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भारतीय भूवैज्ञानिक सर्वेक्षण

GOVERNMENT OF INDIA
GEOLOGICAL SURVEY OF INDIA

कर्नाटक राज्य के उडपी, चिकमंगलुरु और दक्षिणी कन्नड़ जनपदों की टोपोशीट संख्या 48 O/3 एवं 4 के भागों में स्थूल पैमाने (1:50,000) पर भूस्खलन संवेदनशीलता मानचित्रण

(मद कूट: एम4एल.एस.एस.एम./एन.सी.एस.आर./के.जी./2017/12164)

(कार्यसत्र: 2017-18)

MACRO-SCALE (1:50,000) LANDSLIDE SUSCEPTIBILITY MAPPING IN PARTS OF TOPOSHEET NO. 48 O/3 & 4, UDUPI, CHIKMANGALURU AND DAKSHIN KANNADA DISTRICTS, KARNATAKA

(FSP CODE: M4LSSM/NC/SR/SU-KG/2017/12164)

(Field Season 2017-18)

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Project

भूस्खलन संवेदनशीलता मानचित्रण
Landslide Susceptibility Mapping

राज्य इकाई: कर्नाटक व गोवा,
दक्षिणी क्षेत्र

State Unit: Karnataka and Goa
Southern Region

बेंगलुरू / Bengaluru

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कासाका: एम4एलएसएसएम/एनसी/एसआर/एसयू-केजी/2017/12164

(कार्य सत्र: 2017-18)

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सारांश

भारतीय भूवैज्ञानिक सर्वेक्षण (भाभूस) भारत में भूस्खलन का केंद्रक अभिकरण है। इस कारण से भाभूस के द्वारा भूस्खलन अध्ययन के लिए मानक क्रिया पद्धति निर्धारित किए गए है। अध्ययन में विभिन्न विषयक परतों के उपयोग यानि भूमि उपयोग/भूमि परत (एलयूएलसी), भूआकृतिविज्ञान, ढाल गठन पदार्थ (एसएफएम), ढाल अभिमुखता, ढाल वक्रता अपवाह-तंत्र आदि के अध्ययन शामिल हैं। स्थानीय भूभाग की अवस्थाओं को ध्यान में रखते हुए हर एक विषयक परत व उसके वर्गों को भारण प्रदान किए गए है।

पर्याप्त सुदूर संवेदन आँकड़ों व आर्क-जीआईएस में भूमि उपयोग/भूमि परत (एलयूएलसी), भूआकृतिविज्ञान, ढाल गठन पदार्थ, ढाल प्रवणता व ढाल वक्रता जैसे विषयगत परतों के उपयोग करके बहु-कालिक गूगल इमेजरी के दृश्य व्याख्या के द्वारा 1:50000 पैमाने पर टोपोशीट संख्या 48ओ/3 व ओ/4 के भागों में भूस्खलन सुग्राहिता मानचित्रण किया गया।

किसी के क्षेत्र का भूस्खलन सुग्राहिता मानचित्रण क्षेत्र के ढलान फेलियर का गुणात्मक अध्ययन है जो भूस्खलन के लिए निम्न, मधय्म व उच्च के रूप में सुग्राही क्षेत्रों को अभिनिर्धारित करने पर केंद्रित है। जीआईएस के आधार पर भारित बहु वर्ग सूचक उपरिशायी का उपयोग करते हुए विषयगत परतों के रूप में विभिन्न घटक मानचित्रों को भूस्खलन सुग्राहिता को मान्य प्रदान करने के लिए उपयोग किए जाते हैं।

एलयूएलसी के अनुसार क्षेत्र को घने वनस्पति, निम्न ऊँचाई वाले बागान (एलएचपी), मध्यम वनस्पति, उच्च ऊँचाई वाले बागान (एचएचपी), कृषि, अनुत्पादक भूमि, व्यापक ढलान कर्तन, खदान, बस्ती, विरल वनस्पति, संशोधित ढाल पर बस्ती व जल स्त्रोत आदि में विभाजित किए गए हैं। अधिकांश क्षेत्र कुद्रेमुख और श्रिंगेरी के घने वन प्रक्षेत्र सहित सघन वनस्पति से आच्छादित है। अन्वेषण के अधीन आने वाले क्षेत्र में सघन वनस्पति (वन आवरण) जैसे एलयूएलसी श्रेणी के एक व्यापक रेंज है जो टोपोशीट ओ/4 के अधिकांश भागों में और कुछ टोपोशीट ओ/3 में उत्तरी और मध्य भागों में विस्तृत हैं। टॉपशीट ओ/4 में व्यापक रूप से अधिकांश शहरी समूह आते हैं, जिसमें कतिपय बस्तियाँ टोपोशीट ओ/3 के मध्य व उत्तर-पूर्वी चतुर्थांश में आती हैं। कतिपय शहरी समूहों में करकला, वेणूर, अजेकर, मुनीयल, कोक्क्राड़ी, सोमेश्वर, माला और अलादंगाड़ी शामिल हैं।

भूआकृतिक रूप से, अध्ययन क्षेत्र मुख्यतया पेडिमेंट-पदस्थली जटिल शैल समूह युक्त तरंगित भूभाग है जिसके पश्चात अति विच्छेदित ढाल, निम्न रूप से विच्छेदित ढाल व प्रवाही मैदान आते हैं। उच्च और मध्यम रूप से विच्छेदित क्षेत्र अधिकतर कुद्रेमुख और श्रिंगेरी के घने वन प्रक्षेत्रों में सीमित हैं।

भूमि उपयोग/भूमि परत (एलयूएलसी), भूआकृतिविज्ञान, ढाल गठन पदार्थ (एसएफएम) हेतु आईआरएस एलएसआईएसएस III आँकड़ों व बहु-कालिक गूगल इमेजरी के दृश्य व्याख्या के माध्यम से आर्कजीआईएस में पूर्व-क्षेत्रीय मानचित्र तैयार किए गए। गूगल इमेजरी के अलावा, भूविज्ञान, एलयूएलसी व भूआकृतिक मानचित्रों के एकीकरण के द्वारा ढाल गठन के पदार्थों के न्यायिक प्रागुक्ति की गई व क्षेत्र से प्राप्त आँकड़ों व ढाल गठन पदार्थों की सहायता से इन्हें अद्यतन किया गया। क्षेत्र में ढाल गठन पदार्थों को शैल (इसमें एम्फिबोलाइट, पट्टित मैग्नेटाइट-क्वार्टज़ाइट, चार्नोकाइट, संगुटिकाश्म, डोलराइट, गैब्रो, ग्रेनाइट, ग्रेनाइट-नाइस, ग्रेनाइटाभ, लैटराइट, चूना पत्थर, मेटा-अतिमैफाइट, मेटा-बेसाल्ट, क्वार्ट्ज़ युक्त पॉर्फोरी, क्वार्ट्ज़ शिराएँ, क्वार्ट्ज़-क्लोराइट-शिस्ट, क्वार्ट्ज़ाइट, अतिअतिमैफाइट शामिल हैं), अपक्षयित चट्टान व स्वस्थाने मृदा में वर्गीकृत किया जा सकता है। ढाल आकारमिति, ढाल अभिमुखता व वक्रता एवं अपवाह-तंत्र मानचित्रों के द्वारा अभिनिर्धारित किए गए है, ये मानचित्र अंकीय उत्थान प्रतिकृति (डीईएम) से लिए गए हैं। अधिकांश भूस्खलन 15°-25° के ढाल रेंज में आते हैं। वक्रता मानचित्रण को 3 वर्गों, यानि उत्तल, समतल और अवतल ढालों में वर्गीकृत किया गया है जिनकी संबंधित वक्रताएँ <-0.1, -0.1 से 0.1 व > 0.1 हैं।

वर्तमान विश्लेषण के अनुसार, क्षेत्र में भूस्खलन संभवत: मार्ग (सड़क) विस्तारण (सड़क को चौड़े करना), पहाड़ी भागों में नए मार्ग (सड़क) के निर्माण हेतु ढाल संशोधन एवं कतिपय जगहों में परित्यक्त लैटराइट शैल खदान के पास छोड़े गए उत्खनित पदार्थों की गलत अभिक्रिया का परिणाम है। देखे गए अधिकतर कर्तन ढाल फेलियर आगुम्बे घाट सेक्शन, कुद्रेमुख, सीता-नदी व श्रिंगेरी वन क्षेत्रों के अंदर स्थित हैं। इन फेलियर के आसपास में देखे गए ढाल गठन पदार्थ स्वस्थाने मृदा और अपक्षयित शैलो से निर्मित है। यद्यपि कतिपय भूस्खलनों को धारण भित्तियों व बेंचिंग के द्वारा नियंत्रित किए गए हैं, किंतु कतिपय जगहों में इन धारण वाली भित्तियों व बेंचिग में उभार/विदारण से सूक्ष्म छिद्रों के संवृत्त होने की अवस्था से सूक्ष्म छिद्रों में जल दाब देखा गया है। क्षेत्र में पाए गए कर्तन ढाल लगभग 5 मीटर ऊँचा है व इन ढालों के ऊर्ध्वाधर ढाल 80° व 90° के बीच में है। फेलियर मुख्यतया मार्गों (सड़कों)/बस्तियों के निर्माण के लिए पहाड़ी ढाल के गिरिपाद के कर्तन के कारण है। इसके अलावा, अति अपक्षयित/वलनित, विभंगित/अपरूपित चट्टान समूह व अति वर्षा के प्रभाव ढाल फेलियर को उत्पन्न करने में सहायक कारक का कार्य करते हैं। पश्चिमी घाट में मॉनसून के दौरान होते अतिवर्षा सामान्यतया क्षेत्र में अधिकांश भूस्खलनों के प्रवर्तन के लिए जानी जाती है।

क्षेत्र में कुल चालीस ढाल फेलियर/स्खलन अभिनिर्धारित किए गए हैं। स्खलन उथले स्थानांतरीय प्रकृति के हैं व अधिकतर स्खलन मार्गों के किनारों में सीमित हैं जो ढीले व अपक्षयित शैलों से निर्मित हैं।

क्षेत्र में अपर्याप्त भूस्खलन आँकड़ों के कारण, सुग्राहिता मॉडलिंग विश्लेषणात्मक पदानुक्रम प्रक्रिया (एएचपी) के द्वारा किया जाता है जिसमें प्रत्येक कारक को रेटिंग व अंतर-भविष्यवक्ता भार विशेषज्ञ या ज्ञान संचालित तकनीकों का प्रयोग करके दिया जाता है। मात्रात्मक मैट्रिक्स में इस ज्ञान-संचालित अनुपात/भार विभिन्न भूकारक वर्गों के लिए गुणात्मक युगल-वार पर महत्वपूर्ण मैट्रिक्स को निर्माण करने/इस पर निर्णय लेने के पश्चात व स्थानीय विशेषज्ञों और क्षेत्र में भूस्खलन के अध्ययन में रत भूस्खलन वैज्ञानिकों से प्राप्त टिप्पणियों के बाद एएचपी की सहायता से गणितीय रूप से आसानी से निर्धारित किए जा सकते है। लगभग 10.44% (लगभग 156.41 वर्ग किलोमीटर) क्षेत्र उच्च सुग्राहिता वाले संस्तर में आते है, जबकि लगभग 25.95% (388.81 वर्ग किलोमीटर) क्षेत्र मध्यम सुग्राहिता वाले संस्तर में व शेष संस्तर निम्न सुग्राहिता क्षेत्र में स्थित है।

Macro-scale (1:50,000) landslide susceptibility mapping in parts of Toposheets nos. 48 O/3 & 4, Udupi, Chikmangaluru & Dakshin Kannada districts, Karnataka.

FSP CODE: M4LSSM/NC/SR/SU-KG/2017/12164

(Field Season 2017-18)

By

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ABSTRACT

Geological Survey of India (GSI), being the nodal agency for Landslides in India, has put forward a standard operating procedure for carrying-out landslide studies. The studies involve the use of various thematic layers, viz Land use/ Land Cover (LULC), Geomorphology, Slope Forming Material (SFM), Slope aspect, Slope gradient, Slope Curvature Drainage. Each thematic layer and its classes are assigned weightages as per their role in slope failures keeping in view the local terrain conditions.

Landslide Susceptibility Mapping in parts of Topo-sheet no's 48 O/3 and O/4 was carried out on 1:50000 scale using adequate remote sensing data and thematic layers like Land use/ Land Cover (LULC), Geomorphology, Slope Forming Material, Slope gradient and Slope Curvature in Arc GIS through visual interpretation of multi-temporal Google Imagery.

Landslide Susceptibility Mapping is a qualitative study of slope failures in an area with focus on identifying zones susceptible to landslides as low, moderate and high. Various factor maps in the form of thematic layers are used to validate landslide susceptibility using weighted multiclass index overlay on GIS platform.

The area in terms of LULC is divided into: Thick Vegetation, Low Height Plantation (LHP), Moderate Vegetation, High Height Plantation (HHP), Cultivation, Barren, Extensive Slope Cut, Quarry, Settlement, Sparse Vegetation, Settlement on modified slope and Water Body. Most of the area is covered by Thick vegetation including the thick forest ranges of Kudremukh and Singeri. The area under investigation has a wide range of LULC classes like thick vegetation (forest cover) covering most parts of O/4 toposheet and some northern and central parts in toposheet O/3. The urban agglomerations are mostly widespread in toposheet O/4, with some settlements in central and north-east quadrant of toposheet O/3. Some of the urban agglomerations include Karkala, Venoor, Ajekar, Muniyal, Kokkradi. Someshwar, Mala and Aladangadi.

Geomorphologically, the study area is an undulating terrain dominated by pediment-pediplain complex followed by Highly Dissected Slope, Lowly Dissected Slope and Rolling

plains. Highly and moderately dissected areas are mostly confined to the thick forest ranges of Kudremukh and Sringeri.

Pre-field maps for Land use/ Land Cover (LULC), Geomorphology, Slope Forming Material (SFM), were prepared in ArcGIS through visual interpretation of IRS LISS III data and multi-temporal Google Imagery. In addition to using Google imagery, judicious prediction of slope forming material was made by integrating geology, LULC and geomorphology maps and these were updated with field data and finalized the slope forming material map. Slope Forming Material in the area can be classified into rock (including amphibolite, Banded-magnetite-quartzite, Charnokite, Conglomerate, Dolerite, Gabbro, Granite, Granite-gneiss, Granitoid, Laterite, Limestone, Meta-ultramafite, Meta-basalt, Quartz porphyry, Quartz vein, Quartz-chlorite-schist, Quartzite, Ultramafite), weathered rock and in-situ soil. Slope morphometry defined by slope gradient and curvature, and drainage maps were derived from Digital Elevation Model (DEM). Most of the slides are observed to have occurred in slope range of 15°-25°.Curvature map is classified into 3 classes, i.e., convex, flat and concave slopes corresponding to curvatures < -0.1, -0.1 to 0.1 and >0.1.

As per the present analysis, Landslides in the area are probably the outcome of slope modification for road widening, construction of new roads in hilly regions and at places the improper treatment of loose excavated material near abandoned laterite rock quarries. Most of these Cut slope failures observed are located within the Forest areas including Agumbe ghat section, Kudremukh, Sita-nadi and Sringeri forest areas. The Slope forming material in the vicinity of these failures is in-situ soil and weathered rock. Although some of the failures have been controlled by retention walls and benching, but at places bulging/disruption of these retaining walls, chocking of weep holes creating pore water pressure were observed. The cut slopes in the area are about 5m high with a vertical slope angle between 80º and 90º. The failures are mainly due to toe-cutting of hill slopes for the construction of road/settlement. In addition, the presence of highly weathered/folded, fractured/shearing rock mass and the impact of heavy rainfall are the aiding factors in creating slope failures. The heavy rainfall in the Western Ghats during monsoon is in general known to trigger most of landslides in the area.

A total of forty slope failures/slides were identified in the area. The slides in the area are of shallow translational nature and are mostly confined to the roads having loose and weathered material on sides.

Due to insufficient landslide data in the area, the susceptibility modelling is carried out by Analytical Hierarchy Process (AHP) wherein ratings and inter-predictor weights were

given to individual factors using expert or knowledge driven techniques. This knowledge-driven ratings/weights in quantitative matrices can easily be determined mathematically using AHP, after preparing/deciding on the qualitative pair-wise importance matrix for different geo factor classes and comments received from local experts and landslide scientists engaged in landslide studies in the area. Approximately, 10.44 % (about 156.41 sq. km) area is falling in high susceptibility zones while about 25.95 % (388.81 sq. km) area is falling in moderate susceptibility zone and rest of the area falls in low susceptibility zone.

Macro-scale (1:50,000) landslide susceptibility mapping in parts of Toposheets nos. 48 O/3 & 4, Udupi, Chikmangaluru & Dakshin Kannada districts, Karnataka

FSP CODE: M4LSSM/NC/SR/SU-KG/2017/12164

(Field Season 2017-18)

By

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I. INTRODUCTION

1.1 Background:

Landslides in Western Ghats are a recurring problem for years, causing disruption in communication routes, damaging properties and killing people. The road development, the shifting of agricultural practice from orthodox seasonal crops to cash crops has put tremendous pressure on the natural slopes of the Western Ghats. With passage of time the modification of slopes due to human interference in the natural slope has deteriorated the equilibrium attained by nature. While not every landslide results in catastrophe, the damage from many small ones may equal or exceed the impact of a single major failure. Thus, both large and small landslides are capable of causing significant damage and loss to life. With every passing monsoon over the Western Ghats, a number of landslides are triggered. The blockade, damage and disruption of traffic along important roads linking the major cities create lot of inconvenience for the public.

Geological Survey of India (GSI), being the nodal agency for Landslides in India, started integrated approach towards landslide hazard studies which included site specific landslide studies, landslide hazard zonation along important road corridors, around townships and preparation of landslide inventory.

GSI has been carrying out landslide susceptibility zonation/mapping on macro scale (1:50,000/ 25,000) since last 3 to 4 decades. However, compared to the available landslide-prone areas in India (~0.42 Million sq. km spreading over 1112 Survey of India 1: 50,000 scale Topographic Sheets), the target achieved so far (~60,000 sq. km) is quite less. This warrants GSI, being the nodal agency for landslide studies in India, to impart maximum stress towards completion of this basic data generation work on landslides by aiming to complete the remaining task much at a faster pace than what has been followed by GSI so far. This matter was deliberated in detail at the Regional Workshop on Landslide Disaster Management at Shillong on 22-23 November, 2014 and the Joint Secretary, Ministry of Mines has also directed GSI to revamp and fasten its endeavour for this important task for

completing the remaining targets of landslide susceptibility mapping/zonation as early as possible.

Accordingly, since FS 2014-15, GSI undertook a national programme on landslide susceptibility mapping – **Macro scale (1:50, 000) National Landslide Susceptibility Mapping (NLSM)** with an aim to cover the remaining targets expeditiously. This national programme was formally launched by Shri Dinsha Patel, Hon'ble Minister of Mines, Government of India on 5th February, 2014 at the 53rd Central Geological Programming Board Meeting, New Delhi.

Landslide Susceptibility Mapping in parts of Toposheets no. 48 O/3 and O/4 in parts of Udupi, Chikmangaluru and Dakshin Kannada districts, Karnataka was carried out to prepare a seamless landslide susceptibility map and spatial (GIS-based) landslide database on 1:50000 scale using adequate remote sensing and field inputs as per the annual programme of Geological Survey of India for field season 2017-18 vide FSP CODE NO: M4LSSM/NC/SR/SU-KG/2017/12164.

1.2 Study Area:

The study area is bounded by latitudes 13º00'00" and 13º30'00"N and longitudes 75º00'00" and 75º15'00"E falling in Survey of India Toposheet No's 48 O/3 and O/4 in the Udupi, Chikmangaluru and Dakshin Kannada districts of Karnataka. The main road corridors in the area include NH-13, SH-27, 37, 65 (Udupi-Agumbe Highway), 66 and 70. The area is well connected to Shimoga airport by NH-13 and SH-65, Mangalore International airport by SH-66 (Plate 1). Most of the villages and towns of the area are well connected by metaled and non-metaled roads. The administrative office of the area is located at Karkala and main head offices in Udupi, Chikmangaluru and Mangalore. Sringeri taluk headquarters lies 336 kilo metres from Bangalore State capital and 98 km from Chickmagalur, district headquarters and 110 km from Mangalore. The Mangalore Railway Junction (South Central Railway main line) is the nearest railway station in the area. The study area can be approached from Udupi by Udupi-Karkala road, Udupi-Agumbe and from Mangalore by Mangalore-Moodbidri road via SH-66. The nearest airport to the study area is at Mangalore and Shimoga. The behavior of average rainfall pattern and its distribution over the past ten years in the area are well depicted in Annexure-III and Plates 13A, B and C.

1.3 Present Work:

The present work was carried out with following objectives:

i) To prepare landslide inventory database using high-resolution remote sensing data and field inputs.

ii) To prepare Toposheet wise 1:50000 scale spatial database for geofactors of landslides for use as input thematic maps.

iii) To prepare landslide susceptibility map using multi class index overlay method in GIS platform.

The nature and target of work envisaged for field season programme 2017-18 and the achievements are given in Table 1.

Table 1 Nature of work, quantum and achievements.

Nature of work	**Total Work Load envisaged**	**Target for FS 2017-18**	**Achievement**
1. Pre-field preparation			
i) Preparation of Thematic maps (in GIS on scale 1:50,000)	1498 sq. km	-	-
a) Slope Forming Material map		1498 sq. km	1498 sq. km
b) Geomorphology & Lineament map		1498 sq. km	1498 sq. km
c) Slope Morphometry (slope, aspect & curvature) map		1498 sq. km	1498 sq. km
d) Landuse / Landcover map		1498 sq. km	1498 sq. km
e) Drainage map		1498 sq. km	1498 sq. km
f) Regolith depth/thickness map		1498 sq. km	1498 sq. km
ii) Preparation of Landslide Inventory Map		1498 sq. km	1498 sq. km
2. Field-based studies			
i) Field-checking of all thematic maps	1498 sq. km	1498 sq. km	1498 sq. km
ii) Field validation of landslide inventory and collection of recent and historic landslides (using archives, old reports, road register etc)		1498 sq. km	1498 sq. km
iii) Collection of landslide inventory and damage data as per 41 point geo parametric data sheet	1498 sq. km	1498 sq. km	1498 sq. km
3. Post-field studies & modeling			

i) Updation of thematic and inventory maps in GIS	1498 sq. km	1498 sq. km	1498 sq. km
ii) Preparation of Landslide Susceptibility Map in GIS		1498 sq. km	1498 sq. km
4. Collection of rainfall data from available rain stations	1498 sq. km	1498 sq. km	1498 sq. km

Table 2 Details of the man-days spent in the filed

Name	Sep-17	Oct-17	Nov-17	Dec-17	Jan-18	Feb-18	Mar-18	Total Days
Zameer Ahmad Shah	03	-	22	20	26	18	-	89
Kapil Singh	03	-	22	18	26	18	-	87
J. Srihari	-	-	-	-	04	-	-	04

Table 2 gives details of total man-days spent in the field. A total of 89 and 87 days were spent by the two officers along with four days of field inspection by supervisory officer (Director), Shri J. Srihari.

1.4 Physiography and Drainage:

The area forms the part of Western Ghats, which exhibits a highly dissected topography with 90% constituted by high ridges and hills and about 10% forming gently undulating plain. The hills are generally aligned in NNW-SSE to N-S direction having precipitous escarpments on the west and gentle slope to the east. The maximum height of the hill in the area is 1678 m near Kudakala-gudda. The annual rainfall is mostly received from southwest monsoon during the months from June to September. Agumbe Ghat familiarly called Chirrapunji of Karnataka receives the highest rainfall. Humid tropical climate is experienced throughout the year with monsoon active between June and September. Tunga, Bhadra, Nethravathi and Sita are the main rivers in the area. The first three originate from a place called Gangamula whereas Sita Nadi originates from northwestern part of the area from Begged Gudda, Narasimhaparvatha, Pavithra-kallu and Manipur, Menakibetta. Bhadra river passes through Kudremukh Iron Ore prospect area with its easterly flow. There are many tributaries to Bhadra river such as Hosamakki, Sitabhumihole, Kunya hole, Lakhya hole, Kanchige hole and ingsara. There are many tributaries to Tunga river, viz. Tuljankal halla, Kasakan halla, Kanukumbri halla, Nirukandra hole, Kalsankadu halla, Halamaki halla,

Sutitinabbbi falls, Gange hole, Muje hole, Nalini hole and Korakan hole. The drainage pattern of the area is mainly dendritic, sub-dendritic and trellis (Plate 10).

1.5 General Geology:

Geologically, the area comprises rocks belonging to Sargur Group, Peninsular Gneiss over which metavolcanosedimentary sequence of rocks of Bababudan Group is deposited. They are intruded by granites, Kanara granite batholith basic dykes and quartz veins. Amphibolite and meta-ultramafite of Sargur Group occur as enclaves within PGC-I. The basement PGC occupies mainly in the eastern margin of the Bababudan Group of rocks and is represented by biotite-granitic-granodioritic gneiss/migmatites with caught up patches of Sargur Group of rocks. The caught up patches are equated with Sargurs. Good exposures occur along Tunga River, Kademane, Kavade, Walkunji gudda, Halligoli, etc. The gneissic rock is leucocratic, medium grained, exhibits feeble gneissic banding. It consists of biotite, quartz, orthoclase and plagioclase. The gneisses are also well exposed around Hosahitalu, Daregudde, Yennehole, Kelahole, Durga malai area, etc. At places they are covered by laterites as noticed in the southern part of Aladanga hole. They are intruded by Kanara biotite granite at number of places.

Older granitoid (Kanara granite pluton) varies in composition from biotite granite, porphyritic biotite granite to quartz diorite. The Kanara granite also consists of xenoliths of banded magnetite quartzite, tremolite, mica schists, etc. Gneissic blocks occur as enclaves near Mapala within South Kanara granite.

The metavolcanosedimentary lithounits of the area form southern part of Western ghat belt and are grouped under Bababudan Group of Dharwar Supergroup of Archaean age and is comprised of Walkunje, Kudremukh and Kodachadri Formations. Walkunji Formation consists thin bands of oligomictic conglomerate and are exposed at the contact of schist and gneisses near Walkunje gudda. Quartzites/quartz-arenite occur on the top of hill 866, Kurubarakote, NW of Kurubarakote, around Walkunji gudda, 1039 m and around Gangamula.

Kudremukh Formation consists of quartzite (current bedded), amphibolite, quartz-chlorite schist, metabasalt, BMQ and conglomerate. Lithounits belonging to this formation occupy the central part of the area and western half of the schist belt. Quartzite occur as persistent bands between quartz-chlorite schist and metabasalt in the western part of the belt and along eastern margin along Narasimha Parvatha. Amphibolites occur along Kigga-Narasimha Parvatha-Pavithra kallu jungle track associated with garnetiferous mica schist.

They are also found east of Adke, Harebail, Talgere, Mundsar, .1079 hill, Sirimaus, etc. It consists of hornblende-sericite-plagioclase (± garnet, almandine, apatite, magnetite). Kodachadri Formation consists of quartz-chlorite schist, overlies the amphibolite, forms persistent horizon and consists of epidote, calcite, clinozoisite, tremolite and garnet. Sphene is a rare but important constituent in chlorite schist, soda amphibole is also seen associated with calc-chlorite-epidote schist and persistant bands of BMQ exposed in the northeastern corner of the area. Charnockite exposures are present in the southwestern part of the area. Quartz-chlorite schist occurs around Gangamula, Begged gudda, Huge gudda, etc. It is greenish, laminated and exhibit rhythmic banding. It gradually grades to sericite-quartzite with decrease in chlorite content. Banded magnetite quartzite is 5 to 10 m wide. Discontinuous bands of BMQ occur within metavolcanosediments along ridges of Tuljankal gudda (.1426 m), Gangrikal gudda (.1423 m), Padura gudda, Odeyar gudda (1161 m), Harakatan gudda, Kumbada gudda, Matoli gudda, Janikoda, Elakki gudda, Sirimane, Chatvemane and Manipura. It consists of magnetite (martite), grunerite, quartz, apatite (under microscope). Quartz porphyry (acid volcanics) occurs in the northwest of Devrath, south of Oddankarki, north of Gurgi, along Tuljankanahalla, SE of Kudlu, etc. It occurs as lensoid bands within phyllites. It is grey coloured, schistose, porphyritic with phenocrysts of blue quartz set in sericitic and quartz matrix.

Intrusive granite (Kanara granite) is represented by (1) hornblende granite (Sitanadi granite), (2) biotite granite (Narasimha Parvatha-Pavithra Kallu). Hornblende granite is intrusive into metavolcanosediments in the eastern part of the area occurring along the axial trace of the antiformal fold and found around Tavikoda, Hadi, Emmegundi and Bedgi gudda. Basic intrusives are represented by (1) pre-tectonic and (2) post-tectonic basic dykes. Pre-tectonic dolerite and gabbro dykes are confined to metavolcanosediments of Bababudan Group. They exhibit well developed schistosity and their mineral assemblage suggests that they are pre-tectonic. Post-tectonic basic dykes are represented by dolerite and gabbro. They are intruded into all the pre-existing formations, viz., Peninsular gneisses, metavolcanosediments and granites. They are confined to NW of Gangamula, around Turagudda and Begge gudda, etc. Basaltic dykes (post-tectonic) confined to metasedimentary rocks trending mostly in NW-SE direction. They occur around Hotte halla, SE of Turagudda. Post West Coast fault basic dykes occur at the western margin of the area. Quartz-vein intruding in NW-SE directions within basalt in the southern part are grey to white and have strike length of few cm to few meters and width varying from 0.5 to 1 m.

