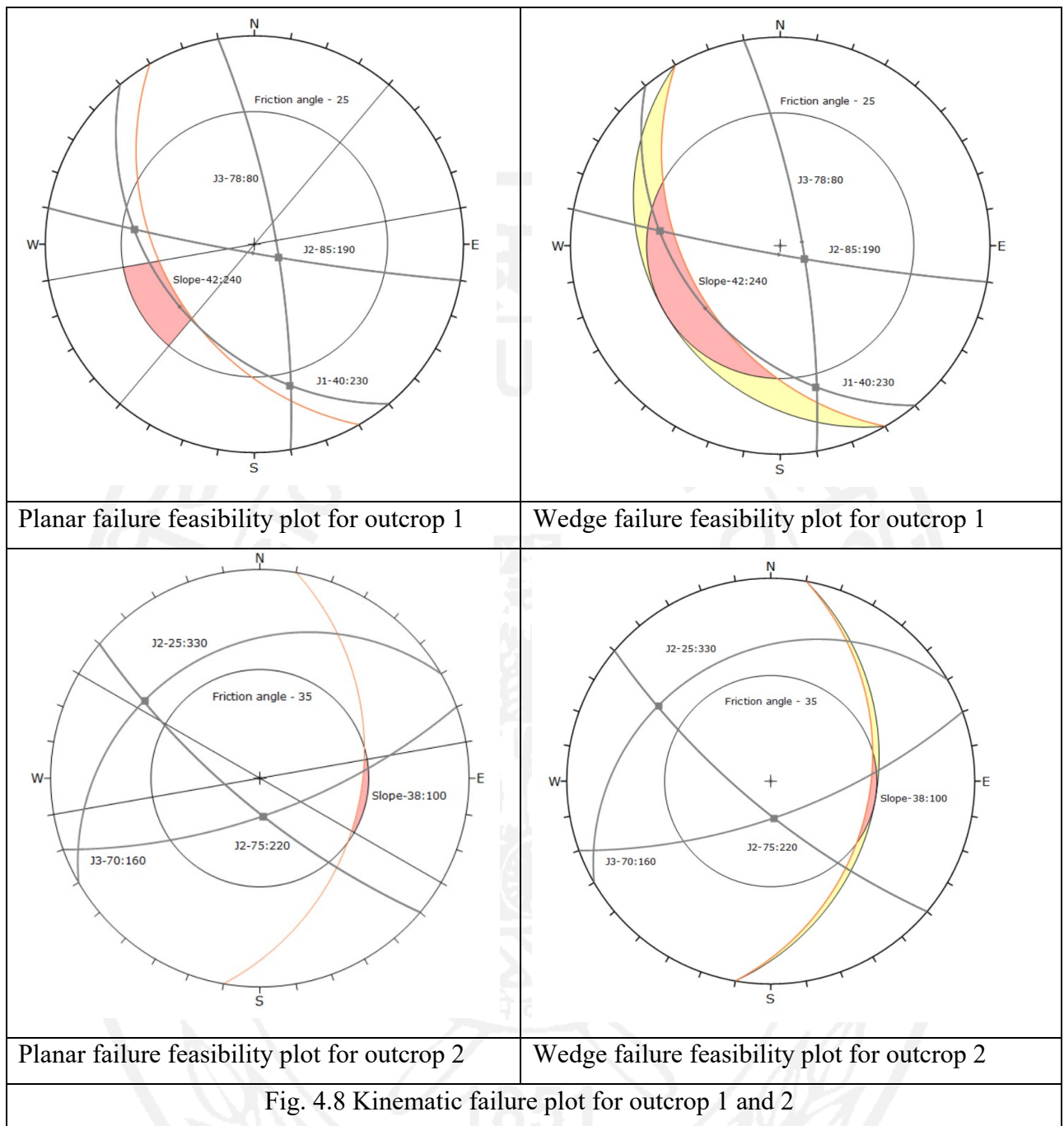
DIP = Dip amount/plunge of joint

S = Slope angle

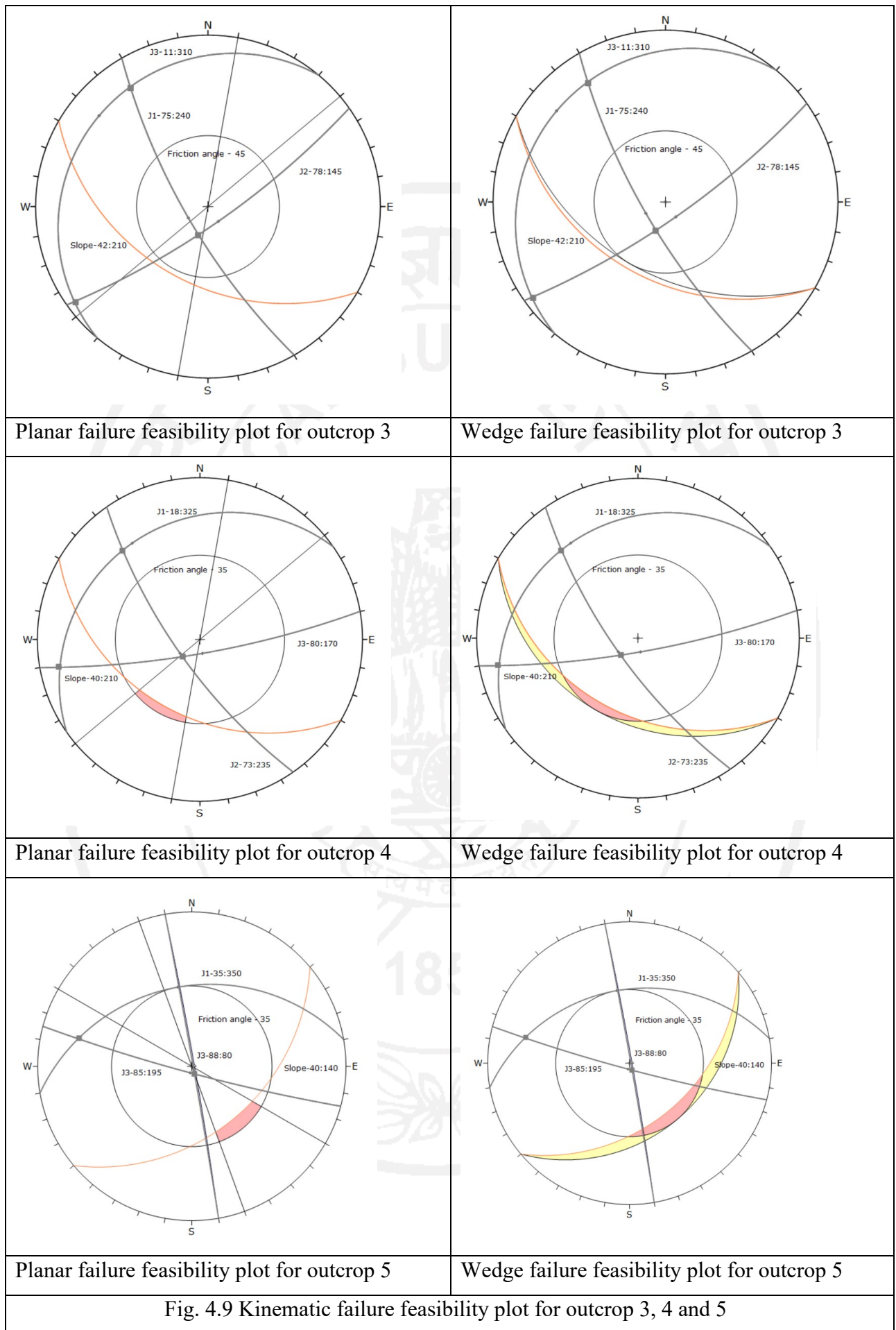
The landslide susceptibility estimated rating of kinematic failure conditions in the current study is given in Table 4.7.

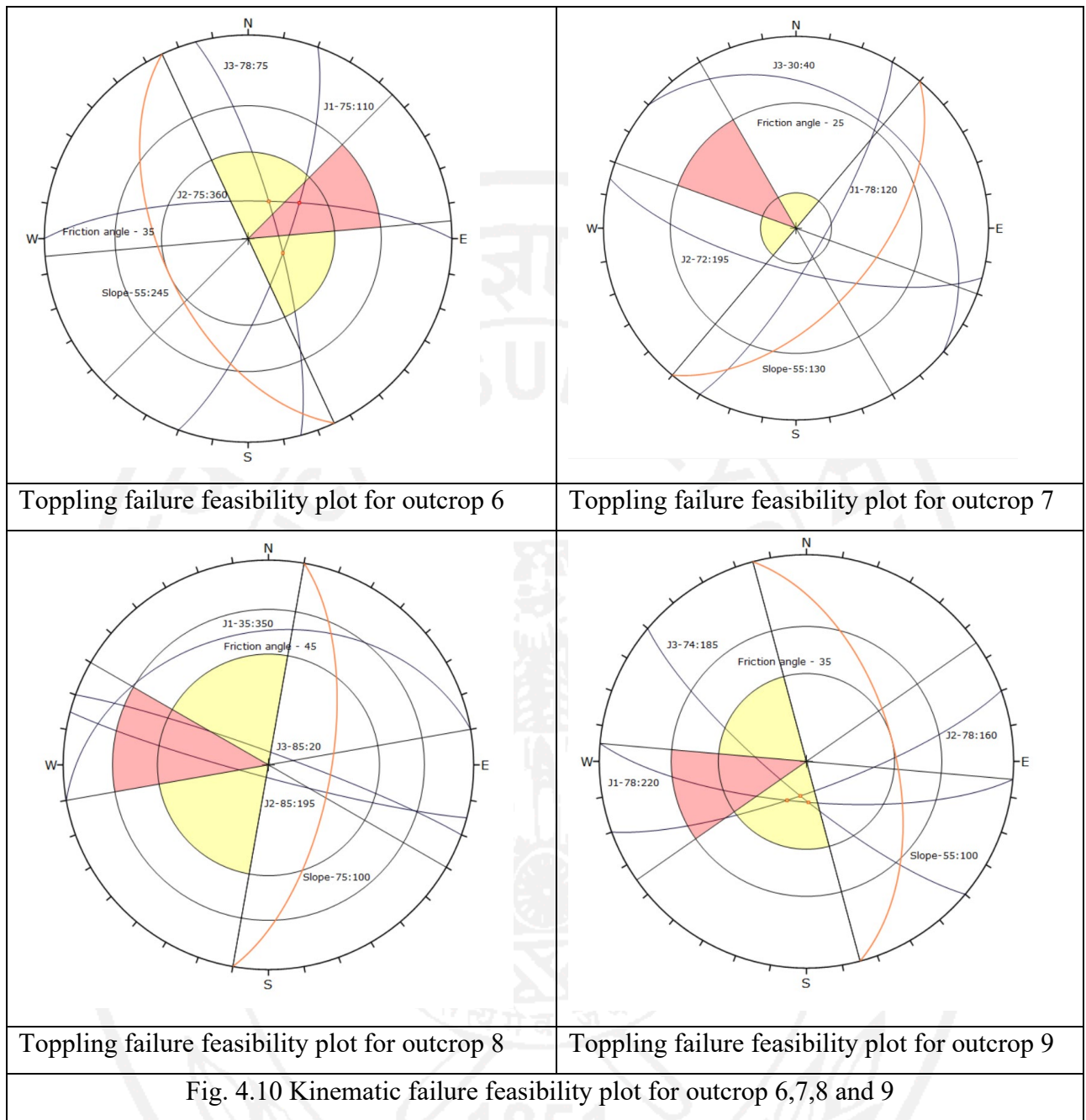
Table 4.7 Landslide susceptibility estimated rating of kinematic failure conditions

Rockslide and rockfall domains	Kinematic failure map	
	Geo-factor classes	LSER
	Critical condition 0	0.2
	Critical condition 1	0.8
	Critical condition 2	1.0









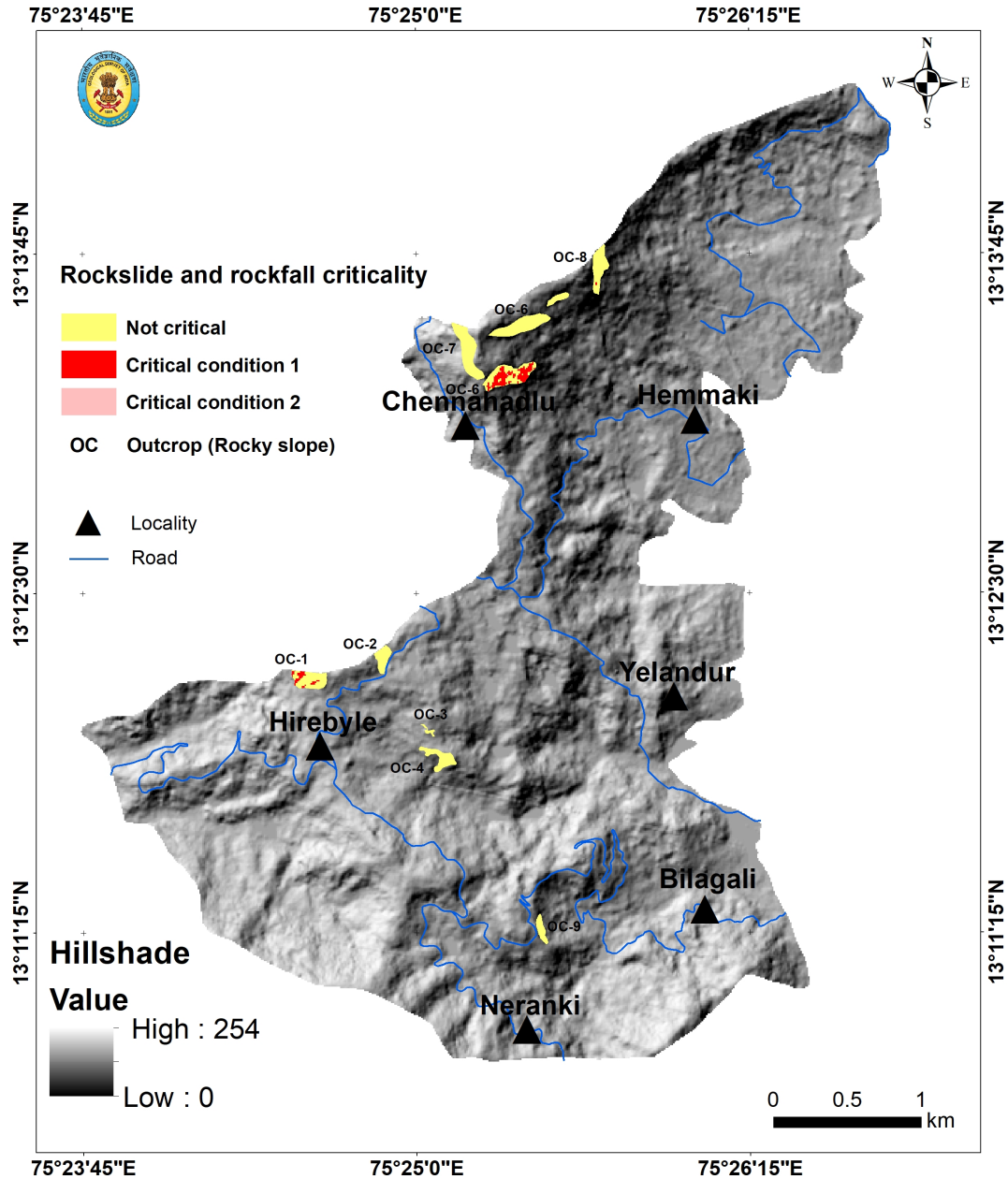


Fig. 4.11 Combined kinematic failure map for rockfall and rock slide domains

#### 4.5 Geo-factors in cut slope domain

The cut slope domain requires consideration of separate geo-factors as the domain represents the slopes that have undergone partial or substantial modification through anthropogenic interference. These include hillslopes where slope profile modification has taken place due to the construction of roads, settlements, and other public utility structures. Partial slope profile modification through extensive slope cutting along the road is observed along the Chennahaddlu and Hemmaki roads and also along the SH-66 connecting Neranki-Hirebyle-Gumingad.

The thematic factors considered are the regolith thickness map, relative relief map, and geotechnical map. In the current study, the slope map has not been included for the cut slope domain because it has been used in deriving the adjusted peak friction angle. The inclusion of the slope map will entail duplication of the thematic map and assigning non-essential additional weightage to the slope factor.

#### 4.5.1. Regolith thickness

The thickness of the regolith is measured in the vertical cut sections exposed along the settlements, roads, and quarries that help in estimating the range of regolith thickness. Generally, the cut slope with higher regolith thickness is more susceptible to landsliding at higher relief. Field observations along the cut sections show that there is extreme spatial variation in the thickness of the overburden. Limitations exist in mapping the spatial extent of overburden thickness in areas with no exposure for which reasonable interpolation is done based on the slope forming material type and the slope morphometry. In order to accommodate such uncertainty, the overburden thickness classes in the cut-slope domain area are classified into five classes with ranges *viz* <0-1 m, 1-2 m, 2-4 m, and >4m (Fig. 4.12). The slopes having thicker overburden are observed to have a spatial association with landslides and the LSER are accordingly assigned (Table 4.8). The study area is covered largely by overburden derived from weathering of granite gneiss and amphibolite. The overburden thickness class 2-4 m is spatially wide within the cut slope domain covering 57% of the area. The overburden thickness greater than 4m is observed only along the gentle foot slopes near Guminkad in the southwestern area, near Neranki in the south, and along the gentler slope north of Hemmaki. The veneer cover of overburden 1-2 m is mostly observed along the midslopes of eastern Malleswara and Chennahadlu hillslopes.

Table 4.8 Landslide susceptibility estimated rating of the classes of regolith thickness

<b>Cut slope domain</b>	<b>Regolith thickness</b>	
	<i>Geo-factor classes</i>	<i>Landslide susceptibility estimated ratings</i>
	0-1	0.2
	1-2	0.4
	2-4	0.7
	>4	1.0



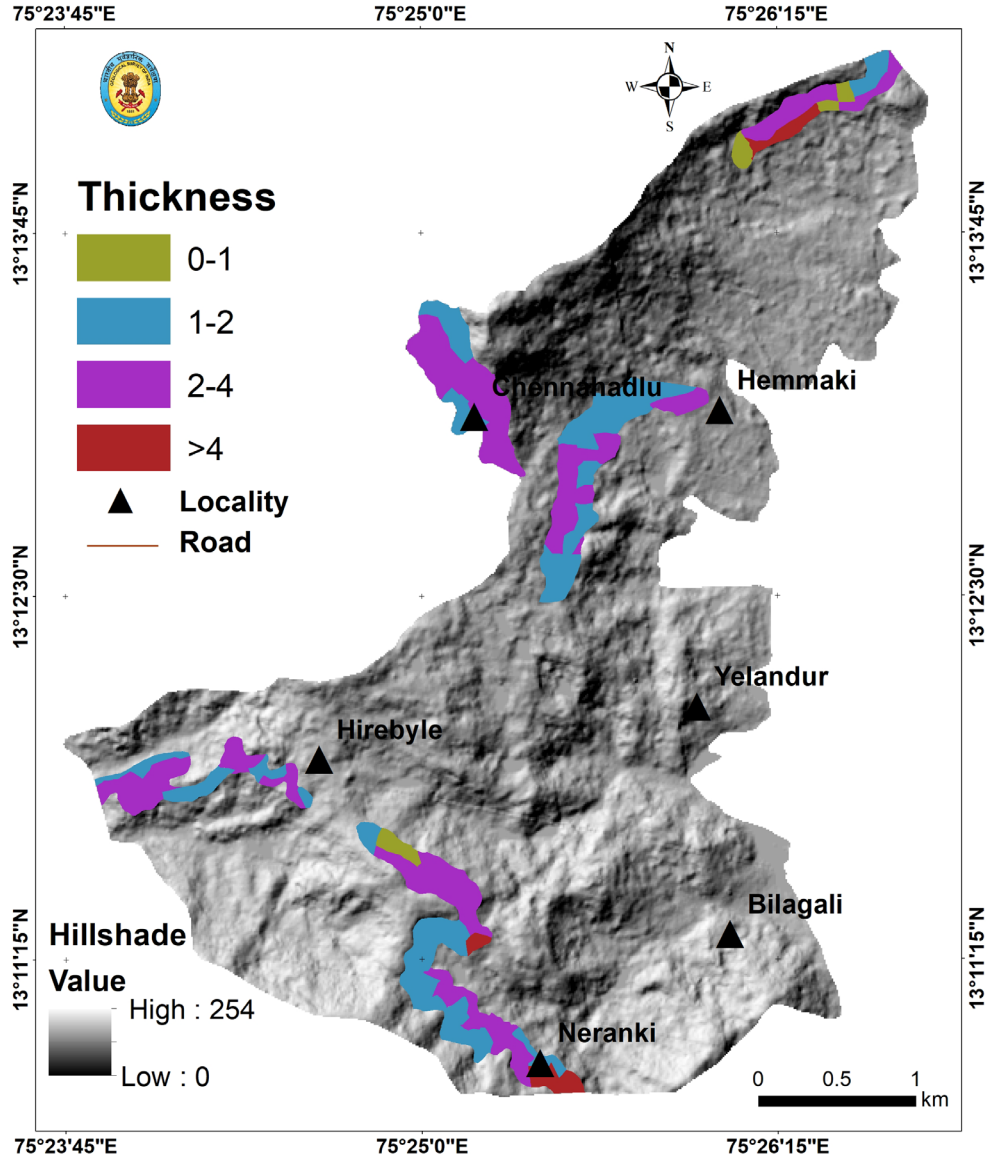


Fig. 4.12 Regolith thickness map of the cut slope domain

#### 4.5.2. Relative relief

A slope unit is considered for defining the relative relief within the cut slope domain. Relative relief is the difference between the maximum and minimum elevation in the slope unit. The higher the relative relief within the slope unit, the greater the head load is available for inducing instability of the slope. The slope units for the cut slope domain are delineated from the topographic map (Anbalagan, 1992). The zonal statistics tool in ArcGIS is used to obtain the range of the elevation for the particular slope facet. The highest class of relative relief (>100m) is observed in Chennahaddlu while low to moderate classes are spatially distributed along all parts of the cut slope domain (Fig. 4.13). The landslide susceptibility estimated rating of the classes is assigned based on the increasing range (Table 4.9).



Table 4.9 Landslide susceptibility estimated rating of the classes of relative relief

Cut slope domain	Relative Relief map	
	Geo-factor classes	LSE
	0-25 m	0.2
	25-50 m	0.4
	50-75 m	0.6
	75-100 m	0.8
	>100 m	1.0

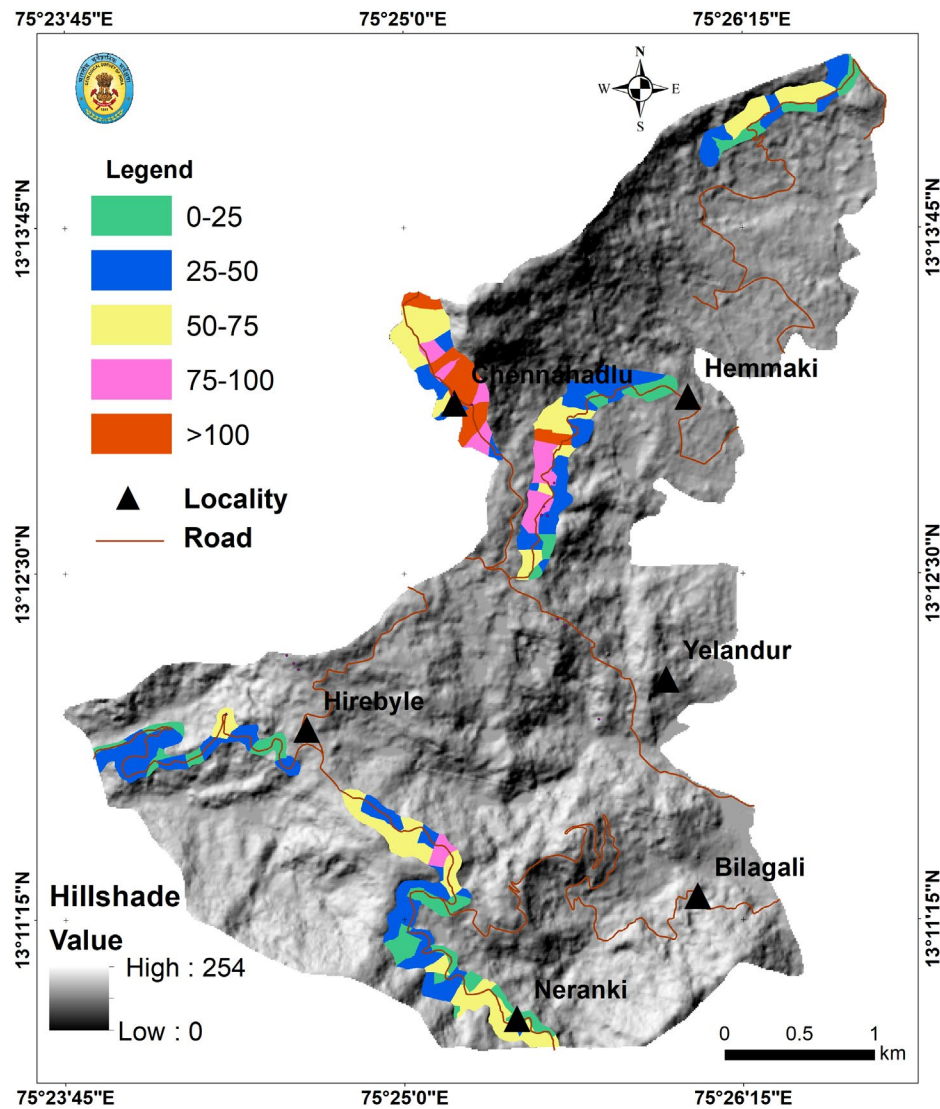


Fig. 4.13 Relative relief map of the cut slope domain

#### 4.5.3. Geotechnical

The geotechnical map for the cut slope domain is prepared and clipped from the same geotechnical map generated seamlessly across all the domains. For the overburden-covered part of the slopes, the slope-forming material type in the cut slope domain is initially mapped and the locations for the sample points are identified. The matrix of the shear parameters of the overburden material (cohesion and internal friction angle) is used to assign ratings (Ghoshal *et al*, 2013) after incorporating the peak friction angle minus slope. The

methodology to generate the geotechnical map is the same as described in section 4.3.4 for the earth and debris slide domain (Fig 4.14).

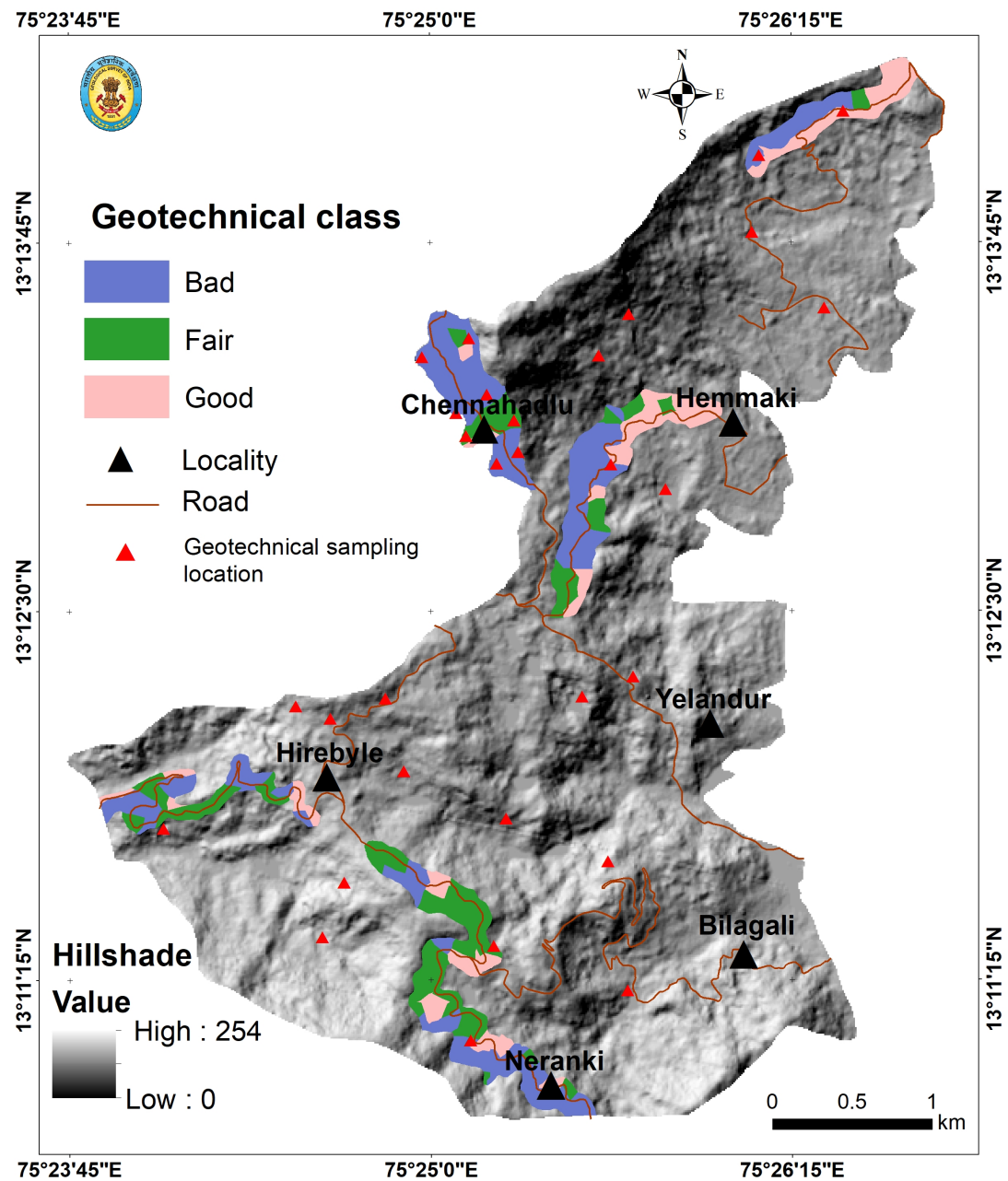


Fig. 4.14 Geotechnical map of the cut slope domain

## 5. LANDSLIDE SUSCEPTIBILITY MAP

The combination of geo-environmental factors and their mutual intricate relationship determine the spatial distribution of landslides. Landslide Susceptibility Estimated Ratings (LSER) of all the preparatory maps are added to obtain the Total Estimated Susceptibility Value (TESV) which is finally classified into ‘high’, ‘moderate’, and ‘low’ for each domain. The Total Estimated Susceptibility Value is 1 for all the domains. A value closer to 1 indicates higher susceptibility values while lesser values indicate lesser susceptibility values. The low susceptible slopes are considered stable under the given set of geo-environmental conditions considered in the study. However, any unmethodical anthropogenic interference can still act as aggravating factor for initiating landslides.

### 5.1 Earth and debris slide susceptibility

The Landslide Susceptibility Estimated Ratings (LSER) of all the thematic layers for the earth and debris domain are added up to derive the susceptibility score map as:

$$\text{TESV} = 0.5\text{GT} + 0.3\text{LF} + 0.1\text{SPI} + 0.1\text{LULC}, (\text{SOP, GSI, 2021})$$

Where, GT – Geotechnical map

LF – Landform

SPI – Stream Power Index

LULC – Land use land cover

In the earth and debris slide domains, it is attempted to derive the susceptibility map based on the natural break (Jenks) but it shows an unrealistic larger percentage of moderate classes. Therefore, in the current study, the break values for the susceptibility score have been manually done into three classes of high, moderate, and low susceptibility so that it adequately represents real field conditions. The high-class accounts for 25%, moderate class accounts for 23% and low susceptibility accounts for 53% of the earth and debris slide domains (Fig. 5.1). The map shows that the high susceptibility areas for the overburden-covered areas are southwest and southeast facing slopes of Malleswara Gudda which includes the localities of Chennahaddlu and upslope of Hemmaki. In the south, the high zones are observed along the Bilagali, Hattla, and Neranki localities. The moderate zones are seen along the fringes of the high zone where there are drainages and are characterized by steep slopes.

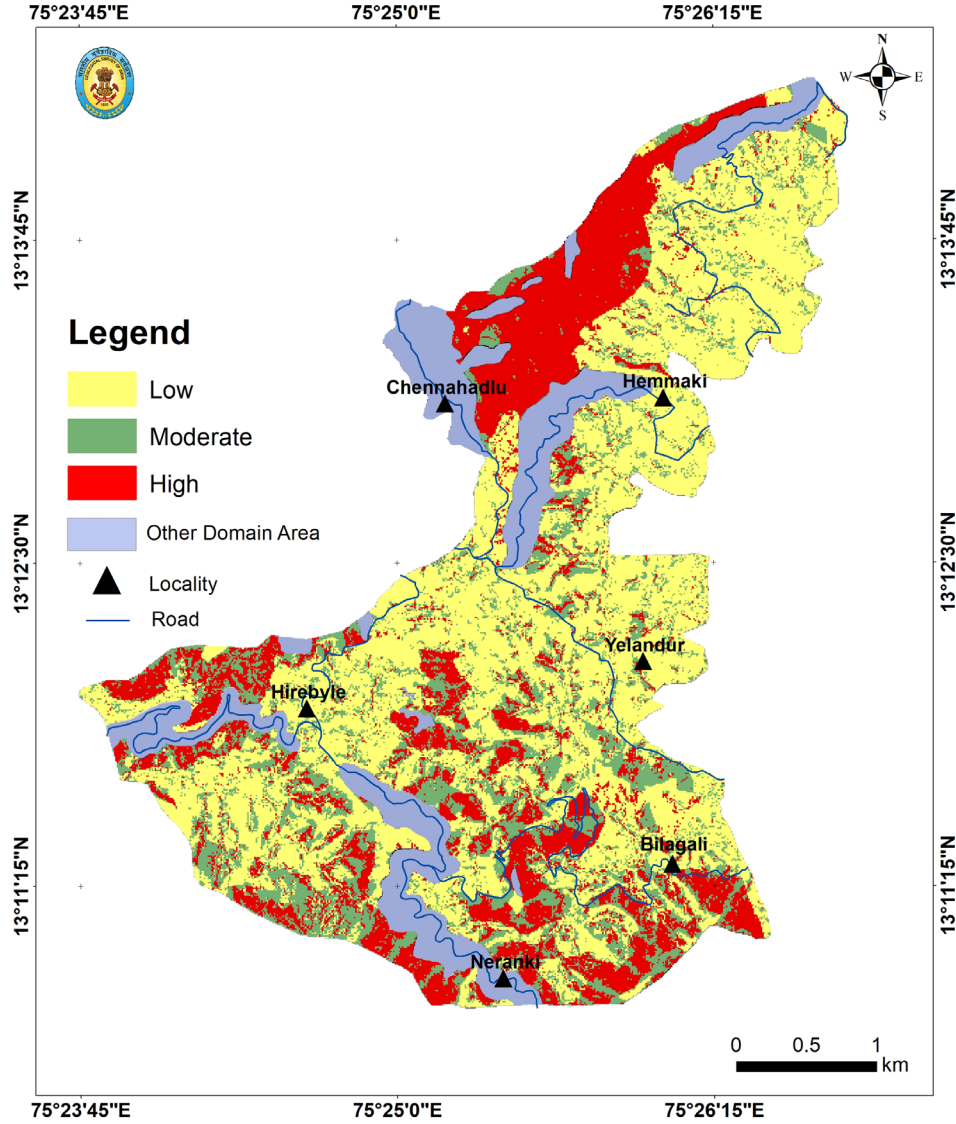


Fig. 5.1 Landslide susceptibility map of earth and debris domain

## 5.2 Rock slide and rock fall susceptibility

The Landslide Susceptibility Estimated Ratings (LSER) of the two geo-factors which include the Geotechnical map and Kinematic failure map are added up to arrive at the susceptibility score of rocky slopes. The parametric equation used for the rock slide susceptibility map is:

$$TESV = 0.6GT + 0.4KF, \text{ (SOP, GSI, 2021)}$$

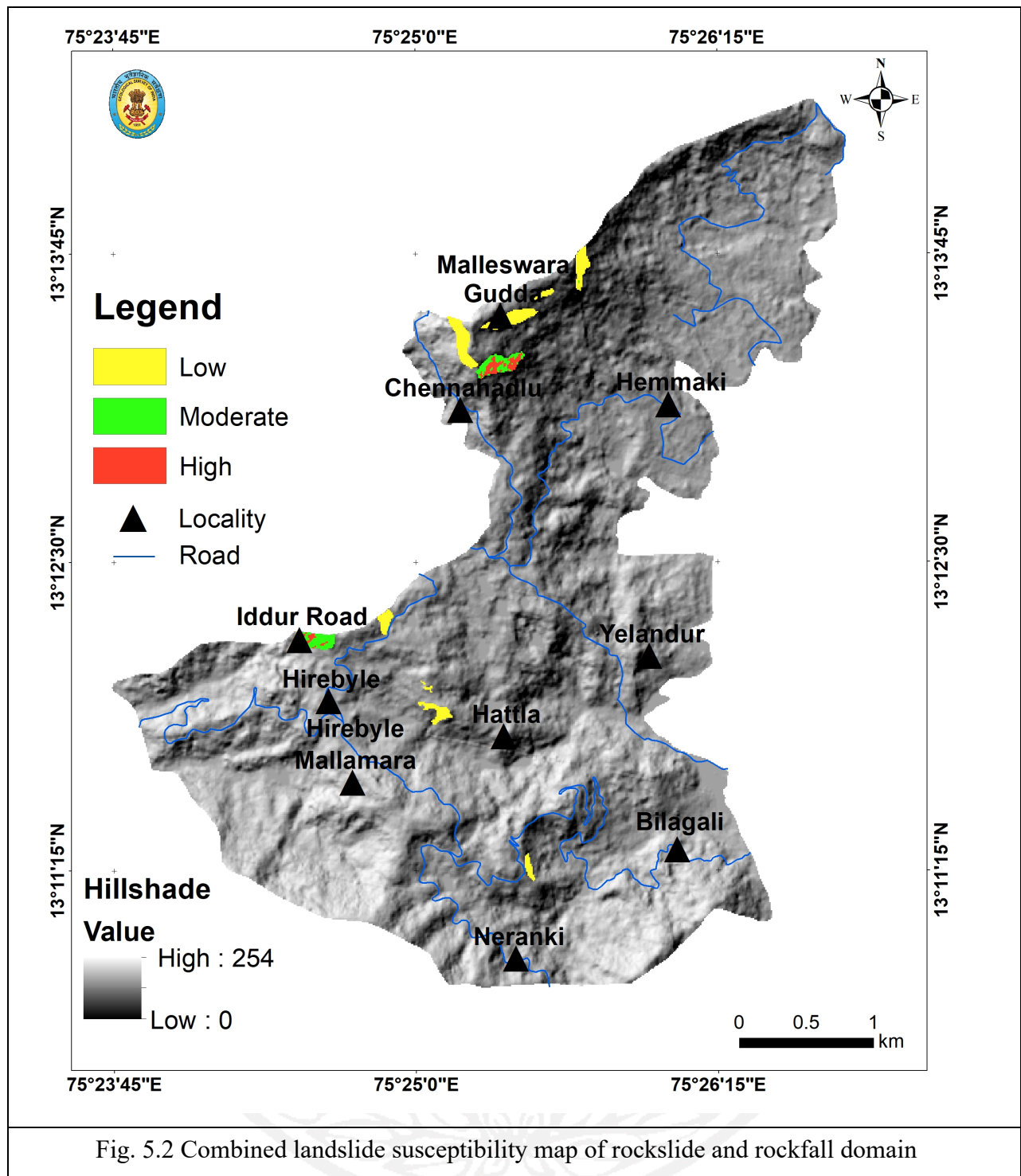
Where GT = Geotechnical map ( $RMR_{basic}$ )

KF = Kinematic Failure map

Rockfall and rock slide susceptibility in the study area are observed to be minimal. The combined rockslide and rockfall susceptibility map show 68% low, 21% moderate, and 11% high susceptible to rock slope instability (Fig. 5.2). The patch of high and moderate zones are seen near the southeast-facing Malleswara Gudda slope and southwest-facing slope along the



Hirebyle-Iddur road from. The steep slopes greater than  $45^\circ$  are limited in the study area and confined to the upper reaches of the Malleswara Gudda where escarpments are present exposing massive bare rock.





### 5.3 Cut slope domain susceptibility

The Landslide Susceptibility Estimated Ratings (LSER) of the four geo-factors of the overburden area which include the relative relief map, overburden thickness map and geotechnical map are added up to arrive at the susceptibility score of the cut slope domain.

The parametric equation is

$$TESV = 0.4GT + 0.3RR + 0.3RT, \text{ (SOP, GSI, 2021)}$$

Where GT = Geotechnical map,

RR = Relative relief map,

RT = Regolith thickness map

The hillslopes along the Neranki, Chennahaddlu, Hemmaki, and Gumingad partly fall in the cut slope domain and are largely represented by high susceptibility. The susceptibility map shows 30% low, 28% moderate, and 42% high coverage of the cut slope domain. (Fig. 5.3).

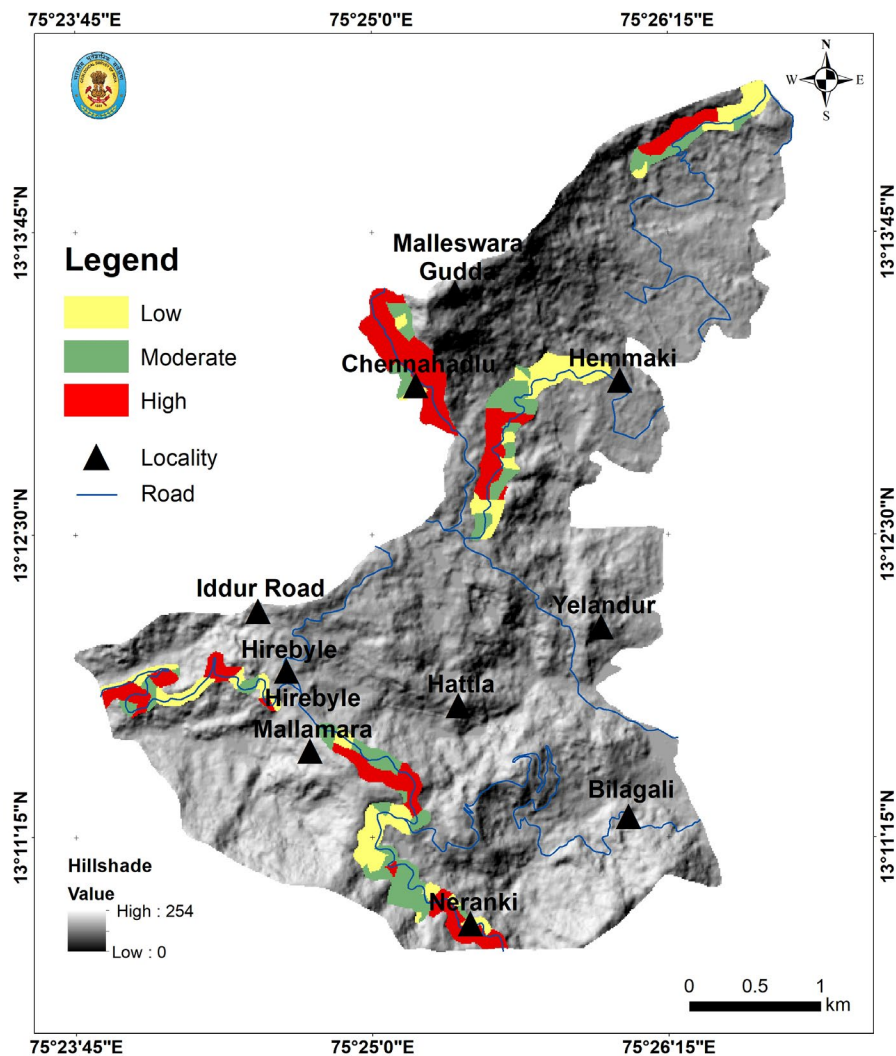


Fig. 5.3 Landslide susceptibility map of cut slope domain

## 5.4 Validation of landslide susceptibility map

The susceptibility map of all the domains have been mosaiced to prepare a seamless combined susceptibility map (Fig. 5.4) The combined landslide susceptibility map for all the domains shows that 50% of the area falls in low susceptibility, 23% in moderate, and 26% in high susceptibility areas.

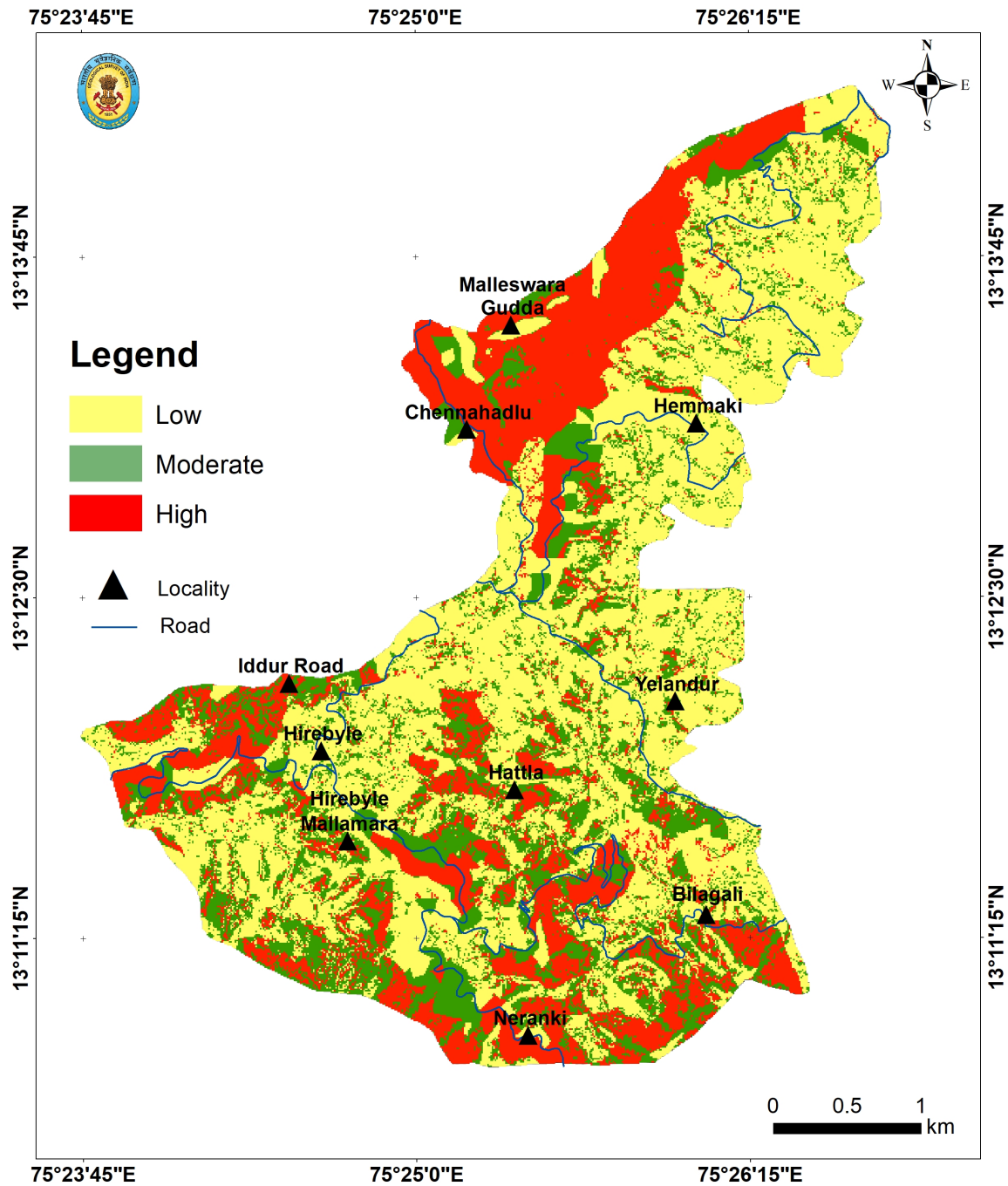


Fig. 5.4 Combined landslide susceptibility map of the study area

The susceptibility map generated is a predictive model which can also be validated with available landslide data. Since the current work does not use landslides directly in statistical modelling or calculating ratings and weights, the landslide data that are available in the study area is used only for calculating the prediction rate (Chung and Fabbri, 1999). For the purpose of meso scale landslide validation, the field validated unstable zones including transverse cracks and old scars are included besides the inventoried landslides. The polygons are rasterized to be crossed with the combined score map of the different domains. It is observed that the prediction rate curve is able to predict very well where 30% of the high susceptible map area is able to classify 78% of the landslide area (Fig. 5.5).