Rich groundwater potential is confined to the areas occupied by laterite, weathered gneiss and well jointed granite. Laterite in the area is generally 10-15 m thick and occurs in the Malnad tracts forming flat topped hills. It is residual and ferruginous in nature (Plate 2). At places they overlie rocks of Sargur Group as noticed in the southern part of Aladanga hole. They are intruded by Kanara biotite granite at number of places. The Stratigraphic succession of the area is given in the table below:

Age	Super Group	Group	Formation	Lithology
Cenozoic				Laterite
Palaeoproterozoic		Younger Intrusives	Acid Intrusives	Quartz vein Pegmatite
			Basic Intrusives	Gabbro Dolerite
			Intrusive Granites	Granite Granite (Sitanadi) Hornblende Granite
Archean	Southern Granulite Complex	Charnokite		Charnokite
	Dharwar	Bababudan (Western ghat)	Kodachadri	Quartz porphyry Banded-Magnetite-Quartzite Quartz chlorite schist
			Kudremukh	Conglomerate Meta-ultramafite Ultramafite Banded- Magnetite-Quartzite Limestone Quartz chlorite schist Amphibolite
			Walkunje	Oligomictic-conglomerate
	Peninsular Gneissic Complex	Peninsular Gneiss-I	Granitoids	Granitoid (Karwar) Porphyritic Granite
			Gneisses	Granite Gneiss
		Sargur		Meta-Ultramafite Amphibolite

1.6 Methodology:

The method employed in the present study is primarily knowledge – driven where ratings of factor classes and weights of the geofactor themes has been estimated through Analytical Hierarchy Process (AHP). It is followed by GIS based modelling approach for integration of all selected and weighted thematic maps to prepare 1:50,000 scale landslide susceptibility maps. Areas having scarce prior landslide information, any one of the following approaches can be taken into consideration as per the preferences or the conditions of the terrain or even discussion with the local experts/workers.

a) An investigation in the nearby area with frequent landslide data will serve as base for individual ratings for geofactor classes and weights of geofactors. Later such ratings and weights will be used for the entire study area for model integration using the same multiclass index overlay method. In case of availability of similar research work in adjacent and similar terrain nearby, the ratings and weights developed and used in such work may also be used after due discussion with the local experts.

b) Individual ratings for geofactor classes and weights of geofactors will be determined using Analytical Hierarchy Process (AHP) after preparing the pair wise qualitative comparison matrix of all factors (Saaty, 1977) after due discussion with local experts and workers.

Methodology adopted can be broadly grouped as follows:

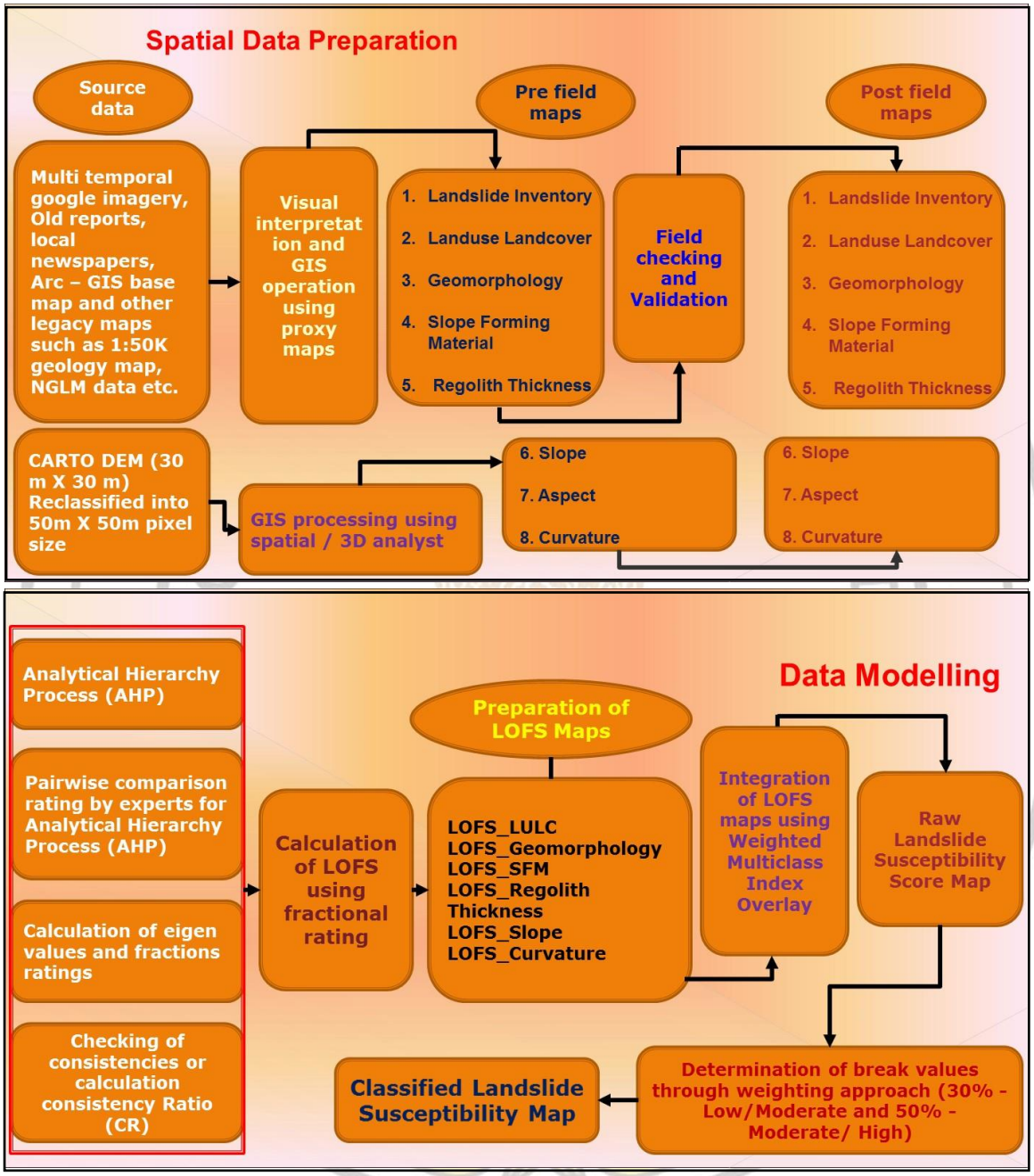
1.6.1 Pre-field Map Preparation: Total eight pre-field thematic maps were generated by using different data capturing sources. The slope morphometry maps viz. Slope aspect, Slope curvature, Slope gradient and Drainage map were prepared from 30m CARTO DEM (Digital Elevation Model). Geomorphology and Landuse Landcover (LULC) maps were prepared with the help of Google imagery (Multi temporal images has been used for digitization of Geomorphology and LULC) that later processed in ArcGIS platform. The proxy of Slope Forming Material (SFM) map was prepared using integration of LULC, Geomorphology and Geology thematic maps in Arc GIS software. Landslide inventory map was prepared by collecting the data from old GSI landslide reports and local newspapers.

1.6.2 Field-based Studies:

- Validation and checking of pre-field maps: Geomorphology, LULC, Slope Forming Material (SFM), Regolith Thickness and Landslide Inventory map.

• Augmentation of existing landslide database by identifying new slope failure incidences and recording 41 geo-parametric sheet at each of the identified sites.

Fig.1 Process of Landslide susceptibility analysis by AHP model



1.6.3 Post-field Modeling: The post-field studies were aimed at:

A. Updating of Pre-Field Maps: In response to the field validation, the modifications in the pre-field map were done wherever it was required. Corrections were attended in Arc GIS Platform by updating the polygons of a particular class/attribute in accordance with the

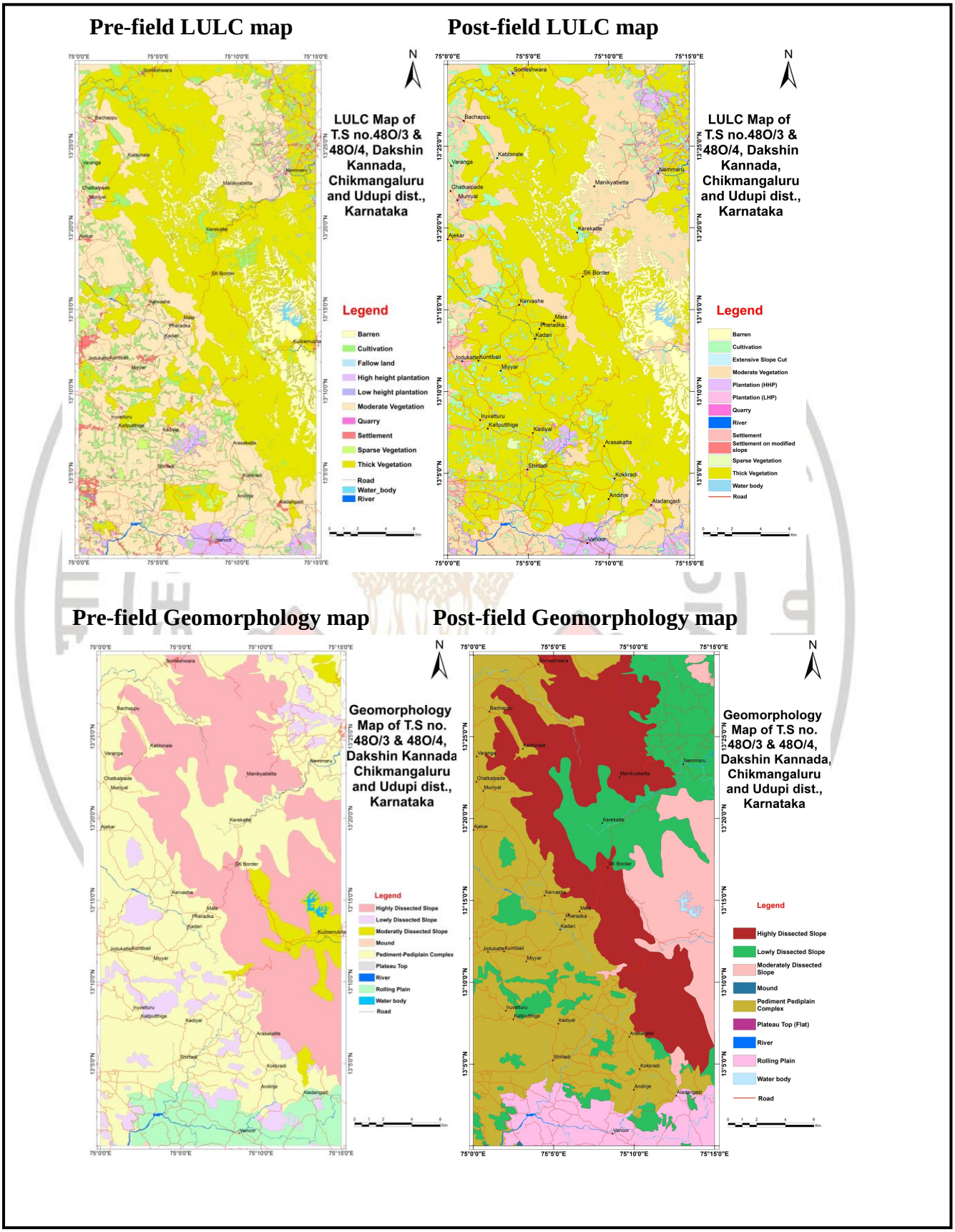
observations in the field. Ultimately, maps for all thematic layers viz. Geomorphology, LULC, Slope Forming Material and Regolith thickness map were finalized.

B. Landslide Susceptibility Modeling: In the Karnataka state, owing to the lesser number of landslides originating on/along natural slopes, Analytical Hierarchy Process (AHP) was used for landslide analysis and preparation of Landslide Susceptibility Map, instead of Statistical Analysis by using landslide incidences. The AHP is multi criteria decision making process of measurement through pairwise comparison and it relies on the judgment of the experts to drive priority scale (Saaty 1977). The entire process of landslide susceptibility modeling is given below:

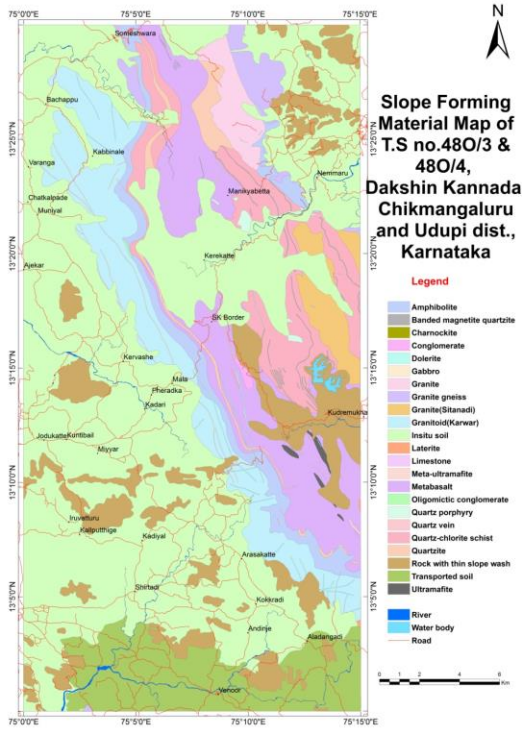
B1. Criteria for assigning ranks to Geo-factor Classes and Maps: Ranking to each geo-factor class was assigned on the basis of expert opinion, knowledge, field experience and observations by different experts working in landslide domain in different parts of southern and western India. Similarly, weightage to every geo-factor map was assigned based on its importance in inducing a slope failure. This consensus of rankings was developed in order to bring out the uniformity in landslide susceptibility mapping zones at a PAN India level. The 9 point ranking scale, ranging from 0 (lowest ranking) to 9 (highest ranking) was finalized and each class/ geo-factor was ranked accordingly. Classes/ Maps more susceptible or inducing failures were assigned relatively higher rankings and vice versa.

B2. AHP Modeling: For AHP modeling, pair-wise comparison matrix of geo-factor classes was executed following calculation of eigen values, fraction rate values and Landslide Occurrence Favorability Score ratings (LOFS). The LOFS values of each factor classes was determined by dividing the fraction rate values of a particular class by the maximum fraction rate value in the corresponding matrix. After determination of LOFS ratings for each geo-factor class of a particular geo-factor map, integer weights of individual geo-factor maps were calculated following the similar procedure of pair-wise comparison matrix of average ranks (assigned during interactive sessions by knowledge-experts), i.e., normalizing by its weight. A raw susceptibility score map was generated using integer weights and LOFS derived from AHP, which was finally classified based on the logic of providing mutual comparison expert-driven ranking of High, Moderate and Low categories/ classes. The changes made in various field based thematic layers after field inputs can be well observed in the figure 2.

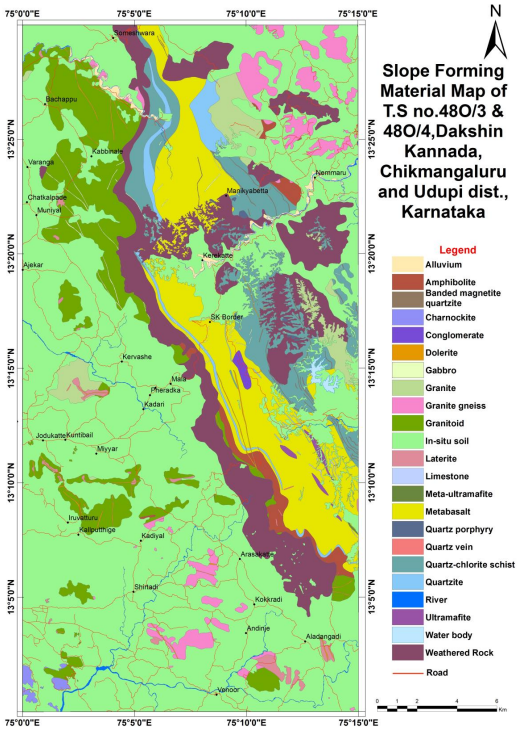
Fig. 2 Pre-field and Post-Field (Validated maps) maps of the study area



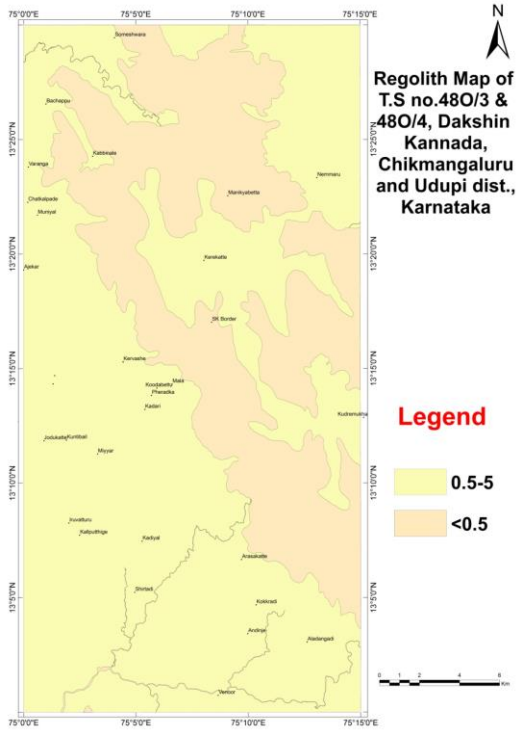
Pre-field SFM map



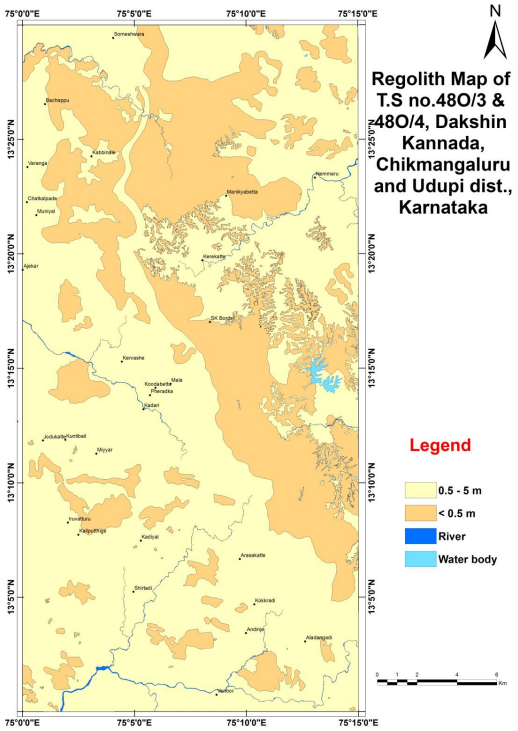
Post-field SFM map



Pre-field Regolith thickness map



Post-field Regolith thickness map



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II. PREVIOUS WORK ON LANDSLIDE STUDIES

In India, preliminary studies in the field of landslide zonation were initiated by Oldham (1880), Middlemiss (1890) and Holland (1897). Seshagiri et.al. (1982) considering five parameters to carry-out landslide hazard zonation by categorizing each parameter and assigning Landslide Susceptibility Index (LSI) on the basis of percentage of Landslides in each category. Anbalagan (1992) used lithology, structure, slope, relief, land use, land cover and ground water condition to prepare landslide zonation map. In Karnataka, Mishra and Pradhan (2007) carried-out a study on landslide inventory along NH and SH of ghat roads in karnataka., Mishra et al. (2010) also carried out zonation of Madikeri Township in a Geographical Information system (GIS) environment. Mishra et al. (2010)[1] also carried out a zonation in GIS environment of road corridor of Charmudi Ghat section from Charmudi to Kotigehara, Kotigehara to Kalasa and Shiradi Ghat section from Sakleshpur to Uppinangadi. Maruthi and Chandran (2012) has carried out zonation on Macro-scale using modified BIS guidelines between Virajpet-Madikeri-Sulya road corridor. Maruthi and Chandran (2013) has also carried-out landslide inventory study along national highway & state highway of ghat roads in Coorg, Dakshina kannada, Udupi, Shimoga and Chikmagalur districts, karnataka.

As per the literature almost all landslides in the area appear to have been caused due to the human inference in modifying the existing natural slopes. The specific causes of landslide in Western Ghats in general are removal of support by toe cutting of hill slopes for the construction of road, for human settlement, presence of weathered and loose rock mass, heavy and frequent rains etc. Studies in the area have been carried out only along transportation corridors (NH & SH) in the Western Ghats. Temporal data for these slides is not available as far as the study area is concerned. Landslides in the study area generally occur frequently from untreated cut slopes. These are usually small in size but pose considerable risk to life and property. Several landslides are reported along roads (Highways) every year during the monsoons indicating that the triggering factor for these slides may be rainfall besides anthropogenic activities. The present study area exhibits extensive cut slopes at various locations which may later transform into slides especially during rainy season. The steep zones along the roads in the Kudremukh and Singeri forest range trending NW-SE are the most promising zones as far as the landslide activity is concerned. The areas with sparse vegetation especially adjacent to the roads are also more prone to failures. The root cause of all the slides in the area is anthropogenic involving road construction and road widening triggered mostly by rainfall.

The slides already reported as per the previous reports of GSI are given below in the table.

Slide No.	Location	Toposheet No.	Latitude			Longitude			Dimension of slide (in m)		
			Deg	Min	Sec	Deg	Min	Sec	Length	Width	Depth
1	On SH-1 from Tirthahalli towards Someshwar, Near sunset view point	48O/3	13	29	46.3	75	4	50.6	12.6	21	0.5
2	200-300 m from slide no KA-628 on SH-1 from Tirthahalli towards Someshwar	48O/3	13	29	51.3	75	4	49.9	18	22.3	0.5
3	400-500 m from slide no KA-629 on SH-1 from Tirthahalli towards Someshwar	48O/3	13	29	37.5	75	4	37.7	23.5	26	1
4	300-400 m from slide no KA-630 on SH-1 from Tirthahalli towards Someshwar	48O/3	13	29	36	75	4	31.2	16.1	18	1
5	1.5 km from slide no KA-631 on SH-1 from Tirthahalli towards Someshwar	48O/3	13	29	18.6	75	4	40.2	18.6	19.4	1
6	2 km after Bandimatha on SH-1 from Tirthahalli towards Someshwar	48O/3	13	28	28	75	2	2.4	13.9	18.2	0.5
7	SH- 1in Agumbe - Udupi road	48O/3	13	29	48	75	4	52	15	45	0.5
8	SH- 1 in Agumbe - Udupi road	48O/3	13	29	51	75	4	41	12.5	14	<1

In addition to this, a landslide was reported on 21st July 2014 which affected the traffic on Mundli-Karkala road. This slide was attributed to the Mundli dam which was flowing above danger mark just prior to landslide occurrence (Mangalore Today, News Paper, Dated 21st July 2014).

III. LANDSLIDE INVENTORY

A landslide inventory map records the location and, where known, the date of occurrence and the types of mass movements that have left discernible traces in an area (Guzzetti et al., 2000). Generation of such inventory is a difficult task as landslides occur individually and have to be identified, mapped and inventoried. A Landslide inventory contain basic information about landslides such as location, classification, morphology, volume, run-out distance, activity and date of occurrence/activity etc. and can be prepared through various methods such as detailed geomorphologic study, mapping from remote sensing data and topographic maps, historical archive studies and interviews. In this study, satellite images are used as the main source for obtaining a multi-temporal landslide inventory.

3.1 Data source:

Landslides leave discernible signs on slopes, most of which can be recognized, classified and mapped in the field or from photo-interpretation (Varnes, 1978). These signatures are mostly visible as morphological changes such as changes in slope type, breaks in slopes, hummocky surfaces, etc. These morphological signs are interpreted here to determine important landslide information such as type of failure, the surface area, cause and the run-out distance. Detailed and systematic field work was carried out to generate the 41-point attribute data for landslides. Preparation of the landslide inventory commenced with the search of archival data sources, particularly published and unpublished reports of GSI.

In the present study, it was not possible to identify landslides from Google Earth as the area is thickly vegetated and if any landslide of recordable dimension is present is masked by the canopy in the area. Around 40 landslides were identified in the present study area.

3.2 Inventory mapping:

The following steps were used for mapping a landslide in the field and building its inventory attribute.

1. For each landslide identified in the field, the attributes such as name, state, district, taluka, toposheet number, morphometry, initiation, slide type, slide material, length, width, surface area, cause, land use and element at risk were recorded. Archival data were used for naming and defining the cause of the landslides.

2. The morphological signatures left by landslides on slopes were used to identify the shape of landslides.

3. After identifying the landslides in the field, the morphological parameters (landslide scar length, width and depth) were noted carefully after measuring them in the field using a meter tape. Additional data such as landslide type, run-out distance, present land use, regolith thickness, Geology, probable cause, and damage details were also added to the inventory.

3.3 Landslides in the Area:

During field 40 landslides or rather slope failures identified in the study area are inventoried which are concentrated mainly along roads and other transportation corridors (Plate 11). Overall landslides studied in the area are mostly confined to roads and seem to be triggered by anthropogenic activities in addition to the role of rainfall in the area. Most of the landslides affecting the road originate from cut slopes, which are left unsupported and become prone to failure during rains (Photo 17-19). At places especially in Kudremukh forest range, retention walls have been established at many places. The bulging and disruption of these walls at places clearly indicate imperceptible movement which may lead to a complete failure in rainy season (Photo 14 and 15). At some places, these slope failures develop road cracks (Photo 13). At places, benching of the slope has been made to avoid any movement along the slope (Photo 16). The slides here are of shallow translational type and are confined to the slopes that have been modified indiscriminately for settlements. Recording these slope failures which are a result of anthropogenic activities and considering them for susceptibility zonation of the study area would be highly biased. Since very few, almost negligible amount of slides are observed in the area, the usually applied method of modelling cannot be used here. In this situation, ratings and inter-predictor weights can only be determined using expert or knowledge driven techniques by implementing one of the following alternatives or by combining knowledge derived from attempting all the alternatives.

Out of 40 cut slope failures, 32 were recorded in toposheet no. 48 O/3 (Plate 11). All mapped landslides (cut slopes) are debris/earth slides triggered by extensive slope cutting followed by spells of rain. The sliding material mostly consists of younger loose debris mixed with fragments of weathered rock. Failures are common during rains when the exposed overburden mass resting on the cut slopes slips downslope. Moreover, the movement of the loose material is confined to the loose humps (loose debris) in the area.

Detailed inventory of 40 landslides for which 41-point inventory data were prepared is shown in Annexure-I. Cut slope failures (Photos 1 to 4) are very much wide spread along modified slopes and roads in the area. Many of the cut slope transform into landslides during rainy season in the area.

IV. LANDSLIDE SUSCEPTIBILITY ANALYSIS

This chapter deals with the material and methods of landslide susceptibility analysis using Analytical Hierarchy Process method.

4.1 Background:

A quantitative or qualitative assessment of the spatial distribution of landslides in an area depicts the landslide susceptibility of that area. Generally, landsliding is expected to occur in the most susceptible areas. One of the draw back of the landslide susceptibility analysis is that it does not take time frame and magnitude into consideration. A susceptibility map therefore gives only the qualitative or quantitative estimation that the mapping unit (e.g., a pixel, slope unit or facet) will be affected by a future landslide. Therefore, using the term "landslide hazard analysis" instead of "landslide susceptibility analysis", for methods of spatial prediction of landslide-prone areas may not be correct.

In GIS-based data-driven methods such as Weighted Multiclass Index Overlay, spatial thematic factors (or layers of evidence) are integrated with a landslide inventory map (target) using various mathematical/statistical integration techniques (Bi-variate, Multivariate, Artificial Neural Network etc) that can model relationships among layers of evidence with respect to targets (Bonham-Carter, 1994).

4.2 Selection of preparatory factors:

For susceptibility mapping, the selection of preparatory factors for landslides depends on the scale of analysis, the characteristics of the study area, the landslide type, the failure mechanisms and the priori knowledge of the main causes of landslides (Guzzetti et al., 1999). A prior knowledge of the main causes of landslides in the area of interest is essential in selecting the most relevant factors out of the many known preparatory factors that can "theoretically" cause landslides (Ghosh et al., 2010).

In the study area, landslides are mostly debris slides affecting natural slopes and are smaller in size. Keeping in consideration the landslide characteristics, seven factor maps were prepared that are considered to be the main spatial causal factors for landslides in the study area. Out of the seven factor maps, three are related to terrain morphometry derived from DEM and four are field based maps prepared from remote sensing data. A brief description of the significance and mapping techniques for each factor is given below.

4.3 Geo-factor Themes:

Landslides occur when the shearing stress along the failure plane exceeds the shearing strength of rock/debris mass (Varnes, 1978). This can be controlled by the dynamic nature of various parameters such as i) physical state of slope such as slope gradient, slope aspect, and slope curvature, ii) lithology or physical characteristics of slope forming mass, iii) spatial variation in thickness of slope forming material, iv) geomorphological forms and processes, v) rock structure: orientation of planar/linear discontinuities in the rock mass in relation to topography, vi) geohydrology and vii) land use/cover including road and other physical features mappable on 1:50,000 scale (Annexure IV). Based on the estimation of above pre-disposing geo-factors, the following factors and its possible factor classes are considered for preparation of geo-factor databases for the GIS-based analysis of susceptibility to landsliding. These spatial factor maps are prepared using various source data and employing different mapping techniques which are detailed below.

4.3.1 Slope Morphometry:

Slope morphometry is evaluated through slope gradient, slope aspect and slope curvature (Plate 3, 4 and 8). In the present investigation, Slope aspect was not taken into consideration keeping in view its least significance.

Slope gradient:

Slope gradient is an essential component of slope stability analysis. As the slope gradient increases, the level of gravitation-induced shear stress in the colluviums or residual soils increases as well. Gentle hillslopes are expected to have a low frequency of landslides because of the generally lower shear stresses associated with low gradients. Slope gradient, the maximum rate of change of elevation of the surface, was then reclassified into five classes: <15º, 15 –25 º, 25–35º, 35–45 º and > 45°.

The slope angle maps were derived from the 30m CARTO DEM using ArcGIS 10.3. Slope gradient in the study area varies between 0° and 35°. In general, landslide frequency increases with the slope gradient until the maximum frequency is reached in the 15–25° category, followed by a decrease (Plate 3).

About 95% of the area exhibit slope gradient up to 25°. The area coverage in pixels along with LOFS and rank is given below in table 3.

Table 3 LOFS, Rank and area coverage in pixels for Slope gradient of T. S. No. 48 O/3 & O/4

Sr. No.	CLASS	Rank	LOFS	Area Coverage (in Pixels)	Area Coverage (in %)
1	<15	2	0.16	113623	19.32
2	15-25	4	0.46	334760	56.93
3	25-35	8	1.00	115419	19.63
4	35-45	6	0.28	21258	3.61
5	>45	2	0.16	3010	0.51

Slope Curvature:

Slope Curvature (Profile curvature) shows the curvature of the surface perpendicular to the slope direction for each cell, and thus determines the shape of a slope in profile. Slope shape was also derived from 30m CARTO DEM using ArcGIS 10.3. A positive curvature represents upwardly convex surface, while a negative curvature indicates that the surface is upwardly concave at a given pixel. The concave hill slopes are having high soil moisture content and receive more surface run-off. Failures can be expected to occur more frequently in those areas than the slopes that are convex along the contour. The curvature maps were reclassified into three classes viz, concave, flat and convex (Plate 8). The area coverage in pixels along with LOFS and rank is given below in table 4.

Table 4 LOFS, Rank and area coverage in pixels for Slope curvature of T. S. No. 48 O/3 & O/4

Sr. No.	CLASS	Rank	LOFS	Area Coverage (in Pixels)	Area Coverage (in %)
1	Concave	4	0.41	387216	24.04
2	Flat	2	0.17	853895	53.01
3	Convex	6	1.00	369567	22.94

4.3.2 Landuse and Landcover:

Mapping or delineating areas prone to landsliding is very essential for land-use activities and management decision making in hilly or mountainous regions. The land use and land cover (LULC) map was prepared from the Google Earth considering 2016 data. Following the generally used mapping procedure in Google Earth, first the polylines of different land use/cover were drawn and the same were imported in ArcGIS through kml to feature conversion. In Arc GIS the features were converted into polygons and then again exported to Google Earth through layer to kml conversion. Each polygon was named as per its LULC class and reconverted into a shape file through kml to layer conversion. Finally, the boundary of the

individual LULC class was corrected from SPOT images available as base map in ArcGIS 10.2. The obtained pre-field LULC map was checked in the field in all accessible locations and all necessary modifications in the boundary and name of the LULC class were incorporated. Plate 5 shows the LULC map for parts of toposheets 48 O/3 and O/4. The area in terms of LU/LC can be divided into following classes: Thick Vegetation (Photo 6), High Height Plantation (HHP), Moderate Vegetation, Cultivation, Barren (Photo 7), Extensive Slope Cut, Fallow Land, Low Height Plantation (LHP), Quarry (Photo 5), Settlement, Sparse Vegetation, and Water Body. Most part of the area is covered with HHP. Extensive cut slopes in the study area are the direct out-come of road widening and construction of settlements on slopes (Photo 1-4) which are most affected by slope failures as far as land use /land cover is concerned. Landslide occurrences favorability score (LOFS), rank and percentage for various LULC classes is given in table 5.

Table 5 LOFS, Rank and area coverage in pixels for Landuse/Landcover of T. S. No48 O/3 & O/4

Sr. No.	CLASS	Rank	LOFS	Area Coverage (in Pixels)	Area Coverage (in %)
1	Barren	1	0.06	43929	7.34
2	Cultivation	2	0.09	45018	7.52
3	Extensive Slope Cut	9	1.00	35	0.01
5	Moderate Vegetation	5	0.29	147520	24.63
6	Plantation (HHP)	4	0.20	18033	3.01
7	Plantation (LHP)	3	0.14	271	0.05
8	Quarry	5	0.29	333	0.06
9	Settlement	1	0.07	7639	1.28
10	Settlement on modified slope	7	0.56	2	0.00
11	Sparse Vegetation	7	0.56	7156	1.19
12	Thick Vegetation	4	0.20	325673	54.38
13	River	0	0.00	2358	0.39
14	Water body	0	0.00	927	0.15

4.3.3 Geomorphology:

The present landscape of the study area under consideration is viewed as the manifestation of a chain of interactions between fluvial and denudational processes operating on underlying geology that has been subjected to past vertical tectonics. Field and laboratory studies indicate that the geomorphology of the study area is marked by ridges with steep slopes, denuded surfaces and sinuous valleys suggesting the considerable period elapsed

during the development of the landforms. Each landform signifies the processes operated in the evolution of the landforms.

Geomorphological map was prepared in ArcGIS through visual interpretation of multi-temporal Google images of the area. National Geomorphological and Lineament Mapping (NGLM) data supplied by GHRM cell was also taken into account while preparing the geomorphology map of the study area. Gemorphologically, the area can be divided into rolling plain, pediment-peneplain complex, alluvial Plain, moderately/lowly dissected slope, plateau top (flat), ridge top, mound and valley fill.

The method used for geomorphology mapping is same as that of LULC map. The obtained pre-field geomorphology map was validated in the field at all accessible locations and related necessary modifications in the boundary and name of the geomorphology classes were incorporated. Plate 6 shows the geomorphology map of parts of toposheets 48 O/3 and O/4. Most part of the area is covered by lowly dissected slope followed by moderately dissected slope and rolling plains. The area coverage for each class in pixels, LOFS and rank is given in table 6.

The details of geomorphic features are given as below:

Pediment – Pediplain Complex: A complex landform where both pediplain and pediments occur and it is difficult to separate them (Photo 8).

Lowly/Moderately Dissected Slopes: These slopes are defined by the intensity of linear features dissecting the landscape of the area (Photo 7).

Rolling Plain: Rolling plain is assigned to areas with hummocky appearance where most of the area is generally flat with some minor wavy undulations.

Table 6 LOFS, Rank and area coverage in pixels for Geomorphology of T. S. No. 48 O/3 & O/4

Sr. No.	CLASS	Rank	LOFS	Area Coverage (in Pixels)	Area Coverage (in %)
1	Highly Dissected Slope	8	0.08	159086	26.56
2	Lowly Dissected Slope	4	0.19	112765	18.83
3	Moderately Dissected Slope	6	0.40	62913	10.50
4	Mound	2	0.08	84	0.01
5	Rolling Plain	0	0.00	45405	7.58
6	Pediment Pediplain Complex	0	0.00	215344	35.96
7	Plateau Top (Flat)	0	0.00	12	0.00
8	River	0	0.00	2358	0.39
9	Water body	0	0.00	927	0.15

4.3.4 Slope Forming Material (SFM):

Slope Forming Material (SFM) map was prepared in ArcGIS 10.1 through visual interpretation of multi-temporal Google Imagery of the area and collection of data for material present on slopes. The study area in terms of Slope Forming Material (SFM) can be classified in to following classes: rock, weathered rock and in-situ soil (Plate 7).

Areas with visible soil profile were categorized under in-situ soil category. On slopes, barren rock is present at places where the slope angle in general is more than 35 degrees. Most of the study area is covered by In-situ soil of granitic origin (Photo 1). Some old outcrops which represent old quarries were observed near village Bellandur (Photo 9) and laterite quarry near Ramabail (Photo 10). Weathered exposures were observed on SK border road with blackish and reddish soil representing the underlying lithology i,e granites. The area covered in pixels LOFS and rank in given in table 7.

Table 7 LOFS, Rank and area coverage in pixels for Slope Forming Material of T. S. No. 48 O/3 & O/4.

Sr. No.	CLASS	Rank	LOFS	Area Coverage (in Pixels)	Area Coverage (in %)
1	Laterite	4	0.24	3328	0.56
2	Alluvium	0	0.00	2815	0.47
3	Amphibolite	4	0.24	7056	1.18
4	Banded magnetite quartzite	1	0.07	1124	0.19
5	Charnockite	1	0.07	1381	0.23
6	Conglomerate	2	0.24	862	0.14
7	Dolerite	1	0.07	1621	0.27
8	Gabbro	1	0.07	903	0.15
9	Granite	1	0.07	12886	2.15
10	Granite gneiss	1	0.07	16951	2.83
11	Granitoid	1	0.07	48184	8.05
12	In-situ soil	4	0.24	333130	55.62
13	Limestone	1	0.07	141	0.02
14	Meta-ultramafite	1	0.07	81	0.01
15	Metabasalt	1	0.07	58115	9.70
16	Quartz-chlorite schist	4	0.24	30773	5.14
17	Quartz porphyry	1	0.07	457	0.08
18	Quartz vein	1	0.07	69	0.01
19	Quartzite	1	0.07	7603	1.27
20	Ultramafite	1	0.07	880	0.15
21	Weathered Rock	6	0.54	67248	11.23
22	River	0	0.00	2358	0.39
23	Water body	0	0.00	927	0.15

4.3.5 Regolith Thickness:

The regolith thickness depends on a large variety of factors, one important being the local variation in terrain morphology; and therefore prediction of the thickness of regolith over a large area is extremely difficult. Ideally, for thickness modelling, a large number of observations (such as drill holes, outcrops or geophysical measurements) are required. However, on a catchment scale, this approach is difficult to implement. Given the above limitations, regolith thickness map was prepared based on field observations and value observations. Assessment of thickness of regolith cover at different sites was made by studying the exposures along the road, streams and landslide scars. Thickness of Overburden is directly controlled by slope forming material (SFM), geomorphology, land use & land cover and slope gradient. An attempt is made to get the approximate overburden thickness and it is observed that the overburden thickness is relatively more (approx. 2-5 m or >5m) in low dissected hill slope with low slope gradient, where as in low dissected slopes having steeper slope gradient, the overburden thickness varies from 1-2m to occasionally up to 5m (Plate 9). In the study area it can be classified into two classes: <0.5 m and 0.5m to 5 m (Plate 11). Along the moderate & steep slopes thickness of overburden in general is less while along major weathered profiles regolith thickness is more, these areas are more prone for landslides. Regolith thickness of less than 0.5m depth is observed on rocky, steep slopes (Photo 11) and classified under rock. Areas with comparatively gentle slope with weathered outcrops exhibit overburden of 0.5 to 5 (Photo 12). The area covered by each factor class in terms of pixels, LOFS and rank is given below in table 8.

Table 8 LOFS, Rank and area coverage in pixels for Regolith Thickness of T. S. No. 48 O/3 & O/4

Sr. No.	CLASS	Rank	LOFS	Area Coverage (in Pixels)	Area Coverage (in %)
1	< 0.5 m	0	0	192416	32.13
2	0.5 - 5 m	7	1	403193	67.32
3	River	0	0	2358	0.39
4	Water body	0	0	927	0.15

4.4 Landslide Susceptibility Analysis:

Landslides in the study area are recorded mainly along roads and other transportation corridors. Recording these slope failures which are a result of anthropogenic activities and

considering them for susceptibility zonation of the study area would be highly biased. Since very few, almost negligible amount of slides are observed elsewhere in the area, the generally used method of modeling cannot be used here. In this situation, ratings and inter-predictor weights can only be determined using expert or knowledge driven techniques.

Methodology: The Analytic Hierarchy Process (AHP), developed by Saaty (1977) is a method of structuring decision problems. The AHP consists of three levels of hierarchy. The first hierarchy level is the goal of the decision making, the second level involves how each of the existing criteria contributes to achievement of goal, and the third level is to find out how each of the alternatives contributes to each of the criteria.

The AHP method is appropriate to be used where decisions are to be assessed quantitatively. It is assumed that human beings' natural reaction when facing a complex decision making process, is by grouping the decision elements according to common characteristics. This involves ranking the decision elements, and then comparing between each pair in each group in a form of matrix. Then inconsistency ratio and weight for each element can be measured. This provides ease in testing the data consistency. The higher consistency ratio, the assessment result becomes more inconsistent. The acceptable consistency ratio is less than or equal to 10%.

According to Taylor, Consistency Index (CI) can be calculated by using the following formula:

$$CI = \text{maks eigen value} - n / n - 1 \qquad \textbf{Eq-1}$$

$$maks.eigenvalue = \sum_{\iota} wi.\text{ci} \qquad \textbf{Eq-2}$$

The consistency ratio is then calculated as,

$$CR = CI / RI \qquad \textbf{Eq-3}$$

Where, n is the amount of items compared, w*i* is the weight, ci is the sum of column, CR is the Consistency Ratio, CI is the Consistency Index and RI is the Random Consistency Index. If CR If $\geq$ 10%, the data acquired is inconsistent and If CR < 10%, the data acquired is consistent. The ratio-scale form is used as an input. The values in the ratio are organized in a matrix, which is called the pairwise comparison matrix. In the AHP method, the scale range 1–9 is assumed. It is limited to a ratio-scale 1–9 because according to the research conducted by Miller, human beings cannot simultaneously compare more than seven objects. The Standard Preference Scale used is shown in Table:

S.No.	Preference Level	Numerical Value
1	Equally Preferred	1
2	Equally to Moderately Preferred	2
3	Moderately Preferred	3
4	Moderately to Strong Preferred	4
5	Strongly Preferred	5
6	Strongly to Very Strongly Preferred	6
7	Very Strongly Preferred	7
8	Very Strongly to Extremely Preferred	8
9	Extremely Preferred	9

Using the above Standard Preference Scale, a group of geoscientists from GSI engaged in landslide studies in India and in Western Ghats, in particular, were asked to rank the factor classes and the factor maps. The obtained score for individual factor class was used for determining the ratings for each factor class. The average score for the factor maps of the area ranked between 0 and 9. Matrix of pairwise ratings; estimated eigenvectors of pairwise rating matrix; and estimation of consistency vector (CV), consistency index (CI) and consistency ratio (CR) for judgment of consistency of pairwise ratings of factors, respectively for all maps was calculated.

Methods followed for Susceptibility Analysis:

Following steps were taken in the susceptibility analysis (as shown in Fig.1), which ultimately led to the susceptibility map preparation:

a. Conversion of six geo-factor thematic maps (LULC, Geomorphology, SFM, Slope Angle, Slope Aspect and Slope Curvature) into raster maps of 50m X 50m pixel size.

b. Calculation of ratings for each geo-factor classes and integer weights of all geo-factor thematic maps in excel, using pair-wise comparison rating matrix, calculation of eigen values, fraction rate values and Landslide Occurrence Favourability Score (LOFS) ratings for six geo-factor maps (provided in Annexure-I).

c. Joining of excel table with the geo-factor maps in ArcGIS.

d. Generation of LOFS rating maps for all geo-factor themes.

e. Combining LOFS rating maps and Integer Weights to obtain raw Landslide Susceptibility Score Map and determination of classification/break pixel values for classification of susceptibility classes, using logic of providing mutual comparison by expert-driven ranking.

Example of LULC for calculation of Landslide Occurrence Favorability Score (LOFS) is given below in Table 9:

Table 9 Generic Table showing mutual comparison rank of LULC factor classes

Calculation of LOFS for LULC

Barren (B)	1
Barren Sand (BS)	0
Cultivation (CL)	2
Extensive Slope Cut (ESC)	9
Fallow Land (FL)	1
Moderate Vegetation (MV)	5
Plantation (HHP)	4
Plantation (LHP)	3
Quarry (QR)	5
Settlement (S)	1
Settlement on modified slope (SM)	7
Settlement with Cultivation (SC)	0
Settlement with Vegetation (SV)	0
Swamp (SW)	0
Thick Vegetation (TV)	4
Sparse Vegetation (SV)	7
Waterbody (WB)	0
Salt Pan (SP)	0

Table 10 Table showing matrix of mutual comparison ranks of LULC classes given rank >0

LULC	B	CL	ESC	FL	MV	HHP	LHP	QR	S	SM	TV	SV
B	1.00	0.50	0.11	1.00	0.20	0.25	0.33	0.20	1.00	0.14	0.25	0.14
CL	2.00	1.00	0.13	2.00	0.25	0.33	0.50	0.25	2.00	0.17	0.33	0.17
ESC	9.00	8.00	1.00	9.00	5.00	6.00	7.00	5.00	9.00	3.00	6.00	3.00
FL	1.00	0.50	0.11	1.00	0.20	0.25	0.33	0.20	1.00	0.14	0.25	0.14
MV	5.00	4.00	0.20	5.00	1.00	2.00	3.00	1.00	5.00	0.33	2.00	0.33
HHP	4.00	3.00	0.17	4.00	0.50	1.00	2.00	0.50	4.00	0.25	1.00	0.25
LHP	3.00	2.00	0.14	3.00	0.33	0.50	1.00	0.33	3.00	0.20	0.50	0.20
QR	5.00	4.00	0.20	5.00	1.00	2.00	3.00	1.00	5.00	0.33	2.00	0.33
S	1.00	0.50	0.11	1.00	0.20	0.25	0.33	0.50	1.00	0.14	0.25	0.14
SM	7.00	6.00	0.33	7.00	3.00	4.00	5.00	3.00	7.00	1.00	4.00	1.00
TV	4.00	3.00	0.17	4.00	0.50	1.00	2.00	0.50	4.00	0.25	1.00	0.25
SV	7.00	6.00	0.33	7.00	3.00	4.00	5.00	3.00	7.00	1.00	4.00	1.00
Sum Clm	49.00	38.50	3.00	49.00	15.18	21.58	29.50	15.48	49.00	6.96	21.58	6.96

Table 11 Table Showing eigen values, fraction rate and LOFS values for LULC classes

LULC	B	CL	ESC	FL	MV	HHP	LHP	QR	S	SM	TV	SV	Sum rows	Frac rate	LOFS
B	0.020	0.013	0.037	0.020	0.013	0.012	0.011	0.013	0.020	0.021	0.012	0.021	0.213	0.018	0.063
CL	0.041	0.026	0.042	0.041	0.016	0.015	0.017	0.016	0.041	0.024	0.015	0.024	0.318	0.027	0.094
ESC	0.184	0.208	0.333	0.184	0.329	0.278	0.237	0.323	0.184	0.431	0.278	0.431	3.399	0.283	1.000

FL	**0.020**	**0.013**	**0.037**	**0.020**	**0.013**	**0.012**	**0.011**	**0.013**	**0.020**	**0.021**	**0.012**	**0.021**	**0.213**	**0.018**	**0.063**
MV	**0.102**	**0.104**	**0.067**	**0.102**	**0.066**	**0.093**	**0.102**	**0.065**	**0.102**	**0.048**	**0.093**	**0.048**	**0.990**	**0.082**	**0.291**
HHP	**0.082**	**0.078**	**0.056**	**0.082**	**0.033**	**0.046**	**0.068**	**0.032**	**0.082**	**0.036**	**0.046**	**0.036**	**0.676**	**0.056**	**0.199**
LHP	**0.061**	**0.052**	**0.048**	**0.061**	**0.022**	**0.023**	**0.034**	**0.022**	**0.061**	**0.029**	**0.023**	**0.029**	**0.464**	**0.039**	**0.137**
QR	**0.102**	**0.104**	**0.067**	**0.102**	**0.066**	**0.093**	**0.102**	**0.065**	**0.102**	**0.048**	**0.093**	**0.048**	**0.990**	**0.082**	**0.291**
S	**0.020**	**0.013**	**0.037**	**0.020**	**0.013**	**0.012**	**0.011**	**0.032**	**0.020**	**0.021**	**0.012**	**0.021**	**0.232**	**0.019**	**0.068**
SM	**0.143**	**0.156**	**0.111**	**0.143**	**0.198**	**0.185**	**0.169**	**0.194**	**0.143**	**0.144**	**0.185**	**0.144**	**1.914**	**0.160**	**0.563**
TV	**0.082**	**0.078**	**0.056**	**0.082**	**0.033**	**0.046**	**0.068**	**0.032**	**0.082**	**0.036**	**0.046**	**0.036**	**0.676**	**0.056**	**0.199**
SV	**0.143**	**0.156**	**0.111**	**0.143**	**0.198**	**0.185**	**0.169**	**0.194**	**0.143**	**0.144**	**0.185**	**0.144**	**1.914**	**0.160**	**0.563**

Table 12 Table showing estimation of consistency vector (CV), consistency index (CI) and consistency ratio (CR) for LULC classes

LULC	B	CL	ESC	FL	MV	HHP	LHP	QR	S	SM	TV	SV	Sum rows	CV
B	**0.018**	**0.013**	**0.031**	**0.018**	**0.016**	**0.014**	**0.013**	**0.016**	**0.019**	**0.023**	**0.014**	**0.023**	**0.2191981**	**12.36**
CL	**0.035**	**0.027**	**0.035**	**0.035**	**0.021**	**0.019**	**0.019**	**0.021**	**0.039**	**0.027**	**0.019**	**0.027**	**0.3229031**	**12.17**
ESC	**0.16**	**0.212**	**0.283**	**0.16**	**0.412**	**0.338**	**0.271**	**0.412**	**0.174**	**0.479**	**0.338**	**0.479**	**3.7177267**	**13.12**
FL	**0.018**	**0.013**	**0.031**	**0.018**	**0.016**	**0.014**	**0.013**	**0.016**	**0.019**	**0.023**	**0.014**	**0.023**	**0.2191981**	**12.36**
MV	**0.089**	**0.106**	**0.057**	**0.089**	**0.082**	**0.113**	**0.116**	**0.082**	**0.097**	**0.053**	**0.113**	**0.053**	**1.0496105**	**12.72**
HHP	**0.071**	**0.08**	**0.047**	**0.071**	**0.041**	**0.056**	**0.077**	**0.041**	**0.077**	**0.04**	**0.056**	**0.04**	**0.698393**	**12.4**
LHP	**0.053**	**0.053**	**0.04**	**0.053**	**0.027**	**0.028**	**0.039**	**0.027**	**0.058**	**0.032**	**0.028**	**0.032**	**0.4718235**	**12.19**
QR	**0.089**	**0.106**	**0.057**	**0.089**	**0.082**	**0.113**	**0.116**	**0.082**	**0.097**	**0.053**	**0.113**	**0.053**	**1.0496105**	**12.72**
S	**0.018**	**0.013**	**0.031**	**0.018**	**0.016**	**0.014**	**0.013**	**0.041**	**0.019**	**0.023**	**0.014**	**0.023**	**0.2439453**	**12.61**
SM	**0.124**	**0.159**	**0.094**	**0.124**	**0.247**	**0.225**	**0.193**	**0.247**	**0.135**	**0.16**	**0.225**	**0.16**	**2.0954329**	**13.14**
TV	**0.071**	**0.08**	**0.047**	**0.071**	**0.041**	**0.056**	**0.077**	**0.041**	**0.077**	**0.04**	**0.056**	**0.04**	**0.698393**	**12.4**
SV	**0.124**	**0.159**	**0.094**	**0.124**	**0.247**	**0.225**	**0.193**	**0.247**	**0.135**	**0.16**	**0.225**	**0.16**	**2.0954329**	**13.14**
													Sum CV	**151.3**

Mean Consistency Vector (Mean CV) = Total CV/ Nos. Of factor class (151.33/12) =12.611
Consistency Index (CI) = (Mean CV - No. Of criteria/ factor class) / (No. Of factor class - 1) =0.0555
Consistency Ratio (CR) = CI/ RI = 0.0555 / 1.49 =0.0373

Table 13 Table showing calculation of consistency index (CI) and consistency ratio (CR).

n	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

Mean CV		**12.6**	
Consistency Index (CI) =			**(Mean CV-number of themes)/(No of themes -1)**
CI	0.06		
Consistency Ratio (CR) =			**CI/RI**
CR	0		
CR should never be more than 0.1			

In the same manner for all the 6 factor maps (not consider Aspect map for LOFS calculation) calculation of LOFS and consistency ratio (CR) was done (Annexure-II). After calculation of LOFS values for all the factor classes of all the factor maps, LOFS maps were prepared using Arc GIS by joining the LOFS tables to the individual maps respectively.

Table 14 Weightage of different Geo-factors considered for AHP modeling and mutual comparison ranks

Factor Classes	
Slope	9
Curvature	2
SFM	6
LULC	8
Geomorphology	4
Regolith Thickness	4

Table 15 Table showing mutual comparison ranks of factor maps.

Factor	Slope	Curvature	SFM	LULC	Geom	RT
Slope	1.00	8.00	4.00	2.00	6.00	6.00
Curvature	0.13	1.00	0.20	0.14	0.33	0.33
SFM	0.25	5.00	1.00	0.33	3.00	3.00
LULC	0.50	7.00	3.00	1.00	5.00	5.00
Geom	0.17	3.00	0.33	0.20	1.00	1.00
RT	0.17	3.00	0.33	0.20	1.00	1.00
Sum Clmn	2.21	27.00	8.87	3.88	16.33	16.33

Table 16 Table showing mutual comparison of individual factor maps and weights.

Factor	Slope	Curvature	SFM	LULC	Geom	RT	Sum rows	Frac rate	Weight	Weight W N
Slope	0.45283	0.296296	0.451128	0.515971	0.367347	0.367347	2.450919	0.408486	12.64217	13
Curvature	0.056604	0.037037	0.022556	0.036855	0.020408	0.020408	0.193869	0.032311	1	1
SFM	0.113208	0.185185	0.112782	0.085995	0.183673	0.183673	0.864517	0.144086	4.459293	4
LULC	0.226415	0.259259	0.338346	0.257985	0.306122	0.306122	1.69425	0.282375	8.73917	9
Geom	0.075472	0.111111	0.037594	0.051597	0.061224	0.061224	0.398223	0.06637	2.054087	2
RT	0.075472	0.111111	0.037594	0.051597	0.061224	0.061224	0.398223	0.06637	2.054087	2

The integer weight or rating and weights derived from AHP were used to obtain landslide susceptibility map. The output map is then regrouped into three susceptibility class (high, moderate and low).

V. LANDSLIDE SUSCEPTIBILITY MAP

The Landslide susceptibility map (Plate 12) of Toposheet 48 O/3 and O/4 was obtained using AHP method. This map was generated after creating LOFS maps for all the factor classes and generating raw susceptibility score map. The raw susceptibility score map prepared by using multi-class index overlay method combined with AHP calculation. The final raw susceptibility score map has been reclassified into three susceptibility zones based on the cut-off margin of 50% for "High" and "Moderate" and 30% for "Moderate" and "Low" categories respectively. Approximately 10.44% (about 156.41 sq. Km's) area is falling in high susceptibility zones, while about 25.95% (388.81.15 sq. Km's) area is falling in moderate susceptibility zone (Table 17). Rest of the area is indicated as low susceptibility zone. Areas with high susceptible zone falls in north east of toposheet no. O/4, south east of O/3 and central and northern parts of O/3. The areas of high susceptible zones mostly fall along Agumbe ghat section, Kudremukh forest range, Sita-nadi forest section including areas like Someshwara, Manikyabetta, Kabbinale, Varanga and SK border. Areas with moderate susceptible character lie on foot hill zones of Kudremukh and Sringerin forest ranges. The south-west parts of the study area around Venoor, Shirtadi, Kadiyal, Andinje, Miyar, Jodukatte, Kuntibail, Kadari, Ajekar and Muniyal mostly fall in the low susceptible zone and this zone pinches-out towards Bachappu in north west quardrant of toposheet O/3. North-eastern parts of toposheet O/3 around Nemmaru and some central parts around Kerekatte demarcate low susceptible zones.

Table 17 Landslide Susceptibility Zones with area of coverage in pixels and percentage

Sr. No.	Class	Area Coverage (in Pixels)	Area Coverage (in %)	Area in Sq. Kms.
1	Low	381873	63.60	952.79
2	Medium	155832	25.95	388.81
3	High	62688	10.44	156.41

VI. CONCLUSIONS AND RECOMMENDATIONS

The aim of the present investigation was to produce a seamless landslide susceptible map on 1:50,000 scale involving adequate remote sensing data, thematic layers and field based inputs. The thematic layers include Land use/ Land Cover (LULC), Geomorphology, Slope Forming Material (SFM), which were generated through visual interpretation of multi-temporal Google Imagery. Thematic layers like Slope aspect, Slope gradient, Slope Curvature and Drainage were prepared from 30 m CARTO DEM (Digital Elevation Model). LULC, Geomorphology and Geology thematic maps were used as a proxy by integrating them in Arc GIS for the preparation of Slope Forming Material (SFM) map. Landslide inventory map was prepared by collecting the old landslide data from previous GSI landslide reports and local newspapers. All these thematic layers were checked and validated during field work. Moreover, new slides which were not reported earlier were recorded including 41 geo-parametric sheet at each of the identified sites. After field work, all the thematic layers were updated wherever required by incorporating various field inputs in Arc GIS platform.

The applicability of the susceptibility map is only valid under the given set of geo-environmental conditions taken as input in the susceptibility modelling. Any changes in the spatial distribution of the geo-environmental factors can affect the susceptibility of the area.

About 10.44% (156.41 sq. km) area is grouped under high susceptibility zone in the study area. Most of this area lies around transportation corridors passing through Agumbe ghat section, Kudremukh, Singeri and Sita-nadi forest ranges. The areas where slope has been excavated for laterite quarries and modified for establishment of settlements also fall in the realm of high susceptible zones.

The susceptibility map thus obtained using Analytical hierarchy process (AHP) gives a qualitative indication of the study area about particular mapping units being susceptible to landslide occurrence under the cumulative effect of geo-factors under consideration. This does not have any time connotation and also it is assumed that the same geo-environmental conditions will prevail in the future that augmented the present slope failures. The entire susceptibility and demarcation of the weak zones from landslide point of view is discussed in following points:

1. The high susceptible zones along transportation corridors passing through Agumbe ghat section, Kudremukh, Sringeri and Sitta-nadi forest range are wholly attributed to the unplanned road cutting and widening. The sloppy areas with loose and weathered over-burden in these areas are very prone to failures in rainy season. Many slides in these sections

have been treated by benching and construction of retention walls. However, inclined growth of vegetation, the bulging and partial damage of these retention walls at places point to the imperceptible movement, which can lead to major failure during rainy season. These retention walls are also required in other areas especially along the slides in Agumbe ghat section. The disruption of the retention walls especially those in the vicinity of Agumbe sun-set point should be properly treated from time to time considering heavy traffic due to tourist importance of the place which attracts huge number of tourists through-out the year.

2. All the historic landslides and landslides demarcated in the current field work are confined to roads reflecting the effects of road widening and toe cutting on slope failures. Slopes along roads generated during road widening must be dealt properly as the same could cause sliding leading to traffic jams during rainy season, like that of Mundli-Karkala road landslide on 21st July, 2014 which affected the traffic disruption for few days. The slope modification for settlements without any preventive measures is very alarming, this should be conveyed to the concerned authorities and preventive measures like slope terracing, construction of retaining walls etc. should be taken up before any construction in such areas. Moreover, the loose debris generated from slope modification as in Sringeri area, loose soil debris lying adjacent to some laterite quarries near Ramabail must be treated and dumped at suitable places to avoid any movement at a later stage.

3. As most of the area is covered by thick vegetation (Forest area), any deforestation for unplanned road widening may lead to loosening of the overburden which can trigger a slide during rainy season. Moreover, running streams that cut across the roads carrying huge load material during rainy season pose a considerable risk to the roads. Proper drainage along the road and diversion of drainage on the top of the slope should be done. Slope stability measures are also required to minimise the risk. Preventive measures like treatment of entire catchment area to minimize the load, slope stabilisation and conservation of forests need to be taken up so that the highway is kept safe from any damage.

4. The preparatory factors (e.g., slope, aspect, curvature, geomorphology and drainage) are not expected to change significantly in a short time period, local morphological changes may occur due to land sliding, but this will not substantially affect the susceptibility model. However, some local changes in the land use pattern can take place, such as terracing of slope for cultivation or excavation for construction of new buildings and deforestation for road widening of some narrow roads especially road along SK border. Such changes can induce instability "locally" and may increase or decrease the susceptibility of that slope.

5. The susceptibility map is generally meant for regional application because the information is shown on scale 1:50,000; however, they are still of considerable significance from the point of specific land use and urban planning. Nevertheless, it is recommended that a detailed site-specific study may be duly conducted before planning and execution of the civil construction works in some areas like Agumbe ghat section. Areas with high susceptibility should be given due attention while executing civil constructions.