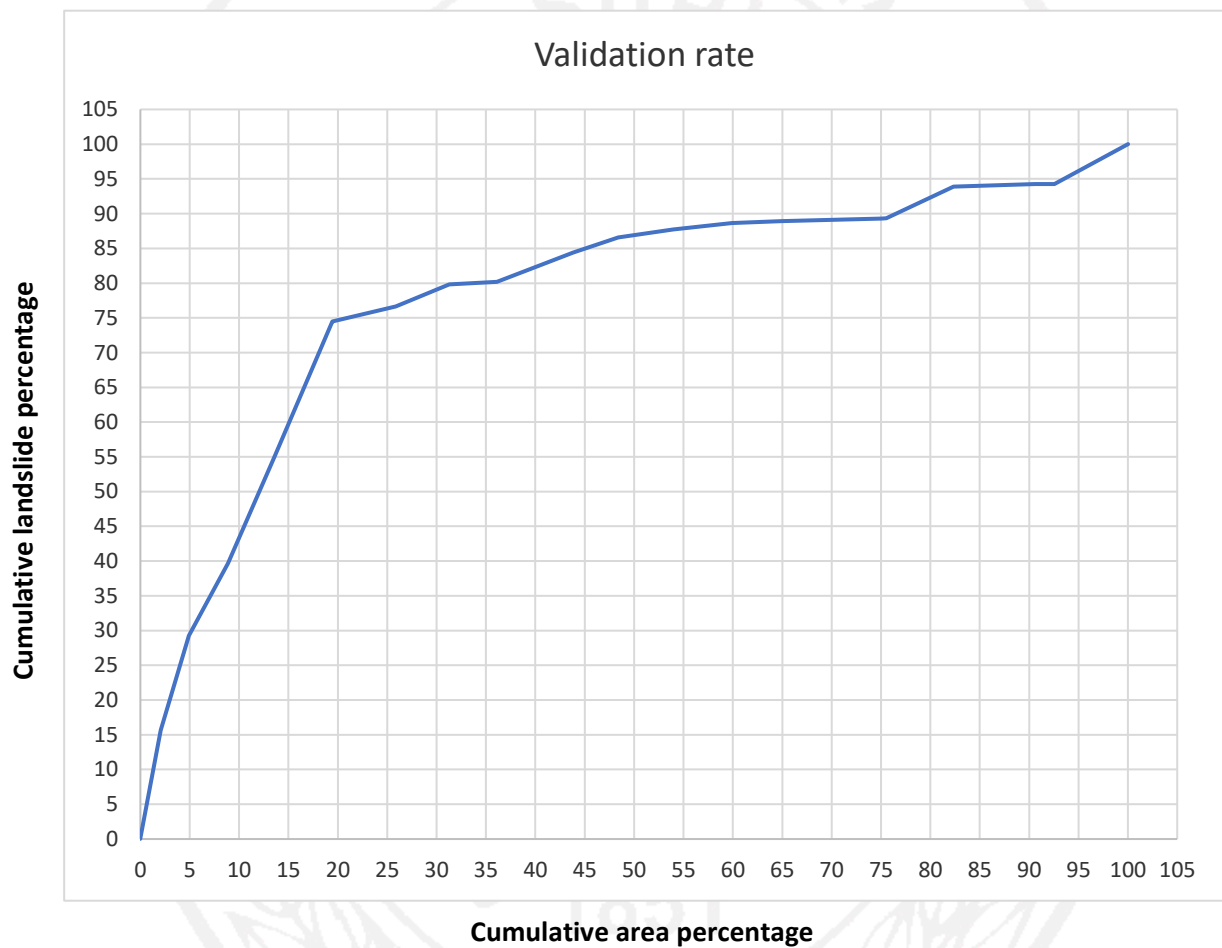


Fig. 5.5 Prediction rate curve of landslide susceptibility map of the area

In addition to the prediction rate curve using cumulative landslide area, the number of documented landslides in the field are cross validated using simple landslide density on the susceptibility map generated. It is found that the high susceptible area accounts for 41 landslide points, the moderate susceptible zone account for 13 landslide points and the low susceptible area shows 3 landslide points (Fig. 5.6).

Table 5.1 Landslide density distribution in each susceptibility class

Class	Total pixels	Area (sq.m)	No of known landslides/instability zones	Landslide density	Landslide percent (%)
Low	82580	8258000	3	0.0000363	5.2
Moderate	38335	3833500	13	0.0003391	22.8
High	43183	4318300	41	0.0009494	72
<b>Total</b>	<b>164098</b>	<b>16409800</b>			

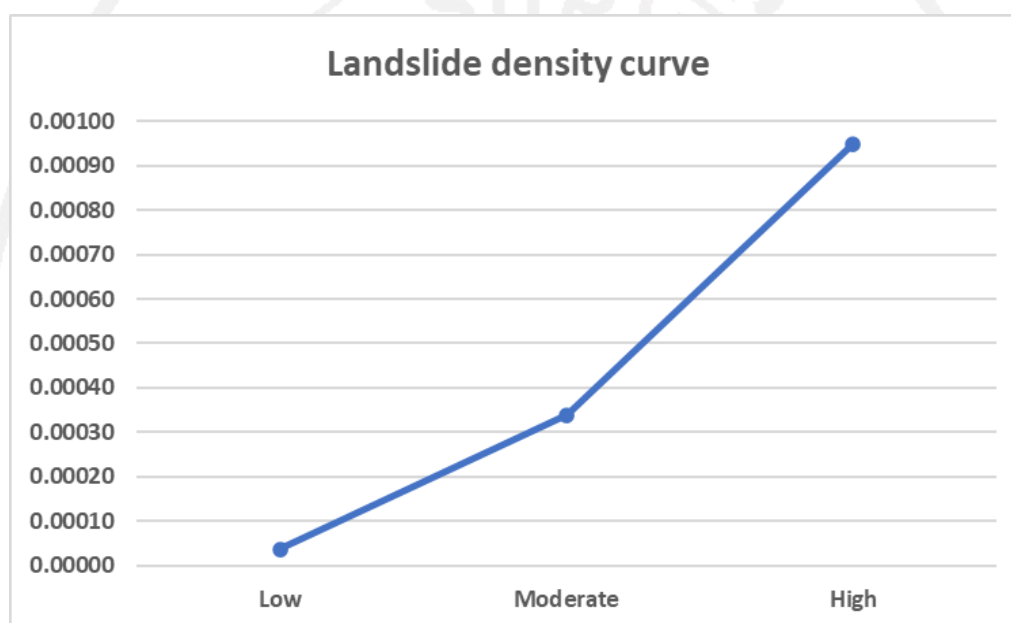


Fig. 5.6 Landslide density distribution in each susceptibility class

## 6. DEBRIS FLOW IMPACT PROBABILITY MAP

The debris flows impact probability map (Fig. 6.1) is an important map that is complementary to landslide susceptibility modeling. In the current study, it is attempted to produce debris flow impact probability map by using r. random walk on high-resolution DEM and debris flow inventory which is a conceptual model of mass wasting proposed by Mergili et al., 2015. The western and eastern hillslopes of Malleswara Gudda housing the localities of Chennahaddlu and Hemmaki respectively have incidences of debris flow with longer runout distances. In addition, a few landslides within other localities of Hirebyle have also been included in the debris flow inventory. An additional area of Chennahaddlu has also been included for inventory and debris flow impact probability mapping.

The available debris flow run out inventory for Malleswara Gudda area 23 which is converted to a raster map for the observed deposition area of the mass movement under investigation. The same is used for validation of the output map. There will be areas with no source or no release areas for the debris. All such parts of the observed impact areas outside of the observed deposition areas or runout area are set to no data or no debris flow area (M. Mergili et al, 2015). This model is primarily a conceptual model based on the available debris flow inventory and catchment area.

As per the map large parts of the Malleswara Gudda which includes Channahaddlu and Hemmaki and the southern area Neranki and Bilagali come under high impact probability. The validation of the debris flow impact probability map with the existing inventory shows that the map can fairly well predict the deposition areas (Fig. 6.2).

A composite map which is a combination of landslide susceptibility map with debris flows impact probability map can serve a important purpose of assessing the landslide related risks (Fig. 6.3). The landslide susceptibility map only gives an area of where the landslides of all types can likely initiate under a set of conditions. It does not take into account where and how far the failed material will travel. It is this run out of the failed material that can play havoc by adversely impacting the critical infrastructures causing loss of life and property. Therefore, the composite map is attempted by superimposing the high debris flows impact probability zones over the landslide susceptibility map to provide a comprehensive perspective on landslide risk management.



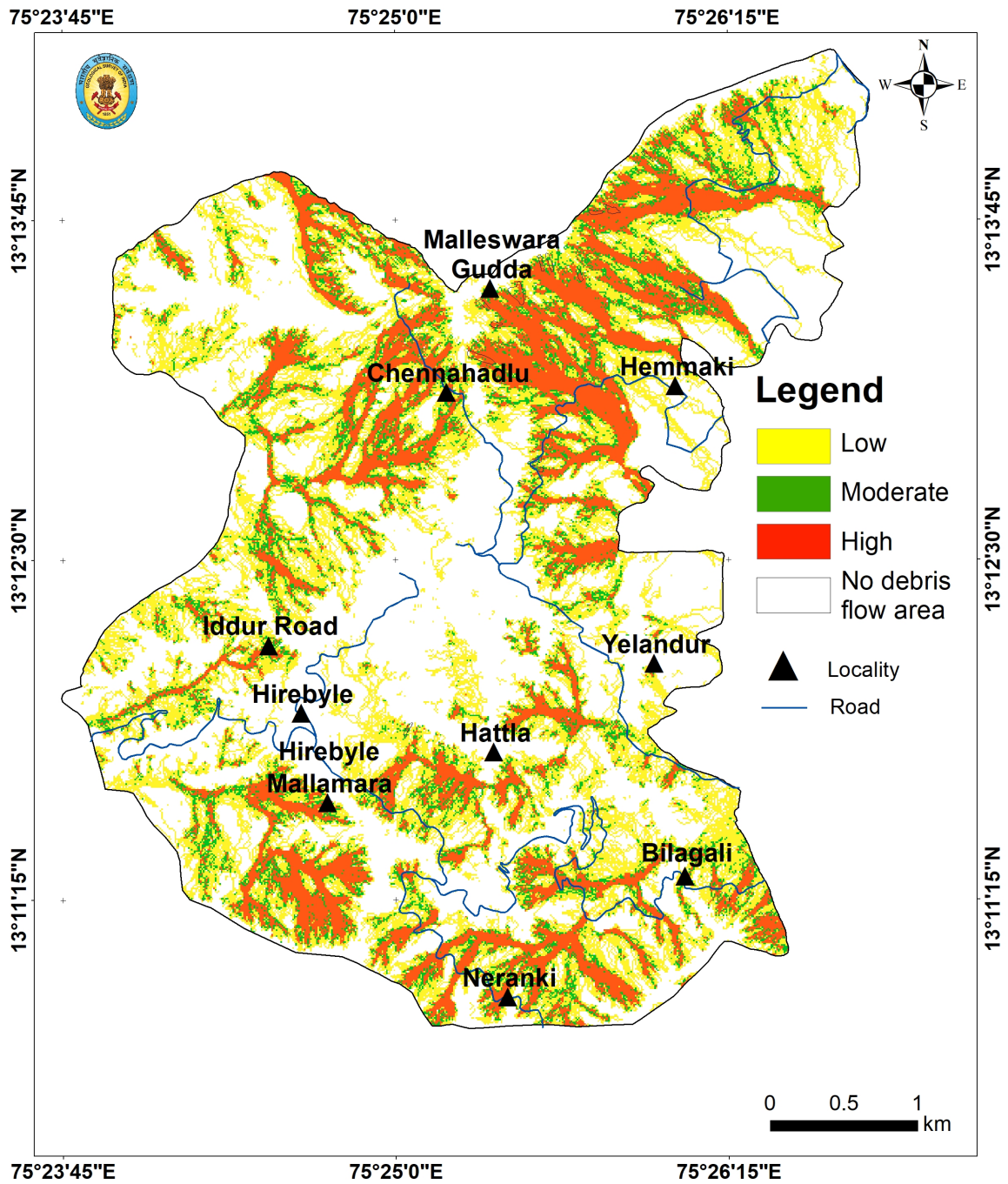


Fig. 6.1 Debris flow impact probability map of the area

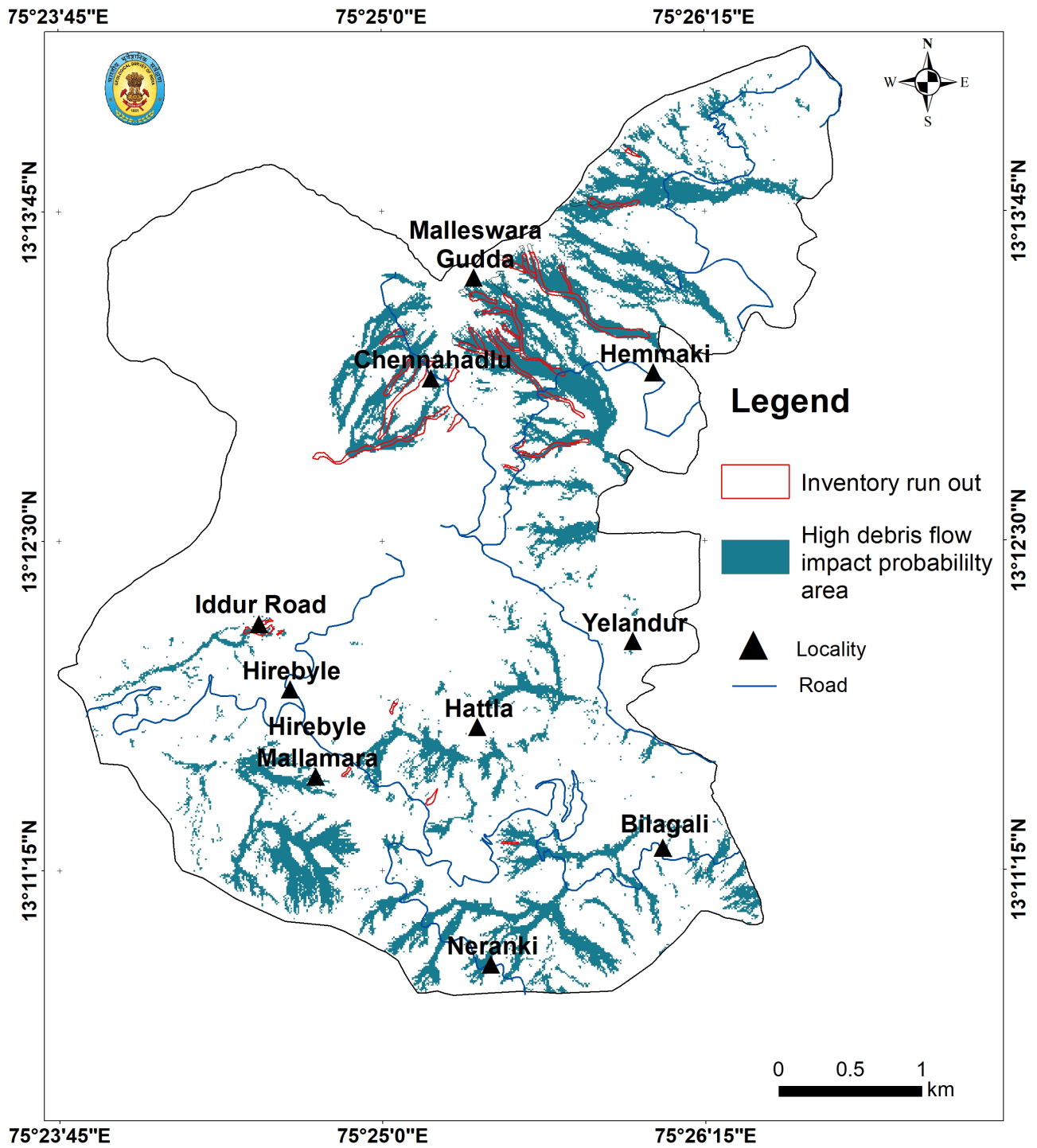


Fig. 6.2 Validation of high debris flow impact probability zone with run out inventory

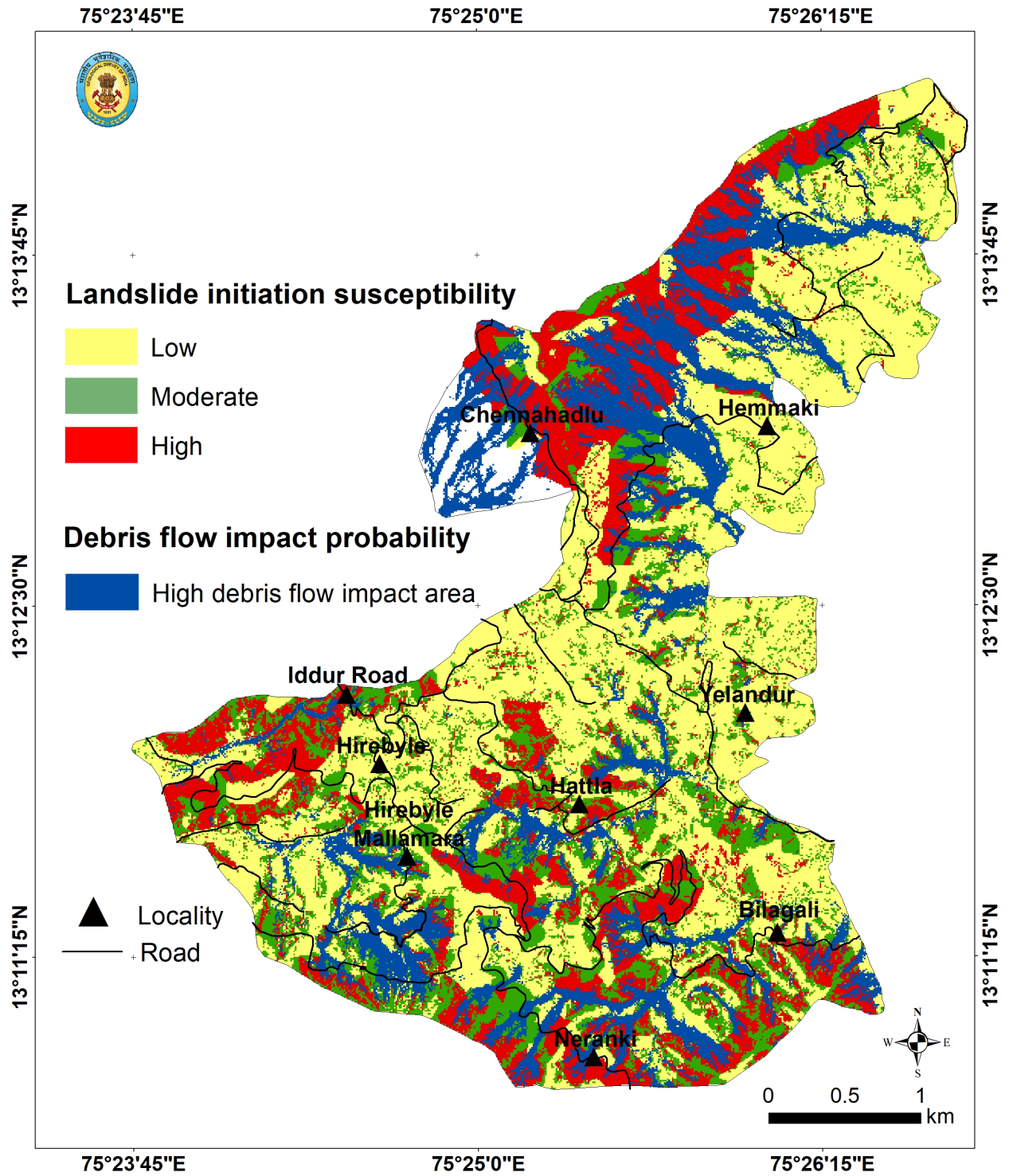


Fig. 6.3 Composite map landslide susceptibility map with high debris flow impact probability zone

## **7. LANDSLIDE RISK MANAGEMENT**

The landslide susceptibility map of the study area as obtained by using the heuristic method of ratings is a map that can be used to understand the relative stability of the study area. A set of geo-environmental factors have been considered during the study to generate the landslide susceptibility map. The map provides a fair idea of the slope susceptibility to failure of any type in response to the interaction of the considered geo-environmental factors. The susceptibility map will, therefore, give a qualitative estimation of how the specific areas will be susceptible to a potential future landslide. However, it may be categorically mentioned that the future landslide does not refer to any specific time frame or frequency of occurrence nor does it carry any connotation on the magnitude or scale of the failure. It is merely an establishment of a relationship of relevant geo-environmental causative factors with landslides for the areas of interest and based on which a qualitative assessment is derived about slope stability.

### **7.1 High-risk areas and mitigation measures**

The landslide susceptibility shows a substantial area of the cut slope domains of Chennahadlu and Hemmaki in high susceptibility zone. In addition, Hirebyle Mallamara and Bilagali fall within high to moderate landslide susceptibility. This assessment is corroborated by field observations of site characteristics. Field assessment was done on the nature and thickness of the material that could be mobilized if a landslide is triggered or re-activated. The composite map of the high debris flows impact probability zones and the landslide susceptibility map is used to assess the possible risks associated with landslide events.

#### **a) Chennahadlu**

In Chennahadlu, there are about 31 settlements scattered on the southwestern-facing hillslope. These settlements are located below and above the cut slope. The landslides inventoried here are largely on the upslope of the cut section and also on the the partly fill slope. The cause of the instability is nature of the material which is immature soil, friable and loose. The thickness of the overburden in this slope ranges from 1-2m. This thick soil profile coupled with moderately steep slope is highly susceptible to active erosion by the several first-order streams observed on the upslopes of the settlements. In addition, the houses are constructed on the benched slope without toe support.

The composite map of landslide susceptibility map and high debris flow impact probability area show that there are about 5 settlements falling within the possible flow path of the landslide debris (Fig. 7.1). As a precautionary measure, during heavy and prolonged rainfall, it is advisable that these settlements along the possible flow path be evacuated



temporarily. The possible escape route in the event of landslides is towards the south on the stable ground marked as temporary safe shelter area.