6. Spatio-temporal prediction of a landslide is still difficult on macro-scale; hence questions can be raised about the predictive capability of a susceptibility map given the uncertainty in the occurrence of a landslide. In the event if a disaster strikes, then loss would be immense if buildings are not safely and properly located. Awareness among people is of utmost importance to reduce the loss of lives and property. The awareness should include information about the potential danger, its identification and its communication; the physical significance of hazard and inherent uncertainties; ways to reduce landslide risk and the available local mitigation options.

Notes:

1) Landslides on macro-scale (1:50,000 scale) are important in order to identify landslide affected/landslide susceptible zones. Potential landslide zones can be studied further on meso-scale, 1:10,000 and 1:5,000 if situation arises.

2) As referred, most of the landslides occurred due to human interference or anthropogenic causes such as unplanned cutting of slopes for road construction and to setup engineering structures.

3) As a general concept offloading of upslope of the slide and strengthening of the toe is to be considered. Very large vertical cut slopes should be avoided and proper benching should be constructed in order to stabilize the slope.

4) Geozute/ Geotextile cab be placed in vulnerable slope, made by overburden material.

5) Retaining wall with proper weep holes/ gabbion walls may be erected to protect the slope.

6) Catch water drain (CWD) and toe drain in upslope to divert the water from slide affect zone. Drainage holes may also be driven in the vulnerable slopes to ease pore water pressure.

7) Afforestation in slide prone areas should be encouraged.

8) Findings of the report should be conveyed to civil work department, NHA, SHA and town planners, district administration so that they can work judiciously/ methodically while carrying-out construction work.

9) Disaster risk reduction (DRD) approach should be adopted to minimize the damage during road/ building construction.

10) The outcome of work carried-out by GSI should also be conveyed to NDMA and SDMA for preparedness in case of any eventuality.

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Locality Index

S/No.	Village	Longitude (E)	Latitude (N)
1	Ajekar	75° 0' 0.07"	13° 19' 18.44"
2	Aladangadi	75° 12' 37.18"	13° 3' 3.59"
3	Andinje	75° 9' 58.60"	13° 3' 25.53"
4	Arasakatte	75° 9' 42.35"	13° 6' 39.72"
5	Bachappu	75° 1' 0.00"	13° 26' 33.06"
6	Chatkalpade	75° 0' 11.31"	13° 22' 15.74"
7	Iruvatturu	75° 2' 1.11"	13° 8' 15.54"
8	Jodukatte	75° 0' 54.47"	13° 11' 50.88"
9	Kabbinale	75° 3' 4.68"	13° 24' 16.14"
10	Kadari	75° 5' 23.97"	13° 13' 12.96"
11	Kadiyal	75° 5' 16.74"	13° 7' 28.01"
12	Kallputthige	75° 2' 29.59"	13° 7' 43.83"
13	Karkala	74° 59' 45.45"	13° 12' 40.61"
14	Kerekatte	75° 8' 2.20"	13° 19' 43.40"
15	Kervashe	75° 4' 25.95"	13° 15' 17.68"
16	Kokkradi	75° 10' 20.81"	13° 4' 40.93"
17	Koodabettu	75° 5' 56.36"	13° 14' 8.99"
18	Kuntibail	75° 1' 54.55"	13° 11' 52.60"
19	Mala	75° 6' 36.75"	13° 14' 19.33"
20	Manikyabetta	75° 9' 6.03"	13° 22' 32.73"
21	Miyyar	75° 3' 17.64"	13° 11' 16.44"
22	Muniyal	75° 0' 36.99"	13° 21' 42.00"
23	Nemmaru	75° 13' 4.29"	13° 23' 19.98"
24	Pheradka	75° 5' 41.71"	13° 13' 49.83"
25	Shirtadi	75° 4' 57.06"	13° 5' 13.92"
26	SK Border	75° 8' 22.54"	13° 17' 1.51"
27	Someshwara	75° 4' 3.10"	13° 29' 26.75"
28	Varanga	75° 0' 12.68"	13° 23' 48.05"
29	Venoor	75° 8' 39.57"	13° 0' 43.95"

SYNOPSIS OF WORK DONE

1	**Title of the report**	Macro-scale (1:50,000) landslide susceptibility mapping in parts of Toposheets nos. 48 O/3 & 4, Udupi, Chikmangaluru & Dakshin Kannada districts, Karnataka.
2	**FSP Code No**	M4LSSM/NC/SR/SU-KG/2017/12164
3	**Field Season**	2017 – 18
4	**Date of Commencement**	25th September, 2017
5	**Date of Completion**	23rd February, 2018
6	**Officers associated with the investigation and no. of days spent in the field**	Zameer Ahmad Shah, Geologist (89 days) Kapil Singh., Geologist (87 days)
7	**Quantum of work done**	

1. Pre-field preparation	
(i) Slope Forming Material map	1498 sq. Km
(ii) Geomorphology & Lineament map	1498 sq. Km
(iii) Slope Morphometry (slope, aspect & curvature) map	1498 sq. Km
(iv) Landuse / Landcover map	1498 sq. Km
(v) Drainage map	1498 sq. Km
(vi) Regolith thickness map	1498 sq. Km
(vii) Preparation of Landslide Inventory Map	1498 sq. Km
2. Field-based studies	
(i) Field-checking of all thematic maps	1498 sq. Km
(ii) Field validation of landslide inventory and collection of recent and historic landslides (using archives, old reports, road register etc.)	1498 sq. Km
(iii) Collection of landslide inventory and damage data as per 41 point geo parametric data sheet	1498 sq. Km (18 nos. of landslides)
3. Post-field studies & modelling	
(i) Updation of thematic and inventory maps in GIS	1498 sq. Km
(ii) Preparation of Landslide Susceptibility Map in GIS	1498 sq. Km
4. Collection of rainfall data from available rain-gauge stations	1498 sq. Km (Collected for 10 years for three rain gauge stations)

FIVE POINT PROFORMA

Title of the report: Macro-scale (1:50,000) landslide susceptibility mapping in parts of Toposheets nos. 48 O/3 & 4, Udupi, Chikmangaluru & Dakshin Kannada districts, Karnataka.	
1. Background of the investigation at whose instance or with what particular objective in view the investigation was undertaken	The item was taken up as per the annual programme of GSI vide FSP Code No: M4LSSM/NC/SR/SU-KG/2017/12164 with an objective to prepare seamless Landslide Susceptibility Map of India.
2. Whether the item of investigation was included in the approved programme for the year concerned. If so, particulars, such as item No. page reference etc. may be given.	Yes FSP Code: M4LSSM/NC/SR/SU-KG/2017/12164
3. Date of commencement of the investigation with month and year, and exact number of days spent by the officer(s) in the field in connection with the investigation.	25th September, 2017 1. Zameer Ahmad Shah, **89 Days** 2. Kapil Singh, **87 Days** **Total 176 days**
4. Brief comments by Director / Supervisory officer on the conclusion and recommendation by the author(s) with suggestion for implementing the same.	I fully agree with the conclusions drawn and recommendations made by the authors.
5. Please state specifically how the results of the investigation were achieved compared with the objective for which it was undertaken	The objective of the investigation is fully achieved.
Date: Place: Bengaluru	 Shri J. Srihari Director

Annexure – I: 41 Point Geo-parametric Data Format for Landslides

1	Name	KAR/DK/48O3/2017/01
2	Latitude (N) (DMS)	13°15'14.43"
3	Longitude (E) (DMS)	75° 7'41.98"
4	Toposheet No	48O/3
5	Village Name	Near Mulluru
6	Road	Karkala-SK border
7	Geomorphic Process	Gravitational
8	Geomorphic Form	Highly Dissected Slope
9	Rock	Amphibolite
10	Weathering	Moderate
11	Rock Character	Massive
12	Dip Foliation	*Data Not Available*
13	Dip Direction Foliation	*Data Not Available*
14	Dip J1	*Data Not Available*
15	Dip Direction J1	*Data Not Available*
16	Overburden Type	Weathered Rock
17	Thickness	0.5-5m
18	Landuse	Extensive Slope Cut
19	Hydrology	Damp
20	Erosion	Base removal/Toe cutting Erosion
21	Susceptibility	High
22	Risk	Moderate
23	Landslide Length	18m
24	Landslide Width	8m
25	Landslide Height	13m
26	Landslide Run Out	7m
27	Landslide Material	Debris
28	Movement Type	Slide
29	Failure Depth	<=5m
30	Landslide Activity	Inactive
31	Landslide Distribution	Retrogressive
32	Landslide Style	Single
33	Landslide Mechanism	Shallow Translational Failure
34	Landslide Initiation	*Data Not Available*
35	Upslope	40°
36	Downslope	80°
37	Triggering Factor	Rainfall
38	Casualties	*Data Not Available*
39	Geo Scientific Cause	Toe cutting
40	Remedial Measures	Benching
41	Remarks	

1	Name	KAR/DK/48O3/2017/02
2	Latitude (N) (DMS)	13°15'43.29"
3	Longitude (E) (DMS)	75° 7'46.23"
4	Toposheet No	48O/3
5	Village Name	Near Mulluru
6	Road	Karkala-SK border
7	Geomorphic Process	Gravitational
8	Geomorphic Form	Highly Dissected Slope
9	Rock	Amphibolite
10	Weathering	Moderate
11	Rock Character	Massive
12	Dip Foliation	*Data Not Available*
13	Dip Direction Foliation	*Data Not Available*
14	Dip J1	*Data Not Available*
15	Dip Direction J1	*Data Not Available*
16	Overburden Type	Weathered Rock
17	Thickness	0.5-5m
18	Landuse	Extensive Slope Cut
19	Hydrology	Damp
20	Erosion	Toe Erosion
21	Susceptibility	High
22	Risk	High
23	Landslide Length	22m
24	Landslide Width	15m
25	Landslide Height	20m
26	Landslide Run Out	15m
27	Landslide Material	Debris
28	Movement Type	Slide
29	Failure Depth	<=5m
30	Landslide Activity	Active
31	Landslide Distribution	Retrogressive
32	Landslide Style	Complex
33	Landslide Mechanism	Shallow Translational Failure
34	Landslide Initiation	*Data Not Available*
35	Upslope	50°
36	Downslope	80°
37	Triggering Factor	Water saturation
38	Casualties	*Data Not Available*
39	Geo Scientific Cause	Toe cutting of the slope for road widening
40	Remedial Measures	Benching
41	Remarks	Slide covered by vegetation.

1	Name	KAR/DK/48O3/2017/03
2	Latitude (N) (DMS)	13°15'46.80"
3	Longitude (E) (DMS)	75° 7'51.60"
4	Toposheet No	48O/3
5	Village Name	Near SK border
6	Road	Karkala-SK border
7	Geomorphic Process	Gravitational
8	Geomorphic Form	Highly Dissected Slope
9	Rock	Amphibolite
10	Weathering	Moderate
11	Rock Character	Massive
12	Dip Foliation	*Data Not Available*
13	Dip Direction Foliation	*Data Not Available*
14	Dip J1	*Data Not Available*
15	Dip Direction J1	*Data Not Available*
16	Overburden Type	Weathered Rock
17	Thickness	0.5-5m
18	Landuse	Extensive Slope Cut
19	Hydrology	Damp
20	Erosion	Toe Erosion
21	Susceptibility	High
22	Risk	Moderate
23	Landslide Length	9m
24	Landslide Width	10m
25	Landslide Height	7m
26	Landslide Run Out	6m
27	Landslide Material	Debris
28	Movement Type	Slide
29	Failure Depth	<=5m
30	Landslide Activity	Active
31	Landslide Distribution	Retrogressive
32	Landslide Style	Single
33	Landslide Mechanism	Shallow Translational Failure
34	Landslide Initiation	*Data Not Available*
35	Upslope	45°
36	Downslope	80°
37	Triggering Factor	Rainfall
38	Casualties	*Data Not Available*
39	Geo Scientific Cause	Toe cutting of the slope for road extension
40	Remedial Measures	Retaining wall with weep holes
41	Remarks	Nil

1	Name	KAR/DK/48O3/2017/04
2	Latitude (N) (DMS)	13°19'30.10"
3	Longitude (E) (DMS)	75° 8'34.07"
4	Toposheet No	48O/3
5	Village Name	Hallimakki
6	Road	NH-13
7	Geomorphic Process	Gravitational
8	Geomorphic Form	Lowly Dissected Slope
9	Rock	Quartz-Chlorite Schist
10	Weathering	Moderate
11	Rock Character	Massive
12	Dip Foliation	*Data Not Available*
13	Dip Direction Foliation	*Data Not Available*
14	Dip J1	*Data Not Available*
15	Dip Direction J1	*Data Not Available*
16	Overburden Type	Insitu soil
17	Thickness	0.5-5m
18	Landuse	Extensive Slope Cut
19	Hydrology	Damp
20	Erosion	Toe Erosion
21	Susceptibility	Moderate
22	Risk	Moderate
23	Landslide Length	19m
24	Landslide Width	8m
25	Landslide Height	14m
26	Landslide Run Out	6m
27	Landslide Material	Debris
28	Movement Type	Slide
29	Failure Depth	<=5 m
30	Landslide Activity	Suspended
31	Landslide Distribution	Retrogressive
32	Landslide Style	Single
33	Landslide Mechanism	Shallow Translational Failure
34	Landslide Initiation	*Data Not Available*
35	Upslope	45°
36	Downslope	80°
37	Triggering Factor	Rainfall
38	Casualties	*Data Not Available*
39	Geo Scientific Cause	Toe cutting of the slope
40	Remedial Measures	Benching
41	Remarks	Vegetation growth upon old debris material

1	Name	KAR/DK/48O3/2017/05
2	Latitude (N) (DMS)	13°20'27.60"
3	Longitude (E) (DMS)	75°10'15.35"
4	Toposheet No	48O/3
5	Village Name	Edagaru
6	Road	NH-13
7	Geomorphic Process	Gravitational
8	Geomorphic Form	Lowly Dissected Slope
9	Rock	Quartz-Chlorite Schist
10	Weathering	Moderate
11	Rock Character	Massive
12	Dip Foliation	*Data Not Available*
13	Dip Direction Foliation	*Data Not Available*
14	Dip J1	*Data Not Available*
15	Dip Direction J1	*Data Not Available*
16	Overburden Type	Insitu soil
17	Thickness	0.5-5m
18	Landuse	Extensive Slope Cut
19	Hydrology	Damp
20	Erosion	Toe Erosion
21	Susceptibility	High
22	Risk	Moderate
23	Landslide Length	11m
24	Landslide Width	5m
25	Landslide Height	9m
26	Landslide Run Out	5 m
27	Landslide Material	Debris
28	Movement Type	Slide
29	Failure Depth	<=5m
30	Landslide Activity	Active
31	Landslide Distribution	Retrogressive
32	Landslide Style	Single
33	Landslide Mechanism	Shallow Translational Failure
34	Landslide Initiation	*Data Not Available*
35	Upslope	35°
36	Downslope	80°
37	Triggering Factor	Rainfall
38	Casualties	*Data Not Available*
39	Geo Scientific Cause	Toe cutting of the slope
40	Remedial Measures	Benching
41	Remarks	Nil

1	Name	KAR/DK/48O3/2017/06
2	Latitude (N) (DMS)	13°21'41.81"
3	Longitude (E) (DMS)	75°12'24.57"
4	Toposheet No	48O/3
5	Village Name	Tanikoda
6	Road	NH-13
7	Geomorphic Process	Gravitational
8	Geomorphic Form	Lowly Dissected Slope
9	Rock	Quartz-Chlorite Schist
10	Weathering	Moderate
11	Rock Character	Massive
12	Dip Foliation	*Data Not Available*
13	Dip Direction Foliation	*Data Not Available*
14	Dip J1	*Data Not Available*
15	Dip Direction J1	*Data Not Available*
16	Overburden Type	Rock
17	Thickness	0.5-5m
18	Name	KAR/DK/48O3/2017/07
19	Latitude (N) (DMS)	13°21'41.81"
20	Longitude (E) (DMS)	75°12'24.57"
21	Toposheet No	48O/4
22	Village Name	Tanikoda
23	Road	NH-14
24	Name	KAR/DK/48O3/2017/07
25	Latitude (N) (DMS)	13°21'41.81"
26	Longitude (E) (DMS)	75°12'24.57"
27	Toposheet No	48O/4
28	Village Name	Tanikoda
29	Road	NH-14
30	Geomorphic Process	Gravitational
31	Geomorphic Form	Lowly Dissected Slope
32	Rock	Quartz-Chlorite Schist
33	Weathering	Moderate
34	Rock Character	Massive
35	Dip Foliation	*Data Not Available*
36	Dip Direction Foliation	*Data Not Available*
37	Road	NH-14
38	Geomorphic Process	Gravitational
39	Geomorphic Form	Lowly Dissected Slope
40	Rock	Quartz-Chlorite Schist
41	Remarks	Slide is water saturated.Joints vertical to sub vertical.Cracks parralel to the road obseved adjacent to the slide.

1	Name	KAR/DK/48O3/2017/07
2	Latitude (N) (DMS)	13°24'13.46"
3	Longitude (E) (DMS)	75°14'0.01"
4	Toposheet No	48O/3
5	Village Name	Tyavana
6	Road	Kachchodi-Handigodu road section (NH-13)
7	Geomorphic Process	Gravitational
8	Geomorphic Form	Lowly Dissected Slope
9	Rock	Granite Gneiss
10	Weathering	Moderate
11	Rock Character	Massive
12	Dip Foliation	*Data Not Available*
13	Dip Direction Foliation	*Data Not Available*
14	Dip J1	*Data Not Available*
15	Dip Direction J1	*Data Not Available*
16	Overburden Type	Insitu
17	Thickness	< 0.5 m
18	Landuse	Thick Vegetation
19	Hydrology	Damp
20	Erosion	Toe Erosion
21	Susceptibility	High
22	Risk	Moderate
23	Landslide Length	14m
24	Landslide Width	8m
25	Landslide Height	11m
26	Landslide Run Out	*Data Not Available*
27	Landslide Material	Debris
28	Movement Type	Slide
29	Failure Depth	<=5m
30	Landslide Activity	Active
31	Landslide Distribution	Retrogressive
32	Landslide Style	Composite
33	Landslide Mechanism	Shallow Translational Failure
34	Landslide Initiation	*Data Not Available*
35	Upslope	*Data Not Available*
36	Downslope	*Data Not Available*
37	Triggering Factor	Rainfall
38	Casualties	*Data Not Available*
39	Geo Scientific Cause	Toe cutting of the slope
40	Remedial Measures	Benching
41	Remarks	Nil

1	Name	KAR/DK/48O4/2017/08
2	Latitude (N) (DMS)	13°12'8.08"
3	Longitude (E) (DMS)	75° 7'4.51"
4	Toposheet No	48O/4
5	Village Name	1.2 km SE of Malachouki
6	Road	Kalnabettu-Malachouki road section
7	Geomorphic Process	Gravitational
8	Geomorphic Form	Pediment-Pediplain complex
9	Rock	Granitoid
10	Weathering	Moderate
11	Rock Character	Massive
12	Dip Foliation	*Data Not Available*
13	Dip Direction Foliation	*Data Not Available*
14	Dip J1	*Data Not Available*
15	Dip Direction J1	*Data Not Available*
16	Overburden Type	Insitu
17	Thickness	< 0.5 m
18	Landuse	Extensive Slope Cut
19	Hydrology	Damp
20	Erosion	Toe Erosion
21	Susceptibility	High
22	Risk	High
23	Landslide Length	17m
24	Landslide Width	15m
25	Landslide Height	9m
26	Landslide Run Out	12m
27	Landslide Material	Debris
28	Movement Type	Slide
29	Failure Depth	<=5m
30	Landslide Activity	Active
31	Landslide Distribution	Retrogressive
32	Landslide Style	Single
33	Landslide Mechanism	Shallow Translational Failure
34	Landslide Initiation	*Data Not Available*
35	Upslope	*Data Not Available*
36	Downslope	*Data Not Available*
37	Triggering Factor	Rainfall
38	Casualties	*Data Not Available*
39	Geo Scientific Cause	Subsidence due to toe cutting
40	Remedial Measures	Retaining wall with weep holes
41	Remarks	Nil

1	Name	KAR/DK/48O4/2017/09
2	Latitude (N) (DMS)	13°12'32.84"
3	Longitude (E) (DMS)	75°12'7.48"
4	Toposheet No	48O/4
5	Village Name	Bhagavati
6	Road	Bhagavati-Kalasa road section
7	Geomorphic Process	Gravitational
8	Geomorphic Form	Moderately Dissected Slope
9	Rock	Metabasalt
10	Weathering	Moderate
11	Rock Character	Massive
12	Dip Foliation	*Data Not Available*
13	Dip Direction Foliation	*Data Not Available*
14	Dip J1	*Data Not Available*
15	Dip Direction J1	*Data Not Available*
16	Overburden Type	Rock
17	Thickness	< 0.5 m
18	Landuse	Barren
19	Hydrology	Damp
20	Erosion	Toe Erosion
21	Susceptibility	High
22	Risk	Moderate
23	Landslide Length	14m
24	Landslide Width	20m
25	Landslide Height	10m
26	Landslide Run Out	5m
27	Landslide Material	Debris
28	Movement Type	Slide
29	Failure Depth	<=5m
30	Landslide Activity	Active
31	Landslide Distribution	Retrogressive
32	Landslide Style	Single
33	Landslide Mechanism	Shallow Translational Failure
34	Landslide Initiation	*Data Not Available*
35	Upslope	*Data Not Available*
36	Downslope	*Data Not Available*
37	Triggering Factor	Rainfall
38	Casualties	*Data Not Available*
39	Geo Scientific Cause	Toe cutting of the slope for road widening
40	Remedial Measures	Retaining wall with weep holes
41	Remarks	Nil

1	Name	KAR/DK/48O4/2017/10
2	Latitude (N) (DMS)	13°12'52.00"
3	Longitude (E) (DMS)	75°13'34.08"
4	Toposheet No	48O/4
5	Village Name	05 km N of village Bilegat
6	Road	Bhagavati-Kalasa road section
7	Geomorphic Process	Gravitational
8	Geomorphic Form	Moderately Dissected Slope
9	Rock	Quartz-Chlorite Schist
10	Weathering	Moderate
11	Rock Character	Massive
12	Dip Foliation	*Data Not Available*
13	Dip Direction Foliation	*Data Not Available*
14	Dip J1	*Data Not Available*
15	Dip Direction J1	*Data Not Available*
16	Overburden Type	In situ Soil
17	Thickness	0.5 - 5 m
18	Landuse	Extensive Slope Cut
19	Hydrology	Damp
20	Erosion	Toe Erosion
21	Susceptibility	High
22	Risk	Moderate
23	Landslide Length	17 m
24	Landslide Width	11 m
25	Landslide Height	12 m
26	Landslide Run Out	*Data Not Available*
27	Landslide Material	Debris
28	Movement Type	Slide
29	Failure Depth	<=5m
30	Landslide Activity	Active
31	Landslide Distribution	Retrogressive
32	Landslide Style	Single
33	Landslide Mechanism	Shallow Translational Failure
34	Landslide Initiation	*Data Not Available*
35	Upslope	*Data Not Available*
36	Downslope	*Data Not Available*
37	Triggering Factor	Rainfall
38	Casualties	*Data Not Available*
39	Geo Scientific Cause	Toe cutting of the slope
40	Remedial Measures	Retaining wall with weep holes
41	Remarks	Nil

1	Name	KAR/DK/48O4/2017/11
2	Latitude (N) (DMS)	13°13'30.50"
3	Longitude (E) (DMS)	75°10'51.20"
4	Toposheet No	48O/4
5	Village Name	1.8 km NW of Village Bhagavati
6	Road	Bhagavati-SK border road section
7	Geomorphic Process	Gravitational
8	Geomorphic Form	Highly Dissected Slope
9	Rock	Metabasalt
10	Weathering	Moderate
11	Rock Character	Massive
12	Dip Foliation	*Data Not Available*
13	Dip Direction Foliation	*Data Not Available*
14	Dip J1	*Data Not Available*
15	Dip Direction J1	*Data Not Available*
16	Overburden Type	Rock
17	Thickness	0.5-5m
18	Landuse	Extensive Slope Cut
19	Hydrology	Damp
20	Erosion	Toe Erosion
21	Susceptibility	High
22	Risk	High
23	Landslide Length	26m
24	Landslide Width	55m
25	Landslide Height	18m
26	Landslide Run Out	*12m*
27	Landslide Material	Debris
28	Movement Type	Slide
29	Failure Depth	<=5m
30	Landslide Activity	Active
31	Landslide Distribution	Retrogressive & Widening
32	Landslide Style	Single
33	Landslide Mechanism	Shallow Translational Failure
34	Landslide Initiation	*Data Not Available*
35	Upslope	*Data Not Available*
36	Downslope	*Data Not Available*
37	Triggering Factor	Rainfall
38	Casualties	*Data Not Available*
39	Geo Scientific Cause	Toe cutting of the slope
40	Remedial Measures	Retaining wall with weep holes
41	Remarks	weathered granite,Joints observed at the top

1	Name	KAR/DK/48O3/2017/12
2	Latitude (N) (DMS)	13°28'40.17"
3	Longitude (E) (DMS)	75° 2'51.04"
4	Toposheet No	48O/3
5	Village Name	Bandimata
6	Road	Sitanadi-Someshwar road section
7	Geomorphic Process	Gravitational
8	Geomorphic Form	Pediment-Pediplain complex
9	Rock	Granite Gneiss
10	Weathering	Moderate
11	Rock Character	Massive
12	Dip Foliation	*Data Not Available*
13	Dip Direction Foliation	*Data Not Available*
14	Dip J1	*Data Not Available*
15	Dip Direction J1	*Data Not Available*
16	Overburden Type	In situ Soil
17	Thickness	0.5 - 5 m
18	Landuse	Extensive Slope Cut
19	Hydrology	Damp
20	Erosion	Toe Erosion
21	Susceptibility	High
22	Risk	Moderate
23	Landslide Length	8m
24	Landslide Width	7m
25	Landslide Height	9m
26	Landslide Run Out	4m
27	Landslide Material	Debris
28	Movement Type	Slide
29	Failure Depth	<=5m
30	Landslide Activity	Active
31	Landslide Distribution	Retrogressive
32	Landslide Style	Single
33	Landslide Mechanism	Shallow Translational Failure
34	Landslide Initiation	*Data Not Available*
35	Upslope	*Data Not Available*
36	Downslope	*Data Not Available*
37	Triggering Factor	Rainfall
38	Casualties	*Data Not Available*
39	Geo Scientific Cause	Toe cutting of the slope
40	Remedial Measures	Retaining wall with weep holes
41	Remarks	Nil

1	Name	KAR/DK/48O3/2017/13
2	Latitude (N) (DMS)	13°29'20.00"
3	Longitude (E) (DMS)	75° 4'39.23"
4	Toposheet No	48O/3
5	Village Name	Near Village Someshwar
6	Road	Someshwar-Agumbe road section
7	Geomorphic Process	Gravitational
8	Geomorphic Form	Highly Dissected Slope
9	Rock	Amphibolite
10	Weathering	High
11	Rock Character	Massive
12	Dip Foliation	*Data Not Available*
13	Dip Direction Foliation	*Data Not Available*
14	Dip J1	*Data Not Available*
15	Dip Direction J1	*Data Not Available*
16	Overburden Type	Weathered rock
17	Thickness	0.5 - 5 m
18	Landuse	Thick vegetation
19	Hydrology	Damp
20	Erosion	Toe Erosion
21	Susceptibility	High
22	Risk	Moderate
23	Landslide Length	9m
24	Landslide Width	7m
25	Landslide Height	8m
26	Landslide Run Out	*4m*
27	Landslide Material	Debris
28	Movement Type	Slide
29	Failure Depth	>=5m
30	Landslide Activity	Active
31	Landslide Distribution	Retrogressive
32	Landslide Style	Single
33	Landslide Mechanism	Shallow Translational Failure
34	Landslide Initiation	*Data Not Available*
35	Upslope	*Data Not Available*
36	Downslope	*Data Not Available*
37	Triggering Factor	Rainfall
38	Casualties	*Data Not Available*
39	Geo Scientific Cause	Toe cutting of the slope for road widening
40	Remedial Measures	Retaining wall with weep holes
41	Remarks	Nil

1	Name	KAR/DK/48O3/2017/14
2	Latitude (N) (DMS)	13°29'37.24"
3	Longitude (E) (DMS)	75° 4'43.29"
4	Toposheet No	48O/3
5	Village Name	Near Village Someshwar
6	Road	Someshwar-Agumbe road section
7	Geomorphic Process	Gravitational
8	Geomorphic Form	Highly Dissected Slope
9	Rock	Amphibolite
10	Weathering	Moderate
11	Rock Character	Massive
12	Dip Foliation	*Data Not Available*
13	Dip Direction Foliation	*Data Not Available*
14	Dip J1	*Data Not Available*
15	Dip Direction J1	*Data Not Available*
16	Overburden Type	Weathered Rock
17	Thickness	0.5-5m
18	Landuse	Extensive Slope Cut
19	Hydrology	Damp
20	Erosion	Toe Erosion
21	Susceptibility	High
22	Risk	Moderate
23	Landslide Length	18m
24	Landslide Width	11m
25	Landslide Height	14m
26	Landslide Run Out	8m
27	Landslide Material	Debris
28	Movement Type	Slide
29	Failure Depth	<=5m
30	Landslide Activity	Active
31	Landslide Distribution	Retrogressive
32	Landslide Style	Single
33	Landslide Mechanism	Shallow Translational Failure
34	Landslide Initiation	*Data Not Available*
35	Upslope	*Data Not Available*
36	Downslope	*Data Not Available*
37	Triggering Factor	Rainfall
38	Casualties	*Data Not Available*
39	Geo Scientific Cause	Toe cutting of the slope
40	Remedial Measures	Retaining wall with weep holes
41	Remarks	

1	Name	KAR/DK/48O3/2017/15
2	Latitude (N) (DMS)	13°29'42.20"
3	Longitude (E) (DMS)	75° 4'47.30"
4	Toposheet No	48O/3
5	Village Name	Near Village Someshwar
6	Road	Someshwar-Agumbe road section
7	Geomorphic Process	Gravitational
8	Geomorphic Form	Highly Dissected Slope
9	Rock	Amphibolite
10	Weathering	Moderate
11	Rock Character	Massive
12	Dip Foliation	*Data Not Available*
13	Dip Direction Foliation	*Data Not Available*
14	Dip J1	*Data Not Available*
15	Dip Direction J1	*Data Not Available*
16	Overburden Type	Weathered Rock
17	Thickness	0.5-5m
18	Landuse	Sparse Vegetation
19	Hydrology	Damp
20	Erosion	Toe Erosion
21	Susceptibility	High
22	Risk	Moderate
23	Landslide Length	8m
24	Landslide Width	5m
25	Landslide Height	6m
26	Landslide Run Out	*4m*
27	Landslide Material	Debris
28	Movement Type	Slide
29	Failure Depth	5 m
30	Landslide Activity	Active
31	Landslide Distribution	Retrogressive
32	Landslide Style	Single
33	Landslide Mechanism	Shallow Translational Failure
34	Landslide Initiation	*Data Not Available*
35	Upslope	*Data Not Available*
36	Downslope	*Data Not Available*
37	Triggering Factor	Rainfall
38	Casualties	*Data Not Available*
39	Geo Scientific Cause	Toe cutting of the slope
40	Remedial Measures	Benching
41	Remarks	Nil

1	Name	KAR/DK/48O3/2017/16
2	Latitude (N) (DMS)	13°29'48.50"
3	Longitude (E) (DMS)	75° 4'44.40"
4	Toposheet No	48O/3
5	Village Name	Near Village Someshwar
6	Road	Someshwar-Agumbe road section
7	Geomorphic Process	Gravitational
8	Geomorphic Form	Highly Dissected Slope
9	Rock	Amphibolite
10	Weathering	Moderate
11	Rock Character	Massive
12	Dip Foliation	*Data Not Available*
13	Dip Direction Foliation	*Data Not Available*
14	Dip J1	*Data Not Available*
15	Dip Direction J1	*Data Not Available*
16	Overburden Type	Weathered Rock
17	Thickness	0.5-5m
18	Landuse	Sparse Vegetation
19	Hydrology	Damp
20	Erosion	Toe Erosion
21	Susceptibility	High
22	Risk	High
23	Landslide Length	14m
24	Landslide Width	7 m
25	Landslide Height	9m
26	Landslide Run Out	*5m*
27	Landslide Material	Debris
28	Movement Type	Slide
29	Failure Depth	<=5m
30	Landslide Activity	Active
31	Landslide Distribution	Retrogressive
32	Landslide Style	Single
33	Landslide Mechanism	Shallow Translational Failure
34	Landslide Initiation	*Data Not Available*
35	Upslope	*Data Not Available*
36	Downslope	*Data Not Available*
37	Triggering Factor	Rainfall
38	Casualties	*Data Not Available*
39	Geo Scientific Cause	Toe cutting of the slope
40	Remedial Measures	Retaining wall with weep holes
41	Remarks	Nil

1	Name	KAR/DK/48O3/2017/17
2	Latitude (N) (DMS)	13°27'13.85"
3	Longitude (E) (DMS)	75° 3'33.05"
4	Toposheet No	48O/3
5	Village Name	Nadpal
6	Road	Ballmane-Nadpal road section
7	Geomorphic Process	Gravitational
8	Geomorphic Form	Pediment-Pediplain complex
9	Rock	Granitoid
10	Weathering	Moderate
11	Rock Character	Massive
12	Dip Foliation	*Data Not Available*
13	Dip Direction Foliation	*Data Not Available*
14	Dip J1	*Data Not Available*
15	Dip Direction J1	*Data Not Available*
16	Overburden Type	In situ Soil
17	Thickness	0.5 - 5 m
18	Landuse	Cultivation
19	Hydrology	Damp
20	Erosion	Toe Erosion
21	Susceptibility	High
22	Risk	High
23	Landslide Length	11m
24	Landslide Width	14m
25	Landslide Height	8m
26	Landslide Run Out	*5m*
27	Landslide Material	Debris
28	Movement Type	Slide
29	Failure Depth	<=5m
30	Landslide Activity	Active
31	Landslide Distribution	Retrogressive
32	Landslide Style	Single
33	Landslide Mechanism	Shallow Translational Failure
34	Landslide Initiation	*Data Not Available*
35	Upslope	*Data Not Available*
36	Downslope	*Data Not Available*
37	Triggering Factor	Rainfall
38	Casualties	*Data Not Available*
39	Geo Scientific Cause	Toe cutting of the slope for road widening
40	Remedial Measures	Retaining wall with weep holes
41	Remarks	Nil

1	Name	KAR/DK/48O3/2017/18
2	Latitude (N) (DMS)	13°23'27.10"
3	Longitude (E) (DMS)	75°10'48.77"
4	Toposheet No	48O/3
5	Village Name	Sirimane
6	Road	Sindodi-Chatnamane road section
7	Geomorphic Process	Gravitational
8	Geomorphic Form	Highly Dissected Slope
9	Rock	Amphibolite
10	Weathering	Moderate
11	Rock Character	Massive
12	Dip Foliation	*Data Not Available*
13	Dip Direction Foliation	*Data Not Available*
14	Dip J1	*Data Not Available*
15	Dip Direction J1	*Data Not Available*
16	Overburden Type	Weathered Rock
17	Thickness	0.5 - 5 m
18	Landuse	Moderate Vegetation
19	Hydrology	Damp
20	Erosion	Toe Erosion
21	Susceptibility	High
22	Risk	High
23	Landslide Length	10m
24	Landslide Width	7m
25	Landslide Height	8m
26	Landslide Run Out	*5m*
27	Landslide Material	Debris
28	Movement Type	Slide
29	Failure Depth	5 m
30	Landslide Activity	Active
31	Landslide Distribution	Retrogressive
32	Landslide Style	Single
33	Landslide Mechanism	Shallow Translational Failure
34	Landslide Initiation	*Data Not Available*
35	Upslope	*Data Not Available*
36	Downslope	*Data Not Available*
37	Triggering Factor	Rainfall
38	Casualties	*Data Not Available*
39	Geo Scientific Cause	Toe cutting of the slope
40	Remedial Measures	Benching
41	Remarks	Nil

1	Name	KAR/DK/48O4/2017/19
2	Latitude (N) (DMS)	13° 0'02.28"
3	Longitude (E) (DMS)	75° 0'37.81"
4	Toposheet No	48O/4
5	Village Name	Aruvail
6	Road	Aruvail-Niddale road section
7	Geomorphic Process	Gravitational
8	Geomorphic Form	Lowly Dissected Slope
9	Rock	Charnockite
10	Weathering	Moderate
11	Rock Character	Massive
12	Dip Foliation	*Data Not Available*
13	Dip Direction Foliation	*Data Not Available*
14	Dip J1	*Data Not Available*
15	Dip Direction J1	*Data Not Available*
16	Overburden Type	Weathered Rock
17	Thickness	0.5 - 5 m
18	Landuse	Moderate Vegetation
19	Hydrology	Damp
20	Erosion	Toe Erosion
21	Susceptibility	High
22	Risk	High
23	Landslide Length	12m
24	Landslide Width	8m
25	Landslide Height	10m
26	Landslide Run Out	*7m*
27	Landslide Material	Debris
28	Movement Type	Slide
29	Failure Depth	<=5m
30	Landslide Activity	Active
31	Landslide Distribution	Retrogressive
32	Landslide Style	Single
33	Landslide Mechanism	Shallow Translational Failure
34	Landslide Initiation	*Data Not Available*
35	Upslope	*Data Not Available*
36	Downslope	*Data Not Available*
37	Triggering Factor	Rainfall
38	Casualties	*Data Not Available*
39	Geo Scientific Cause	Toe cutting of the slope
40	Remedial Measures	Retaining wall with weep holes
41	Remarks	Nil

1	Name	KAR/DK/48O3/2017/20
2	Latitude (N) (DMS)	13°15'12.87"
3	Longitude (E) (DMS)	75° 7'40.48"
4	Toposheet No	48O/3
5	Village Name	1.4 km N of Village Heranje
6	Road	Mulluru-SK border road section
7	Geomorphic Process	Gravitational
8	Geomorphic Form	Highly Dissected Slope
9	Rock	Amphibolite
10	Weathering	Moderate
11	Rock Character	Massive
12	Dip Foliation	*Data Not Available*
13	Dip Direction Foliation	*Data Not Available*
14	Dip J1	*Data Not Available*
15	Dip Direction J1	*Data Not Available*
16	Overburden Type	Weathered Rock
17	Thickness	0.5 - 5 m
18	Landuse	Extensive Cut slope
19	Hydrology	Damp
20	Erosion	Toe Erosion
21	Susceptibility	High
22	Risk	High
23	Landslide Length	18m
24	Landslide Width	14m
25	Landslide Height	16m
26	Landslide Run Out	*12m*
27	Landslide Material	Debris
28	Movement Type	Slide
29	Failure Depth	<=5m
30	Landslide Activity	Dormant
31	Landslide Distribution	Retrogressive
32	Landslide Style	Composite
33	Landslide Mechanism	Shallow Translational Failure
34	Landslide Initiation	*Data Not Available*
35	Upslope	*Data Not Available*
36	Downslope	*Data Not Available*
37	Triggering Factor	Rainfall
38	Casualties	*Data Not Available*
39	Geo Scientific Cause	Toe cutting of the slope
40	Remedial Measures	Retaining wall with weep holes
41	Remarks	Nil

1	Name	KAR/DK/48O3/2017/21
2	Latitude (N) (DMS)	13°15'41.04"
3	Longitude (E) (DMS)	75° 7'45.06"
4	Toposheet No	48O/3
5	Village Name	2.28 km N of Village Heranje
6	Road	Mulluru-SK border road section
7	Geomorphic Process	Gravitational
8	Geomorphic Form	Highly Dissected Slope
9	Rock	Amphibolite
10	Weathering	Moderate
11	Rock Character	Massive
12	Dip Foliation	*Data Not Available*
13	Dip Direction Foliation	*Data Not Available*
14	Dip J1	*Data Not Available*
15	Dip Direction J1	*Data Not Available*
16	Overburden Type	Weathered Rock
17	Thickness	0.5 - 5 m
18	Landuse	Extensive Cut slope
19	Hydrology	Damp
20	Erosion	Toe Erosion
21	Susceptibility	High
22	Risk	High
23	Landslide Length	18m
24	Landslide Width	14m
25	Landslide Height	16m
26	Landslide Run Out	*12m*
27	Landslide Material	Debris
28	Movement Type	Slide
29	Failure Depth	<=5m
30	Landslide Activity	Dormant
31	Landslide Distribution	Retrogressive
32	Landslide Style	Composite
33	Landslide Mechanism	Shallow Translational Failure
34	Landslide Initiation	*Data Not Available*
35	Upslope	*Data Not Available*
36	Downslope	*Data Not Available*
37	Triggering Factor	Rainfall
38	Casualties	*Data Not Available*
39	Geo Scientific Cause	Toe cutting of the slope
40	Remedial Measures	Retaining wall with weep holes
41	Remarks	Nil

1	Name	KAR/DK/48O3/2017/22
2	Latitude (N) (DMS)	13°17'13.35"
3	Longitude (E) (DMS)	75° 8'59.14"
4	Toposheet No	48O/3
5	Village Name	1.5 km SW of Village Siralu
6	Road	SK border-Malleshwara road section
7	Geomorphic Process	Gravitational
8	Geomorphic Form	Lowly Dissected Slope
9	Rock	Metabasalt
10	Weathering	Moderate
11	Rock Character	Massive
12	Dip Foliation	*Data Not Available*
13	Dip Direction Foliation	*Data Not Available*
14	Dip J1	*Data Not Available*
15	Dip Direction J1	*Data Not Available*
16	Overburden Type	Weathered Rock
17	Thickness	0.5 - 5 m
18	Landuse	Thick Vegetation
19	Hydrology	Damp
20	Erosion	Toe Erosion
21	Susceptibility	Moderate
22	Risk	Moderate
23	Landslide Length	11m
24	Landslide Width	7m
25	Landslide Height	9m
26	Landslide Run Out	*5m*
27	Landslide Material	Debris
28	Movement Type	Slide
29	Failure Depth	<=5m
30	Landslide Activity	Dormant
31	Landslide Distribution	Retrogressive
32	Landslide Style	Single
33	Landslide Mechanism	Shallow Translational Failure
34	Landslide Initiation	*Data Not Available*
35	Upslope	*Data Not Available*
36	Downslope	*Data Not Available*
37	Triggering Factor	Rainfall
38	Casualties	*Data Not Available*
39	Geo Scientific Cause	Toe cutting of the slope
40	Remedial Measures	Retaining wall with weep holes
41	Remarks	Nil

1	Name	KAR/DK/48O4/2017/23
2	Latitude (N) (DMS)	13°14'14.93"
3	Longitude (E) (DMS)	75°10'34.15"
4	Toposheet No	48O/4
5	Village Name	Near Kadambe falls
6	Road	Bhagvati-Hale Siralu road section
7	Geomorphic Process	Gravitational
8	Geomorphic Form	Moderately Dissected Slope
9	Rock	Metabasalt
10	Weathering	Moderate
11	Rock Character	Massive
12	Dip Foliation	*Data Not Available*
13	Dip Direction Foliation	*Data Not Available*
14	Dip J1	*Data Not Available*
15	Dip Direction J1	*Data Not Available*
16	Overburden Type	Rock
17	Thickness	<0.5m
18	Landuse	Thick Vegetation
19	Hydrology	Damp
20	Erosion	Toe Erosion
21	Susceptibility	Moderate
22	Risk	Moderate
23	Landslide Length	15m
24	Landslide Width	7m
25	Landslide Height	12m
26	Landslide Run Out	*6m*
27	Landslide Material	Debris
28	Movement Type	Slide
29	Failure Depth	<=5m
30	Landslide Activity	Dormant
31	Landslide Distribution	Retrogressive
32	Landslide Style	Single
33	Landslide Mechanism	Shallow Translational Failure
34	Landslide Initiation	*Data Not Available*
35	Upslope	*Data Not Available*
36	Downslope	*Data Not Available*
37	Triggering Factor	Rainfall
38	Casualties	*Data Not Available*
39	Geo Scientific Cause	Toe cutting of the slope
40	Remedial Measures	Retaining wall with weep holes
41	Remarks	Nil

1	Name	KAR/DK/48O3/2017/24
2	Latitude (N) (DMS)	13°22'16.18"
3	Longitude (E) (DMS)	75°12'50.91"
4	Toposheet No	48O/3
5	Village Name	Sunkadamakki
6	Road	Harebail-Kachchodi road section (NH-13)
7	Geomorphic Process	Gravitational
8	Geomorphic Form	Lowly Dissected Slope
9	Rock	Granite Gneiss
10	Weathering	High
11	Rock Character	Weathered
12	Dip Foliation	*Data Not Available*
13	Dip Direction Foliation	*Data Not Available*
14	Dip J1	*Data Not Available*
15	Dip Direction J1	*Data Not Available*
16	Overburden Type	Insitu Soil
17	Thickness	0.5-5m
18	Landuse	Moderate Vegetation
19	Hydrology	Damp
20	Erosion	Toe Erosion
21	Susceptibility	Moderate
22	Risk	Moderate
23	Landslide Length	15m
24	Landslide Width	7m
25	Landslide Height	12m
26	Landslide Run Out	*6m*
27	Landslide Material	Debris
28	Movement Type	Slide
29	Failure Depth	<=5m
30	Landslide Activity	Dormant
31	Landslide Distribution	Retrogressive
32	Landslide Style	Composite
33	Landslide Mechanism	Shallow Translational Failure
34	Landslide Initiation	*Data Not Available*
35	Upslope	*Data Not Available*
36	Downslope	*Data Not Available*
37	Triggering Factor	Rainfall
38	Casualties	*Data Not Available*
39	Geo Scientific Cause	Toe cutting of the slope
40	Remedial Measures	Retaining wall with weep holes
41	Remarks	Road parralel to Tunga River

1	Name	KAR/DK/48O3/2017/25
2	Latitude (N) (DMS)	13°17'3.45"
3	Longitude (E) (DMS)	75° 7'39.15"
4	Toposheet No	48O/3
5	Village Name	1.3 km S of Heggantota
6	Road	Karkala-SK border road section
7	Geomorphic Process	Gravitational
8	Geomorphic Form	Highly Dissected Slope
9	Rock	Metabasalt
10	Weathering	Moderate
11	Rock Character	Massive
12	Dip Foliation	*Data Not Available*
13	Dip Direction Foliation	*Data Not Available*
14	Dip J1	*Data Not Available*
15	Dip Direction J1	*Data Not Available*
16	Overburden Type	Rock
17	Thickness	<0.5m
18	Landuse	Extensive Slope Cut
19	Hydrology	Damp
20	Erosion	Toe Erosion
21	Susceptibility	Moderate
22	Risk	Moderate
23	Landslide Length	22m
24	Landslide Width	60m
25	Landslide Height	16m
26	Landslide Run Out	*9m*
27	Landslide Material	Debris
28	Movement Type	Slide
29	Failure Depth	<=5m
30	Landslide Activity	Active
31	Landslide Distribution	Retrogressive
32	Landslide Style	Composite
33	Landslide Mechanism	Shallow Translational Failure
34	Landslide Initiation	*Data Not Available*
35	Upslope	*Data Not Available*
36	Downslope	*Data Not Available*
37	Triggering Factor	Rainfall
38	Casualties	*Data Not Available*
39	Geo Scientific Cause	Toe cutting of the slope
40	Remedial Measures	Benching
41	Remarks	Nil

1	Name	KAR/DK/48O3/2017/26
2	Latitude (N) (DMS)	13°22'28.31"
3	Longitude (E) (DMS)	75°12'50.73"
4	Toposheet No	48O/3
5	Village Name	Sunkadamakki
6	Road	Harebail-Kachchodi road section (NH-13)
7	Geomorphic Process	Gravitational
8	Geomorphic Form	Lowly Dissected Slope
9	Rock	Granite Gneiss
10	Weathering	High
11	Rock Character	Weathered
12	Dip Foliation	*Data Not Available*
13	Dip Direction Foliation	*Data Not Available*
14	Dip J1	*Data Not Available*
15	Dip Direction J1	*Data Not Available*
16	Overburden Type	Insitu soil
17	Thickness	0.5-5m
18	Landuse	Extensive Slope Cut
19	Hydrology	Damp
20	Erosion	Toe Erosion
21	Susceptibility	High
22	Risk	High
23	Landslide Length	17m
24	Landslide Width	65m
25	Landslide Height	15m
26	Landslide Run Out	*06m*
27	Landslide Material	Debris
28	Movement Type	Slide
29	Failure Depth	<=5m
30	Landslide Activity	Active
31	Landslide Distribution	Retrogressive
32	Landslide Style	Single
33	Landslide Mechanism	Shallow Translational Failure
34	Landslide Initiation	*Data Not Available*
35	Upslope	*Data Not Available*
36	Downslope	*Data Not Available*
37	Triggering Factor	Rainfall
38	Casualties	*Data Not Available*
39	Geo Scientific Cause	Toe cutting of the slope for Road widening
40	Remedial Measures	Retaining wall with weep holes
41	Remarks	Muscovite along the slip surface act as a lubricant for slippage of the rock mass. Alternate banding of Quartz Chlorite Schist & BMQ

1	Name	KAR/DK/48O3/2017/27
2	Latitude (N) (DMS)	13°22'34.51"
3	Longitude (E) (DMS)	75°12'43.07"
4	Toposheet No	48O/3
5	Village Name	Sunkadamakki
6	Road	Harebail-Kachchodi road section (NH-13)
7	Geomorphic Process	Gravitational
8	Geomorphic Form	Lowly Dissected Slope
9	Rock	Granite Gneiss
10	Weathering	High
11	Rock Character	Weathered
12	Dip Foliation	*Data Not Available*
13	Dip Direction Foliation	*Data Not Available*
14	Dip J1	*Data Not Available*
15	Dip Direction J1	*Data Not Available*
16	Overburden Type	Insitu soil
17	Thickness	0.5-5m
18	Landuse	Moderate Vegetation
19	Hydrology	Damp
20	Erosion	Toe Erosion
21	Susceptibility	Moderate
22	Risk	Moderate
23	Landslide Length	22m
24	Landslide Width	8m
25	Landslide Height	18m
26	Landslide Run Out	*07m*
27	Landslide Material	Debris
28	Movement Type	Slide
29	Failure Depth	<=5m
30	Landslide Activity	Active
31	Landslide Distribution	Retrogressive
32	Landslide Style	Single
33	Landslide Mechanism	Shallow Translational Failure
34	Landslide Initiation	*Data Not Available*
35	Upslope	*Data Not Available*
36	Downslope	*Data Not Available*
37	Triggering Factor	Rainfall
38	Casualties	*Data Not Available*
39	Geo Scientific Cause	Toe erosion by River
40	Remedial Measures	Restoring productivity through topsoil redistribution
41	Remarks	Remotely Sensed from alongside of the road at 310°.Slide occur along the river Tunga.

1	Name	KAR/DK/48O3/2017/28
2	Latitude (N) (DMS)	13°26'12.15"
3	Longitude (E) (DMS)	75°11'25.47"
4	Toposheet No	48O/3
5	Village Name	Hulse
6	Road	Kellar-Hulse road section (NH-13)
7	Geomorphic Process	Gravitational
8	Geomorphic Form	Lowly Dissected Slope
9	Rock	Granite Gneiss
10	Weathering	High
11	Rock Character	Weathered
12	Dip Foliation	*Data Not Available*
13	Dip Direction Foliation	*Data Not Available*
14	Dip J1	*Data Not Available*
15	Dip Direction J1	*Data Not Available*
16	Overburden Type	Insitu soil
17	Thickness	0.5-5m
18	Landuse	Moderate Vegetation
19	Hydrology	Damp
20	Erosion	Toe Erosion
21	Susceptibility	Moderate
22	Risk	Moderate
23	Landslide Length	16m
24	Landslide Width	7m
25	Landslide Height	9m
26	Landslide Run Out	*7m*
27	Landslide Material	Debris
28	Movement Type	Slide
29	Failure Depth	<=5m
30	Landslide Activity	Active
31	Landslide Distribution	Retrogressive
32	Landslide Style	Single
33	Landslide Mechanism	Shallow Translational Failure
34	Landslide Initiation	*Data Not Available*
35	Upslope	*Data Not Available*
36	Downslope	*Data Not Available*
37	Triggering Factor	Rainfall
38	Casualties	*Data Not Available*
39	Geo Scientific Cause	Toe erosion by road construction
40	Remedial Measures	Retaining wall with weep holes
41	Remarks	Nil

1	Name	KAR/DK/48O3/2017/29
2	Latitude (N) (DMS)	13°28'19.04"
3	Longitude (E) (DMS)	75°14'26.72"
4	Toposheet No	48O/3
5	Village Name	Melinkoppa
6	Road	Holekoppa-Melinkoppa road section
7	Geomorphic Process	Gravitational
8	Geomorphic Form	Moderately Dissected Slope
9	Rock	Granite Gneiss
10	Weathering	High
11	Rock Character	Weathered
12	Dip Foliation	*Data Not Available*
13	Dip Direction Foliation	*Data Not Available*
14	Dip J1	*Data Not Available*
15	Dip Direction J1	*Data Not Available*
16	Overburden Type	Insitu soil
17	Thickness	0.5-5m
18	Landuse	Thick Vegetation
19	Hydrology	Damp
20	Erosion	Toe Erosion
21	Susceptibility	Low
22	Risk	Low
23	Landslide Length	16m
24	Landslide Width	50m
25	Landslide Height	12m
26	Landslide Run Out	*8m*
27	Landslide Material	Debris
28	Movement Type	Slide
29	Failure Depth	<=5m
30	Landslide Activity	Dormant
31	Landslide Distribution	Retrogressive
32	Landslide Style	Single
33	Landslide Mechanism	Shallow Translational Failure
34	Landslide Initiation	*Data Not Available*
35	Upslope	*Data Not Available*
36	Downslope	*Data Not Available*
37	Triggering Factor	Rainfall
38	Casualties	*Data Not Available*
39	Geo Scientific Cause	Toe erosion by road construction
40	Remedial Measures	Retaining wall with weep holes
41	Remarks	Nil

1	Name	KAR/DK/48O3/2017/30
2	Latitude (N) (DMS)	13°28'25.85"
3	Longitude (E) (DMS)	75° 2'2.01"
4	Toposheet No	48O/3
5	Village Name	Sitanadi
6	Road	Bandimata-Chendakundu road section
7	Geomorphic Process	Gravitational
8	Geomorphic Form	Pediment-Pediplain complex
9	Rock	Granitoid
10	Weathering	Moderate
11	Rock Character	Massive
12	Dip Foliation	*Data Not Available*
13	Dip Direction Foliation	*Data Not Available*
14	Dip J1	*Data Not Available*
15	Dip Direction J1	*Data Not Available*
16	Overburden Type	Insitu soil
17	Thickness	0.5-5m
18	Landuse	Extensive Cut Slope
19	Hydrology	Damp
20	Erosion	Toe Erosion
21	Susceptibility	High
22	Risk	High
23	Landslide Length	16m
24	Landslide Width	50m
25	Landslide Height	12m
26	Landslide Run Out	*8m*
27	Landslide Material	Debris
28	Movement Type	Slide
29	Failure Depth	<=5m
30	Landslide Activity	Active
31	Landslide Distribution	Retrogressive
32	Landslide Style	Composite
33	Landslide Mechanism	Shallow Translational Failure
34	Landslide Initiation	*Data Not Available*
35	Upslope	*Data Not Available*
36	Downslope	*Data Not Available*
37	Triggering Factor	Rainfall
38	Casualties	*Data Not Available*
39	Geo Scientific Cause	Toe erosion by widening of road
40	Remedial Measures	Retaining wall with weep holes
41	Remarks	Presence of an Old Retaining wall in damaging condition pointing to the past movement in the slope.Debris hump at the base of the slope is observed.Well Jointed rocks are exposed.

1	Name	KAR/DK/48O3/2017/31
2	Latitude (N) (DMS)	13°29'42.08"
3	Longitude (E) (DMS)	75° 4'50.52"
4	Toposheet No	48O/3
5	Village Name	Near Agumbe
6	Road	Agumbe Ghat section
7	Geomorphic Process	Gravitational
8	Geomorphic Form	Highly Dissected Slope
9	Rock	Amphibolite
10	Weathering	Moderate
11	Rock Character	Weathered
12	Dip Foliation	*Data Not Available*
13	Dip Direction Foliation	*Data Not Available*
14	Dip J1	*Data Not Available*
15	Dip Direction J1	*Data Not Available*
16	Overburden Type	Insitu soil
17	Thickness	0.5-5m
18	Landuse	Sparse Vegetation
19	Hydrology	Damp
20	Erosion	Toe Erosion
21	Susceptibility	High
22	Risk	High
23	Landslide Length	20m
24	Landslide Width	8m
25	Landslide Height	16m
26	Landslide Run Out	*6m*
27	Landslide Material	Debris
28	Movement Type	Slide
29	Failure Depth	<=5m
30	Landslide Activity	Active
31	Landslide Distribution	Retrogressive
32	Landslide Style	Single
33	Landslide Mechanism	Shallow Translational Failure
34	Landslide Initiation	*Data Not Available*
35	Upslope	*Data Not Available*
36	Downslope	*Data Not Available*
37	Triggering Factor	Rainfall
38	Casualties	*Data Not Available*
39	Geo Scientific Cause	Toe erosion by widening of road
40	Remedial Measures	Deep-rooted vegetation for slope stabilization
41	Remarks	Slumped slope with leaning trees.An old retaining wall adjucent to the slope is observed damaged.Rocks are dipping inside.

1	Name	KAR/DK/48O3/2017/32
2	Latitude (N) (DMS)	13°29'44.87"
3	Longitude (E) (DMS)	75° 4'49.06"
4	Toposheet No	48O/3
5	Village Name	Near Agumbe
6	Road	Agumbe Ghat section
7	Geomorphic Process	Gravitational
8	Geomorphic Form	Highly Dissected Slope
9	Rock	Amphibolite
10	Weathering	Moderate
11	Rock Character	Weathered
12	Dip Foliation	*Data Not Available*
13	Dip Direction Foliation	*Data Not Available*
14	Dip J1	*Data Not Available*
15	Dip Direction J1	*Data Not Available*
16	Overburden Type	Insitu soil
17	Thickness	0.5-5m
18	Landuse	Sparse Vegetation
19	Hydrology	Damp
20	Erosion	Toe Erosion
21	Susceptibility	High
22	Risk	High
23	Landslide Length	17m
24	Landslide Width	12m
25	Landslide Height	13m
26	Landslide Run Out	*5m*
27	Landslide Material	Debris
28	Movement Type	Slide
29	Failure Depth	<=5m
30	Landslide Activity	Active
31	Landslide Distribution	Retrogressive
32	Landslide Style	Single
33	Landslide Mechanism	Shallow Translational Failure
34	Landslide Initiation	*Data Not Available*
35	Upslope	*Data Not Available*
36	Downslope	*Data Not Available*
37	Triggering Factor	Rainfall
38	Casualties	*Data Not Available*
39	Geo Scientific Cause	Toe erosion by widening of road
40	Remedial Measures	Benching on the slope and Deep-rooted vegetation for slope stabilization
41	Remarks	Slumped slope with leaning trees.An old retaining wall at the base of the slope is damaged.Rocks at the base are showing cracks resulted due to overlying load.

1	Name	KAR/DK/48O3/2017/33
2	Latitude (N) (DMS)	13°29'49.81"
3	Longitude (E) (DMS)	75° 4'49.92"
4	Toposheet No	48O/3
5	Village Name	Near Agumbe
6	Road	Agumbe Ghat section
7	Geomorphic Process	Gravitational
8	Geomorphic Form	Highly Dissected Slope
9	Rock	Amphibolite
10	Weathering	Moderate
11	Rock Character	Weathered
12	Dip Foliation	*Data Not Available*
13	Dip Direction Foliation	*Data Not Available*
14	Dip J1	*Data Not Available*
15	Dip Direction J1	*Data Not Available*
16	Overburden Type	Insitu soil
17	Thickness	0.5-5m
18	Landuse	Extensive Cut Slope
19	Hydrology	Damp
20	Erosion	Toe Erosion
21	Susceptibility	High
22	Risk	High
23	Landslide Length	16m
24	Landslide Width	14m
25	Landslide Height	13m
26	Landslide Run Out	*3m*
27	Landslide Material	Debris
28	Movement Type	Slide
29	Failure Depth	<=5m
30	Landslide Activity	Active
31	Landslide Distribution	Retrogressive
32	Landslide Style	Composite
33	Landslide Mechanism	Shallow Translational Failure
34	Landslide Initiation	*Data Not Available*
35	Upslope	*Data Not Available*
36	Downslope	*Data Not Available*
37	Triggering Factor	Rainfall
38	Casualties	*Data Not Available*
39	Geo Scientific Cause	Toe erosion by road cutting
40	Remedial Measures	Benching on the slope and Deep-rooted vegetation for slope stabilization
41	Remarks	Slumped slope with leaning trees.