The mitigation measures recommended for the Chennahadlu hillslope include:

- i) Since the landslides on the hillslope characterized by thick immature soil are aggravated by slope profile modification, further slope cutting near the surface crack or landslide must be strictly prohibited.
- ii) During extreme rainfall, uncontrolled surface runoff can aggravate debris flow in the area. To stop runoff and lessen surface water moving downstream across the slope's face, surface drainage works are particularly crucial near the the settlement and along the hillside road. Lined open ditches to arrest surface water flow on loose soil can be done particularly where houses are constructed on the fill slope.
- iii) The fill slopes must be properly compacted before construction of the buildings.
- iv) A masonry breast wall is necessary at the landslide toe along the road. The upslope of the road can be benched following the appropriate run-rise ratio.

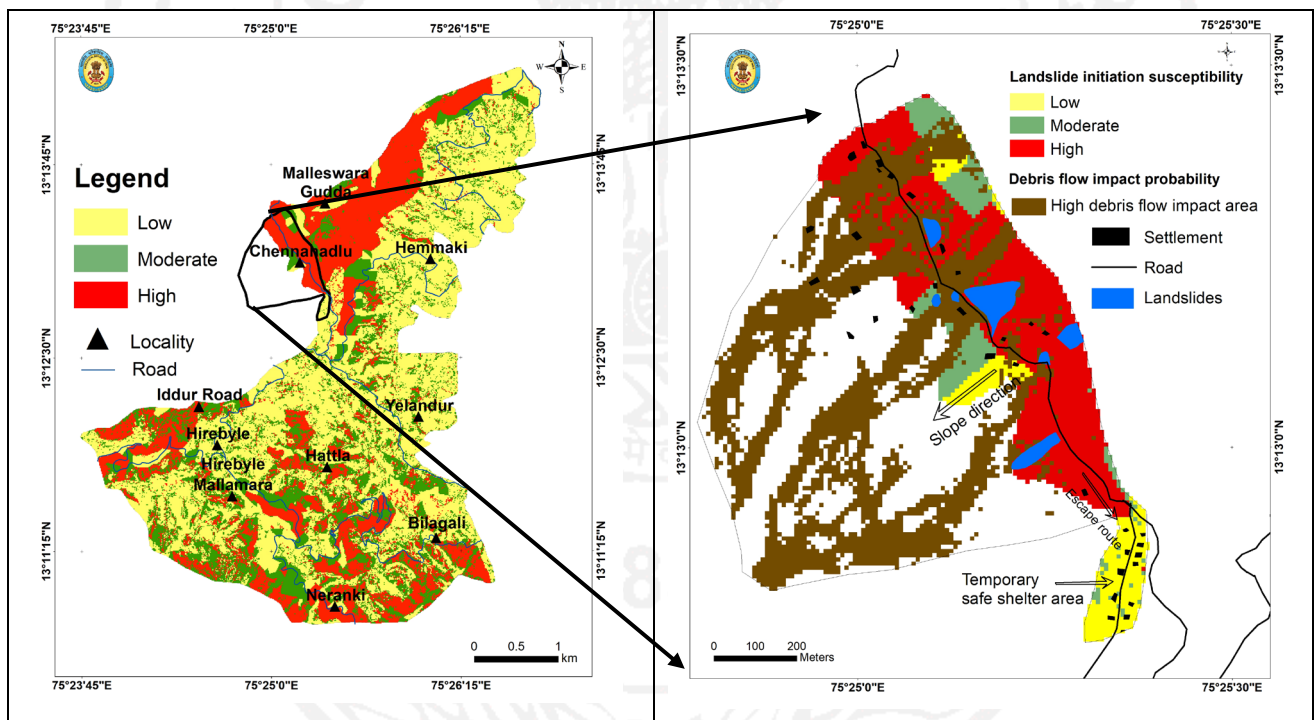
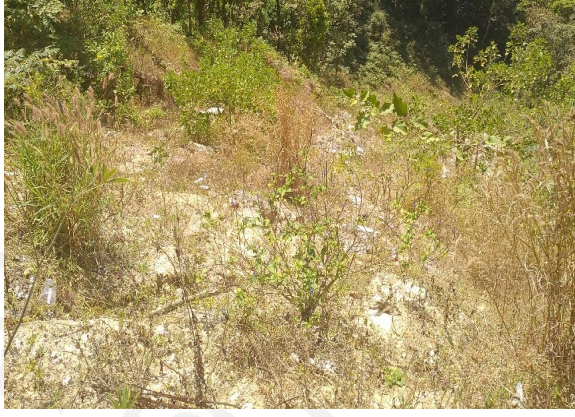


Fig. 7.1 Chennahadlu area on landslide susceptibility map and debris flow impact probability map showing Elements at Risk (EatR) with possible safe shelter and escape route.



	
Fig. 7.1a Landslide inventoried at Chennahadlu which damaged a house.	Fig. 7.1b Landslide inventoried at Chennahadlu which damaged a house.

## b) Hemmaki road hillslope

The eastern facing Malleswara Gudda slopes fall under high landslide susceptibility area. The Hemmaki road has suffered damages due to the impact of the debris flow from the upper reaches of the Malleswara Gudda. Here, several of the landslides are initiated on the flanks of the first and second order streams on the upper reaches. The landslides debris flow coalesced along the channelized streams downslope. The run out distances range from 50m to 350m which damage the roads, culverts and coffee plantation downstream by the impact of the debris. The colluvium material and other assorted loose materials are critically disposed along the midslopes which have a high tendency to be remobilized during heavy rainfall.

The composite map of landslide susceptibility map and high debris flow impact probability area show that there are about 6 settlements falling within the possible flow path of the landslide debris (Fig. 7.2).

During any extreme hydrological event and debris flow from the upper reaches and midslopes of Malleswara Gudda, the most feasible escape route is towards the eastern side of the area farther away from possible affected footslopes. The eastern side of the footslope has very low landslide susceptibility and no run out zone where the temporary safe shelter can be arranged.

A few recommendations include:

- i) The stream channels are observed to intersect the Hemmaki road. Therefore, the intersection points should be provided with adequate pre-cast pipes to accommodate the maximum discharge of the debris flow and thereby reduce the impact of the debris on the road and culvert structures.

- ii) To redirect excess water and minimise the impact of flooding and debris flow, diversion channels can be made at the appropriate location in the high-impact probable area especially along the stream channels.
- iii) Debris flow direction controlling works such as the erection of deflection walls or berms can be considered in the low-lying area where settlements are clustered. This can divert the flow channel to another region of the debris fan rather than allowing it to continue straight. These can be utilized to safeguard a building-structures at the bottom of a hill that alters the flow direction.

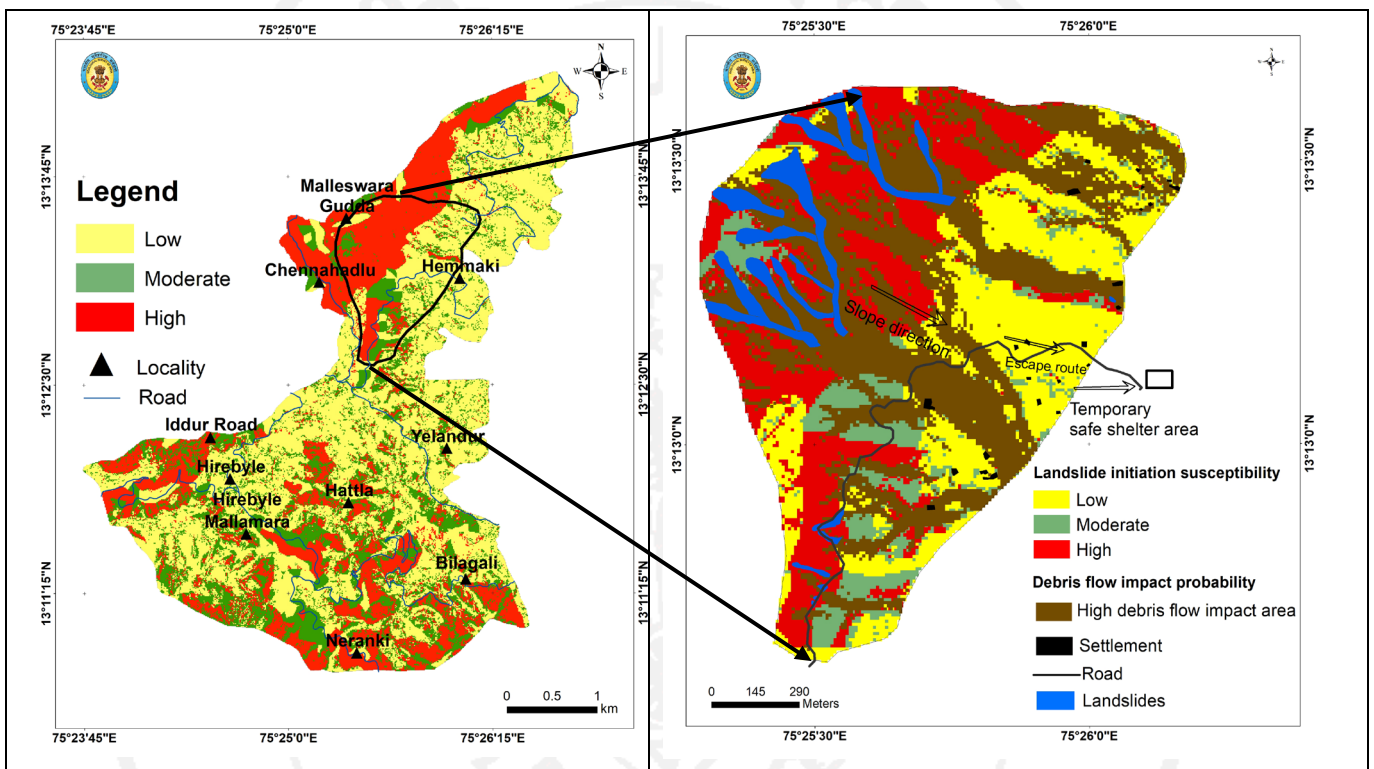


Fig. 7.2 Hemmaki area on landslide susceptibility map and debris flow impact probability map showing Elements at Risk (EatR) with possible safe shelter and escape route.



Fig. 7.2a Debris flow inventoried at Malleshwara which damaged the road



Fig. 7.2b Colluvium brought down with debris flow at Malleshwara midslope



### c) Bilagali

Bilagali area has seen slope instability both on the steeper slopes and gentle slopes. The steeper slopes are characterized by a thin cover of mature soil with an active plantation of coffee. The debris flow on this steep slope has damaged the coffee plantation and subsequently formed a flow path channel along which future debris flow is likely to be remobilized. The gentler slopes have thicker soil cover and abundant areca nut plantation with 4th order stream. Transverse cracks and scars have developed indicating a varying degree of instability. The 4th order stream has also eroded the banks and contributed to the instability along the footslopes. The footslope where the transverse cracks are documented is characterized by concave slope morphometry where persistent water flow convergence is anticipated.

The composite map of landslide susceptibility and high debris flow impact probability area show that there no settlements falling within the possible flow path of the landslide debris except the vital road leading to Bilagali. The safe shelter can be conveniently arranged on the western part of the map (Fig. 7.3) assessed as the stable area representing flat hilltop. The escape route can be either towards the east or north away from the unstable areas.

However, there are two settlements falling within the high landslide susceptibility area. A landslide has been inventoried on the downslope of these settlements. The signatures of any retrogression of the landslide should be monitored.

The recommendations include:

- i) It is recommended for channel linings along the stream bank at the footslope of Bilagali where the bridge is located which can be effective both in maintaining channel alignment and in reducing the frequency and volume of debris flows. It is recommended to apply the linings over the entire reach of an unstable channel, especially near the bridge in Bilagali where intensive scouring is observed causing instability to the bridge.
- ii) The drainage system close to the cracks and subsidence area near the Bilagali bridge should be properly maintained and the impervious material can be used to seal and level the cracks.
- iii) The steeper hillslopes may be avoided for cutting and plantation purposes that have aggravated instability in the area.
- iv) Several links roads are observed here and therefore any slope profile modification done here should be systematically carried out by strictly following engineering principles and structural support systems.

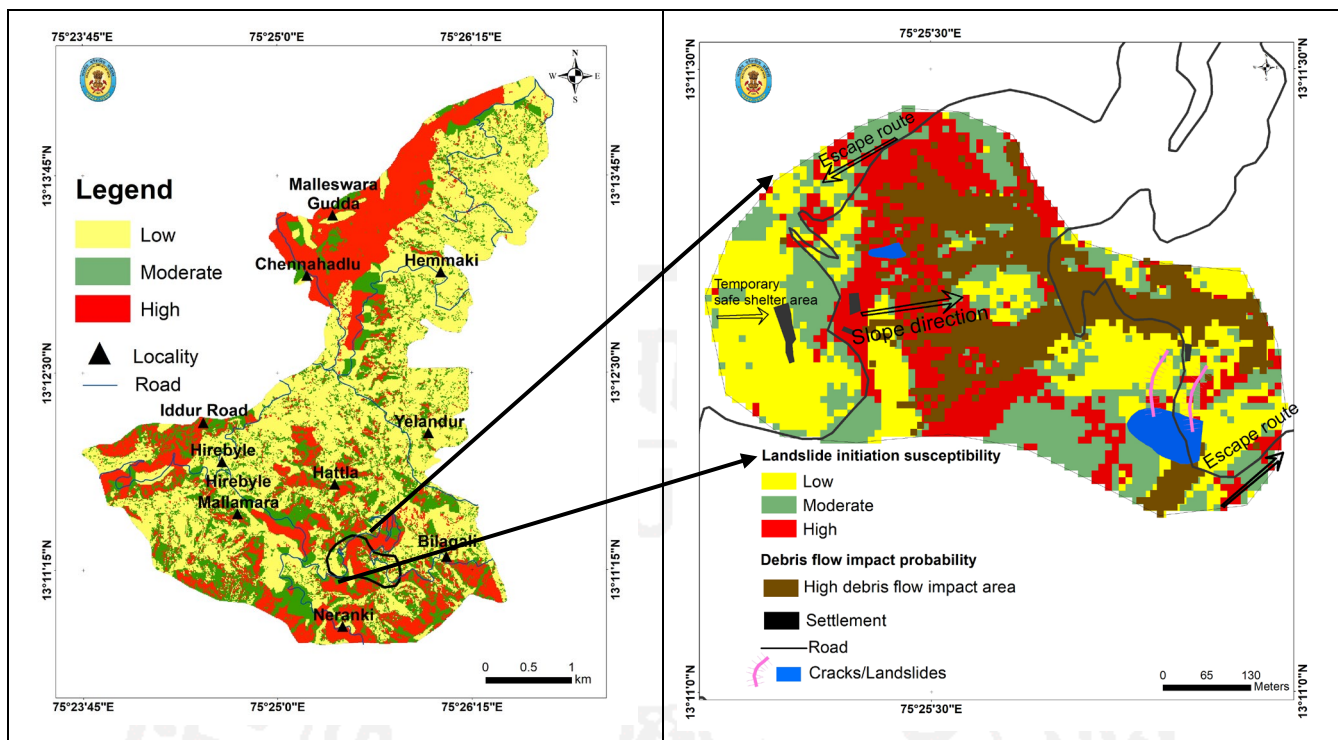


Fig. 7.3 Bilagali area on landslide susceptibility map and debris flow impact probability map showing Elements at Risk (EatR) with possible safe shelter and escape route.



Fig. 7.3a Debris flow damaged coffee plantation



Fig. 7.3b Transverse cracks on the footslope of Bilagali

#### d) Hirebyle Mallamara

The southwest facing hillslope of Mallamara locality of Hirebyle has a cluster of settlements along the road leading to the Goomankhan tea estate. The settlements have been constructed on the cut slopes and partly fill slopes. A few NW-SE trending cracks on the floors of the buildings were observed. The area falls within moderate to high landslide susceptibility. The composite map of landslide susceptibility and high debris flow impact probability area show that there are 4 settlements falling within the possible flow path of the



landslide debris (Fig. 7.4). The northeast facing hillslope has a landslide which is observed to be suspended at the time of investigation. However, the thin cover of soil over highly weathered and fractured banded magnetite quartzite (BMQ) on the steep slope has served as a critical pre-disposing factor for further initiation of landslide.

The escape route to from the possible debris flow impact areas is towards the north near the Hirebyle Primary school located adjacent to the roadside which can serve as the temporary safe shelter in the area.

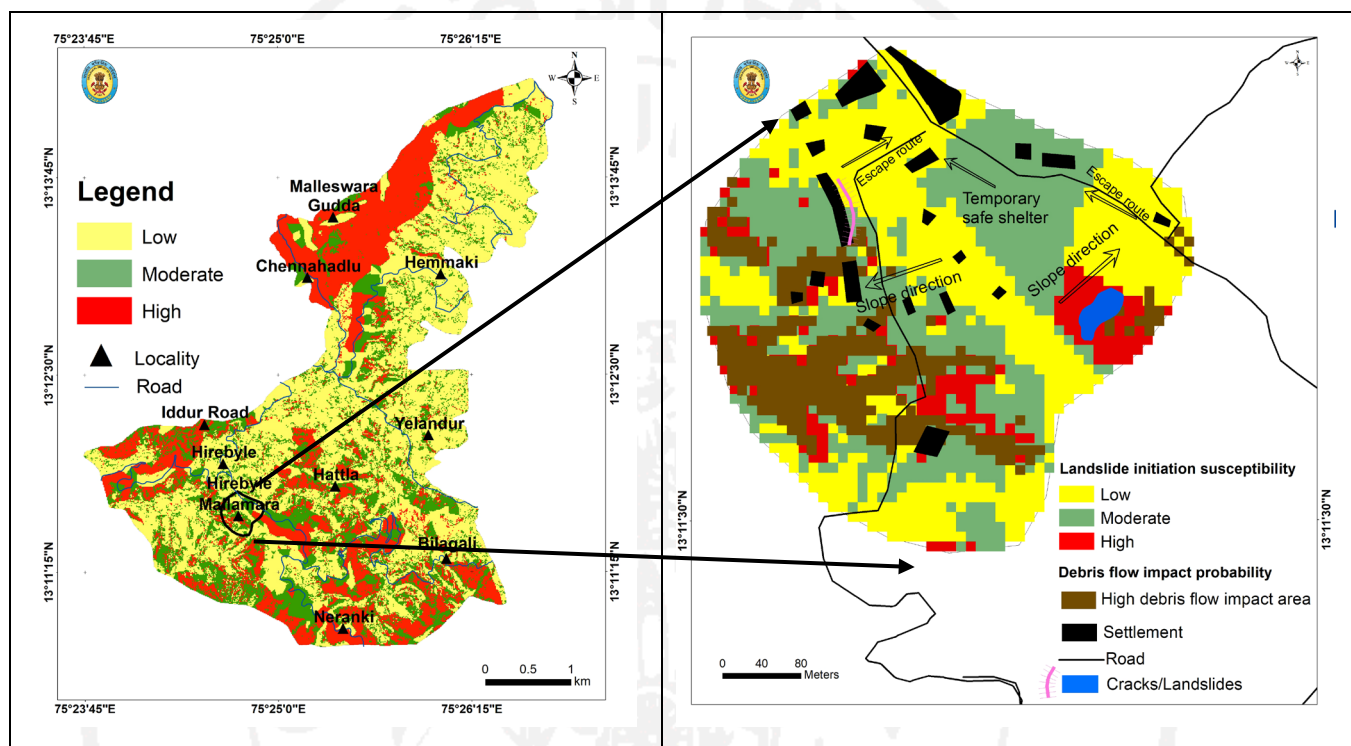


Fig. 7.4. Hirebyle Mallamara area on landslide susceptibility map and debris flow impact probability map showing Elements at Risk (EatR) with possible safe shelter and escape route.

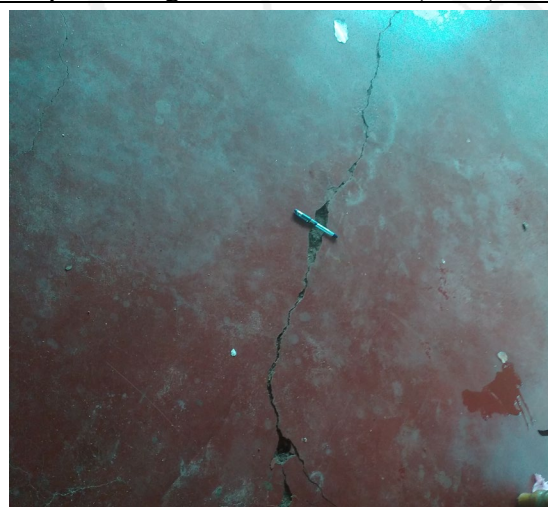


Fig. 7.4a Cracks observed on the floor of the building at Mallamara Hirebyle



Fig. 7.4b Landslide scar on the NE facing slope of Mallamara Hirebyle



## 7.2 Discussion and conclusion

The landslide inventory of recent years and the study of available rainfall data reveal that the landslides in Chennahadlu, Hemmaki road, Bilagali and Iddur road are triggered by prolonged or intense rainfall. The field observations on the causative factors and failure mechanism involved show that there are landslides both on the unmodified natural slopes and on the modified slopes. This indicates that in addition to the landslides caused by the natural geofactors, the land use interference is aggravating slope instability in the area. Some sectors of Chennahadlu and Hemmaki hillslopes have been aggravated by anthropogenic interference while the landslides of the Malleswara Gudda and Bilagali hillslopes are inventoried on the natural hillslopes.

The landslide susceptibility map generated in this work will serve as a foundational step within the larger framework of landslide risk management. The stakeholders including the local administration and Panchayat can use the output susceptibility map to establish relevant criteria for value judgments in managing risks associated with landslides in specific areas of landslide-affected hillslopes.

In the earth and debris slide domains, the high-class accounts for 25%, the moderate class for 23%, and the low susceptibility for 53%. The southwest and southeast facing slopes of Malleswara Gudda, which comprise the settlements of Chennahadlu and upslope of Hemmaki, are shown on the map as having a high susceptibility to initiation of both old and new landslides. Also such high zones are seen along the Bilagali, Hattla, and Neranki locations in the south. The moderate zones have steep slopes and are found on the edges of the high zone where there are drainages.

In rockslide and rockfall domain, very little area is seen as critical since rock exposures are limited. However, minimum exposures having rockslide criticality is seen in Iddur road and rockfall criticality in Malleswara Gudda. Such criticality is based primarily on average values of the friction angle and slope angle which can vary from one rockslope to another. In addition, the slope angle can be modified through slope cutting in which case the failure envelope can be enlarged. The combined rockslide and rockfall susceptibility map shows 68% low, 21% moderate, and 11% high susceptible to rock slope instability.

The cut slope domain has a relatively large proportion of high susceptibility zone. The land use involving slope profile modification without a methodical support system or drainage system has served as an important pre-disposing factor to landslide initiation during monsoon. The landslide inventory and field investigation have corroborated this because a substantial

number of the landslides within the Chennahadlu, Hattla, and Hemmaki hillslopes have been inventoried in the cut slope domain. The susceptibility map shows 30% low, 28% moderate, and 42% high coverage of the cut slope domain.

After the field investigation, a few pockets of localities like Chennahadlu and Iddur road of Marasanige Panchayat and Malleswara Gudda, Hemmaki, Hirebyle, Yelandur, Hattla and Bilagali of Idakani Panchayat road hillslopes are assessed to be susceptible to landslides as corroborated by past landslide incidences and field observations.

In addition to the landslide susceptibility map, debris flows impact probability map was attempted which helped in to derive composite map which can serve an important purpose of assessing the landslide related risks. Several of the existing debris flow inventory shows that they have been initiated along the high landslide susceptibility area which are the source areas for debris flow. The debris flow impact probability maps shows that some of the low lying areas and footslopes are high probable areas which are otherwise low landslide susceptible zones. Therefore, the composite map by superimposing the high debris flows impact probability zones over the landslide susceptibility map can provide a comprehensive perspective on landslide risk management.