1	Name	KAR/DK/48O3/2017/34
2	Latitude (N) (DMS)	13°29'46.08"
3	Longitude (E) (DMS)	75° 4'39.45"
4	Toposheet No	48O/3
5	Village Name	Near Agumbe
6	Road	Agumbe Ghat section
7	Geomorphic Process	Gravitational
8	Geomorphic Form	Highly Dissected Slope
9	Rock	Amphibolite
10	Weathering	Moderate
11	Rock Character	Weathered
12	Dip Foliation	*Data Not Available*
13	Dip Direction Foliation	*Data Not Available*
14	Dip J1	*Data Not Available*
15	Dip Direction J1	*Data Not Available*
16	Overburden Type	Weathered Rock
17	Thickness	0.5-5m
18	Landuse	Sparse Vegetation
19	Hydrology	Damp
20	Erosion	Toe Erosion
21	Susceptibility	High
22	Risk	High
23	Landslide Length	20m
24	Landslide Width	25m
25	Landslide Height	16m
26	Landslide Run Out	*9m*
27	Landslide Material	Debris
28	Movement Type	Slide
29	Failure Depth	<=5m
30	Landslide Activity	Dormant
31	Landslide Distribution	Retrogressive
32	Landslide Style	Composite
33	Landslide Mechanism	Shallow Translational Failure
34	Landslide Initiation	*Data Not Available*
35	Upslope	*Data Not Available*
36	Downslope	*Data Not Available*
37	Triggering Factor	Rainfall
38	Casualties	*Data Not Available*
39	Geo Scientific Cause	Toe erosion by road cutting
40	Remedial Measures	Benching on the slope and Deep-rooted vegetation for slope stabilization
41	Remarks	

1	Name	KAR/DK/48O3/2017/35
2	Latitude (N) (DMS)	13°29'40.01"
3	Longitude (E) (DMS)	75° 4'41.92"
4	Toposheet No	48O/3
5	Village Name	Near Agumbe
6	Road	Agumbe Ghat section
7	Geomorphic Process	Gravitational
8	Geomorphic Form	Highly Dissected Slope
9	Rock	Amphibolite
10	Weathering	Moderate
11	Rock Character	Weathered
12	Dip Foliation	*Data Not Available*
13	Dip Direction Foliation	*Data Not Available*
14	Dip J1	*Data Not Available*
15	Dip Direction J1	*Data Not Available*
16	Overburden Type	Weathered Rock
17	Thickness	0.5-5m
18	Landuse	Sparse Vegetation
19	Hydrology	Damp
20	Erosion	Toe Erosion
21	Susceptibility	High
22	Risk	High
23	Landslide Length	15m
24	Landslide Width	7m
25	Landslide Height	13m
26	Landslide Run Out	*6m*
27	Landslide Material	Debris
28	Movement Type	Slide
29	Failure Depth	<=5m
30	Landslide Activity	Active
31	Landslide Distribution	Retrogressive
32	Landslide Style	Composite
33	Landslide Mechanism	Shallow Translational Failure
34	Landslide Initiation	*Data Not Available*
35	Upslope	*Data Not Available*
36	Downslope	*Data Not Available*
37	Triggering Factor	Rainfall
38	Casualties	*Data Not Available*
39	Geo Scientific Cause	Toe erosion by road cutting
40	Remedial Measures	Benching on the slope and Deep-rooted vegetation for slope stabilization
41	Remarks	Fallen trees on the slope were observed

1	Name	KAR/DK/48O3/2017/36
2	Latitude (N) (DMS)	13°29'44.00"
3	Longitude (E) (DMS)	75° 4'33.54"
4	Toposheet No	48O/3
5	Village Name	Near Agumbe
6	Road	Agumbe Ghat section
7	Geomorphic Process	Gravitational
8	Geomorphic Form	Highly Dissected Slope
9	Rock	Amphibolite
10	Weathering	Moderate
11	Rock Character	Weathered
12	Dip Foliation	*Data Not Available*
13	Dip Direction Foliation	*Data Not Available*
14	Dip J1	*Data Not Available*
15	Dip Direction J1	*Data Not Available*
16	Overburden Type	Weathered Rock
17	Thickness	0.5-5m
18	Landuse	Sparse Vegetation
19	Hydrology	Damp
20	Erosion	Toe Erosion
21	Susceptibility	High
22	Risk	High
23	Landslide Length	18m
24	Landslide Width	9m
25	Landslide Height	15m
26	Landslide Run Out	*5m*
27	Landslide Material	Debris
28	Movement Type	Slide
29	Failure Depth	<=5m
30	Landslide Activity	Active
31	Landslide Distribution	Retrogressive
32	Landslide Style	Composite
33	Landslide Mechanism	Shallow Translational Failure
34	Landslide Initiation	*Data Not Available*
35	Upslope	*Data Not Available*
36	Downslope	*Data Not Available*
37	Triggering Factor	Rainfall
38	Casualties	*Data Not Available*
39	Geo Scientific Cause	Toe erosion for Road widening
40	Remedial Measures	Benching on the slope and Deep-rooted vegetation for slope stabilization
41	Remarks	

1	Name	KAR/DK/48O3/2017/37
2	Latitude (N) (DMS)	13°29'40.20"
3	Longitude (E) (DMS)	75° 4'30.58"
4	Toposheet No	48O/3
5	Village Name	Near Agumbe
6	Road	Agumbe Ghat section
7	Geomorphic Process	Gravitational
8	Geomorphic Form	Highly Dissected Slope
9	Rock	Amphibolite
10	Weathering	Moderate
11	Rock Character	Weathered
12	Dip Foliation	*Data Not Available*
13	Dip Direction Foliation	*Data Not Available*
14	Dip J1	*Data Not Available*
15	Dip Direction J1	*Data Not Available*
16	Overburden Type	Weathered Rock
17	Thickness	0.5-5m
18	Landuse	Thick Vegetation
19	Hydrology	Damp
20	Erosion	Toe Erosion
21	Susceptibility	High
22	Risk	High
23	Landslide Length	20m
24	Landslide Width	22m
25	Landslide Height	16m
26	Landslide Run Out	*6m*
27	Landslide Material	Debris
28	Movement Type	Slide
29	Failure Depth	<=5m
30	Landslide Activity	Active
31	Landslide Distribution	Retrogressive
32	Landslide Style	Single
33	Landslide Mechanism	Shallow Translational Failure
34	Landslide Initiation	*Data Not Available*
35	Upslope	*Data Not Available*
36	Downslope	*Data Not Available*
37	Triggering Factor	Rainfall
38	Casualties	*Data Not Available*
39	Geo Scientific Cause	Toe erosion for Road widening
40	Remedial Measures	Benching on the slope and Deep-rooted vegetation for slope stabilization
41	Remarks	Jointed Rock blocks at the base of the slope is observed.

1	Name	KAR/DK/48O3/2017/38
2	Latitude (N) (DMS)	13°29'10.78"
3	Longitude (E) (DMS)	75° 4'42.81"
4	Toposheet No	48O/3
5	Village Name	Near Agumbe
6	Road	Agumbe Ghat section
7	Geomorphic Process	Gravitational
8	Geomorphic Form	Highly Dissected Slope
9	Rock	Amphibolite
10	Weathering	Moderate
11	Rock Character	Weathered
12	Dip Foliation	*Data Not Available*
13	Dip Direction Foliation	*Data Not Available*
14	Dip J1	*Data Not Available*
15	Dip Direction J1	*Data Not Available*
16	Overburden Type	Weathered Rock
17	Thickness	0.5-5m
18	Landuse	Thick Vegetation
19	Hydrology	Damp
20	Erosion	Toe Erosion
21	Susceptibility	High
22	Risk	High
23	Landslide Length	14m
24	Landslide Width	8m
25	Landslide Height	9m
26	Landslide Run Out	*3m*
27	Landslide Material	Debris
28	Movement Type	Slide
29	Failure Depth	<=5m
30	Landslide Activity	Active
31	Landslide Distribution	Retrogressive
32	Landslide Style	Single
33	Landslide Mechanism	Shallow Translational Failure
34	Landslide Initiation	*Data Not Available*
35	Upslope	*Data Not Available*
36	Downslope	*Data Not Available*
37	Triggering Factor	Rainfall
38	Casualties	*Data Not Available*
39	Geo Scientific Cause	Toe erosion for Road widening
40	Remedial Measures	Benching on the slope and Deep-rooted vegetation for slope stabilization
41	Remarks	NIL

1	Name	KAR/DK/48O4/2017/39
2	Latitude (N) (DMS)	13° 1'54.45"
3	Longitude (E) (DMS)	75° 6'33.42"
4	Toposheet No	48O/4
5	Village Name	Padandadka
6	Road	Venur-Peranje road section
7	Geomorphic Process	Gravitational
8	Geomorphic Form	Rolling plain
9	Rock	Granite Gneiss
10	Weathering	Moderate
11	Rock Character	Weathered
12	Dip Foliation	*Data Not Available*
13	Dip Direction Foliation	*Data Not Available*
14	Dip J1	*Data Not Available*
15	Dip Direction J1	*Data Not Available*
16	Overburden Type	Insitu soil
17	Thickness	0.5-5m
18	Landuse	Thick Vegetation
19	Hydrology	Damp
20	Erosion	Toe Erosion
21	Susceptibility	Low
22	Risk	Low
23	Landslide Length	11m
24	Landslide Width	14m
25	Landslide Height	7m
26	Landslide Run Out	*5m*
27	Landslide Material	Soil
28	Movement Type	Slide
29	Failure Depth	<=5m
30	Landslide Activity	Dormant
31	Landslide Distribution	Retrogressive
32	Landslide Style	Single
33	Landslide Mechanism	Shallow Translational Failure
34	Landslide Initiation	*Data Not Available*
35	Upslope	*Data Not Available*
36	Downslope	*Data Not Available*
37	Triggering Factor	Rainfall
38	Casualties	*Data Not Available*
39	Geo Scientific Cause	Toe erosion for Road widening
40	Remedial Measures	Retention wall with weep holes
41	Remarks	Soil Slide at the bend of the road resulted due to subsidence.

1	Name	KAR/DK/48O4/2017/40
2	Latitude (N) (DMS)	13° 1'55.94"
3	Longitude (E) (DMS)	75° 6'3.90"
4	Toposheet No	48O/4
5	Village Name	Hosangadi
6	Road	Venur-Peranje road section
7	Geomorphic Process	Gravitational
8	Geomorphic Form	Rolling plain
9	Rock	Granite Gneiss
10	Weathering	Moderate
11	Rock Character	Weathered
12	Dip Foliation	*Data Not Available*
13	Dip Direction Foliation	*Data Not Available*
14	Dip J1	*Data Not Available*
15	Dip Direction J1	*Data Not Available*
16	Overburden Type	Insitu soil
17	Thickness	0.5-5m
18	Landuse	Thick Vegetation
19	Hydrology	Damp
20	Erosion	Toe Erosion
21	Susceptibility	Low
22	Risk	Low
23	Landslide Length	12m
24	Landslide Width	11m
25	Landslide Height	9m
26	Landslide Run Out	*5m*
27	Landslide Material	Soil
28	Movement Type	Slide
29	Failure Depth	<=5m
30	Landslide Activity	Dormant
31	Landslide Distribution	Retrogressive
32	Landslide Style	Single
33	Landslide Mechanism	Shallow Translational Failure
34	Landslide Initiation	*Data Not Available*
35	Upslope	*Data Not Available*
36	Downslope	*Data Not Available*
37	Triggering Factor	Rainfall
38	Casualties	*Data Not Available*
39	Geo Scientific Cause	Toe erosion
40	Remedial Measures	Retention wall with weep holes
41	Remarks	NIL

Annexure – II: Calculation of LOFS and consistency ratio (CR) for all factor maps.

Geofactor: Geomorphology

Rank of Geomorphology Classes

Sl No	Class Name	Code	Rank
1	Denudational Slope	DS	**9**
2	Escarpment	ESC	**2**
3	Mound	MOUND	**2**
4	Colluvial Foot Slope	CFS	**3**
5	Lowly Dissected Slope	LDS	**4**
6	Moderately Dissected Slope	MDS	**6**
7	Highly Dissected Slope	HDS	**8**
8	Piedmont Slope	PIED SLOPE	**4**
9	Ridge - top	RT	0
10	Tidal Flat	TF	0
11	Colluvial Plain	CP	0
12	Plateau Top (Flat)	PT	0
13	Rolling Plain	RP	0
14	Valley Fill	VF	0
15	Alluvial Plain	AP	0
16	Beach	BE	0
17	Pediment – Pediplain Complex	PPC	0
18	Hilltop	HT	0
19	Water body	WB	0

Geofactor: Geomorphology

Matrix of Pairwise Ratings of Geomorphology Class

GEOM	DS	ESC	MOUND	CFS	LDS	MDS	HDS	PIED SLOPE
DS	1.00	8.00	8.00	7.00	6.00	4.00	2.00	6.00
ESC	0.13	1.00	1.00	0.50	0.33	0.20	0.14	0.33
MOUND	0.13	1.00	1.00	0.50	0.33	0.20	0.14	0.33
CFS	0.14	2.00	2.00	1.00	0.50	0.25	0.17	0.50
LDS	0.17	3.00	3.00	2.00	1.00	0.33	0.20	1.00
MDS	0.25	5.00	5.00	4.00	3.00	1.00	0.33	3.00
HDS	0.50	7.00	7.00	6.00	5.00	3.00	1.00	5.00
PIED SLOPE	0.17	3.00	3.00	2.00	1.00	0.33	0.20	1.00
Sum Column	**2.48**	**30.00**	**30.00**	**23.00**	**17.17**	**9.32**	**4.19**	**17.17**

Estimated Eigen values, fraction rate and LOFS for Geomorphology classes

GEOM	DS	ESC	MOUND	CFS	LDS	MDS	HDS	PIED SLOPE	Sum Rows	Frac Weight	LOFS
DS	0.4038	0.2667	0.2667	0.3043	0.3495	0.4293	0.4778	0.3495	2.8477	0.3560	1.0000
ESC	0.0505	0.0333	0.0333	0.0217	0.0194	0.0215	0.0341	0.0194	0.2333	0.0292	0.0819
MOUND	0.0505	0.0333	0.0333	0.0217	0.0194	0.0215	0.0341	0.0194	0.2333	0.0292	0.0819
CFS	0.0577	0.0667	0.0667	0.0435	0.0291	0.0268	0.0398	0.0291	0.3594	0.0449	0.1262
LDS	0.0673	0.1000	0.1000	0.0870	0.0583	0.0358	0.0478	0.0583	0.5543	0.0693	0.1947
MDS	0.1010	0.1667	0.1667	0.1739	0.1748	0.1073	0.0796	0.1748	1.1447	0.1431	0.4020
HDS	0.2019	0.2333	0.2333	0.2609	0.2913	0.3220	0.2389	0.2913	2.0729	0.2591	0.7279
PIED SLOPE	0.0673	0.1000	0.1000	0.0870	0.0583	0.0358	0.0478	0.0583	0.5543	0.0693	0.1947

Geofactor: Geomorphology

Estimation of consistency vector (CV), consistency index (CI) and consistency ratio (CR) for Geomorphology classes

GEOM	DS	ESC	MOUND	CFS	LDS	MDS	HDS	PIED SLOPE	Sum Rows	CV
DS	0.3560	0.2333	0.2333	0.3145	0.4157	0.5723	0.5182	0.4157	3.0591	8.5940
ESC	0.0445	0.0292	0.0292	0.0225	0.0231	0.0286	0.0370	0.0231	0.2371	8.1302
MOUND	0.0445	0.0292	0.0292	0.0225	0.0231	0.0286	0.0370	0.0231	0.2371	8.1302
CFS	0.0509	0.0583	0.0583	0.0449	0.0346	0.0358	0.0432	0.0346	0.3607	8.0284
LDS	0.0593	0.0875	0.0875	0.0899	0.0693	0.0477	0.0518	0.0693	0.5623	8.1146
MDS	0.0890	0.1458	0.1458	0.1797	0.2079	0.1431	0.0864	0.2079	1.2055	8.4253
HDS	0.1780	0.2042	0.2042	0.2696	0.3465	0.4293	0.2591	0.3465	2.2371	8.6338
PIED SLOPE	0.0593	0.0875	0.0875	0.0899	0.0693	0.0477	0.0518	0.0693	0.5623	8.1146
									Sum CV	66.1711
									Mean Consistency Vector (Mean CV) = Total CV/ Nos. Of factor class (66.1711/8) =	8.2714
									Consistency Index (CI) = (Mean CV - No. Of criteria/ factor class) / (No. Of factor class - 1) =	0.0388
									Consistency Ratio (CR) = CI/ RI = 0.0388 / 1.41 =	0.0275

Geofactor: Slope Forming Material (SFM)
Rank of SFM Classes

Sl No	Class Name	Code	Rank
1	Compact Slide Debris	CSD	**3**
2	In – situ Soil	IS	**4**
3	Colluvium	CL	**5**
4	Loose Slide Debris	LSD	**8**
5	Rock Class Type – I	R - I	**1**
6	Rock Class Type – II	R - II	**2**
7	Rock Class Type – III	R - III	**4**
8	Transported Soil	TS	**3**
9	Weathered Rock	WR	**6**
10	Salt	SL	0
11	Water	WT	0
12	Alluvium	AL	0
13	Barren Sand	BS	0

Geofactor: Slope Forming Material (SFM)
Matrix of Pairwise Ratings of SFM Class

SFM	CSD	IS	CL	LSD	R – I	R – II	R – III	TS	WR
CSD	1.00	0.50	0.33	0.17	3.00	2.00	0.50	1.00	0.25
IS	2.00	1.00	0.50	0.20	4.00	3.00	1.00	2.00	0.33
CL	3.00	2.00	1.00	0.25	5.00	4.00	2.00	3.00	0.50
LSD	6.00	5.00	4.00	1.00	8.00	7.00	5.00	6.00	3.00
R - I	0.33	0.25	0.20	0.13	1.00	0.50	0.25	0.33	0.17
R - II	0.50	0.33	0.25	0.14	2.00	1.00	0.33	0.50	0.20
R - III	2.00	1.00	0.50	0.20	4.00	3.00	1.00	2.00	0.33
TS	1.00	0.50	0.33	0.17	3.00	2.00	0.50	1.00	0.25
WR	4.00	3.00	2.00	0.33	6.00	5.00	3.00	4.00	1.00
Sum Column	**19.83**	**13.58**	**9.12**	**2.58**	**36.00**	**27.50**	**13.58**	**19.83**	**6.03**

Estimated Eigen values, fraction rate and LOFS for SFM classes

SFM	CSD	IS	CL	LSD	R – I	R – II	R – III	TS	WR	Sum Rows	Frac Weight	LOFS
CSD	0.0504	0.0368	0.0366	0.0645	0.0833	0.0727	0.0368	0.0504	0.0414	0.4730	0.0526	0.1506
IS	0.1008	0.0736	0.0548	0.0774	0.1111	0.1091	0.0736	0.1008	0.0552	0.7566	0.0841	0.2409
CL	0.1513	0.1472	0.1097	0.0967	0.1389	0.1455	0.1472	0.1513	0.0829	1.1706	0.1301	0.3727
LSD	0.3025	0.3681	0.4388	0.3869	0.2222	0.2545	0.3681	0.3025	0.4972	3.1409	0.3490	1.0000
R - I	0.0168	0.0184	0.0219	0.0484	0.0278	0.0182	0.0184	0.0168	0.0276	0.2143	0.0238	0.0682
R - II	0.0252	0.0245	0.0274	0.0553	0.0556	0.0364	0.0245	0.0252	0.0331	0.3073	0.0341	0.0978
R - III	0.1008	0.0736	0.0548	0.0774	0.1111	0.1091	0.0736	0.1008	0.0552	0.7566	0.0841	0.2409
TS	0.0504	0.0368	0.0366	0.0645	0.0833	0.0727	0.0368	0.0504	0.0414	0.4730	0.0526	0.1506
WR	0.2017	0.2209	0.2194	0.1290	0.1667	0.1818	0.2209	0.2017	0.1657	1.7077	0.1897	0.5437

Geofactor: Slope Forming Material (SFM)

Estimation of consistency vector (CV), consistency index (CI) and consistency ratio (CR) for SFM classes

SFM	CSD	IS	CL	LSD	R – I	R – II	R – III	TS	WR	Sum Rows	CV
CSD	0.078834	0.06305	0.065035	0.087248	0.107155	0.102422	0.06305	0.078834	0.071153	0.716781	9.09223
IS	0.157669	0.1261	0.097553	0.104697	0.142873	0.153632	0.1261	0.157669	0.09487	1.161163	9.208286
CL	0.236503	0.2522	0.195106	0.130872	0.178592	0.204843	0.2522	0.236503	0.142305	1.829123	9.375031
LSD	0.473007	0.630499	0.780423	0.523486	0.285746	0.358475	0.630499	0.473007	0.853831	5.008973	9.568486
R - I	0.026278	0.031525	0.039021	0.065436	0.035718	0.025605	0.031525	0.026278	0.047435	0.328822	9.205977
R - II	0.039417	0.042033	0.048776	0.074784	0.071437	0.051211	0.042033	0.039417	0.056922	0.466031	9.100245
R - III	0.157669	0.1261	0.097553	0.104697	0.142873	0.153632	0.1261	0.157669	0.09487	1.161163	9.208286
TS	0.078834	0.06305	0.065035	0.087248	0.107155	0.102422	0.06305	0.078834	0.071153	0.716781	9.09223
WR	0.315338	0.378299	0.390212	0.174495	0.21431	0.256054	0.378299	0.315338	0.28461	2.706955	9.511097
										Sum CV	83.36187
										Mean Consistency Vector (Mean CV) = Total CV/ Nos. Of factor class (83.36187/9) =	9.26243
										Consistency Index (CI) = (Mean CV - No. Of criteria/ factor class) / (No. Of factor class - 1) =	0.032804
										Consistency Ratio (CR) = CI/ RI = 0.032804/ 1.45 =	0.022623

Geofactor: Regolith Thickness
Rank of Regolith Thickness Classes

Sl No	Class Name	Code	Rank
1	< 0.5 m	< 0.5 m	0
2	0.5 m – 5 m	0.5 m – 5 m	**7**
3	5 m – 10 m	5 m – 10 m	**4**
4	> 10 m	> 10 m	**2**

Matrix of Pairwise Ratings of Regolith Thickness Class

Regolith Thickness	0.5 – 5 m	5 – 10 m	> 10 m
0.5 – 5 m	1.00	4.00	6.00
5 – 10 m	0.25	1.00	3.00
> 10 m	0.17	0.33	1.00
Sum Column	**1.42**	**5.33**	**10.00**

Geofactor: Regolith Thickness

Estimated Eigen values, fraction rate and LOFS for Regolith Thickness classes

Regolith Thickness	0.5 – 5 m	5 – 10 m	> 10 m	Sum Rows	Frac Weight	LOFS
0.5 – 5 m	0.705882	0.75	0.6	2.055882	0.685294	1.0000
5 – 10 m	0.176471	0.1875	0.3	0.663971	0.221324	0.3230
> 10 m	0.117647	0.0625	0.1	0.280147	0.093382	0.1363

Estimation of consistency vector (CV), consistency index (CI) and consistency ratio (CR) for Regolith Thickness classes

Regolith Thickness	0.5 – 5 m	5 – 10 m	> 10 m	Sum Rows	CV
0.5 – 5 m	0.685294	0.885294	0.560294	2.130882	3.109442
5 – 10 m	0.171324	0.221324	0.280147	0.672794	3.039867
> 10 m	0.114216	0.073775	0.093382	0.281373	3.013123
				Sum CV	9.162433
				Mean Consistency Vector (Mean CV) = Total CV/ Nos. Of factor class (9.162433/3) =	3.054144
				Consistency Index (CI) = (Mean CV - No. Of criteria/ factor class) / (No. Of factor class - 1) =	0.027072
				Consistency Ratio (CR) = CI/ RI = 0.027072 / 0.58 =	0.0467

Geofactor: Slope Angle
Rank of Slope Angle Classes

Sl No	Class Name	Code	Rank
1	< 15°	< 15°	**4**
2	15° - 25°	15° - 25°	**6**
3	25° - 35°	25° - 35°	**8**
4	35° - 45°	35° - 45°	**5**
5	> 45°	> 45°	**4**

Matrix of Pairwise Ratings of Slope Angle Class

Slope Class	< 15°	15° - 25°	25° - 35°	35° - 45°	> 45°
< 15°	1.00	0.33	0.20	0.50	1.00
15° - 25°	3.00	1.00	0.33	2.00	3.00
25° - 35°	5.00	3.00	1.00	4.00	5.00
35° - 45°	2.00	0.50	0.25	1.00	2.00
> 45°	1.00	0.33	0.20	0.50	1.00
Sum Column	**12.00**	**5.17**	**1.98**	**8.00**	**12.00**

Geofactor: Slope Angle

Estimated Eigen values, fraction rate and LOFS for Slope Angle classes

Slope Class	< 15°	15° - 25°	25° - 35°	35° - 45°	> 45°	Sum Rows	Frac Weight	LOFS
< 15°	0.083333333	0.064516129	0.100840336	0.0625	0.083333333	0.394523132	0.078904626	0.1631
15° - 25°	0.25	0.193548387	0.168067227	0.25	0.25	1.111615614	0.222323123	0.4597
25° - 35°	0.416666667	0.580645161	0.504201681	0.5	0.416666667	2.418180175	0.483636035	1.0000
35° - 45°	0.166666667	0.096774194	0.12605042	0.125	0.166666667	0.681157947	0.136231589	0.2817
> 45°	0.083333333	0.064516129	0.100840336	0.0625	0.083333333	0.394523132	0.078904626	0.1631

Estimation of consistency vector (CV), consistency index (CI) and consistency ratio (CR) for Slope Angle classes

Slope Class	< 15°	15° - 25°	25° - 35°	35° - 45°	> 45°	Sum Rows	CV
< 15°	0.078904626	0.074107708	0.096727207	0.068115795	0.078904626	0.396759962	5.028348531
15° - 25°	0.236713879	0.222323123	0.161212012	0.272463179	0.236713879	1.129426072	5.080110684
25° - 35°	0.394523132	0.666969368	0.483636035	0.544926358	0.394523132	2.484578025	5.13728888
35° - 45°	0.157809253	0.111161561	0.120909009	0.136231589	0.157809253	0.683920665	5.02027957
> 45°	0.078904626	0.074107708	0.096727207	0.068115795	0.078904626	0.396759962	5.028348531
Sum CV							**25.29438**
Mean Consistency Vector (Mean CV) = Total CV/ Nos. Of factor class (25.68495/5) =							**5.05888**
Consistency Index (CI) = (Mean CV - No. Of criteria/ factor class) / (No. Of factor class - 1) =							**0.01472**
Consistency Ratio (CR) = CI/ RI = 0.034248 / 1.12 =							**0.01314**

Geofactor: Slope Curvature
Rank of Slope Curvature Classes

Sl No	Class Name	Code	Rank
1	< -0.1	Concave	**4**
2	-0.1 – 0.1	Flat	**2**
3	> 0.1	Convex	**6**

Matrix of Pairwise Ratings of Slope Curvature Class

Slope Curvature	Concave	Flat	Convex
Concave	1.00	3.00	0.33
Flat	0.33	1.00	0.20
Convex	3.00	5.00	1.00
Sum Column	**4.33**	**9.00**	**1.53**

Geofactor: Slope Curvature

Estimated Eigen values, fraction rate and LOFS for Slope Curvature classes

Slope Curvature	Concave	Flat	Convex	Sum Rows	Frac Weight	LOFS
Concave	0.230769	0.333333	0.217391	0.781494	0.260498	0.4113
Flat	0.076923	0.111111	0.130435	0.318469	0.106156	0.1676
Convex	0.692308	0.555556	0.652174	1.900037	0.633346	1.0000

Estimation of consistency vector (CV), consistency index (CI) and consistency ratio (CR) for Slope Angle classes

Slope Curvature	Concave	Flat	Convex	Sum Rows	CV
Concave	0.260498	0.318469	0.211115	0.790082	3.032969
Flat	0.086833	0.106156	0.126669	0.319658	3.011202
Convex	0.781494	0.530782	0.633346	1.945621	3.071973
				Sum CV	**9.116144**
				Mean Consistency Vector (Mean CV) = Total CV/ Nos. Of factor class (9.116144/3) =	**3.038715**
				Consistency Index (CI) = (Mean CV - No. Of criteria/ factor class) / (No. Of factor class - 1) =	**0.019357**
				Consistency Ratio (CR) = CI/ RI = 0.019357 / 0.58 =	**0.0334**

Factor Class
Rank of Factor Classes

Sl No	Factor Class Name	Code	Rank
1	Slope	SLP	**9**
2	Curvature	CUR	**2**
3	Slope Forming Material	SFM	**6**
4	Land Use Land Cover	LULC	**8**
5	Geomorphology	GEOM	**6**
6	Regolith Thickness	RT	**4**

Matrix of Pairwise Ratings of Factor Class

Factor Class	SLP	CUR	SFM	LULC	GEOM	RT
SLP	1.00	8.00	4.00	2.00	4.00	6.00
CUR	0.13	1.00	0.20	0.14	0.20	0.33
SFM	0.25	5.00	1.00	0.33	1.00	3.00
LULC	0.50	7.00	3.00	1.00	3.00	5.00
GEOM	0.25	5.00	1.00	0.33	1.00	3.00
RT	0.17	3.00	0.33	0.20	0.33	1.00
Sum Column	**2.29**	**29.00**	**9.53**	**4.01**	**9.53**	**18.33**

Factor Class

Estimated Eigen values, fraction rate and Weight for Factor classes

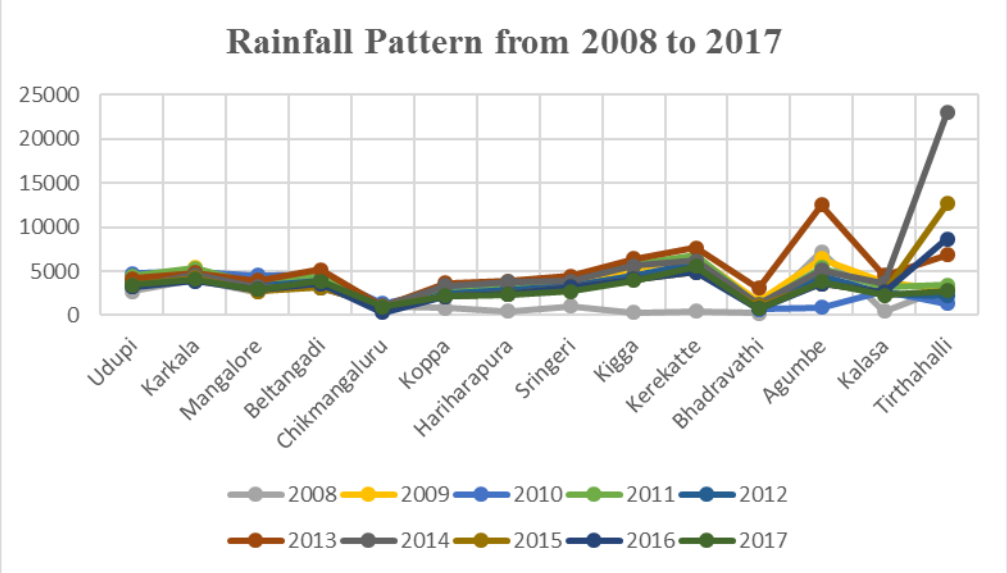
Factor Class	SLP	CUR	SFM	LULC	GEOM	RT	Sum Rows	Frac Weight	Weight
SLP	0.43636	0.27586	0.41958	0.49881	0.41958	0.32727	2.37747	0.396245271	12.86527835 ~ 13
CUR	0.05455	0.03448	0.02098	0.03563	0.02098	0.01818	0.18480	0.030799588	1 ~ 1
SFM	0.10909	0.17241	0.10490	0.08314	0.10490	0.16364	0.73807	0.123011111	3.993920696 ~ 4
LULC	0.21818	0.24138	0.31469	0.24941	0.31469	0.27273	1.61107	0.268510868	8.718001981 ~ 9
GEOM	0.10909	0.17241	0.10490	0.08314	0.10490	0.16364	0.73807	0.123011111	3.993920696 ~ 4
RT	0.07273	0.10345	0.03497	0.04988	0.03497	0.05455	0.35053	0.058422051	1.896845233 ~ 2

Estimation of consistency vector (CV), consistency index (CI) and consistency ratio (CR) for Factor classes

Factor Class	SLP	CUR	SFM	LULC	GEOM	RT	Sum Rows	CV
SLP	0.396245271	0.246396703	0.492044445	0.537021735	0.492044445	0.350532308	2.514284907	6.345274237
CUR	0.049530659	0.030799588	0.024602222	0.038358695	0.024602222	0.019474017	0.187367404	6.083438671
SFM	0.099061318	0.153997939	0.123011111	0.089503623	0.123011111	0.175266154	0.763851256	6.209611865
LULC	0.198122635	0.215597115	0.369033334	0.268510868	0.369033334	0.292110257	1.712407542	6.377423591
GEOM	0.099061318	0.153997939	0.123011111	0.089503623	0.123011111	0.175266154	0.763851256	6.209611865
RT	0.066040878	0.092398763	0.041003704	0.053702174	0.041003704	0.058422051	0.352571274	6.034900625
							Sum CV	**37.2603**
							Mean Consistency Vector (Mean CV) = Total CV/ Nos. Of factor class (37.2603/6) =	**6.210043**
							Consistency Index (CI) = (Mean CV - No. Of criteria/ factor class) / (No. Of factor class - 1) =	**0.042009**
							Consistency Ratio (CR) = CI/ RI = 0.042009 / 1.24 =	**0.033878**

Annexure-III Average Rainfall pattern in the area at different rain-gauge stations from 2008 to 2017.