The high-risk area is a qualitative assessment that is driven by the presence of elements at risk (EatR) near the distressed slopes. These high-risk areas require judicious management of the slope. To mitigate potential remobilization of the material in the slopes where a modification has taken place for construction purposes, all possible regulations at the local level must be put in place to avoid unmethodical excavation of slopes. The unsupervised anthropogenic interference can aggravate localized slope instability and therefore, safe and sustainable landuse practices need to be adopted especially in hillslopes around Hattla, Bilagali and Hemmaki where extensive coffee plantation is practiced.

The landslide susceptibility map of the area has been adequately validated by the available landslides using a prediction rate curve and simple landslide density curve. The landslide susceptibility map of the study area generated using the heuristic method represents areas or slopes most likely to fail in response to the geo-environmental factors considered in the study. The combination of geo-environmental factors and their mutual intricate relationship determine the spatial distribution of landslides. The susceptibility map will, therefore, give a qualitative estimation of how the hillslopes within the study area will be susceptible to a potential future landslide.

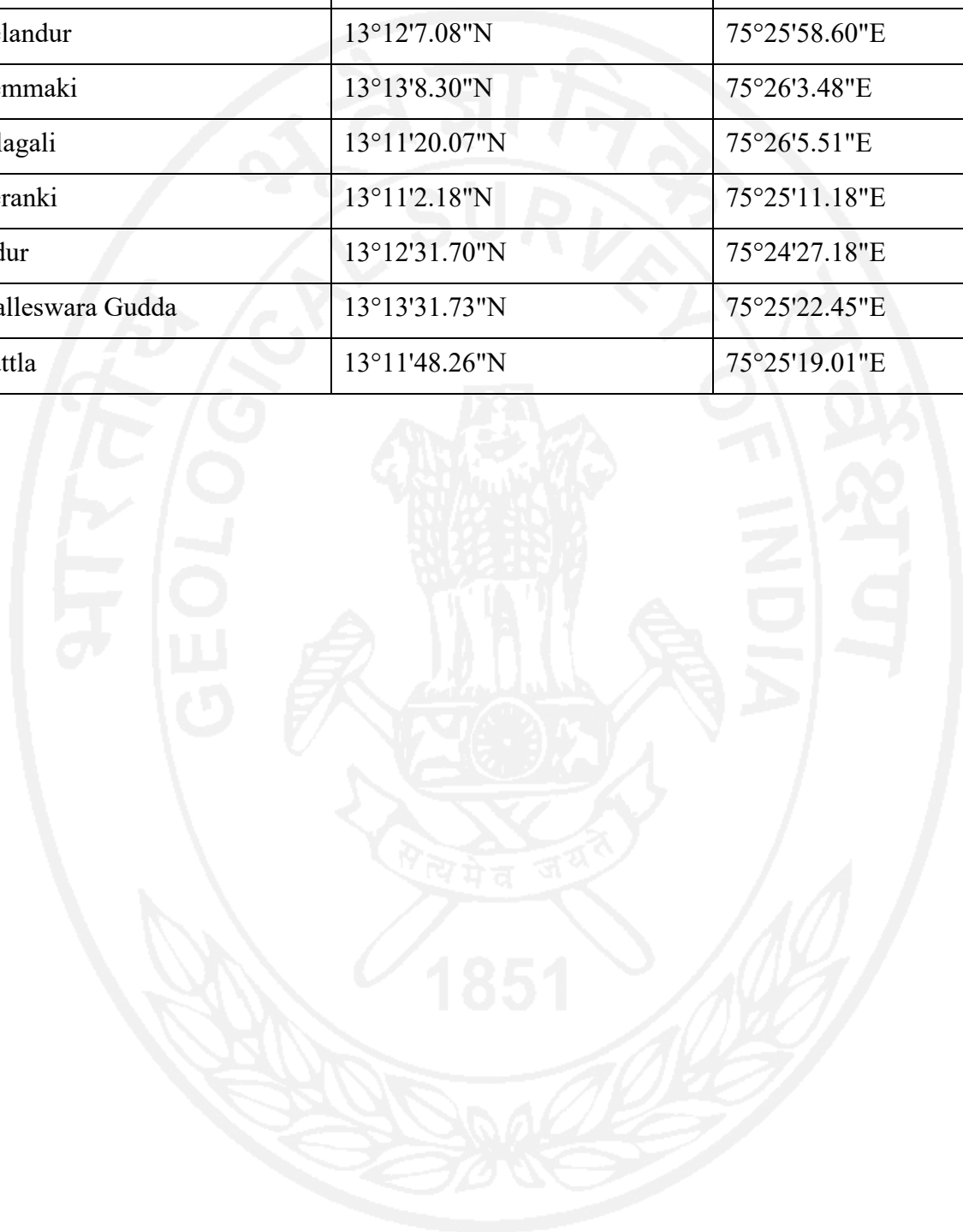
It may be categorically stated that the susceptibility map does not have time connotation in any way because of the temporal variability in the triggering factor which is primarily the monsoonal rainfall. The rainfall during the monsoon of 2018, 2019, and 2020

served as the primary triggering factor for the inventoried landslides in the area. The adverse hydrological event and prolonged antecedent rainfall can trigger landslides of varying dimensions or re-activate the old landslides. Therefore, the common mitigation for the assessed high-risk area is the management of drainage through the provision of adequate lining and weep holes. Since the landslides in the area are temporally associated with rainfall, it is important to have rain gauge stations in each of this critical hillslopes which includes Chennahadlu, Hemmaki, Hirebyle and Bilagali and practically record the rainfall data to correlate the landslide incidences with antecedent rainfall.

It is recommended that the local people residing in the identified hillslopes who serve as first responders need to be empowered through capacity building and imparting awareness about dealing with landslide risks such as vacating buildings during prolonged heavy rainfall of 4-5 days and avoiding unmethodical excavation of hillslopes.



Locality Index		
Hirebyle	13°11'56.23"N	75°24'39.02"E
Kalasa	13°13'57.73"N	75°21'34.83"E
Chennahadlu	13°13'6.97"N	75°25'11.85"E
Yelandur	13°12'7.08"N	75°25'58.60"E
Hemmaki	13°13'8.30"N	75°26'3.48"E
Bilagali	13°11'20.07"N	75°26'5.51"E
Neranki	13°11'2.18"N	75°25'11.18"E
Iddur	13°12'31.70"N	75°24'27.18"E
Malleswara Gudda	13°13'31.73"N	75°25'22.45"E
Hattla	13°11'48.26"N	75°25'19.01"E





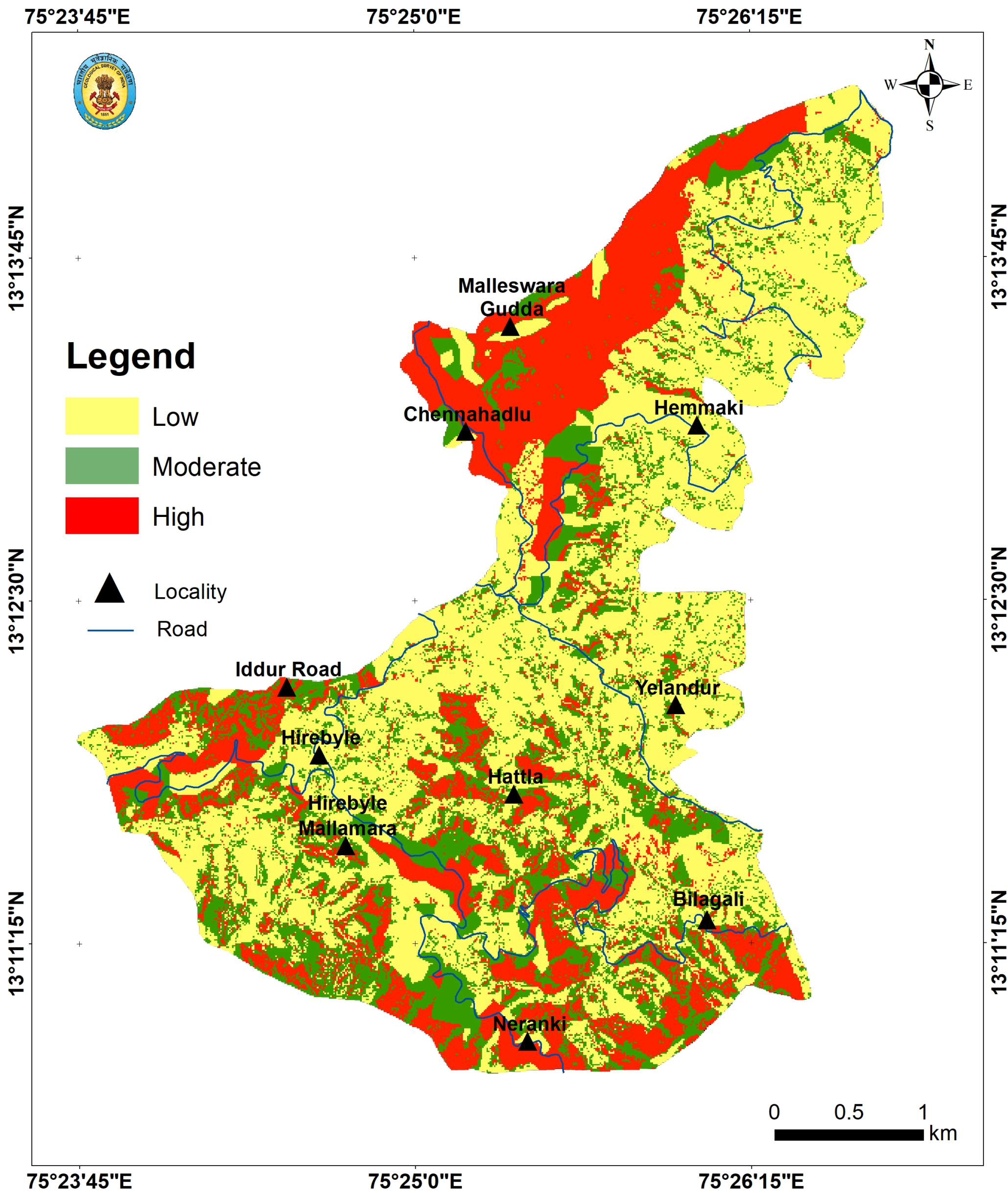
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PLATE – I Combined landslide Susceptibility map (1:10000)





No	Field	
1	Slide No (LS.No.)	KG/CHI/4808/2021-22/1
2	State	Karnataka
3	District	Chikkamangalur
4	Toposheet	4808
5	Name of the slide	Yedur road slide
6	NH/SH/Locality	Yedur road
7	Latitude	13.202962°
8	Longitude	75.409863°
9	Length	40 m
10	Width	35m
11	Height	20m
12	Area	1400 sq.m
13	Depth	2 m
14	Volume	2800 cu.m
15	Run out distance	10
16	Type of Material	Rock
17	Type of movement	Slide
18	Rate of movement	Rapid
19	Activity	Suspended
20	Distribution	Confined
21	Style	Single
22	Failure mechanism	Shallow translational
23	History	Initiated in August 9, 2019
24	Geomorphology	Moderately dissected slope
25	Geology	Granite
26	Structure	Nil
27	Land use/ Land cover	Sparsely vegetated
28	Hydrological condition	Damp
29	Triggering Factor	Rainfall
30	Death of persons	Nil
31	People affected	Nil
32	Live-stock loss	Nil
33	Communication	Partial drainage blockage downslope
34	Infrastructure	Nil
35	Agriculture/forest/Barren	Forested upslope

36	Geo-scientific Causes	-Highly deformed and weathered rock profile. -The vulnerable joint set dipping valley ward and less than the slope angle.
37	Remedial measures	1. The existing foot track on the crown area should be diverted further upslope 2. Construction lined contour drain at the upslope above the crown.
38	Remarks, if any	
39	Photos. Sketch of Plan & section of the slide	
40	Summary/Abstract	A shallow translational rock slide is caused due to highly deformed and weathered rock profile and the vulnerable joint set dipping valley ward and less than the slope angle. It was triggered by prolonged rainfall.
41	Pdf	Attached
42	Landslide category	III

No	Field	
1	Slide No (LS .No.)	KG/CHI/4808/2021-22/2
2	State	Karnataka
3	District	Chikkamangalur
4	Toposheet	4808

5	Name of the slide	Yedur road slide
6	NH/SH/Locality	Yedur road
7	Latitude	13.203370°
8	Longitude	75.409634°
9	Length	30 m
10	Width	15m
11	Height	15 m
12	Area	450 sq.m
13	Depth	1 m
14	Volume	450 cu.m
15	Run out distance	15m
16	Type of Material	Debris
17	Type of movement	Slide
18	Rate of movement	Rapid
19	Activity	Suspended
20	Distribution	Confined
21	Style	Single
22	Failure mechanism	Shallow translational
23	History	Initiated in August 9 2019
24	Geomorphology	Moderately dissected slope
25	Geology	Granite
26	Structure	Nil
27	Land use/ Land cover	Sparse vegetation
28	Hydrological condition	Damp
29	Triggering Factor	Rainfall
30	Death of persons	Nil
31	People affected	Nil
32	Live-stock loss	Nil
33	Communication	Nil
34	Infrastructure	Nil
35	Agriculture/forest/Barren	Forested upslope
36	Geo-scientific Causes	-The presence of thick overburden on the steep slope with sparse vegetation - Sustained percolation of surface runoff at the crown area.
37	Remedial measures	1. The existing foot track on the crown area should be diverted further upslope

		2. Construction lined contour drain at the upslope above the crown.
38	Remarks, if any	
39	Photos. Sketch of Plan & section of the slide	
40	Summary/Abstract	A shallow translational debris slide is inventoried which is caused due to presence of thick overburden with steep slope. A contour drain at the crown area to divert surface runoff is suggested.
41	Pdf	Attached
42	Landslide category	III



No	Field	
1	Slide No (LS .No.)	KG/CHI/48O8/2021-22/3
2	State	Karnataka
3	District	Chikkamangalur
4	Toposheet	48O8
5	Name of the slide	Yedur road slide
6	NH/SH/Locality	Yedur road
7	Latitude	13.202581°
8	Longitude	75.410134°
9	Length	15
10	Width	12
11	Height	10
12	Area	180 sq.m
13	Depth	1 m
14	Volume	180 cu.m
15	Run out distance	5 m
16	Type of Material	Debris
17	Type of movement	Slide
18	Rate of movement	Rapid
19	Activity	Suspended
20	Distribution	Widening
21	Style	Single
22	Failure mechanism	Shallow translational
23	History	9 August 2019
24	Geomorphology	Moderately dissected slopes
25	Geology	Granite
26	Structure	Nil
27	Land use/ Land cover	Partially Modified Slope for settlement
28	Hydrological condition	Dry
29	Triggering Factor	Rainfall
30	Death of persons	Nil
31	People affected	Nil
32	Live-stock loss	Nil
33	Communication	Nil
34	Infrastructure	Nil

35	Agriculture/forest/Barren	Forest upslope
36	Geo-scientific Causes	-Highly weathered granitic rockmass overlain by thin overburden and debris. - Toe support removal due to slope cutting for settlement.
37	Remedial measures	-Construction of breast wall with weep holes and toe drain
38	Remarks, if any	
39	Photos. Sketch of Plan & section of the slide	
40	Summary/Abstract	A shallow translational failure at the Yedur road hillslope is caused by the slope cutting without any structural support at the toe. A toe support system is recommended at the toe of the slide.
41	Pdf	Attached
42	Landslide category	III

No	Field	
1	Slide No (LS .No.)	KG/CHI/48O8/2021-22/4
2	State	Karnataka
3	District	Chikkamangalur
4	Toposheet	48O8
5	Name of the slide	Gumminkad slide
6	NH/SH/Locality	Gumminkad
7	Latitude	13.197068°
8	Longitude	75.397791°
9	Length	10
10	Width	12
11	Height	8
12	Area	120 sq.m
13	Depth	1 m
14	Volume	120 cu.m
15	Run out distance	0
16	Type of Material	Soil
17	Type of movement	Slide
18	Rate of movement	Rapid
19	Activity	Suspended
20	Distribution	Widening
21	Style	Single
22	Failure mechanism	Shallow translational
23	History	Occurred in 2018
24	Geomorphology	Lowly dissected slopes
25	Geology	Granite
26	Structure	Nil
27	Land use/ Land cover	Partially Modified Slope for road
28	Hydrological condition	Dry
29	Triggering Factor	Rainfall
30	Death of persons	Nil
31	People affected	Nil
32	Live-stock loss	Nil
33	Communication	Nil
34	Infrastructure	Nil

35	Agriculture/forest/Barren	Coffee Plantation upslope
36	Geo-scientific Causes	-Presence of thick overburden /insitu soil on the upslope. -Toe support removal due to slope cutting for road widening. -Sustained toe erosion by surface runoff.
37	Remedial measures	-Construction of breast wall with weep holes and toe drain along the hillside
38	Remarks, if any	
39	Photos. Sketch of Plan & section of the slide	
40	Summary/Abstract	A soil slide is caused near Gumminkad due to steep slope cutting for the widening of the road. The slope is characterized by thick insitu soil. It is recommended for the construction of breast wall with weep holes and toe drain.
41	Pdf	Attached
42	Landslide category	III



No	Field	
1	Slide No (LS .No.)	KG/CHI/48O8/2021-22/5
2	State	Karnataka
3	District	Chikkamangalur
4	Toposheet	48O8
5	Name of the slide	Gumminkad
6	NH/SH/Locality	Gumminkad slide
7	Latitude	13.199900°
8	Longitude	75.405711°
9	Length	12 m
10	Width	20 m
11	Height	8m
12	Area	240 sq.m
13	Depth	1m
14	Volume	240 cu.m
15	Run out distance	0
16	Type of Material	Soil
17	Type of movement	Slide
18	Rate of movement	Rapid
19	Activity	Suspended
20	Distribution	Confined
21	Style	Single
22	Failure mechanism	Shallow translational
23	History	Reportedly initiated in August 2020
24	Geomorphology	Lowly dissected slopes
25	Geology	Granite
26	Structure	Nil
27	Land use/Land cover	Partially Modified Slope
28	Hydrological condition	Damp
29	Triggering Factor	Rainfall
30	Death of persons	Nil
31	People affected	Nil
32	Live-stock loss	Nil
33	Communication	Nil
34	Infrastructure	Nil
35	Agriculture/forest/Barren	Coffee Plantation upslope

36	Geo-scientific Causes	-Highly weathered schistose rock overlain by thick overburden.   -Steep slope cutting without any toe support system.   -Natural drainage near the crown without any lining aggravated erosion.
37	Remedial measures	-Construction of breast wall with a lined hillside drainage system
38	Remarks, if any	The slope failure may reactivate subsequent to monsoon in absence of a proper drainage system.
39	Photos. Sketch of Plan & section of the slide	
40	Summary/Abstract	A shallow translational debris slide is caused by absence of drainage system to divert the surface water. It is recommended to install a proper drainage system to control the slope instability.
41	Pdf	Attached
42	Landslide category	III

No	Field	
1	Slide No (LS. No.)	KG/CHI/48O8/2021-22/6
2	State	Karnataka
3	District	Chikkamangalur
4	Toposheet	48O8
5	Name of the slide	Yelandur slide
6	NH/SH/Locality	Yelandur
7	Latitude	13.205598°
8	Longitude	75.426081°
9	Length	5
10	Width	7
11	Height	4
12	Area	35 sq.m
13	Depth	2 m
14	Volume	70 cu.m
15	Run out distance	0
16	Type of Material	Soil
17	Type of movement	Slide
18	Rate of movement	Rapid
19	Activity	Suspended
20	Distribution	Confined
21	Style	Single
22	Failure mechanism	Shallow translational
23	History	Initiated in 2020
24	Geomorphology	Lowly dissected slopes
25	Geology	Granite gneiss
26	Structure	Nil
27	Land use/ Land cover	Partially Modified Slope for road
28	Hydrological condition	Damp
29	Triggering Factor	Incessant rainfall
30	Death of persons	Nil
31	People affected	Nil
32	Live-stock loss	Nil
33	Communication	Nil
34	Infrastructure	Nil

35	Agriculture/forest/Barren	Coffee plantation upslope
36	Geo-scientific Causes	The presence of clay-rich thick insitu soil and aggravated by poor drainage to train the surface water.
37	Remedial measures	Construction of a lined hillside drainage to arrest further erosion.
38	Remarks, if any	Nil
39	Photos. Sketch of Plan & section of the slide	
40	Summary/Abstract	A minor shallow translational slide is caused by poor drainage system to drain the surface water subsequent erosion of the toe area of the cut slope.
41	Pdf	Attached
42	Landslide category	III



No	Field	
1	Slide No (LS. No.)	KG/CHI/48O8/2021-22/7
2	State	Karnataka
3	District	Chikkamangalur
4	Toposheet	48O8
5	Name of the slide	North slide
6	NH/SH/Locality	Upslope of Temple
7	Latitude	13.205236°
8	Longitude	75.426479°
9	Length	5m
10	Width	5 m
11	Height	4 m
12	Area	25 sq.m
13	Depth	1 m
14	Volume	25 cu.m
15	Run out distance	0 m
16	Type of Material	Soil
17	Type of movement	Slide
18	Rate of movement	Rapid
19	Activity	Suspended
20	Distribution	Confined
21	Style	Single
22	Failure mechanism	Shallow translational.
23	History	Initiated in August 2020
24	Geomorphology	Moderately dissected slopes
25	Geology	Granite
26	Structure	Nil
27	Land use/ Land cover	Partially Modified Slope/Fill slope
28	Hydrological condition	Dry
29	Triggering Factor	Incessant rainfall
30	Death of persons	Nil
31	People affected	Nil
32	Live-stock loss	Nil
33	Communication	Nil
34	Infrastructure	Partial Road blockage

35	Agriculture/forest/Barren	Coffee plantation upslope
36	Geo-scientific Causes	Steep slope without any provision of toe support system. The material is clay-rich thick insitu soil and aggravated by poor drainage to train the surface water.
37	Remedial measures	Construction of a lined hillside drainage to arrest further erosion.
38	Remarks, if any	
39	Photos. Sketch of Plan & section of the slide	
40	Summary/Abstract	A soil slide is caused due to steep slope cutting without any provision of toe support system. The material is clay-rich thick insitu soil and aggravated by poor drainage to train the surface water. It is recommended to provide a lined hillside drainage to arrest further erosion.
41	Pdf	Attached
42	Landslide category	III

No	Field	
1	Slide No (LS. No.)	KG/CHI/48O8/2021-22/8
2	State	Karnataka
3	District	Chikkamangalur
4	Toposheet	48O8
5	Name of the slide	Yelandur slide
6	NH/SH/Locality	Yelandur
7	Latitude	13.199564°
8	Longitude	75.428616°
9	Length	10
10	Width	7m
11	Height	9 m
12	Area	70 sq.m
13	Depth	1m
14	Volume	70 cu.m
15	Run out distance	5 m
16	Type of Material	Soil
17	Type of movement	Slide
18	Rate of movement	Rapid
19	Activity	Suspended
20	Distribution	Confined
21	Style	Single
22	Failure mechanism	Shallow translational
23	History	August 2019
24	Geomorphology	Lowly dissected slopes
25	Geology	Gneiss
26	Structure	Nil
27	Land use/ Land cover	Partially Modified Slope for road
28	Hydrological condition	Damp
29	Triggering Factor	Incessant rainfall
30	Death of persons	Nil
31	People affected	Nil
32	Live-stock loss	Nil
33	Communication	Nil
34	Infrastructure	Nil

35	Agriculture/forest/Barren	Plantation upslope
36	Geo-scientific Causes	- The steep cutting of slope beyond the angle of repose for construction of the road. No support system was provided.
37	Remedial measures	-Moderation of the slope through benching of the upslope and provision of toe drain to arrest erosion.
38	Remarks, if any	
39	Photos. Sketch of Plan & section of the slide	
40	Summary/Abstract	The shallow translational slide is caused by the steep cutting of slope beyond the angle of repose for construction of the road. The overburden thickness is about 1 m. It is recommended to ease the slope angle through benching.
41	Pdf	Attached
42	Landslide category	III



No	Field	
1	Slide No (LS. No.)	KG/CHI/48O8/2021-22/9
2	State	Karnataka
3	District	Chikkamangalur
4	Toposheet	48O8
5	Name of the slide	Hirebyle slide
6	NH/SH/Locality	Hirebyle
7	Latitude	13.191619°
8	Longitude	75.419432°
9	Length	20m
10	Width	25m
11	Height	17m
12	Area	500 sq.m
13	Depth	1.0m
14	Volume	500 cu.m
15	Run out distance	Nil
16	Type of Material	Debris
17	Type of movement	Slide
18	Rate of movement	Rapid
19	Activity	Suspended
20	Distribution	Widening
21	Style	Single
22	Failure mechanism	Shallow translational
23	History	Initiated in 2019
24	Geomorphology	Moderately dissected slopes
25	Geology	Granite gneiss
26	Structure	Nil
27	Land use/ Land cover	Partially Modified Slope/Thick vegetation
28	Hydrological condition	Dry
29	Triggering Factor	Incessant rainfall
30	Death of persons	Nil
31	People affected	Nil
32	Live-stock loss	Nil
33	Communication	Nil
34	Infrastructure	Temporary road blockage

35	Agriculture/forest/Barren	Forested upslope
36	Geo-scientific Causes	-Presence of concave slope morphometry downslope where the confluence of surface drainage observed and subsequent toe erosion.
37	Remedial measures	Construction of lined cross drain to divert the water from the crown area as well as prevent toe erosion.
38	Remarks, if any	
39	Photos. Sketch of Plan & section of the slide	
40	Summary/Abstract	The shallow translational slide is caused by the confluence of surface drainage and sustained saturation of the overburden material. Linee hillside drainage near the crown is recommended for the site.
41	Pdf	Attached
42	Landslide category	III

No	Field	
1	Slide No (LS. No.)	KG/CHI/48O8/2021-22/10
2	State	Karnataka
3	District	Chikkamangalur
4	Toposheet	48O8
5	Name of the slide	Hemmaki slide
6	NH/SH/Locality	Hemmaki road
7	Latitude	13.212161°
8	Longitude	75.425065°
9	Length	8
10	Width	10 m
11	Height	7 m
12	Area	80 sq.m
13	Depth	1 m
14	Volume	80 cu.m
15	Run out distance	Nil
16	Type of Material	Debris
17	Type of movement	Slide
18	Rate of movement	Rapid
19	Activity	Suspended
20	Distribution	Retrogressive
21	Style	Single
22	Failure mechanism	Shallow translational
23	History	Nil
24	Geomorphology	Moderately dissected slopes
25	Geology	Amphibolite
26	Structure	Nil
27	Land use/ Land cover	Mixed vegetation
28	Hydrological condition	Damp
29	Triggering Factor	Rainfall
30	Death of persons	Nil
31	People affected	Nil
32	Live-stock loss	Nil
33	Communication	Nil
34	Infrastructure	Nil
35	Agriculture/forest/Barren	Forest upslope

36	Geo-scientific Causes	The layer of debris and soil overlying the weathered rock profile. Percolation of water along the debris-weathered rock interface along the steep slope aggravated the landslide.
37	Remedial measures	Construction of breast wall and toe drain to divert the water and prevent toe erosion.
38	Remarks, if any	
39	Photos. Sketch of Plan & section of the slide	
40	Summary/Abstract	A shallow translational failure aggravated by debris overlying the weathered rock and percolation of water along the debris-rock interface. A breast wall along at the toe is recommended on this Hemmaki road stretch.
41	Pdf	Attached
42	Landslide category	III



No	Field	
1	Slide No (LS. No.)	KG/CHI/48O8/2021-22/11
2	State	Karnataka
3	District	Chikkamangalur
4	Toposheet	48O8
5	Name of the slide	Hemmaki slide
6	NH/SH/Locality	Hemmaki road
7	Latitude	13.211987°
8	Longitude	75.424953°
9	Length	5 m
10	Width	4 m
11	Height	4
12	Area	20 sq.m
13	Depth	1m
14	Volume	20 cu.m
15	Run out distance	0 m
16	Type of Material	Debris
17	Type of movement	Slide
18	Rate of movement	Rapid
19	Activity	Suspended
20	Distribution	Confined
21	Style	Single
22	Failure mechanism	Shallow translational
23	History	August 2020
24	Geomorphology	Lowly dissected slopes
25	Geology	Granite
26	Structure	Nil
27	Land use/ Land cover	Partially Modified Slope/Thick vegetation
28	Hydrological condition	Damp
29	Triggering Factor	Incessant rainfall
30	Death of persons	Nil
31	People affected	Nil

32	Live-stock loss	Nil
33	Communication	Nil
34	Infrastructure	Nil
35	Agriculture/forest/Barren	Forested
36	Geo-scientific Causes	The layer of debris and soil overlying the weathered rock profile. Percolation of water along the debris-weathered rock interface along the steep slope aggravated the landslide.
37	Remedial measures	Construction of breast wall and toe drain to divert the water and prevent toe erosion.
38	Remarks, if any	
39	Photos. Sketch of Plan & section of the slide	
40	Summary/Abstract	A shallow translational failure aggravated by debris overlying the weathered rock and percolation of water along the debris-rock interface. A breast wall along at the toe is recommended on this Hemmaki road stretch.
41	Pdf	Attached
42	Landslide category	III

No	Field	
1	Slide No (LS. No.)	KG/CHI/48O8/2021-22/12
2	State	Karnataka
3	District	Chikkamangalur
4	Toposheet	48O8
5	Name of the slide	Hemmaki slide
6	NH/SH/Locality	Hemmaki road
7	Latitude	13.212484°
8	Longitude	75.425198°
9	Length	6 m
10	Width	5m
11	Height	4m
12	Area	30 sq.m
13	Depth	2 m
14	Volume	60 cu.m
15	Run out distance	0 m
16	Type of Material	Debris
17	Type of movement	Slide
18	Rate of movement	Rapid
19	Activity	Suspended
20	Distribution	Retrogressive
21	Style	Single
22	Failure mechanism	Shallow rotational
23	History	Initiated during august 2020
24	Geomorphology	Lowly dissected slopes
25	Geology	Granite gneiss
26	Structure	Nil
27	Land use/ Land cover	Thick vegetation
28	Hydrological condition	Dry
29	Triggering Factor	Incessant rainfall
30	Death of persons	Nil
31	People affected	Nil
32	Live-stock loss	Nil
33	Communication	Nil
34	Infrastructure	Nil

35	Agriculture/forest/Barren	Forested upslope
36	Geo-scientific Causes	-Steep slope with the presence of thick overburden in between the rocky flanks and drainage above the crown flowing over the slope face and saturating the overburden.
37	Remedial measures	- A breastwall with proper drainage system should be erected at the toe.
38	Remarks, if any	
39	Photos. Sketch of Plan & section of the slide	
40	Summary/Abstract	Shallow rotational slide along the steep slope with the presence of thick overburden in between the rocky flanks and drainage above the crown flowing over the slope face and saturating the overburden.
41	Pdf	Attached
42	Landslide category	III



N o	Field	
1	Slide No (LS. No.)	KG/CHI/48O8/2021-22/13
2	State	Karnataka
3	District	Chikkamangalur
4	Toposheet	48O8
5	Name of the slide	Hemmaki slide
6	NH/SH/Locality	Hemmaki road
7	Latitude	13.213854°
8	Longitude	75.425569°
9	Length	80
10	Width	20
11	Height	50
12	Area	1600 sq.m
13	Depth	1 m
14	Volume	1600 cu.m
15	Run out distance	Nil
16	Type of Material	Debris
17	Type of movement	Slide
18	Rate of movement	Rapid
19	Activity	Suspended
20	Distribution	Confined
21	Style	Single
22	Failure mechanism	Shallow translational
23	History	Initiated in August 2020
24	Geomorphology	Lowly dissected slopes
25	Geology	Granite gneiss
26	Structure	Nil
27	Land use/ Land cover	Partially Modified Slope for road
28	Hydrological condition	Dry
29	Triggering Factor	Incessant rainfall
30	Death of persons	Nil
31	People affected	Nil
32	Live-stock loss	Nil
33	Communication	Nil
34	Infrastructure	Nil

35	Agriculture/forest/Barren	Forested upslope
36	Geo-scientific Causes	-Presence of 1-2m thick colluvium material and soil over the steep slope on the flanks of first order stream. Headward erosion aggravated the debris slide.
37	Remedial measures	-Construction of a chute drain and proper drainage system at the toe should be constructed.
38	Remarks, if any	
39	Photos. Sketch of Plan & section of the slide	
40	Summary/Abstract	The shallow translational debris slide in is caused by the preponderance of colluvium on the steep slope at the flanks of the first order stream. It is inventoried along the Hemmaki road stretch.
41	Pdf	Attached
42	Landslide category	III

No	Field	
1	Slide No (LS. No.)	KG/CHI/48O8/2021-22/14
2	State	Karnataka
3	District	Chikkamangalur
4	Toposheet	48O8
5	Name of the slide	Hirebyle slide
6	NH/SH/Locality	Hirebyle
7	Latitude	13.193335°
8	Longitude	75.414127°
9	Length	15 m
10	Width	12m
11	Height	10m
12	Area	180 sq.m
13	Depth	1m
14	Volume	180 cu.m
15	Run out distance	4m
16	Type of Material	Debris
17	Type of movement	Slide
18	Rate of movement	Rapid
19	Activity	Suspended
20	Distribution	Confined
21	Style	Single
22	Failure mechanism	Shallow translational
23	History	Initiated in August 2019
24	Geomorphology	Lowly dissected slopes
25	Geology	Granite
26	Structure	Nil
27	Land use/ Land cover	Coffee plantation
28	Hydrological condition	Dry
29	Triggering Factor	Incessant rainfall
30	Death of persons	Nil
31	People affected	Nil
32	Live-stock loss	Nil
33	Communication	Nil
34	Infrastructure	Nil

35	Agriculture/forest/Barren	Coffee plantation
36	Geo-scientific Causes	-Highly weathered rock with about 1 m thick overburden/residual soil -Concave slope morphometry augmenting water flow accumulation on the slope.
37	Remedial measures	-Construction of drainage to be provided on the hillside along with chute drain on the flanks to prevent possible widening through erosion.
38	Remarks, if any	
39	Photos. Sketch of Plan & section of the slide	
40	Summary/Abstract	The slide is inventoried within the coffee plantation where highly weathered rock with about 1 m thick overburden/residual soil. In addition slope morphometry is concave augmenting water flow accumulation on the slope.
41	Pdf	Attached
42	Landslide category	III



No	Field	
1	Slide No (LS. No.)	KG/CHI/48O8/2021-22/15
2	State	Karnataka
3	District	Chikkamangalur
4	Toposheet	48O8
5	Name of the slide	Hemmaki north slide
6	NH/SH/Locality	Hemmaki
7	Latitude	13.237212°
8	Longitude	75.440448°
9	Length	10m
10	Width	12 m
11	Height	8m
12	Area	120 sq.m
13	Depth	1m
14	Volume	120 cu.m
15	Run out distance	5m
16	Type of Material	Debris
17	Type of movement	Slide
18	Rate of movement	Rapid
19	Activity	Suspended
20	Distribution	Confined
21	Style	Single
22	Failure mechanism	Shallow translational
23	History	Initiated in August 2020
24	Geomorphology	Lowly dissected slopes
25	Geology	Amphibolite
26	Structure	Nil
27	Land use/ Land cover	Partially Modified Slope for road
28	Hydrological condition	Dry
29	Triggering Factor	Incessant rainfall
30	Death of persons	Nil
31	People affected	Nil
32	Live-stock loss	Nil
33	Communication	Nil
34	Infrastructure	Nil

35	Agriculture/forest/Barren	Forest upslope
36	Geo-scientific Causes	-About 1m thick overburden overlying the valley dipping rock. Failure along the overburden-rock interface. -Steep cutting of overburden covered slope for road without proper toe buttress.
37	Remedial measures	-Construction of breast wall with sufficient weep holes and lined drainage to be provided on the hillside along with chute drain on the flanks to prevent possible widening through erosion.
38	Remarks, if any	
39	Photos. Sketch of Plan & section of the slide	
40	Summary/Abstract	It is observed that about 1m thick overburden overlying the valley dipping rock and water percolation along the overburden-rock interface initiated the failure along the road north of Hemmaki.
41	Pdf	Attached
42	Landslide category	III

No	Field	
1	Slide No (LS. No.)	KG/CHI/48O8/2021-22/16
2	State	Karnataka
3	District	Chikkamangalur
4	Toposheet	48O8
5	Name of the slide	Hemmaki north slide
6	NH/SH/Locality	Hemmaki
7	Latitude	13.236980°
8	Longitude	75.439819°
9	Length	15m
10	Width	30m
11	Height	13 m
12	Area	450sq.m
13	Depth	1m
14	Volume	450 cu.m
15	Run out distance	10
16	Type of Material	Debris
17	Type of movement	Slide
18	Rate of movement	Rapid
19	Activity	Suspended
20	Distribution	Confined
21	Style	Single
22	Failure mechanism	Shallow translational
23	History	Initiated in August 2020
24	Geomorphology	Lowly dissected slopes
25	Geology	Granite
26	Structure	Nil
27	Land use/ Land cover	Coffee plantation
28	Hydrological condition	Dry
29	Triggering Factor	Incessant rainfall
30	Death of persons	Nil
31	People affected	Nil
32	Live-stock loss	Nil
33	Communication	Nil
34	Infrastructure	Nil
35	Agriculture/forest/Barren	Forested upslope
36	Geo-scientific Causes	-Thin cover of overburden overlying the highly fractured amphibolite rock. Failure along the overburden-rock interface.

		-Steep cutting of overburden covered slope for road without proper toe buttress.
37	Remedial measures	-Construction of breast wall with sufficient weep holes and lined drainage to be provided on the hillside along with chute drain on the flanks to prevent possible widening through erosion.
38	Remarks, if any	
39	Photos. Sketch of Plan & section of the slide	
40	Summary/Abstract	The shallow translational slide in is caused by steep cutting of the slope without any toe support and water infiltration over the overburden-rock interface. It is recommended to construct a hillside drain to prevent further toe erosion.
41	Pdf	Attached
42	Landslide category	III

No	Field	
1	Slide No (LS. No.)	KG/CHI/4808/2021-22/17
2	State	Karnataka
3	District	Chikkamangalur
4	Toposheet	4808
5	Name of the slide	Hemmaki north slide
6	NH/SH/Locality	Hemmaki
7	Latitude	13.234094°



8	Longitude	75.435418°
9	Length	15
10	Width	20
11	Height	10 m
12	Area	300
13	Depth	2 m
14	Volume	600 cu.m
15	Run out distance	10
16	Type of Material	Soil
17	Type of movement	Slide
18	Rate of movement	Rapid
19	Activity	Suspended
20	Distribution	Confined
21	Style	Single
22	Failure mechanism	Shallow rotational
23	History	Initiated in August 2020
24	Geomorphology	Lowly dissected slopes
25	Geology	Amphibolite
26	Structure	Nil
27	Land use/ Land cover	Partially Modified Slope/Thick vegetation
28	Hydrological condition	Dry
29	Triggering Factor	Rainfall
30	Death of persons	Nil
31	People affected	Nil
32	Live-stock loss	Nil
33	Communication	Nil
34	Infrastructure	Nil
35	Agriculture/forest/Barren	Forested upslope
36	Geo-scientific Causes	-It is observed that the slope has about 2m thick overburden/residual soil and it is cut without provision of toe support system. The left flank of the slide steeper and erosion is more intense at this side.
37	Remedial measures	-Construction of breast wall with sufficient weep holes and lined drainage to be provided on the hillside along with chute drain on the flanks to prevent possible widening through erosion.
38	Remarks, if any	It is assessed as an old slide where vegetation growth has taken place.

39	Photos. Sketch of Plan & section of the slide	
40	Summary/Abstract	The shallow rotational slide in is caused due to steep cutting of an overburden-covered slope for road without proper toe buttress. The slope is characterized by thick overburden/residual soil. It is recommended to construct a breast wall with sufficient weep holes and lined drainage to be provided on the hillside.
41	Pdf	Attached
42	Landslide category	III

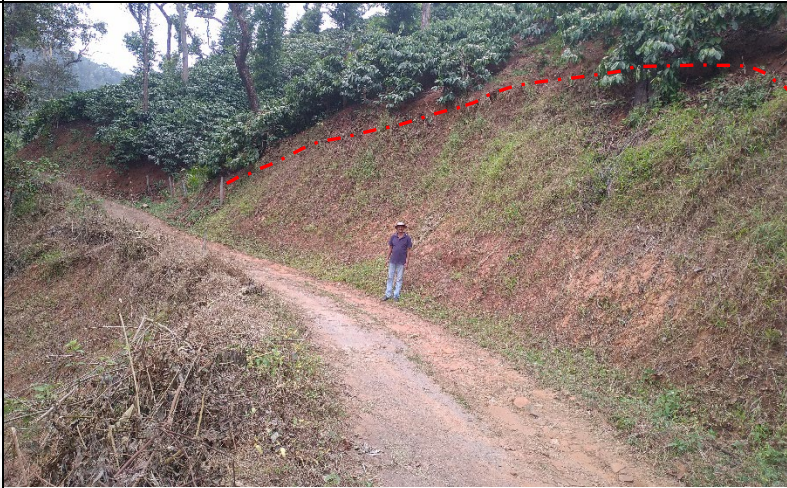
No	Field	
1	Slide No (LS. No.)	KG/CHI/48O8/2021-22/18
2	State	Karnataka
3	District	Chikkamangalur
4	Toposheet	48O8
5	Name of the slide	Hattla slide
6	NH/SH/Locality	Hattla
7	Latitude	13.195354°
8	Longitude	75.423060°
9	Length	18m
10	Width	15 m

11	Height	13 m
12	Area	270 sq.m
13	Depth	1m
14	Volume	270 cu.m
15	Run out distance	Nil
16	Type of Material	Soil
17	Type of movement	Slide
18	Rate of movement	Rapid
19	Activity	Suspended
20	Distribution	Confined
21	Style	Single
22	Failure mechanism	Shallow translational
23	History	August 2019
24	Geomorphology	Lowly dissected slopes
25	Geology	Granite gneiss
26	Structure	Nil
27	Land use/ Land cover	Partially Modified Slope for road
28	Hydrological condition	Dry
29	Triggering Factor	Incessant rainfall
30	Death of persons	Nil
31	People affected	Nil
32	Live-stock loss	Nil
33	Communication	Nil
34	Infrastructure	Temporary road blockage
35	Agriculture/forest/Barren	Coffee plantation upslope
36	Geo-scientific Causes	-Steep slope cutting without any provision of toe buttress for the 2m thick overburden/residual soil cover on the slope height of about 50 m. -Surface drainage observed on the crown area flowing towards the left flank that aggravated the erosion.
37	Remedial measures	-Construction of a breast wall with sufficient weep holes and a lined drainage to be provided on the hillside along with a chute drain on the flanks to prevent possible widening through erosion.
38	Remarks, if any	

39	Photos. Sketch of Plan & section of the slide	
40	Summary/Abstract	The shallow translational slide in is caused due to steep cutting of overburden-covered slope for road widening. The slope is characterized by thick overburden/residual soil. It is recommended to construct a breast wall with sufficient weep holes and lined drainage to be provided on the hillside.
41	Pdf	Attached
42	Landslide category	III

No	Field	
1	Slide No (LS. No.)	KG/CHI/48O8/2021-22/19
2	State	Karnataka
3	District	Chikkamangalur
4	Toposheet	48O8
5	Name of the slide	Hattla slide
6	NH/SH/Locality	Hattla
7	Latitude	13.195735°
8	Longitude	75.424239°
9	Length	13m
10	Width	7m
11	Height	10 m
12	Area	91 sq.m
13	Depth	1 m
14	Volume	91 cu.m
15	Run out distance	Nil
16	Type of Material	Soil



17	Type of movement	Slide
18	Rate of movement	Rapid
19	Activity	Suspended
20	Distribution	Confined
21	Style	Single
22	Failure mechanism	Shallow translational
23	History	August 2019
24	Geomorphology	Moderate dissected hills
25	Geology	Granite gneiss
26	Structure	Nil
27	Land use/ Land cover	Partially Modified Slope
28	Hydrological condition	Dry
29	Triggering Factor	Incessant rainfall
30	Death of persons	Nil
31	People affected	Nil
32	Live-stock loss	Nil
33	Communication	Road partially damaged
34	Infrastructure	Nil
35	Agriculture/forest/Barren	Coffee plantation upslope
36	Geo-scientific Causes	-Thick overburden/residual soil over the steep slope -Steep cutting of overburden covered slope for road without proper toe buttress.
37	Remedial measures	-Breast wall needs to be constructed and lined drainage to prevent toe erosion
38	Remarks, if any	
39	Photos. Sketch of Plan & section of the slide	
40	Summary/Abstract	The shallow translational slide in is caused due to steep cutting of an overburden-covered slope for road without toe support systems. The slope is characterized by thick overburden/residual soil. It is recommended to construct a

		breast wall with sufficient weep holes and lined drainage to be provided on the hillside.
41	Pdf	Attached
42	Landslide category	III

No	Field	
1	Slide No (LS. No.)	KG/CHI/48O8/2021-22/20
2	State	Karnataka
3	District	Chikkamangalur
4	Toposheet	48O8
5	Name of the slide	Hattla slide
6	NH/SH/Locality	Hattla
7	Latitude	13.195924°
8	Longitude	75.424656°
9	Length	10 m
10	Width	8 m
11	Height	7m
12	Area	80 sq.m
13	Depth	1m
14	Volume	80 cu.m
15	Run out distance	Nil
16	Type of Material	Soil
17	Type of movement	Slide
18	Rate of movement	Rapid
19	Activity	Suspended
20	Distribution	Widening
21	Style	Single
22	Failure mechanism	Shallow Translational
23	History	August 2019
24	Geomorphology	Highly dissected slopes
25	Geology	Granite gneiss
26	Structure	Nil
27	Land use/ Land cover	Coffee plantation
28	Hydrological condition	Dry
29	Triggering Factor	Rainfall
30	Death of persons	Nil

31	People affected	Nil
32	Live-stock loss	Nil
33	Communication	Nil
34	Infrastructure	Nil
35	Agriculture/forest/Barren	Forested
36	Geo-scientific Causes	1. The slope forming material is largely immature soil. The granite gneiss is observed to be highly weathered.   2. Concave slope morphometry above the crown area along the slope within which water converge to augment pore water pressure has aggravated instability.
37	Remedial measures	-Breast wall needs to be constructed and lined drainage to prevent toe erosion
38	Remarks, if any	
39	Photos. Sketch of Plan & section of the slide	
40	Summary/Abstract	The shallow translational slide in east is caused due to steep cutting of an overburden-covered slope for road widening. The slope is characterized by thick overburden/residual soil. It is recommended to construct a breast wall with sufficient weep holes and lined drainage to be provided on the hillside.
41	Pdf	Attached
42	Landslide category	III

No	Field	
1	Slide No (LS. No.)	KG/CHI/48O8/2021-22/21
2	State	Karnataka
3	District	Chikkamangalur
4	Toposheet	48O8