Raingauge Station	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Udupi	2750.0	4090.0	4742.0	4456.0	3847.0	4169.7	3198.7	3472.2	3218.3	3429.8
Karkala	4068.0	5417.0	4896.0	5341.0	4151.0	4819.2	4569.1	4217.4	3863.9	4102.8
Mangalore	2661.0	3146.0	4500.7	3416.0	3394.1	3915.5	3254.2	2751.3	2919.9	2948.3
Beltangadi	4044.0	4818.0	4601.1	4590.5	3974.4	5163.4	3179.7	3179.7	3596.1	3898.6
Chikmangaluru	1022.9	1154.2	1358.6	866.5	621.6	1015.3	1013.3	976.6	339.5	955.3
Koppa	857.2	3177.3	2949.0	2619.6	2489.3	3637.6	3383.5	2138.6	2138.6	2232.7
Hariharapura	445.7	3310.3	3100.9	3014.3	2933.6	3907.0	3794.0	2423.4	2423.4	2335.0
Sringeri	1079.9	3945.6	3356.6	4105.0	3263.5	4481.9	3882.7	3240.0	3240.0	2723.5
Kigga	328.5	5238.9	4448.2	5759.8	4458.6	6394.9	5588.2	4062.2	4062.2	3983.6
Kerekatte	453.2	6648.9	5515.7	6775.8	5956.3	7645.0	6198.3	4912.5	4912.5	5537.5
Bhadravathi	286.7	1588.6	653.2	1224.9	1010.8	3091.5	1300.9	1042.3	747.7	794.8
Agumbe	7199.4	6400.3	897.8	5425.0	4553.1	12494.2	5076.7	3619.6	3578.5	3805.6
Kalasa	434.7	3813.6	2813.8	3171.4	2493.6	4534.8	3682.6	2619.6	2619.6	2318.5
Tirthahalli	3154.5	2971.5	1338.2	3461.3	2210.1	6827.1	22996.2	12665.5	8690.7	2754.6



Annexure-IV Field Data Collection Sheet

Location No	TS No	Locality / Village	Latitude	Longitude	Geomorphological Process	Geomorphological form	Rock Type	Weathering	Overburden Type	Overburden Thickness	Landuse Type	Hydrological Condition	Erosion	Susceptibility Assesment of Slope	Qualitative Risk Assessment
1	48O/4	Hirte	13° 12' 27.69" N	75° 01' 58.35" E	Gravitational	Pediment pediplain	Granite gneiss	Moderate	In-situ soil	0.5 – 5 m	Plantation (LHP)	Damp	Toe erosion by Nala and River	Stable	Low or absent
2	48O/4	NH-13 (Mangalore-Solapur)	13° 12' 41.00" N	75° 05' 08.19" E	Gravitational	Pediment pediplain	Granite gneiss	Moderate	In-situ soil	< 0.5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
3	48O/4	Mullur	13° 14' 12.92" N	75° 06' 41.13" E	Gravitational	Pediment pediplain	Granite gneiss	Moderate	In-situ soil	0.5 – 5 m	Barren	Damp	Toe erosion by Nala and River	Stable	Low or absent
4	48O/4	Kudremukh forest	13° 14'34.76" N	75° 07' 16.57" E	Gravitational	Lowly Dissceted Slope	Granite gneiss	Low	In-situ soil	< 0.5 m	Extensive Slope Cut	Damp	Toe erosion by Nala and River	Meta Stable	Moderate
5	48 O/3	Kudremukh forest	13° 15' 08.00" N	75° 07' 39.25" E	Gravitational	Highly Dissceted Slope	Granite gneiss	Moderate	Rock	< 0.5 m	Extensive Slope Cut	Damp	Toe erosion by Nala and River	Meta Stable	Moderate
6	48O/3	Kudremukh forest check point	13° 15' 12.86" N	75° 07' 40.66" E	Gravitational	Highly Dissceted Slope	Granite (Sitanadi)	Moderate	In-situ soil	0.5 – 5 m	Extensive Slope Cut	Damp	Toe erosion by Nala and River	Meta Stable	Moderate
7	48O/3	NW of Check point	13° 15' 43.34" N	75° 07' 46.12" E	Gravitational	Highly Dissceted Slope	Granite	Fresh	Rock	< 0.5	Barren	Damp	Toe erosion by Nala and River	Meta Stable	Moderate
8	48O/3	Kudremukh forest near waterfall	13° 15' 46.21" N	75° 07' 48.62" E	Gravitational	Highly Dissceted Slope	Granite	Fresh	Rock	< 0.5 m	Extensive Slope Cut	Damp	Toe erosion by Nala and River	Meta Stable	Low or absent
9	48O/3	SK Border	13° 17' 04.41" N	75° 08' 27.82" E	Gravitational	Lowly Dissceted Slope	Granite	Fresh	In-situ soil	0.5 – 5 m	Plantation (LHP)	Damp	Toe erosion by Nala and River	Stable	Low or absent
10	48O/4	Bajegoli	13° 11' 51.52" N	75° 03' 49.84" E	Gravitational	Pediment pediplain	Granite	Low to fresh	Rock	< 0.5 m	Barren	Damp	Toe erosion by Nala and River	Stable	Low or absent
11	48O/4	SW of Bajegoli	13° 10' 38.07" N	75° 05' 04.50" E	Gravitational	Pediment pediplain	Granite gneiss	Moderate	In-situ soil	0.5 – 5 m	Thick Vegetation	Damp	Toe erosion by Nala and River	Meta Stable	Low or absent
12	48O/4	Bajegoli Karkala road	13° 08'22.77" N	75° 07' 02.47" E	Gravitational	Pediment pediplain	Granite	Moderate	Rock	< 0.5 m	Barren	Damp	Toe erosion by Nala and River	Stable	Low or absent
13	48O/4	Nelikar	13° 08' 50.32" N	75° 06' 14.68" E	Gravitational	Pediment pediplain	Granite gneiss	Low to fresh	In-situ soil	0.5 – 5 m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Stable	Low or absent

14	48O/4	NW of Nelikar	13° 09' 11.47" N	75° 04' 46.90" E	Gravitational	Lowly Dissceted Slope	Granite	Low to fresh	In-situ soil	0.5 – 5 m	Thick Vegetation	Damp	Toe erosion by Nala and River	Meta Stable	Moderate
15	48O/4	Renjada forest	13° 09'22.57" N	75° 04' 24.82" E	Gravitational	Lowly Dissceted Slope	Granite gneiss	Low to fresh	In-situ soil	0.5 – 5 m	Settlement	Damp	Toe erosion by Nala and River	Stable	Low or absent
16	48O/4	Sombettu	13° 09' 26.27" N	75° 04' 04.64" E	Gravitational	Lowly Dissceted Slope	Quartz chlorite schist	Low to fresh	In-situ soil	0.5 – 5 m	Thick Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
17	48O/4	NW of Sombettu	13° 09' 32.52" N	75° 03' 20.54" E	Gravitational	Lowly Dissceted Slope	Quartz chlorite schist	Low to fresh	In-situ soil	0.5 – 5 m	Thick Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
18	48O/4	4 km NW of Sombettu	13° 10' 00.00" N	75° 03' 08.13" E	Gravitational	Pediment pediplain	Granite	Low to fresh	In-situ soil	0.5 – 5 m	Thick Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
19	48O/4	Sombettu SK border road	13° 09' 52.07" N	75° 01' 51.00" E	Gravitational	Pediment pediplain	Granite	Moderate	In-situ soil	0.5 – 5 m	Extensive Slope Cut	Damp	Toe erosion by Nala and River	Meta Stable	Moderate
20	48O/4	Borakatte	13° 10' 26.57" N	75° 01' 35.62" E	Gravitational	Lowly Dissceted Slope	Granite gneiss	Moderate	In-situ soil	0.5 – 5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
21	48O/4	SE of Borakatte	13° 13' 41.85" N	75° 01' 07.91" E	Gravitational	Pediment pediplain	Granite gneiss	Moderate	In-situ soil	0.5 – 5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
22	48O/3	Near Hydro-power project	13° 15' 38.84" N	75° 02' 04.29" E	Gravitational	Lowly Dissceted Slope	Granite gneiss	Low to fresh	In-situ soil	0.5 – 5 m	Thick Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
23	48O/3	Hermande	13° 16' 40.03" N	75° 01' 13.98" E	Gravitational	Lowly Dissceted Slope	Granite gneiss	Moderate	Rock	< 0.5 m	Cultivation	Damp	Toe erosion by Nala and River	Stable	Low or absent
24	48O/3	S of Hermande	13° 17' 01.10" N	75° 00' 48.74" E	Gravitational	Pediment pediplain	Granite	Moderate	Rock	< 0.5 m	Cultivation	Damp	Toe erosion by Nala and River	Stable	Low or absent
25	48O/3	SW of Hermande	13° 17' 56.49" N	75° 00' 32.28" E	Gravitational	Pediment pediplain	Granite	Moderate	In-situ soil	0.5 – 5 m	Thick Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
26	48O/3	Ajekar	13° 19' 17.49" N	75° 01' 12.62" E	Gravitational	Pediment pediplain	Granitoid	Moderate	In-situ soil	0.5 – 5 m	Moderate Vegetation	Dry	Toe erosion by Nala and River	Stable	Low or absent
27	48O/3	NW of Ajekar	13° 19' 51.67" N	75° 02' 03.77" E	Gravitational	Pediment pediplain	Granitoid	Moderate	In-situ soil	0.5 – 5 m	Thick Vegetation	Dry	Toe erosion by Nala and River	Stable	Low or absent
28	48O/3	Mutlupadi	13° 21' 40.98" N	75° 02' 22.72" E	Gravitational	Highly Dissceted Slope	Granitoid	Moderate	In-situ soil	0.5 – 5 m	Settlement	Damp	Toe erosion by Nala and River	Stable	Low or absent
29	48O/	Bobettaye	13° 23'	75° 02'	Gravitati	Highly	Granitoid	Moderate	Rock	< 0.5	Extensive	Damp	Toe erosion	Meta Stable	Moderate

	3		10.42" N	09.94" E	onal	Dissceted Slope					Slope Cut		by Nala and River		
30	48O/3	W of Bobettaye	13° 23' 25.01" N	75° 02' 22.64" E	Gravitational	Moderately Dissceted Slope	Granitoid	Moderate	In-situ soil	0.5 – 5 m	Thick Vegetation	Damp	Toe erosion by Nala and River	Meta Stable	Moderate
31	48O/3	Kabinaley	13° 23' 57.23" N	75° 02' 40.36" E	Gravitational	Moderately Dissceted Slope	Banded magnetite quartzite	Low to fresh	Rock	< 0.5 m	Thick Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
32	48O/3	SE of Kabinaley	13° 25' 27.05" N	75° 02' 20.42" E	Gravitational	Highly Dissceted Slope	Banded magnetite quartzite	Low to fresh	Rock	< 0.5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
33	48O/4	Kyaradka	13° 13' 31.69" N	75° 01' 41.65" E	Gravitational	Pediment pediplain	Banded magnetite quartzite	Moderate	In-situ soil	0.5 – 5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
34	48O/4	NE of Kyaradka	13° 13' 41.22" N	75° 02' 00.10" E	Gravitational	Moderately Dissceted Slope	Banded magnetite quartzite	Moderate	In-situ soil	0.5 – 5 m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Stable	Low or absent
35	48O/4	SW of Kyaradka	13° 22' 22.39" N	75° 02' 03.24" E	Gravitational	Moderately Dissceted Slope	Meta-basalt	Moderate	In-situ soil	0.5 – 5 m	Thick Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
36	48O/4	S of Kyaradka	13° 13' 25.62" N	75° 02' 06.27" E	Gravitational	Moderately Dissceted Slope	Meta-basalt	Moderate	In-situ soil	0.5 – 5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Meta Stable	Moderate
37	48O/4	8 km ahead of Keragatte	13° 13' 28.85" N	75° 02' 30.57" E	Gravitational	Pediment pediplain	Meta-basalt	Moderate	Rock	< 0.5 m	Plantation (LHP)	Flowing	Toe erosion by Nala and River	Stable	Low or absent
38	48O/4	Kyaradka II	13° 14' 06.71" N	75° 03' 22.91" E	Gravitational	Moderately Dissceted Slope	Meta-basalt	Moderate	In-situ soil	0.5 – 5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Meta Stable	Moderate
39	48O/4	Durgamola Reserve forest	13° 14' 29.45" N	75° 03' 00.34" E	Gravitational	Moderately Dissceted Slope	Meta-basalt	Moderate	Meta-basalt	< 0.5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Meta Stable	Moderate
40	48O/4	Durgamola Reserve forest	13° 14' 22.60" N	75° 04' 10.45" E	Gravitational	Moderately Dissceted Slope	Meta-basalt	Low to fresh	Rock	< 0.5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
41	48O/3	Keragatte	13° 17' 14.06" N	75° 08' 37.61" E	Gravitational	Moderately Dissceted Slope	Meta-basalt	Moderate	Rock	< 0.5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Meta Stable	Moderate
42	48O/3	SE of Keragatte	13° 18' 40.16" N	75° 08' 36.37" E	Gravitational	Moderately Dissceted Slope	Quartz chlorite schist	Moderate	In-situ soil	0.5 – 5 m	Extensive Slope Cut	Damp	Toe erosion by Nala and River	Meta Stable	Moderate
43	48O/3	Kerakatte	13° 19' 31.50" N	75° 08' 32.07" E	Gravitational	Lowly Dissceted Slope	Quartz chlorite schist	Moderate	Rock	< 0.5 m	Extensive Slope Cut	Damp	Toe erosion by Nala and River	Meta Stable	Moderate
44	48O/3	NW of Kerakatte	13° 19' 28.27" N	75° 08' 42.67" E	Gravitational	Highly Dissceted Slope	Quartz chlorite schist	Moderate	In-situ soil	0.5 – 5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent

45	48O/3	300 m E of Location 44	13° 19'55.11" N	75° 09' 09.72" E	Gravitational	Moderately Dissceted Slope	Quartz chlorite schist	Moderate	Rock	< 0.5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
46	48O/3	NW of Kerakatte	13° 20' 29.39" N	75° 10' 16.63" E	Gravitational	Moderately Dissceted Slope	Porphyritic Granite	Moderate	In-situ soil	0.5 – 5 m	Extensive Slope Cut	Damp	Toe erosion by Nala and River	Meta Stable	Moderate
47	48O/3	NNW of Kerakatte	13° 20' 35.22" N	75° 11' 07.36" E	Gravitational	Moderately Dissceted Slope	Porphyritic Granite	Low to fresh	In-situ soil	0.5 – 5 m	Cultivation	Damp	Toe erosion by Nala and River	Stable	Low or absent
48	48O/3	1.5 km SE of Location 47	13° 21' 36.97" N	75° 12' 09.17" E	Gravitational	Pediment pediplain	Porphyritic Granite	Moderate	In-situ soil	0.5 – 5 m	Cultivation	Damp	Toe erosion by Nala and River	Stable	Low or absent
49	48O/3	SSW of Kerakatte	13° 21' 40.52" N	75° 12' 20.65" E	Gravitational	Pediment pediplain	Granite gneiss	Moderate	Weathered Rock	0.5 – 5 m	Extensive Slope Cut	Damp	Toe erosion by Nala and River	Meta Stable	Moderate
50	48O/3	NE of Mallur	13° 22' 28.48" N	75° 12' 50.51" E	Gravitational	Lowly Dissceted Slope	Banded magnetite quartzite	Moderate	In-situ soil	0.5 – 5 m	Extensive Slope Cut	Damp	Toe erosion by Nala and River	Meta Stable	Moderate
51	48O/3	3 km SW of Mallur	13° 24' 13.71" N	75° 14' 00.00" E	Gravitational	Moderately Dissceted Slope	Banded magnetite quartzite	Moderate	In-situ soil	0.5 – 5 m	Extensive Slope Cut	Damp	Toe erosion by Nala and River	Meta Stable	Moderate
52	48O/4	Mallur	13° 14' 07.28" N	75° 07' 11.04" E	Gravitational	Pediment pediplain	Banded magnetite quartzite	Moderate	In-situ soil	0.5 – 5 m	Cultivation	Damp	Toe erosion by Nala and River	Stable	Low or absent
53	48O/4	Mallur Monubettu road	13° 14' 27.60" N	75° 07' 46.00" E	Gravitational	Moderately Dissceted Slope	Granite gneiss	Moderate	In-situ soil	0.5 – 5 m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Stable	Low or absent
54	48O/4	Mallur Monubettu road	13° 13' 35.52" N	75° 07' 37.65" E	Gravitational	Moderately Dissceted Slope	Dolerite	Moderate	Rock	< 0.5 m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Stable	Low or absent
55	48O/4	Mallur Monubettu road	13° 13' 27.13" N	75° 06' 54.71" E	Gravitational	Pediment pediplain	Dolerite	Moderate	In-situ soil	0.5 – 5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
56	48O/4	Mallur Monubettu road	13° 12' 07.86" N	75° 07' 04.36" E	Gravitational	Pediment pediplain	Granite gneiss	Moderate	In-situ soil	0.5 – 5 m	Extensive Slope Cut	Damp	Toe erosion by Nala and River	Meta Stable	Moderate
57	48O/4	Manubettu	13° 10' 17.58" N	75° 06' 50.06" E	Gravitational	Moderately Dissceted Slope	Granite gneiss	Moderate	In-situ soil	0.5 – 5 m	Thick Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
58	48O/4	Manubettu	13° 09' 52.39" N	75° 06' 44.43" E	Gravitational	Pediment pediplain	Granite gneiss	Moderate	In-situ soil	0.5 – 5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
59	48O/4	Kodebettu	13° 14' 17.21" N	75° 05' 06.12" E	Gravitational	Pediment pediplain	Granite gneiss	Low to fresh	Rock	< 0.5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
60	48O/	Kervashe	13° 15'	75° 04'	Gravitati	Pediment	Charnokite	Low to	Rock	< 0.5 m	Plantation	Damp	Toe erosion	Stable	Low or

	3		34.64" N	23.89" E	onal	pediplain		fresh			(HHP)		by Nala and River		absent
61	48O/3	Yermala	13° 17' 24.91" N	75° 04' 34.81" E	Gravitational	Pediment pediplain	Granite gneiss	Moderate	Rock	< 0.5 m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Stable	Low or absent
62	48O/3	Near Shertaddi	13° 18' 51.14" N	75° 03' 03.24" E	Gravitational	Pediment pediplain	Granite gneiss	Moderate	In-situ soil	0.5 – 5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
63	48O/3	Pakeybail	13° 19' 34.84" N	75° 02' 45.63" E	Gravitational	Pediment pediplain	Granite gneiss	Moderate	In-situ soil	0.5 – 5 m	Cultivation	Damp	Toe erosion by Nala and River	Stable	Low or absent
64	48O/3	SE of Pakeybail	13° 17' 11.90" N	75° 08' 47.66" E	Gravitational	Moderately Dissceted Slope	Granite gneiss	Low to fresh	In-situ soil	0.5 – 5 m	Thick Vegetation	Damp	Toe erosion by Nala and River	Meta Stable	Moderate
65	48O/3	SSE of Pakeybail	13° 17' 07.85" N	75° 09' 00.50" E	Gravitational	Moderately Dissceted Slope	Granite gneiss	Moderate	Rock	< 0.5 ,m	Thick Vegetation	Damp	Toe erosion by Nala and River	Meta Stable	Moderate
66	48O/3	4 km Sw of location 65	13° 16' 45.47" N	75° 09' 08.25" E	Gravitational	Highly Dissceted Slope	Pegmatite	Low to fresh	Rock	< 0.5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
67	48O/3	NW of Pakeybail	13° 16' 00.70" N	75° 09' 25.75" E	Gravitational	Moderately Dissceted Slope	Banded magnetite quartzite	Moderate	Weathered Rock	0.5 – 5 m	Thick Vegetation	Damp	Toe erosion by Nala and River	Meta Stable	Moderate
68	48O/3	4 km NW of Jodukatte	13° 13' 49.99" N	75° 10' 51.21" E	Gravitational	Highly Dissceted Slope	Banded magnetite quartzite	Moderate	Rock	< 0.5 m	Thick Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
69	48O/3	Jodukatte	13° 12' 25.69" N	75° 11' 32.61" E	Gravitational	Moderately Dissceted Slope	Banded magnetite quartzite	Low to fresh	In-situ soil	0.5 – 5 m	Thick Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
70	48O/4	1.5 km SE of Jodukatte	13° 11' 17.10" N	75° 01' 18.18" E	Gravitational	Pediment pediplain	Banded magnetite quartzite	Moderate	In-situ soil	0.5 – 5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
71	48O/4	Kundaje	13° 10' 30.55" N	75° 03' 07.55" E	Gravitational	Pediment pediplain	Banded magnetite quartzite	Moderate	Rock	< 0.5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
72	48O/4	Ranjade	13° 09' 28.14" N	75° 02' 18.99" E	Gravitational	Moderately Dissceted Slope	Granite gneiss	Low to fresh	In-situ soil	0.5 – 5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
73	48O/4	SW of Ranjade	13° 08' 58.89" N	75° 02' 33.38" E	Gravitational	Moderately Dissceted Slope	Granite gneiss	Low to fresh	In-situ soil	0.5 – 5 m	Thick Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
74	48O/4	Dareygudey	13° 07' 34.85" N	75° 04' 02.73" E	Gravitational	Moderately Dissceted Slope	Granite gneiss	Moderate	In-situ soil	0.5 – 5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
75	48O/4	SE of Dareygudey	13° 07' 14.03" N	75° 05' 05.19" E	Gravitational	Pediment pediplain	Granite gneiss	Low to fresh	Rock	< 0.5 m	Plantation (LHP)	Damp	Toe erosion by Nala and River	Stable	Low or absent

76	48O/4	Near Hosmar	13° 07' 49.57" N	75° 06' 31.21" E	Gravitational	Moderately Dissected Slope	Banded magnetite quartzite	Moderate	Weathered Rock	0.5 – 5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
77	48O/4	SE of Hosmar	13° 07' 57.34" N	75° 06' 59.56" E	Gravitational	Pediment pediplain	Granite gneiss	Low to fresh	Rock	< 0.5 m	Quarry	Dry	Toe erosion by Nala and River	Meta Stable	Moderate
78	48O/4	Bhagwatti Camp	13° 12' 28.27" N	75° 11' 45.80" E	Gravitational	Moderately Dissected Slope	Dolerite	Low to fresh	Rock	< 0.5 m	Plantation (LHP)	Damp	Toe erosion by Nala and River	Meta Stable	Moderate
79	48O/4	Bhagwatti Camp	13° 12' 49.11" N	75° 14' 01.54" E	Gravitational	Moderately Dissected Slope	Granite gneiss	Moderate	Rock	< 0.5 m	Plantation (LHP)	Damp	Toe erosion by Nala and River	Stable	Low or absent
80	48O/4	4 km SE of Bhagwatti camp	13° 12' 48.37" N	75° 15' 13.52" E	Gravitational	Moderately Dissected Slope	Granite gneiss	Moderate	Rock	< 0.5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
81	48O/4	Bhagwatti camp-exit	13° 13' 01.47" N	75° 14' 20.42" E	Gravitational	Moderately Dissected Slope	Granite gneiss	Moderate	Weathered Rock	0.5 – 5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Meta Stable	Moderate
82	48O/4	Near Bhagwatti camp	13° 12' 52.00" N	75° 13' 34.08" E	Gravitational	Moderately Dissected Slope	Banded magnetite quartzite	Moderate	Weathered Rock	0.5 – 5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
83	48O/4	Near Bhagwatti camp	13° 13' 30.85" N	75° 10' 51.05" E	Gravitational	Moderately Dissected Slope	Banded magnetite quartzite	Moderate	Rock	< 0.5 m	Extensive Slope Cut	Damp	Toe erosion by Nala and River	Meta Stable	Moderate
84	48O/3	Near Muniyal	13° 22' 41.87" N	75° 00' 24.55" E	Gravitational	Pediment pediplain	Granitoid	Moderate	In-situ soil	0.5 – 5 m	Thick Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
85	48O/3	Near Varankejin temple	13° 23' 45.93" N	75° 00' 27.34" E	Gravitational	Pediment pediplain	Granitoid	Moderate	Rock	< 0.5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
86	48O/3	Adke	13° 23' 59.05" N	75° 00' 39.66" E	Gravitational	Moderately Dissected Slope	Granitoid	Moderate	In-situ soil	0.5 – 5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
87	48O/3	Bandimata	13° 28' 40.13" N	75° 02' 51.10" E	Gravitational	Pediment pediplain	Granite	Moderate	In-situ soil	0.5 – 5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
88	48O/3	Someshwara	13° 29' 26.94" N	75° 04' 02.86" E	Gravitational	Pediment pediplain	Amphibolite	Moderate	In-situ soil	0.5 – 5 m	Settlement	Damp	Toe erosion by Nala and River	Stable	Low or absent
89	48O/3	SW of Someshwara	13° 29' 26.45" N	75° 04' 34.81" E	Gravitational	Moderately Dissected Slope	Amphibolite	Moderate	Weathered Rock	0.5 – 5 m	Thick Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
90	48O/3	SSW of Someshwara	13° 29' 23.10" N	75° 04' 38.87" E	Gravitational	Highly Dissected Slope	Banded magnetite quartzite	Moderate	Weathered Rock	0.5 – 5 m	Extensive Slope Cut	Damp	Toe erosion by Nala and River	Meta Stable	Moderate

91	48O/3	NE of Someshwara	13° 29' 38.13" N	75° 04' 39.00" E	Gravitational	Highly Dissceted Slope	Banded magnetite quartzite	Moderate	Weathered Rock	0.5 – 5 m	Extensive Slope Cut	Damp	Toe erosion by Nala and River	Meta Stable	Moderate
92	48O/3	Near Batavanae	13° 29' 52.39" N	75° 04' 51.88" E	Gravitational	Highly Dissceted Slope	Amphibolite	Low to fresh	Rock	< 0.5 m	Thick Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
93	48O/3	Near Aghumbe	13° 29' 49.82" N	75° 04' 59.60" E	Gravitational	Highly Dissceted Slope	Granite gneiss	Moderate	Weathered Rock	0.5 – 5 m	Extensive Slope Cut	Damp	Toe erosion by Nala and River	Meta Stable	Moderate
94	48O/3	Aghumbe ghat section	13° 29' 49.20" N	75° 04' 45.30" E	Gravitational	Highly Dissceted Slope	Granite gneiss	Moderate	Weathered Rock	0.5 – 5 m	Extensive Slope Cut	Damp	Toe erosion by Nala and River	Meta Stable	Moderate
95	48O/3	Batvanae	13° 27' 556.56" N	75° 03' 06.95" E	Gravitational	Pediment pediplain	Granite gneiss	Low to fresh	In-situ soil	0.5 – 5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
96	48O/3	Nillekatte	13° 26' 46.76" N	75° 04' 20.05" E	Gravitational	Moderately Dissceted Slope	Granite gneiss	Moderate	In-situ soil	0.5 – 5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
97	48O/3	Near Siramane falls	13° 25' 55.09" N	75° 05' 340.92" E	Gravitational	Moderately Dissceted Slope	Amphibolite	Moderate	In-situ soil	0.5 – 5 m	Thick Vegetation	Damp	Toe erosion by Nala and River	Meta Stable	Moderate
98	48O/3	Near Siramane falls	13° 24' 43.64" N	75° 06' 36.78" E	Gravitational	Moderately Dissceted Slope	Amphibolite	Moderate	Rock	< 0.5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
99	48O/3	Kudlu falls	13° 24' 39.18" N	75° 06' 43.29" E	Gravitational	Highly Dissceted Slope	Amphibolite	Moderate	In-situ soil	0.5 – 5 m	Thick Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
100	48O/4	Near Nallur	13° 10' 22.29" N	75° 05' 15.54" E	Gravitational	Moderately Dissceted Slope	Gabbro	Moderate	Rock	< 0.5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
101	48O/4	S of Nallur	13° 09' 41.59" N	75° 08' 06.90" E	Gravitational	Lowly Dissceted Slope	Gabbro	Moderate	In-situ soil	0.5 – 5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
102	48O/4	4 km SE of Nallur	13° 09' 54.97" N	75° 08' 06.90" E	Gravitational	Moderately Dissceted Slope	Quartz chlorite schist	Moderate	In-situ soil	0.5 – 5 m	Cultivation	Damp	Toe erosion by Nala and River	Stable	Low or absent
103	48O/4	Kunetad	13° 10' 21.13" N	75° 08' 26.58" E	Gravitational	Lowly Dissceted Slope	Quartz chlorite schist	Moderate	In-situ soil	0.5 – 5 m	Settlement	Damp	Toe erosion by Nala and River	Stable	Low or absent
104	48O/4	SE of Kunetad	13° 09' 59.70" N	75° 03' 54.77" E	Gravitational	Moderately Dissceted Slope	Quartzite	Moderate	Rock	< 0.5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
105	48O/4	SSE of Kunetad	13° 08' 49.71" N	75° 09' 36.55" E	Gravitational	Pediment pediplain	Granite gneiss	Moderate	In-situ soil	0.5 – 5 m	Extensive Slope Cut	Damp	Toe erosion by Nala and River	Stable	Low or absent
106	48O/4	SW of Kunetad	13° 08' 52.47" N	75° 09' 39.95" E	Gravitational	Rolling Plain	Granite gneiss	Moderate	In-situ soil	0.5 – 5 m	Settlement	Damp	Toe erosion by Nala and	Stable	Low or absent