5	Name of the slide	Hattla slide
6	NH/SH/Locality	Hattla
7	Latitude	13.195673°
8	Longitude	75.423542°
9	Length	10m
10	Width	70m
11	Height	80m
12	Area	70 sq.m
13	Depth	1 m
14	Volume	70 cu.m
15	Run out distance	Nil
16	Type of Material	Soil
17	Type of movement	Slide
18	Rate of movement	Rapid
19	Activity	Suspended
20	Distribution	Widening
21	Style	Single
22	Failure mechanism	Shallow translational
23	History	August 2019
24	Geomorphology	Lowly dissected hills
25	Geology	Granite gneiss
26	Structure	Nil
27	Land use/ Land cover	Coffee plantation
28	Hydrological condition	Dry
29	Triggering Factor	Rainfall
30	Death of persons	Nil
31	People affected	Nil
32	Live-stock loss	Nil
33	Communication	Nil
34	Infrastructure	Coffee plantation partial damage
35	Agriculture/forest/Barren	Forested
36	Geo-scientific Causes	1.The slope forming material is largely mature soil of about 1 m thick. 2. Concave slope morphometry on the upslope within which surface water flow converged to augment pore water pressure has aggravated instability.
37	Remedial measures	- It is recommended to construct a breastwall at the toe of



		the slide.
38	Remarks, if any	
39	Photos. Sketch of Plan & section of the slide	
40	Summary/Abstract	The shallow translational slide in the Hattla Coffee plantation is caused due to infiltration of surface runoff into the overburden-covered slope. The slope is characterized by thick mature overburden/residual soil. It is recommended to construct a breastwall at the toe of the slide.
41	Pdf	Attached
42	Landslide category	III

No	Field	
1	Slide No (LS. No.)	KG/CHI/48O8/2021-22/22
2	State	Karnataka
3	District	Chikkamangalur
4	Toposheet	48O8
5	Name of the slide	Hattla slide
6	NH/SH/Locality	Hattla
7	Latitude	13.197706°
8	Longitude	75.426592°
9	Length	12m
10	Width	10m
11	Height	10m
12	Area	120 sq.m
13	Depth	2 m
14	Volume	240 cu.m

15	Run out distance	Nil
16	Type of Material	Soil
17	Type of movement	Slide
18	Rate of movement	Rapid
19	Activity	Suspended
20	Distribution	Confined
21	Style	Single
22	Failure mechanism	Shallow translational
23	History	August 2019
24	Geomorphology	Lowly dissected hills
25	Geology	Granite
26	Structure	Nil
27	Land use/ Land cover	Partially Modified Slope/Thick vegetation
28	Hydrological condition	Dry
29	Triggering Factor	Anthropogenic
30	Death of persons	Nil
31	People affected	Nil
32	Live-stock loss	Nil
33	Communication	Nil
34	Infrastructure	1 house partially damaged
35	Agriculture/forest/Barren	Forested
36	Geo-scientific Causes	1. The slope forming material is largely immature soil where steep cutting without toe buttress is observed. 2. Concave slope morphometry on the upslope within which water converges to augment pore water pressure has aggravated instability.
37	Remedial measures	-Channelization of the surface water away from the crown area and construction of breastwall and lined hillside drain to arrest toe erosion
38	Remarks, if any	

39	Photos. Sketch of Plan & section of the slide	
40	Summary/Abstract	The shallow rotational slide in is caused due to steep cutting of an overburden-covered slope for construction of houses without any toe support systems. The slope is characterized by thick overburden/residual soil. It is recommended to construct a breast wall with sufficient weep holes and lined drainage to be provided on the hillside.
41	Pdf	Attached
42	Landslide category	III

No	Field	
1	Slide No (LS. No.)	KG/CHI/48O8/2021-22/23
2	State	Karnataka
3	District	Chikkamangalur
4	Toposheet	48O8
5	Name of the slide	Hattla slide
6	NH/SH/Locality	Hattla
7	Latitude	13.198324°
8	Longitude	75.417662°

9	Length	22m
10	Width	15
11	Height	15
12	Area	330 sq.m
13	Depth	1
14	Volume	330 cu.m
15	Run out distance	Nil
16	Type of Material	Rock
17	Type of movement	Slide
18	Rate of movement	Rapid
19	Activity	Suspended
20	Distribution	Confined
21	Style	Single
22	Failure mechanism	Shallow translational
23	History	August 2019
24	Geomorphology	Lowly dissected hills
25	Geology	Granite gneiss
26	Structure	Nil
27	Land use/ Land cover	Sparse vegetation
28	Hydrological condition	Dry
29	Triggering Factor	Rainfall
30	Death of persons	Nil
31	People affected	Nil
32	Live-stock loss	Nil
33	Communication	Nil
34	Infrastructure	Nil
35	Agriculture/forest/Barren	Plantation upslope
36	Geo-scientific Causes	-Highly fractured rock and overlain by thin debris and residual soil. -Rock fractures dipping in the valley direction
37	Remedial measures	-It is recommended to avoid cutting of the toe area to widen the foot track on the downslope to prevent to erosion.
38	Remarks, if any	



39	Photos. Sketch of Plan & section of the slide	
40	Summary/Abstract	The shallow translational rock slide is caused due to highly fractured and unfavourable disposition and cutting of an overburden-covered slope for the road widening. It is recommended to avoid any slope cutting at the toe area of the slide.
41	Pdf	Attached
42	Landslide category	III

No	Field	
1	Slide No (LS .No.)	KG/CHI/48O8/2021-22/24
2	State	Karnataka
3	District	Chikkamangalur
4	Toposheet	48O8
5	Name of the slide	Chennahadlu slide
6	NH/SH/Locality	Chennahadlu
7	Latitude	13.219795°
8	Longitude	75.419941°
9	Length	25m
10	Width	22m
11	Height	18m
12	Area	550 sq.m
13	Depth	2m
14	Volume	1100 cu.m
15	Run out distance	Nil
16	Type of Material	Soil
17	Type of movement	Slide

18	Rate of movement	Rapid
19	Activity	Suspended
20	Distribution	Retrogressive
21	Style	Single
22	Failure mechanism	Shallow rotational
23	History	August 2019
24	Geomorphology	Moderately dissected hills
25	Geology	Amphibolite
26	Structure	Nil
27	Land use/ Land cover	Coffee and silver oak plantation
28	Hydrological condition	Damp
29	Triggering Factor	Rainfall
30	Death of persons	Nil
31	People affected	Nil
32	Live-stock loss	Nil
33	Communication	Temporary Road blockade
34	Infrastructure	Nil
35	Agriculture/forest/Barren	Forested
36	Geo-scientific Causes	-Slope characterized by thick (2-3m) immature soil. -Toe cutting of the steep slope with thick overburden induced slope instability. -No toe support system was provided after slope cutting.
37	Remedial measures	-Construction of benched gabion wall can prevent the reactivation of the landslide
38	Remarks, if any	
39	Photos. Sketch of Plan & section of the slide	
40	Summary/Abstract	The shallow rotational slide is caused due to steep cutting of

		an overburden covered slope for road widening without toe support. The slope is characterized by thick overburden/residual soil. It is recommended to construct a gabion wall with sufficient weep holes and lined drainage to be provided on the hillside.
41	Pdf	Attached
42	Landslide category	III

No	Field	
1	Slide No (LS.No.)	KG/CHI/4808/2021-22/25
2	State	Karnataka
3	District	Chikkamangalur
4	Toposheet	4808
5	Name of the slide	Chennahadlu slide
6	NH/SH/Locality	Chennahadlu
7	Latitude	13.219752°
8	Longitude	75.418440°
9	Length	13m
10	Width	10 m
11	Height	10 m
12	Area	130 sq.m
13	Depth	1m
14	Volume	130 cu.m
15	Run out distance	Nil
16	Type of Material	Debris
17	Type of movement	Slide
18	Rate of movement	Rapid
19	Activity	Suspended
20	Distribution	Retrogressive
21	Style	Single
22	Failure mechanism	Shallow translational
23	History	August 2019
24	Geomorphology	Lowly dissected hills
25	Geology	Amphibolite
26	Structure	Nil
27	Land use/ Land cover	Silver oak plantation



28	Hydrological condition	Damp
29	Triggering Factor	Rainfall
30	Death of persons	Nil
31	People affected	Nil
32	Live-stock loss	Nil
33	Communication	Nil
34	Infrastructure	Temporary road blockage
35	Agriculture/forest/Barren	Forested
36	Geo-scientific Causes	-Toe cutting of the steep slope for construction of settlement and without any structural support. -The slope is characterized by thin debris and residual soil.
37	Remedial measures	-Construction of line hillside drainage and breastwall at the toe.
38	Remarks, if any	
39	Photos. Sketch of Plan & section of the slide	
40	Summary/Abstract	The shallow translational slide is caused due to steep cutting of an overburden-covered slope for widening of approach road for settlement. The slope is characterized by less compact debris and residual soil. It is recommended to construct a breastwall with sufficient weep holes and lined drainage to be provided on the hillside.
41	Pdf	Attached
42	Landslide category	III

No	Field	
1	Slide No (LS .No.)	KG/CHI/48O8/2021-22/26



62	State	Karnataka
3	District	Chikkamangalur
4	Toposheet	4808
5	Name of the slide	Chennahadlu slide
6	NH/SH/Locality	Chennahadlu
7	Latitude	13.219902°
8	Longitude	75.418781°
9	Length	10m
10	Width	7 m
11	Height	8 m
12	Area	70 sq.m
13	Depth	1m
14	Volume	70 cu.m
15	Run out distance	Nil
16	Type of Material	Debris
17	Type of movement	Slide
18	Rate of movement	Rapid
19	Activity	Suspended
20	Distribution	Retrogressive
21	Style	Single
22	Failure mechanism	Shallow translational
23	History	August 2019
24	Geomorphology	Lowly dissected hills
25	Geology	Amphibolite
26	Structure	Nil
27	Land use/ Land cover	Partially modified slope for construction of road and settlement
28	Hydrological condition	Dry
29	Triggering Factor	Rainfall and alteration of steep slope.
30	Death of persons	Nil
31	People affected	Nil
32	Live-stock loss	Nil
33	Communication	Nil
34	Infrastructure	Partial road blockade
35	Agriculture/forest/Barren	Forested
36	Geo-scientific Causes	-Toe cutting of the steep slope for construction of settlement and without any structural support. -The slope is characterized by thin debris and residual soil.
37	Remedial measures	-Construction of line hillside drainage and breastwall at the toe.
38	Remarks, if any	

39	Photos. Sketch of Plan & section of the slide	
40	Summary/Abstract	The shallow translational slide is caused due to steep cutting of an overburden-covered slope for widening of approach road for settlement and no structural support was provided. The slope is characterized by less compact debris and residual soil. It is recommended to construct a breastwall with sufficient weep holes and lined drainage to be provided on the hillside.
41	Pdf	Attached
42	Landslide category	III

No	Field	
1	Slide No (LS .No.)	KG/CHI/48O8/2021-22/27
2	State	Karnataka
3	District	Chikkamangalur
4	Toposheet	48O8
5	Name of the slide	Chennahadlu slide
6	NH/SH/Locality	Chennahadlu
7	Latitude	13.221490°
8	Longitude	75.418283°
9	Length	20m
10	Width	20m
11	Height	18m
12	Area	400 sq.m
13	Depth	2 m
14	Volume	800 cu.m
15	Run out distance	0
16	Type of Material	Debris
17	Type of movement	Slide
18	Rate of movement	Very rapid
19	Activity	Suspended
20	Distribution	Widening
21	Style	Single
22	Failure mechanism	Shallow translational
23	History	August 2019
24	Geomorphology	Moderately dissected hills
25	Geology	Amphibolite
26	Structure	Nil
27	Land use/ Land cover	Partially Modified Slope for construction of settlement and road
28	Hydrological condition	Dry
29	Triggering Factor	Rainfall and alteration of the steep slope.
30	Death of persons	Nil
31	People affected	Nil
32	Live-stock loss	Nil
33	Communication	Road blockade
34	Infrastructure	1 house abandoned

35	Agriculture/forest/Barren	Forested
36	Geo-scientific Causes	-Slope characterized by thick (2-3m) immature soil. -Toe cutting of the steep slope with thick overburden induced slope instability. -No toe support system was provided after slope cutting.
37	Remedial measures	-Construction of benched gabion wall can prevent the reactivation of the landslide
38	Remarks, if any	
39	Photos. Sketch of Plan & section of the slide	
40	Summary/Abstract	The shallow translational slide in is caused due to steep cutting of an overburden-covered slope for house construction and road widening. N structural support was provided at the time of investigation. It is recommended to construct a breast wall with sufficient weep holes and lined drainage to be provided on the hillside.
41	Pdf	Attached
42	Landslide category	II

No	Field	
1	Slide No (LS. No.)	KG/CHI/4808/2021-22/28
2	State	Karnataka
3	District	Chikkamangalur
4	Toposheet	4808
5	Name of the slide	Chennahadlu slide
6	NH/SH/Locality	Chennahadlu
7	Latitude	13.218696°



8	Longitude	75.420822°
9	Length	15 m
10	Width	10m
11	Height	12m
12	Area	150 sq.m
13	Depth	1m
14	Volume	150 cu.m
15	Run out distance	Nil
16	Type of Material	Debris
17	Type of movement	Slide
18	Rate of movement	Rapid
19	Activity	Suspended
20	Distribution	Retrogressive
21	Style	Single
22	Failure mechanism	Shallow translational
23	History	Initiated in August 2019
24	Geomorphology	Moderately dissected hills
25	Geology	Amphibolite
26	Structure	Nil
27	Land use/ Land cover	Partially Modified Slope/Thick vegetation
28	Hydrological condition	Dry
29	Triggering Factor	Rainfall
30	Death of persons	Nil
31	People affected	Nil
32	Live-stock loss	Nil
33	Communication	Nil
34	Infrastructure	Nil
35	Agriculture/forest/Barren	Forested
36	Geo-scientific Causes	-The slope is characterized by 2-3m thick soil and the left flank of slide is subjected to erosion by first order stream which aggravated the landslide. -No structural toe support was provided for the slope cut.
37	Remedial measures	-Construction of breastwall with weep holes and hillside drainage to arrest further erosion.
38	Remarks, if any	

39	Photos. Sketch of Plan & section of the slide	
40	Summary/Abstract	The shallow translational slide in Chennahadlu is caused by toe erosion of the slope characterized by 2-3m thick soil by first order stream. It is recommended for construction of breastwall with weep holes and hillside drainage to arrest further erosion.
41	Pdf	-
42	Landslide category	III

No	Field	
1	Slide No (LS. No.)	KG/CHI/48O8/2021-22/29
2	State	Karnataka
3	District	Chikkamangalur
4	Toposheet	48O8
5	Name of the slide	Chennahadlu slide
6	NH/SH/Locality	Chennahadlu
7	Latitude	13.219281°
8	Longitude	75.421672°
9	Length	12 m
10	Width	9 m
11	Height	8 m
12	Area	108 sq.km
13	Depth	1m
14	Volume	108 cu.m
15	Run out distance	Nil
16	Type of Material	Debris
17	Type of movement	Slide

18	Rate of movement	Rapid
19	Activity	Suspended
20	Distribution	Retrogressive
21	Style	Single
22	Failure mechanism	Shallow translational
23	History	Initiated in August 2019
24	Geomorphology	Moderately dissected hills
25	Geology	Amphibolite
26	Structure	Nil
27	Land use/ Land cover	Partially Modified Slope/Thick vegetation
28	Hydrological condition	Damp
29	Triggering Factor	Rainfall
30	Death of persons	Nil
31	People affected	Nil
32	Live-stock loss	Nil
33	Communication	Nil
34	Infrastructure	Nil
35	Agriculture/forest/Barren	Forested
36	Geo-scientific Causes	-Sustained toe erosion by the stream at the downslope of the landslide. The material is less compacted debris and residual soil.
37	Remedial measures	-Construction of gabion wall with weep holes and lined drainage to at the toe of the slide.
38	Remarks, if any	
39	Photos. Sketch of Plan & section of the slide	
40	Summary/Abstract	The shallow translational slide near midslope of Chennahadlu is caused due to sustained toe erosion by the stream at the downslope. The slope is characterized by 1-2m overburden/residual soil. It is recommended to construct a gabion wall with sufficient weep holes and lined drainage to at the toe of the slide.

41	Pdf	Attached
42	Landslide category	III

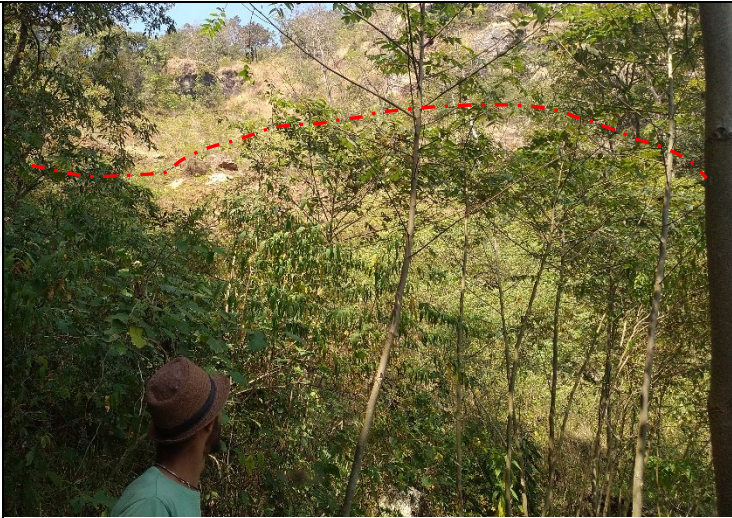
No	Field	
1	Slide No (LS. No.)	KG/CHI/48O8/2021-22/30
2	State	Karnataka
3	District	Chikkamangalur
4	Toposheet	48O8
5	Name of the slide	Chennahadlu slide
6	NH/SH/Locality	Chennahadlu
7	Latitude	13.216833°
8	Longitude	75.421021°
9	Length	12 m
10	Width	15 m
11	Height	7 m
12	Area	180 sq.km
13	Depth	1 m
14	Volume	180 cu.m
15	Run out distance	70m
16	Type of Material	Debris
17	Type of movement	Slide
18	Rate of movement	Rapid
19	Activity	Suspended
20	Distribution	Retrogressive
21	Style	Single
22	Failure mechanism	Shallow translational
23	History	Initiated in 2019
24	Geomorphology	Moderately dissected hills
25	Geology	Granite gneiss
26	Structure	Nil
27	Land use/ Land cover	Partially Modified Slope
28	Hydrological condition	Dry
29	Triggering Factor	Rainfall
30	Death of persons	1
31	People affected	Nil
32	Live-stock loss	Nil
33	Communication	Nil
34	Infrastructure	House damaged
35	Agriculture/forest/Barren	Forested
36	Geo-scientific Causes	-It was observed as a fillslope with low compaction and



		poor drainage system at the crown area to divert the surface water flow.
37	Remedial measures	-It is recommended to avoid further cutting of slope. The fillslope need to be properly compacted and provide suitable drainage system at the crown area.
38	Remarks, if any	
39	Photos. Sketch of Plan & section of the slide	
40	Summary/Abstract	The shallow translational slide was observed within the fillslope with low compaction and poor drainage system at the crown area to divert the surface water flow. It is recommended to avoid further cutting of slope. The fillslope need to be properly compacted and provide suitable drainage system at the crown area.
41	Pdf	-
42	Landslide category	II

No	Field	
1	Slide No (LS. No.)	KG/CHI/48O8/2021-22/31
2	State	Karnataka
3	District	Chikkamangalur
4	Toposheet	48O8
5	Name of the slide	Malleswara gudda slide
6	NH/SH/Locality	Malleswara gudda
7	Latitude	13.220775°
8	Longitude	75.421766°
9	Length	45 m
10	Width	35 m
11	Height	25 m
12	Area	1575 sq.m
13	Depth	2 m

14	Volume	3150 cu.m
15	Run out distance	250
16	Type of Material	Debris
17	Type of movement	Slide
18	Rate of movement	Rapid
19	Activity	Suspended
20	Distribution	Retrogressive
21	Style	Single
22	Failure mechanism	Shallow translational
23	History	Initiated in 2019
24	Geomorphology	Moderately dissected hills
25	Geology	Amphibolite
26	Structure	Nil
27	Land use/ Land cover	Thick vegetation
28	Hydrological condition	Dripping
29	Triggering Factor	Rainfall
30	Death of persons	Nil
31	People affected	Nil
32	Live-stock loss	Nil
33	Communication	Nil
34	Infrastructure	Nil
35	Agriculture/forest/Barren	Forested
36	Geo-scientific Causes	-The slope is characterized 1-2 m of colluvium and steeply dipping. The first order stream has caused headward erosion and aggravated the slide.
37	Remedial measures	-It is recommended that proper lining of drainage and pre-cast pipe of adequate diameter be provided at the downslope where the Hemmaki road is intersected by the drainage.
38	Remarks, if any	

39	Photos. Sketch of Plan & section of the slide	
40	Summary/Abstract	-It is observed that the slope here is characterized 1-2 m of colluvium and thickly forested. The first order stream has caused headward erosion and aggravated the slide. At the landslide initiation point no structural remedial measure may be required because the slide is in remote forest. However, it is recommended that proper lining of drainage and pre-cast pipe of adequate diameter be provided at the downslope where the Hemmaki road is intersected by the drainage.
41	Pdf	Attached
42	Landslide category	III

No	Field	
1	Slide No (LS. No.)	KG/CHI/4808/2021-22/32
2	State	Karnataka
3	District	Chikkamangalur
4	Toposheet	4808
5	Name of the slide	Malleswara gudda slide
6	NH/SH/Locality	Malleswara gudda
7	Latitude	13.221942°
8	Longitude	75.422984°
9	Length	25 m
10	Width	15 m
11	Height	15 m
12	Area	375 sq.m
13	Depth	1 m
14	Volume	375 cu.m
15	Run out distance	50
16	Type of Material	Debris

17	Type of movement	Slide
18	Rate of movement	Rapid
19	Activity	Suspended
20	Distribution	Retrogressive
21	Style	Single
22	Failure mechanism	Shallow translational
23	History	Initiated in 2019
24	Geomorphology	Moderately dissected hills
25	Geology	Amphibolite
26	Structure	Nil
27	Land use/ Land cover	Thick vegetation
28	Hydrological condition	Dripping
29	Triggering Factor	Rainfall
30	Death of persons	Nil
31	People affected	Nil
32	Live-stock loss	Nil
33	Communication	Nil
34	Infrastructure	Nil
35	Agriculture/forest/Barren	Forested
36	Geo-scientific Causes	-The slope is steeply dipping and filled with colluvium. The slide initiated on the right bank of the first order stream which has caused headward erosion and aggravated the slide.
37	Remedial measures	- At the landslide initiation point no structural remedial measure may be required because the slide is in remote forest. However, it is recommended that proper lining of drainage and pre-cast pipe of adequate diameter may be provided at the downslope where the Hemmaki road is intersected by the drainage in the event of debris flow during extreme hydrological condition.
38	Remarks, if any	



39	Photos. Sketch of Plan & section of the slide	
40	Summary/Abstract	-It is observed that the slope here is characterized 1-2 m of colluvium and steeply dipping forested. The first order stream has caused headward erosion and aggravated the slide. The slide is in remote thickly forested area of Malleswara gudda and no immediate structural remedial measure may be required at the site. But the drainage downslope may be provided with suitable structural measures to accommodate debris flow.
41	Pdf	Attached
42	Landslide category	III

No	Field	
1	Slide No (LS. No.)	KG/CHI/48O8/2021-22/33
2	State	Karnataka
3	District	Chikkamangalur
4	Toposheet	48O8
5	Name of the slide	Malleswara gudda slide
6	NH/SH/Locality	Malleswara gudda
7	Latitude	13.222818°
8	Longitude	75.423086°
9	Length	27 m
10	Width	20 m
11	Height	19 m
12	Area	540 sq.m
13	Depth	2 m
14	Volume	1080 cu.m
15	Run out distance	40
16	Type of Material	Debris
17	Type of movement	Slide

18	Rate of movement	Rapid
19	Activity	Suspended
20	Distribution	Retrogressive
21	Style	Single
22	Failure mechanism	Shallow translational
23	History	Initiated in 2019
24	Geomorphology	Moderately dissected hills
25	Geology	Amphibolite
26	Structure	Nil
27	Land use/ Land cover	Thick vegetation
28	Hydrological condition	Dripping
29	Triggering Factor	Rainfall
30	Death of persons	Nil
31	People affected	Nil
32	Live-stock loss	Nil
33	Communication	Nil
34	Infrastructure	Nil
35	Agriculture/forest/Barren	Forested
36	Geo-scientific Causes	- The first order stream has caused headward erosion on both banks of the drainage and aggravated the slide. The slope is characterized by 1-2 m of colluvium.
37	Remedial measures	- It is recommended that proper lining of drainage and pre-cast pipe of adequate diameter may be provided at the downslope where the Hemmaki road is intersected by the drainage in the event of debris flow during extreme hydrological condition.
38	Remarks, if any	
39	Photos. Sketch of Plan & section of the slide	
40	Summary/Abstract	-It is observed that the slope here is characterized 1-2 m of colluvium and steeply dipping forested. The first order stream has caused headward erosion and aggravated the

		slide. The slide is in remote thickly forested area of Malleswara gudda and no immediate structural remedial measure may be required at the site. But the drainage downslope may be provided with suitable structural measures to accommodate debris flow.
41	Pdf	Attached
42	Landslide category	III

No	Field	
1	Slide No (LS. No.)	KG/CHI/48O8/2021-22/34
2	State	Karnataka
3	District	Chikkamangalur
4	Toposheet	48O8
5	Name of the slide	Malleswara gudda slide
6	NH/SH/Locality	Malleswara gudda
7	Latitude	13.223744°
8	Longitude	75.422957°
9	Length	35 m
10	Width	28 m
11	Height	25 m
12	Area	980 sq.m
13	Depth	2 m
14	Volume	1960 cu.m
15	Run out distance	60
16	Type of Material	Debris
17	Type of movement	Slide
18	Rate of movement	Rapid
19	Activity	Suspended
20	Distribution	Retrogressive
21	Style	Single
22	Failure mechanism	Shallow translational
23	History	Initiated in 2019
24	Geomorphology	Moderately dissected hills
25	Geology	Amphibolite
26	Structure	Nil
27	Land use/ Land cover	Thick vegetation
28	Hydrological condition	Flowing
29	Triggering Factor	Rainfall
30	Death of persons	Nil
31	People affected	Nil



32	Live-stock loss	Nil
33	Communication	Nil
34	Infrastructure	Nil
35	Agriculture/forest/Barren	Forested
36	Geo-scientific Causes	-The slope is characterized 1-2 m of colluvium resting over the moderately weathered amphibolite rock. In addition, the first order stream has caused headward erosion and aggravated the slide. Percolation of water into the overburden-rock interface has aggravated the slide.
37	Remedial measures	- It is recommended that proper lining of drainage and pre-cast pipe of adequate diameter may be provided at the downslope where the Hemmaki road is intersected by the drainage in the event of debris flow during extreme hydrological condition.
38	Remarks, if any	
39	Photos. Sketch of Plan & section of the slide	
40	Summary/Abstract	-The slide is inventoried at Malleswara gudda where the slope is characterized 1-2 m of colluvium resting over the moderately weathered amphibolite rock. The first order stream has caused headward erosion and aggravated the slide. It is a natural slide in remote forest with no elements at risk and therefore no immediate remedial measure may be required. But the point of intersection of drainage with Hemmaki road downslope may be provided with suitable structural measures to accommodate debris flow.
41	Pdf	Attached
42	Landslide category	III

No	Field	
1	Slide No (LS. No.)	KG/CHI/48O8/2021-22/35
2	State	Karnataka



3	District	Chikkamangalur
4	Toposheet	48O8
5	Name of the slide	Malleswara gudda slide
6	NH/SH/Locality	Malleswara gudda
7	Latitude	13.225767°
8	Longitude	75.426028°
9	Length	43 m
10	Width	40 m
11	Height	30 m
12	Area	1720 sq.m
13	Depth	2 m
14	Volume	3440 cu.m
15	Run out distance	100m
16	Type of Material	Debris
17	Type of movement	Slide
18	Rate of movement	Rapid
19	Activity	Suspended
20	Distribution	Retrogressive
21	Style	Single
22	Failure mechanism	Shallow translational
23	History	Initiated in 2019
24	Geomorphology	Moderately dissected hills
25	Geology	Amphibolite
26	Structure	Nil
27	Land use/ Land cover	Thick vegetation
28	Hydrological condition	Dripping
29	Triggering Factor	Rainfall
30	Death of persons	Nil
31	People affected	Nil
32	Live-stock loss	Nil
33	Communication	Nil
34	Infrastructure	Nil
35	Agriculture/forest/Barren	Forested
36	Geo-scientific Causes	-The slope is characterized 1-2 m of colluvium and assorted boulders. The slope is steep and the first order stream has caused toe erosion at the downslope area and aggravated the slide.
37	Remedial measures	- It is recommended that proper lining of drainage and pre-cast pipe of adequate diameter may be provided at the downslope where the Hemmaki road is intersected by the

		drainage in the event of debris flow.
38	Remarks, if any	
39	Photos. Sketch of Plan & section of the slide	
40	Summary/Abstract	-It is observed that the slope here is characterized 1-2 m of colluvium and thickly forested. The first order stream has caused toe erosion and aggravated the slide. It is a natural slide in remote forest with no elements at risk and therefore no immediate remedial measure may be required at the landslide site but it is recommended that proper lining of drainage and pre-cast pipe of adequate diameter may be provided at the downslope where the Hemmaki road is intersected by the drainage in the event of debris flow.
41	Pdf	Attached
42	Landslide category	III

No	Field	
1	Slide No (LS. No.)	KG/CHI/48O8/2021-22/36
2	State	Karnataka
3	District	Chikkamangalur
4	Toposheet	48O8
5	Name of the slide	Malleswara gudda slide
6	NH/SH/Locality	Malleswara gudda
7	Latitude	13.229565°
8	Longitude	75.429101°
9	Length	42 m
10	Width	37 m
11	Height	28 m
12	Area	1554 sq.m

13	Depth	2 m
14	Volume	3108 cu.m
15	Run out distance	70
16	Type of Material	Debris
17	Type of movement	Slide
18	Rate of movement	Rapid
19	Activity	Suspended
20	Distribution	Retrogressive
21	Style	Single
22	Failure mechanism	Shallow translational
23	History	Initiated in 2019
24	Geomorphology	Moderately dissected hills
25	Geology	Amphibolite
26	Structure	Nil
27	Land use/ Land cover	Thick vegetation
28	Hydrological condition	Dripping
29	Triggering Factor	Rainfall
30	Death of persons	Nil
31	People affected	Nil
32	Live-stock loss	Nil
33	Communication	Nil
34	Infrastructure	Nil
35	Agriculture/forest/Barren	Forested
36	Geo-scientific Causes	-The slope is characterized 1-2 m of colluvium and assorted boulders. The slope is steep and the first order stream has caused toe erosion at the downslope area and aggravated the slide.
37	Remedial measures	- It is recommended that proper lining of drainage and pre-cast pipe of adequate diameter may be provided at the downslope where the Hemmaki road is intersected by the drainage in the event of debris flow.
38	Remarks, if any	

39	Photos. Sketch of Plan & section of the slide	
40	Summary/Abstract	-It is observed that the slope here is characterized 1-2 m of colluvium and boulders. It is recommended that proper lining of drainage and pre-cast pipe of adequate diameter may be provided at the downslope where the Hemmaki road is intersected by the drainage in the event of debris flow.
41	Pdf	Attached
42	Landslide category	III

No	Field	
1	Slide No (LS. No.)	KG/CHI/48O8/2021-22/37
2	State	Karnataka
3	District	Chikkamangalur
4	Toposheet	48O8
5	Name of the slide	Malleswara gudda slide
6	NH/SH/Locality	Malleswara gudda
7	Latitude	13.233196°
8	Longitude	75.432255°
9	Length	43 m
10	Width	35 m
11	Height	27 m
12	Area	1505 sq.m
13	Depth	2 m
14	Volume	3010 cu.m
15	Run out distance	60
16	Type of Material	Debris
17	Type of movement	Slide
18	Rate of movement	Rapid
19	Activity	Suspended



20	Distribution	Retrogressive
21	Style	Single
22	Failure mechanism	Shallow translational
23	History	Initiated in 2019
24	Geomorphology	Moderately dissected hills
25	Geology	Amphibolite
26	Structure	Nil
27	Land use/ Land cover	Thick vegetation
28	Hydrological condition	Dripping
29	Triggering Factor	Rainfall
30	Death of persons	Nil
31	People affected	Nil
32	Live-stock loss	Nil
33	Communication	Nil
34	Infrastructure	Nil
35	Agriculture/forest/Barren	Forested
36	Geo-scientific Causes	-The slope morphometry is concave augmenting the water flow convergence and is the catchment area for the first order stream. Sustained headward erosion of the colluvium material aggravated the slide.
37	Remedial measures	- It is recommended that proper lining of drainage and pre-cast pipe of adequate diameter may be provided at the downslope where the Hemmaki road and other plantation area is intersected by the drainage in the event of debris flow.
38	Remarks, if any	
39	Photos. Sketch of Plan & section of the slide	

40	Summary/Abstract	-It is observed that the slope here is characterized 1-2 m of colluvium and thickly forested. It is recommended that proper lining of drainage and pre-cast pipe of adequate diameter be provided at the downslope where the Hemmaki road is intersected by the drainage.
41	Pdf	Attached
42	Landslide category	III

No	Field	
1	Slide No (LS. No.)	KG/CHI/48O8/2021-22/38
2	State	Karnataka
3	District	Chikkamangalur
4	Toposheet	48O8
5	Name of the slide	Goomankhan slide
6	NH/SH/Locality	Goomankhan tea state
7	Latitude	13.186041°
8	Longitude	75.411101°
9	Length	15 m
10	Width	12 m
11	Height	8 m
12	Area	180 sq.m
13	Depth	1.5 m
14	Volume	270 cu.m
15	Run out distance	Nil
16	Type of Material	Debris
17	Type of movement	Slide
18	Rate of movement	Rapid
19	Activity	Suspended
20	Distribution	Confined
21	Style	Single
22	Failure mechanism	Shallow translational
23	History	Initiated in 2019
24	Geomorphology	Moderately dissected hills
25	Geology	Amphibolite
26	Structure	Nil
27	Land use/ Land cover	Tea estate
28	Hydrological condition	Dripping
29	Triggering Factor	Rainfall
30	Death of persons	Nil
31	People affected	Nil

32	Live-stock loss	Nil
33	Communication	Nil
34	Infrastructure	Nil
35	Agriculture/forest/Barren	Forested
36	Geo-scientific Causes	-The slope is characterized 1-2 m of immature soil and the steep slope cutting was observed at the site compared to adjacent slope without any structural support system at the toe.
37	Remedial measures	-It is recommended that a breastwall be constructed with proper lining of drainage.
38	Remarks, if any	
39	Photos. Sketch of Plan & section of the slide	
40	Summary/Abstract	- The slide is inventoried at Goomankhan tea estate where the slope is characterized 1-2 m of immature soil and the steep slope cutting was observed at the site compared to adjacent slope without any structural support system at the toe. It is recommended that a breastwall be constructed with proper lining of drainage.
41	Pdf	Attached
42	Landslide category	III

No	Field	
1	Slide No (LS. No.)	KG/CHI/4808/2021-22/39
2	State	Karnataka
3	District	Chikkamangalur
4	Toposheet	4808
5	Name of the slide	Yelandur slide
6	NH/SH/Locality	Yelandur
7	Latitude	13.200817°

8	Longitude	75.425459°
9	Length	15 m
10	Width	20 m
11	Height	13 m
12	Area	300 sq.m
13	Depth	1 m
14	Volume	300 cu.m
15	Run out distance	0
16	Type of Material	Debris
17	Type of movement	Slide
18	Rate of movement	Rapid
19	Activity	Suspended
20	Distribution	Retrogressive
21	Style	Single
22	Failure mechanism	Shallow translational
23	History	Initiated in 2019
24	Geomorphology	Moderately dissected hills
25	Geology	Granite gneiss
26	Structure	Nil
27	Land use/ Land cover	Coffee plantation
28	Hydrological condition	Damp
29	Triggering Factor	Rainfall
30	Death of persons	Nil
31	People affected	Nil
32	Live-stock loss	Nil
33	Communication	Nil
34	Infrastructure	Nil
35	Agriculture/forest/Barren	Forested
36	Geo-scientific Causes	-The slope is characterized 1-2 m of mature soil and steeply dipping. The approach road to coffee plantation was constructed without any structural support drainage system.
37	Remedial measures	-It is recommended to construct a lined hillside drainage system to arrest toe erosion and further reactivation of the slide.
38	Remarks, if any	



39	Photos. Sketch of Plan & section of the slide	
40	Summary/Abstract	-The slide is inventoried within the coffee plantation at Yelandur where the slope is characterized 1-2 m of mature soil and steeply dipping. The approach road to coffee plantation was constructed without any structural support drainage system. It is recommended to construct a lined hillside drainage system to arrest toe erosion and further reactivation of the slide.
41	Pdf	-
42	Landslide category	III

No	Field	
1	Slide No (LS. No.)	KG/CHI/48O8/2021-22/40
2	State	Karnataka
3	District	Chikkamangalur
4	Toposheet	48O8
5	Name of the slide	Hemmaki slide
6	NH/SH/Locality	Hemmaki
7	Latitude	13.220826°
8	Longitude	75.434083°
9	Length	18 m
10	Width	22 m
11	Height	15 m
12	Area	396 sq.m
13	Depth	1 m
14	Volume	396 cu.m
15	Run out distance	0
16	Type of Material	Debris
17	Type of movement	Slide
18	Rate of movement	Rapid

19	Activity	Suspended
20	Distribution	Retrogressive
21	Style	Single
22	Failure mechanism	Shallow translational
23	History	Initiated in august 2019
24	Geomorphology	Moderately dissected hills
25	Geology	Granite gneiss
26	Structure	Nil
27	Land use/ Land cover	Arecanut plantation
28	Hydrological condition	Damp
29	Triggering Factor	Rainfall
30	Death of persons	Nil
31	People affected	Nil
32	Live-stock loss	Nil
33	Communication	Nil
34	Infrastructure	Nil
35	Agriculture/forest/Barren	Forested
36	Geo-scientific Causes	-The slope is characterized 1-2 m of colluvium soil and the slope has been subjected to sustained toe erosion by the 2 nd order stream at the left flank which aggravated the landslide.
37	Remedial measures	-It is recommended to construct a gabion wall or drystone wall to arrest the toe erosion by the stream.
38	Remarks, if any	

39	Photos. Sketch of Plan & section of the slide	
40	Summary/Abstract	-The slide is inventoried at Hemmaki area where the slope is characterized 1-2 m of colluvium soil and the slope has been subjected to sustained toe erosion by the 2 nd order stream at the left flank which aggravated the landslide. It is recommended to construct a gabion wall or drystone wall to arrest the toe erosion by the stream.
41	Pdf	
42	Landslide category	III

N o	Field	
1	Slide No (LS. No.)	KG/CHI/48O8/2021-22/41
2	State	Karnataka
3	District	Chikkamangalur
4	Toposheet	48O8
5	Name of the slide	Bilagali slide
6	NH/SH/Locality	Bilagali
7	Latitude	13.189177°
8	Longitude	75.424377°
9	Length	25 m
10	Width	20 m
11	Height	20 m

12	Area	500 sq.m
13	Depth	1 m
14	Volume	500 cu.m
15	Run out distance	10
16	Type of Material	Debris
17	Type of movement	Slide
18	Rate of movement	Rapid
19	Activity	Active
20	Distribution	Retrogressive
21	Style	Single
22	Failure mechanism	Shallow rotational
23	History	Initiated in 2020
24	Geomorphology	Moderately dissected hills
25	Geology	Granite gneiss
26	Structure	Nil
27	Land use/ Land cover	Coffee plantation
28	Hydrological condition	Damp
29	Triggering Factor	Rainfall
30	Death of persons	Nil
31	People affected	Nil
32	Live-stock loss	Nil
33	Communication	Nil
34	Infrastructure	Nil
35	Agriculture/forest/Barren	Forested
36	Geo-scientific Causes	-The slope is characterized 1-2 m of immature soil and colluvium and steeply dipping. First order stream was seen to have active erosion on the slope.
37	Remedial measures	-It is recommended to monitor and observe for any indicators of slope instability such as cracks on the upslope because there is a settlement 60m on the upslope. It is recommended to construct proper drainage system and drystone walls to arrest the toe erosion by the stream.
38	Remarks, if any	



39	Photos. Sketch of Plan & section of the slide	
40	Summary/Abstract	-The slide is inventoried in Bilagali where the slope is characterized 1-2 m of immature soil and colluvium and steeply dipping. First order stream was seen to have active erosion on the slope. It is recommended to monitor and observe for any indicators of slope instability such as cracks on the upslope because there is a settlement 60m on the upslope. It is recommended to construct proper drainage system and drystone walls to arrest the toe erosion by the stream.
41	Pdf	
42	Landslide category	III

No	Field	
1	Slide No (LS. No.)	KG/CHI/4808/2021-22/42
2	State	Karnataka
3	District	Chikkamangalur
4	Toposheet	4808
5	Name of the slide	Bilagali slide
6	NH/SH/Locality	Bilagali
7	Latitude	13.186824°
8	Longitude	75.427937°
9	Length	27 m
10	Width	22 m
11	Height	10 m
12	Area	594 sq.m

13	Depth	2 m
14	Volume	1188 cu.m
15	Run out distance	10
16	Type of Material	Debris
17	Type of movement	Slide
18	Rate of movement	Rapid
19	Activity	Suspended
20	Distribution	Retrogressive
21	Style	Single
22	Failure mechanism	Shallow rotational
23	History	Initiated in 2019
24	Geomorphology	Moderately dissected hills
25	Geology	Granite gneiss
26	Structure	Nil
27	Land use/ Land cover	Arecanut plantation
28	Hydrological condition	Damp
29	Triggering Factor	Rainfall
30	Death of persons	Nil
31	People affected	Nil
32	Live-stock loss	Nil
33	Communication	Nil
34	Infrastructure	Nil
35	Agriculture/forest/Barren	Forested
36	Geo-scientific Causes	-The slope is characterized about 2 m of mature soil. The slope is gentle but the third order stream was observed to have active bank erosion in the area. Creep movement due to the sustained erosion of the bank can be seen.
37	Remedial measures	-It is recommended to construct proper drainage system and drystone walls to arrest the toe erosion by the stream. In addition, concrete retaining wall may be constructed near the adjacent bridge to arrest erosion of the bridge abutment area.
38	Remarks, if any	

39	Photos. Sketch of Plan & section of the slide	
40	Summary/Abstract	-The slide is inventoried in Bilagali where the slope is characterized by about 2 m mature residual soil. Third order stream was also observed where active bank erosion can be seen. It is recommended to construct proper drainage system and drystone walls to arrest the toe erosion by the stream. In addition, concrete retaining wall may be constructed near the adjacent bridge to arrest erosion of the bridge abutment area.
41	Pdf	-
42	Landslide category	III

Annexure – IV- Rock Mass Rating							
Sl no	Lat/Long	Rock type	RMR _{basic}		Range of values	Ratings	Rock mass class
1	13.203004°/75.409767°	Granite gneiss	Uniaxial Compressive strength		40 Mpa	4	III
			RQD		72%	13	
			Spacing of joints		50 cm	8	
			Condition of Discontinuities	Persistence	8m	2	
				Aperture	>5mm	0	
				Roughness	Slightly rough	3	
				Infilling	None	6	
				Weathering	Slightly weathered	5	
				Groundwater	Completely dry	15	
Total				56			
2	13.204239°/75.414654°	Granite gneiss	Uniaxial Compressive strength		41 Mpa	4	II
			RQD		95%	20	
			Spacing of joints		50cm	10	
			Condition of Discontinuities	Persistence	2m	4	
				Aperture	>5mm	0	
				Roughness	Slightly rough	3	
				Infilling	None	6	
				Weathering	Slightly weathered	5	
				Groundwater	Completely dry	15	
Total				67			
	13.199812°/75.417586°		Uniaxial Compressive strength		58 MPa	7	
			RQD		95%	20	
			Spacing of joints		2m	20	
				Persistence	8m	2	



3		Porphyritic granite	Condition of Discontinuities	Aperture	None	6	I
				Roughness	Smooth	1	
				Infilling	None	6	
				Weathering	Unweathered	6	
				Groundwater	Completely dry	15	
			Total			83	
4	13.198582°/ 75.417871°	Porphyritic granite	Uniaxial Compressive strength		50 Mpa	7	II
			RQD		95%	20	
			Spacing of joints		>m	15	
			Condition of Discontinuities	Persistence	9m	2	
				Aperture	3mm	1	
				Roughness	Slightly rough	3	
				Infilling	None	6	
				Weathering	Slightly weathered	5	
				Groundwater	Completely dry	15	
			Total			74	

Sl no	Lat/Long	Rock type	RMR _{basic}		Range of values	Ratings	Rock mass class
5	13.187666°/ 75.424421°	Granite gneiss	Uniaxial Compressive strength		51 Mpa	7	II
			RQD		91%	20	
			Spacing of joints		1 m	15	
			Condition of Discontinuities	Persistence	8m	2	
				Aperture	>5mm	0	
				Roughness	Slightly rough	3	
				Infilling	None	6	
				Weathering	Slightly weathered	5	

				Ground water	Completely dry	15	
			<b>Total</b>			<b>73</b>	
6	13.221537°/ 75.421956°	Amphibolite	Uniaxial Compressive strength		38 Mpa	4	III
			RQD		60 %	13	
			Spacing of joints		50cm	10	
			Condition of Discontinuities	Persistence	9m	2	
				Aperture	>5mm	0	
				Roughness	Slightly rough	3	
				Infilling	None	6	
				Weathering	Slightly weathered	5	
				Groundwater	Dripping	4	
			<b>Total</b>			<b>47</b>	
7	13.222018°/75.420266°	Amphibolite	Uniaxial Compressive strength		54 Mpa	7	II
			RQD		68%	13	
			Spacing of joints		1m	15	
			Condition of Discontinuities	Persistence	9m	2	
				Aperture	>5mm	0	
				Roughness	Slightly rough	3	
				Infilling	None	6	
				Weathering	Slightly weathered	5	
				Groundwater	Completely dry	15	
			<b>Total</b>			<b>66</b>	

Sl no	Lat/Long	Rock type	RMR _{basic}	Range of values	Ratings	Rock mass class
8			Uniaxial Compressive strength	42 Mpa	4	
			RQD	70%	13	
			Spacing of joints	80cm	15	

	13.224808°/ 75.423611°	Amphibolite	Condition of Discontinuities	Persistence	2m	4	<b>II</b>
				Aperture	>5mm	0	
				Roughness	Slightly rough	3	
				Infilling	None	6	
				Weathering	Slightly weathered	5	
				Groundwater	Completely dry	15	
			<b>Total</b>			<b>65</b>	
<b>9</b>	13.226463°/ 75.425665°	Amphibolite	Uniaxial Compressive strength		49 Mpa	4	<b>II</b>
			RQD		68%	13	
			Spacing of joints		60cm	15	
			Condition of Discontinuities	Persistence	7m	2	
				Aperture	>5mm	0	
				Roughness	Slightly rough	5	
				Infilling	None	6	
				Weathering	Slightly weathered	5	
				Groundwater	Completely dry	15	
			<b>Total</b>			<b>65</b>	
<b>10</b>	13.228434°/ 75.428000°	Amphibolite	Uniaxial Compressive strength		52 MPa	7	<b>I</b>
			RQD		70%	13	
			Spacing of joints		>2 m	20	
			Condition of Discontinuities	Persistence	<1m	6	
				Aperture	<0.1mm	5	
				Roughness	Rough	5	
				Infilling	None	6	
				Weathering	Slightly weathered	5	
				Groundwater	Completely dry	15	
			<b>Total</b>			<b>82</b>	