													River		
107	48O/4	Panjoli	13° 06' 19.38" N	75° 10' 13.47" E	Gravitational	Rolling Plain	Granite gneiss	Moderate	In-situ soil	0.5 – 5 m	Cultivation	Damp	Toe erosion by Nala and River	Stable	Low or absent
108	48O/4	SE of Panjoli	13° 06' 39.38" N	75° 10' 38.88" E	Gravitational	Pediment pediplain	Granite gneiss	Moderate	In-situ soil	0.5 – 5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
109	48O/4	Kudremukh bio-park	13° 06' 31.48" N	75° 11' 23.72" E	Gravitational	Moderately Dissceted Slope	Meta-basalt	Moderate	In-situ soil	0.5 – 5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
110	48O/4	Kudremukh bio-park	13° 05' 21.29" N	75° 09' 48.15" E	Gravitational	Rolling Plain	Meta-basalt	Moderate	In-situ soil	0.5 – 5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
111	48O/4	Kudremukh bio-park	13° 05' 45.72" N	75° 09' 22.08" E	Gravitational	Rolling Plain	Meta-basalt	Moderate	In-situ soil	0.5 – 5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
112	48O/4	Maradi	13° 05' 45.08" N	75° 08' 27.54" E	Gravitational	Moderately Dissceted Slope	Granite gneiss	Moderate	In-situ soil	0.5 – 5 m	Settlement	Damp	Toe erosion by Nala and River	Stable	Low or absent
113	48O/4	SE of Maradi	13° 06' 02.22" N	75° 08' 48.12" E	Gravitational	Lowly Dissceted Slope	Amphibolite	Moderate	In-situ soil	0.5 – 5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
114	48O/4	SW of Maradi	13° 06' 15.02" N	75° 08' 41.15" E	Gravitational	Rolling Plain	Granite gneiss	Moderate	In-situ soil	0.5 – 5 m	Extensive Slope Cut	Damp	Toe erosion by Nala and River	Meta Stable	Moderate
115	48O/4	SW of Kutluru	13° 08' 46.22" N	75° 06' 20.80" E	Gravitational	Rolling Plain	Amphibolite	Moderate	In-situ soil	0.5 – 5 m	Plantation (LHP)	Damp	Toe erosion by Nala and River	Stable	Low or absent
116	48O/4	SSW of Kutluru	13° 07' 13.25" N	75° 07' 49.85" E	Gravitational	Pediment pediplain	Amphibolite	Moderate	In-situ soil	0.5 – 5 m	Plantation (LHP)	Damp	Toe erosion by Nala and River	Stable	Low or absent
117	48O/4	5 km SW of Kutluru	13° 06' 50.20" N	75° 08' 26.95" E	Gravitational	Pediment pediplain	Granite gneiss	Moderate	In-situ soil	0.5 – 5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
118	48O/4	Kutluru main junction	13° 05' 37.29" N	75° 06' 49.00" E	Gravitational	Rolling Plain	Granite gneiss	Moderate	In-situ soil	0.5 – 5 m	Plantation (LHP)	Damp	Toe erosion by Nala and River	Stable	Low or absent
119	48O/4	Kutluru road junction	13° 05' 32.97" N	75° 05' 32.81" E	Gravitational	Rolling Plain	Granite gneiss	Moderate	In-situ soil	0.5 – 5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
120	48O/4	Kutluru	13°05' 34.05" N	75° 10' 27.75" E	Gravitational	Pediment pediplain	Granite gneiss	Moderate	In-situ soil	0.5 – 5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
121	48O/4	Sulkeri	13° 04' 55.07" N	75° 11' 30.93" E	Gravitational	Rolling Plain	Granite gneiss	Moderate	In-situ soil	0.5 – 5 m	Quarry	Damp	Toe erosion by Nala and River	Stable	Low or absent

122	48O/4	SW of Sulkeri	13° 05' 07.64" N	75° 11' 56.70" E	Gravitational	Rolling Plain	Granite gneiss	Moderate	In-situ soil	0.5 – 5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
123	48O/4	4 km SSwW of Sulkeri	13° 04' 42.42" N	75° 12' 05.88" E	Gravitational	Rolling Plain	Granite gneiss	Moderate	In-situ soil	0.5 – 5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
124	48O/4	SW of Kambuje	13° 03' 36.40" N	75° 12' 47.18" E	Gravitational	Rolling Plain	Granite gneiss	Moderate	In-situ soil	0.5 – 5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
125	48O/7	SSW of Kambuje	13° 03'55.68" N	75° 13' 05.08" E	Gravitational	Rolling Plain	Granite gneiss	Moderate	In-situ soil	0.5 – 5 m	Settlement of mod. Slope	Damp	Toe erosion by Nala and River	Meta Stable	Moderate
126	48O/4	W of Magundi	13° 04' 18.24" N	75° 12' 52.84" E	Gravitational	Moderately Dissceted Slope	Granite gneiss	Moderate	Weathered Rock	0.5 – 5 m	Settlement	Damp	Toe erosion by Nala and River	Stable	Low or absent
127	48O/4	Kambuje	13° 05' 19.00" N	75° 12' 78.81" E	Gravitational	Rolling Plain	Granite gneiss	Moderate	In-situ soil	0.5 – 5 m	Settlement	Damp	Toe erosion by Nala and River	Stable	Low or absent
128	48O/4	S of Kambuje	13° 02' 44.92" N	75° 11' 47.77" E	Gravitational	Pediment pediplain	Granite gneiss	Moderate	Rock	< 0.5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
129	48O/4	Nanajimala Reserve forest	13° 02' 06.90" N	75° 10' 48.05" E	Gravitational	Pediment pediplain	Granite gneiss	Moderate	In-situ soil	0.5 – 5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
130	48O/4	Nanajimala Reserve forest	13° 01' 37.39" N	75° 10' 05.93" E	Gravitational	Pediment pediplain	Meta-basalt	Moderate	Rock	< 0.5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
131	48O/4	S of Nanajimala Reserve forest	13° 01' 19.15" N	75° 09' 45.06" E	Gravitational	Moderately Dissceted Slope	Meta-basalt	Moderate	In-situ soil	0.5 – 5 m	Extensive Slope Cut	Damp	Toe erosion by Nala and River	Meta Stable	Moderate
132	48O/4	SW of Parapu	13° 00' 23.04" N	75° 09' 45.06" E	Gravitational	Pediment pediplain	Meta-basalt	Moderate	In-situ soil	0.5 – 5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
133	48O/4	Parapu	13° 00' 50.49" N	75° 09' 13.03" E	Gravitational	Moderately Dissceted Slope	Meta-basalt	Moderate	In-situ soil	0.5 – 5 m	Thick Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
134	48O/4	NE of Parapu	13° 00' 23.13" N	75° 09' 04.70" E	Gravitational	Pediment pediplain	Meta-basalt	Moderate	In-situ soil	0.5 – 5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Meta Stable	Moderate
135	48O/4	5 km SSW of Parapu	13° 00' 34.33" N	75° 08' 52.34" E	Gravitational	Rolling Plain	Banded magnetite quartzite	Moderate	In-situ soil	0.5 – 5 m	Extensive Slope Cut	Damp	Toe erosion by Nala and River	Meta Stable	Moderate
136	48O/4	NW of Mundail	13° 01' 08.93" N	75° 08' 22.97" E	Gravitational	Lowly Dissceted Slope	Granite gneiss	Moderate	In-situ soil	0.5 – 5 m	Extensive Slope Cut	Damp	Toe erosion by Nala and River	Meta Stable	Moderate
137	48O/	Mundail	13° 01'	75° 09'	Gravitati	Moderately	Granite	Moderate	In-situ soil	0.5 – 5 m	Moderate	Damp	Toe erosion	Stable	Low or

	4		58.43" N	26.39" E	onal	Dissceted Slope	gneiss				Vegetation		by Nala and River		absent
138	48O/4	Kokradi	13° 04' 01.32" N	75° 09' 21.83" E	Gravitational	Pediment pediplain	Granite gneiss	Moderate	In-situ soil	0.5 – 5 m	Settlement	Damp	Toe erosion by Nala and River	Stable	Low or absent
139	48O/4	Shirtaddi	13° 06' 36.51" N	75° 05' 09.79" E	Gravitational	Pediment pediplain	Granite gneiss	Moderate	In-situ soil	0.5 – 5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
140	48O/4	Nelikar	13° 10' 07.48" N	75° 05' 23.43" E	Gravitational	Pediment pediplain	Granite gneiss	Moderate	In-situ soil	0.5 – 5 m	Extensive Slope Cut	Damp	Toe erosion by Nala and River	Meta Stable	Moderate
141	48O/3	SW of Nelikar	13° 23' 55.52" N	75° 12' 53.11" E	Gravitational	Rolling Plain	Banded magnetite quartzite	Moderate	In-situ soil	0.5 – 5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
142	48O/3	Toronagadde	13° 23' 33.37" N	75° 12' 31.45" E	Gravitational	Pediment pediplain	Banded magnetite quartzite	Moderate	In-situ soil	0.5 – 5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
143	48O/3	SW of Toronagadde	13° 25' 04.11" N	75° 12' 19.64" E	Gravitational	Rolling Plain	Granite gneiss	Moderate	In-situ soil	0.5 – 5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
144	48O/3	SSW of Toronagadde	13° 24' 32.95" N	75° 13' 13.85" E	Gravitational	Moderately Dissceted Slope	Granite gneiss	Moderate	In-situ soil	5 – 10 m	Extensive Slope Cut	Damp	Toe erosion by Nala and River	Meta Stable	Moderate
145	48O/3	NE of Toronagadde	13° 24' 57.90" N	75° 10' 50.10" E	Gravitational	Moderately Dissceted Slope	Granite gneiss	Moderate	Weathered Rock	5 – 10 m	Extensive Slope Cut	Damp	Toe erosion by Nala and River	Meta Stable	Moderate
146	48O/3	Towards Siramanne falls	13° 24' 21.07" N	75° 11' 02.32" E	Gravitational	Moderately Dissceted Slope	Granite gneiss	Moderate	Weathered Rock	0.5 – 5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
147	48O/3	Near Sirmanne falls	13° 23' 28.81" N	75° 11' 00.55" E	Gravitational	Pediment pediplain	Granite gneiss	Moderate	Weathered Rock	0.5 – 5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
148	48O/3	Sirmanne falls	13° 23' 18.54" N	75° 10' 46.50" E	Gravitational	Highly Dissceted Slope	Banded magnetite quartzite	Moderate	In-situ soil	0.5 – 5 m	Extensive Slope Cut	Damp	Toe erosion by Nala and River	Meta Stable	Moderate
149	48O/3	Sirmanne falls	13° 23' 10.06" N	75° 10' 37.87" E	Gravitational	Highly Dissceted Slope	Banded magnetite quartzite	Moderate	Weathered Rock	0.5 – 5 m	Extensive Slope Cut	Damp	Toe erosion by Nala and River	Meta Stable	Moderate
150	48O/3	SW of Hirgale	13° 22' 55.84" N	75° 10' 37.11" E	Gravitational	Lowly Dissceted Slope	Banded magnetite quartzite	Moderate	Weathered Rock	0.5 – 5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
151	48O/3	Hirgale	13° 22' 49.46" N	75° 10' 24.79" E	Gravitational	Highly Dissceted Slope	Granite gneiss	Moderate	Weathered Rock	0.5 – 5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
152	48O/3	Singeri	13° 25' 02.96" N	75° 14' 12.66" E	Gravitational	Highly Dissceted Slope	Granite gneiss	Moderate	In-situ soil	0.5 – 5 m	Extensive Slope Cut	Damp	Toe erosion by Nala and River	Meta Stable	Moderate

153	48O/3	SW of Singeri	13°11' 47.54" N	75° 00' 15.60" E	Gravitational	Rolling Plain	Granite gneiss	Moderate	In-situ soil	0.5 – 5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
154	48O/3	SSW of Singeri	13° 11' 11.57" N	75° 00' 20.65" E	Gravitational	Rolling Plain	Granite gneiss	Moderate	Weathered Rock	0.5 – 5 m	Barren	Damp	Toe erosion by Nala and River	Stable	Low or absent
155	48O/4	SW of Irvatur	13° 10' 37.89" N	75° 00' 33.39" E	Gravitational	Moderately Dissceted Slope	Meta-ultramafite	Moderate	In-situ soil	0.5 – 5 m	Extensive Slope Cut	Damp	Toe erosion by Nala and River	Meta Stable	Moderate
156	48O/4	SSW of Irvatur	13° 09' 47.25" N	74° 59' 51.91" E	Gravitational	Moderately Dissceted Slope	Meta-ultramafite	Moderate	In-situ soil	0.5 – 5 m	Extensive Slope Cut	Damp	Toe erosion by Nala and River	Meta Stable	Moderate
157	48O/4	Irvatur	13° 08' 44.38" N	75° 01' 28.15" E	Gravitational	Rolling Plain	Granite gneiss	Moderate	In-situ soil	0.5 – 5 m	Settlement	Damp	Toe erosion by Nala and River	Stable	Low or absent
158	48O/4	SE of Irvatur	13° 06' 29.28" N	75° 01' 56.95" E	Gravitational	Moderately Dissceted Slope	Granite gneiss	Moderate	In-situ soil	0.5 – 5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
159	48O/4	SW of Dekallu	13° 05' 34.65" N	75° 01' 02.32" E	Gravitational	Moderately Dissceted Slope	Granite gneiss	Moderate	In-situ soil	0.5 – 5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
160	48O/4	Near Dekallu	13° 05' 19.18" N	75° 01' 25.16" E	Gravitational	Moderately Dissceted Slope	Granite gneiss	Moderate	In-situ soil	0.5 – 5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
161	48O/4	Dekallu	13° 05' 32.71" N	75° 01' 51.37" E	Gravitational	Moderately Dissceted Slope	Granite	Moderate	In-situ soil	0.5 – 5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
162	48O/4	4 km NE of Dekallu	13° 04' 34.36" N	75° 01' 33.00" E	Gravitational	Moderately Dissceted Slope	Meta-basalt	Moderate	Laterite	0.5 – 5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
163	48O/4	S of Killur	13°05' 10.89" N	75° 02' 04.39" E	Gravitational	Moderately Dissceted Slope	Granite	Low to fresh	Rock	< 0.5 m	Quarry	Damp	Toe erosion by Nala and River	Meta Stable	Moderate
164	48O/4	Manya	13° 4' 30.79" N	75° 02' 06.82" E	Gravitational	Rolling Plain	Granite gneiss	Moderate	In-situ soil	0.5 – 5 m	Quarry	Damp	Toe erosion by Nala and River	Stable	Low or absent
165	48O/4	SW of Manya	13° 03' 40.27" N	75° 00' 36.09" E	Gravitational	Rolling Plain	Granite gneiss	Moderate	In-situ soil	0.5 – 5 m	Settlement	Damp	Toe erosion by Nala and River	Stable	Low or absent
166	48O/4	SSW of Manya	13° 03' 13.92" N	75° 00' 12.81" E	Gravitational	Rolling Plain	Granite gneiss	Moderate	In-situ soil	0.5 – 5 m	Settlement	Damp	Toe erosion by Nala and River	Stable	Low or absent
167	48O/4	Bogargudde	13°02' 52.57" N	75° 00' 27.91" E	Gravitational	Plateau top	Granite gneiss	Moderate	In-situ soil	0.5 – 5 m	Extensive Slope Cut	Damp	Toe erosion by Nala and River	Meta Stable	Moderate
168	48O/4	Hosabettu	13° 02' 49.05" N	75° 00' 14.78" E	Gravitational	Rolling Plain	Meta-basalt	Moderate	Laterite	0.5 – 5 m	Extensive Slope Cut	Damp	Toe erosion by Nala and	Meta Stable	Moderate

													River		
169	48O/4	SW of Hosabettu	13° 03' 02.79" N	74° 59' 44.25" E	Gravitational	Rolling Plain	Pegmatite	Moderate	In-situ soil	0.5 – 5 m	Extensive Slope Cut	Damp	Toe erosion by Nala and River	Meta Stable	Moderate
170	48O/4	SSW of Hosabettu	13° 01' 47.93" N	75° 00' 23.58" E	Gravitational	Pediment pediplain	Granite gneiss	Moderate	In-situ soil	0.5 – 5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
171	48O/4	5 km SE of Hosabettu	13° 1' 18.76" N	75° 00' 38.14" E	Gravitational	Moderately Dissceted Slope	Granite gneiss	Moderate	In-situ soil	0.5 – 5 m	Extensive Slope Cut	Damp	Toe erosion by Nala and River	Meta Stable	Moderate
172	48O/4	Hosabettu II	13° 00' 08.24" N	75° 00' 36.47" E	Gravitational	Highly Dissceted Slope	Banded magnetite quartzite	Moderate	In-situ soil	0.5 – 5 m	Settlement	Damp	Toe erosion by Nala and River	Stable	Low or absent
173	48O/4	SSW of Harebail	13° 00' 02.28" N	75° 00' 37.81" E	Gravitational	Moderately Dissceted Slope	Granite gneiss	Moderate	In-situ soil	0.5 – 5 m	Extensive Slope Cut	Damp	Toe erosion by Nala and River	Meta Stable	Moderate
174	48O/3	6 km NE of Harebail	13° 14' 32.23" N	75° 07' 21.52" E	Gravitational	Highly Dissceted Slope	Granite gneiss	Moderate	Rock	< 0.5 m	Extensive Slope Cut	Damp	Toe erosion by Nala and River	Meta Stable	Moderate
175	48O/3	SE of Sunkadammki	13° 15' 12.87" N	75° 07' 40.48" E	Gravitational	Rolling Plain	Granite gneiss	Moderate	In-situ soil	0.5 – 5 m	Thick Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
176	48O/3	Harebail	13° 21' 42.81" N	75° 11' 39.20" E	Gravitational	Pediment pediplain	Meta-basalt	Moderate	Weathered Rock	0.5 – 5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Meta Stable	Moderate
177	48O/3	Sunkadammki	13° 22' 14.85" N	75° 22' 50.35" E	Gravitational	Pediment pediplain	Granite gneiss	Moderate	In-situ soil	0.5 – 5 m	Extensive Slope Cut	Damp	Toe erosion by Nala and River	Meta Stable	Moderate
178	48O/3	Singeri	13° 5' 30.11" N	75° 14' 58.30" E	Gravitational	Pediment pediplain	Granite gneiss	Moderate	In-situ soil	0.5 – 5 m	Extensive Slope Cut	Damp	Toe erosion by Nala and River	Meta Stable	Moderate
179	48O/3	SW of Singeri	13° 26' 03.72" N	75° 14' 58.36" E	Gravitational	Lowly Dissceted Slope	Charnokite	Moderate	In-situ soil	0.5 – 5 m	Extensive Slope Cut	Damp	Toe erosion by Nala and River	Meta Stable	Moderate
180	48O/3	SW of Gubba goddi	13° 27' 07.34" N	75° 14' 04.44" E	Gravitational	Lowly Dissceted Slope	Granite gneiss	Moderate	In-situ soil	0.5 – 5 m	Extensive Slope Cut	Damp	Toe erosion by Nala and River	Meta Stable	Moderate
181	48O/4	6 km NW ofGubba goddi	13° 15' 02.80" N	75° 07' 40.02" E	Gravitational	Moderately Dissceted Slope	Granite gneiss	Moderate	Rock	< 0.5 mn	Thick Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
182	48O/4	Gubba goddi	13° 17' 03.53" N	75° 07' 39.05" E	Gravitational	Highly Dissceted Slope	Amphibolite	Moderate	Weathered Rock	0.5 – 5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
183	48O/3	Gubba goddi	13° 25' 02.39" N	75° 13' 49.15" E	Gravitational	Highly Dissceted Slope	Amphibolite	Moderate	In-situ soil	0.5 – 5 m	Extensive Slope Cut	Damp	Toe erosion by Nala and River	Meta Stable	Moderate

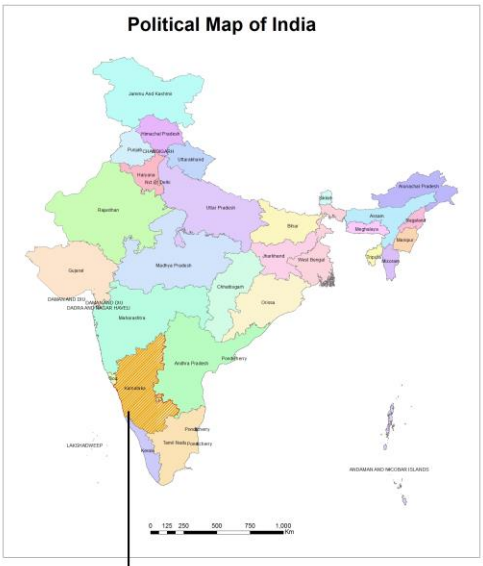
184	48O/3	Hulse	13° 26' 05.28" N	75° 11' 22.82" E	Gravitational	Highly Dissceted Slope	Granite gneiss	Moderate	In-situ soil	0.5 – 5 m	Extensive Slope Cut	Damp	Toe erosion by Nala and River	Meta Stable	Moderate
185	48O/3	Kalavanti Kodage	13° 26' 41.51" N	75° 10' 46.38" E	Gravitational	Rolling Plain	Laterite	Moderate	In-situ soil	0.5 – 5 m	Extensive Slope Cut	Damp	Toe erosion by Nala and River	Meta Stable	Moderate
186	48O/3	SW of Kalavanti Kodage	13° 27' 57.45" N	75° 10' 55.72" E	Gravitational	Rolling Plain	Laterite	Moderate	In-situ soil	0.5 – 5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
187	48O/3	SW of Hulse	13° 28' 27.47" N	75° 02' 39.25" E	Gravitational	Rolling Plain	Granite gneiss	Moderate	Weathered Rock	0.5 – 5 m	Extensive Slope Cut	Damp	Toe erosion by Nala and River	Meta Stable	Moderate
188	48O/3	SSW of Hulse	13° 28' 22.94" N	75° 12' 11.43" E	Gravitational	Lowly Dissceted Slope	Granite gneiss	Moderate	In-situ soil	0.5 – 5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
189	48O/3	Near Hulse	13° 27' 41.80" N	75° 11' 59.49" E	Gravitational	Rolling Plain	Granite gneiss	Moderate	In-situ soil	0.5 – 5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
190	48O/3	SSW of Sittamadi	13° 26' 48.36" N	75° 11' 55.05" E	Gravitational	Rolling Plain	Granite gneiss	Moderate	Weathered Rock	0.5 – 5 m	Extensive Slope Cut	Damp	Toe erosion by Nala and River	Meta Stable	Moderate
191	48O/3	SW of Sittamadi	13° 26' 57.90" N	75° 10' 10.53" E	Gravitational	Pediment pediplain	Granite gneiss	Moderate	In-situ soil	0.5 – 5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
192	48O/3	Sittmnadi near bridge	13° 26' 48.80" N	75° 12' 41.95" E	Gravitational	Pediment pediplain	Granite gneiss	Moderate	In-situ soil	0.5 – 5 m	Extensive Slope Cut	Damp	Toe erosion by Nala and River	Meta Stable	Moderate
193	48O/3	Nea Nellingeri	13° 26' 41.95" N	75° 14' 26.06" E	Gravitational	Pediment pediplain	Granite gneiss	Moderate	In-situ soil	5 – 10 m	Quarry	Damp	Toe erosion by Nala and River	Meta Stable	Moderate
194	48O/3	SW of Nellingeri	13° 28' 22.50" N	75° 14' 51.65" E	Gravitational	Rolling Plain	Granite gneiss	Moderate	Rock	< 0.5 m	Quarry	Damp	Toe erosion by Nala and River	Meta Stable	Moderate
195	48O/4	Nellingeri	13° 03' 26.19" N	75° 08' 26.08" E	Gravitational	Pediment pediplain	Granite	Moderate	Rock	< 0.5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
196	48O/4	Kandiga	13° 00' 58.21" N	75° 08'00.33" E	Gravitational	Moderately Dissceted Slope	Hornblende granite	Moderate	In-situ soil	5 – 10 m	Extensive Slope Cut	Damp	Toe erosion by Nala and River	Meta Stable	Moderate
197	48O/4	Karimanelu	13°01' 27.33" N	75° 07' 18.11" E	Gravitational	Moderately Dissceted Slope	Hornblende granite	Moderate	In-situ soil	0.5 – 5 m	Extensive Slope Cut	Damp	Toe erosion by Nala and River	Meta Stable	Moderate
198	48O/4	Perange	13° 02' 48.45" N	75° 04' 50.90" E	Gravitational	Pediment pediplain	Laterite	Moderate	In-situ soil	0.5 – 5 m	Extensive Slope Cut	Damp	Toe erosion by Nala and River	Meta Stable	Moderate
199	48O/4	Takote	13° 01' 52.94" N	75° 02' 36.68" E	Gravitational	Pediment pediplain	Granite gneiss	Moderate	In-situ soil	0.5 – 5 m	Thick Vegetation	Damp	Toe erosion by Nala and	Stable	Low or absent

													River		
200	48O/4	Ramabail	13° 01' 34.25" N	75°02' 217.57" E	Gravitational	Moderately Dissceted Slope	Granite gneiss	Moderate	In-situ soil	0.5 – 5 m	Extensive Slope Cut	Damp	Toe erosion by Nala and River	Meta Stable	Moderate
201	48O/4	Sombettu	13° 10' 31.85" N	75° 05' 02.65" E	Gravitational	Moderately Dissceted Slope	Granite gneiss	Moderate	In-situ soil	0.5 – 5 m	Extensive Slope Cut	Damp	Toe erosion by Nala and River	Meta Stable	Moderate
202	48O/4	Aldangadi	13° 02' 51.59" N	75° 13' 24.80" E	Gravitational	Moderately Dissceted Slope	Amphibolite	Moderate	In-situ soil	0.5 – 5 m	Extensive Slope Cut	Damp	Toe erosion by Nala and River	Meta Stable	Moderate
203	48O/4	SW of Aldangadi	13° 04' 06.18" N	75° 13' 44.01" E	Gravitational	Pediment pediplain	Charnokite	Moderate	In-situ soil	0.5 – 5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
204	48O/4	SSW of Aldangadi	13° 04' 35.35" N	75° 13' 52.20" E	Gravitational	Moderately Dissceted Slope	Granite gneiss	Moderate	Rock	< 0.5 m	Settlement	Damp	Toe erosion by Nala and River	Stable	Low or absent
205	48O/4	Karambaru	13° 02' 05.30" N	75° 14' 08.17" E	Gravitational	Highly Dissceted Slope	Granite gneiss	Moderate	In-situ soil	0.5 – 5 m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Stable	Low or absent
206	48O/4	Malantabettu	13° 00' 17.20" N	75° 14' 18.19" E	Gravitational	Pediment pediplain	Granite gneiss	Moderate	In-situ soil	0.5 – 5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
207	48O/4	SW of Malantabettu	13° 00' 56.35" N	75° 13' 43.74" E	Gravitational	Highly Dissceted Slope	Granite gneiss	Moderate	In-situ soil	0.5 – 5 m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Stable	Low or absent
208	48O/4	Tanka Karandur	13°01' 33.52" N	75° 12' 43.28" E	Gravitational	Pediment pediplain	Granite gneiss	Moderate	In-situ soil	0.5 – 5 m	Settlement	Damp	Toe erosion by Nala and River	Stable	Low or absent
209	48O/4	SE of Tanka Karandur	13° 01' 13.7" N	75° 12' 34.40" E	Gravitational	Moderately Dissceted Slope	Granite gneiss	Moderate	In-situ soil	0.5 – 5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
210	48O/4	7 km SSW of Tanka Karandur	13° 01' 24.08" N	75° 12' 15.92" E	Gravitational	Rolling Plain	Banded magnetite quartzite	Moderate	In-situ soil	0.5 – 5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent
211	48O/4	NW of Herur	13° 02' 27.13" N	75° 13' 18.34" E	Gravitational	Rolling Plain	Banded magnetite quartzite	Moderate	In-situ soil	0.5 – 5 m	Moderate Vegetation	Damp	Toe erosion by Nala and River	Stable	Low or absent

Plate 1

Location Map of the Study Area

Study Area covering T.S No. 48O/3 & O/4 of Dakshin Kannada,Chikmangalur & Udupi District,Karnataka



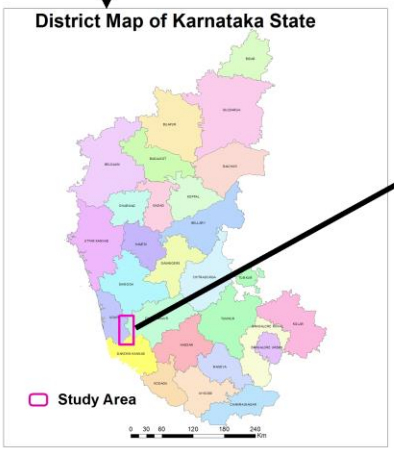
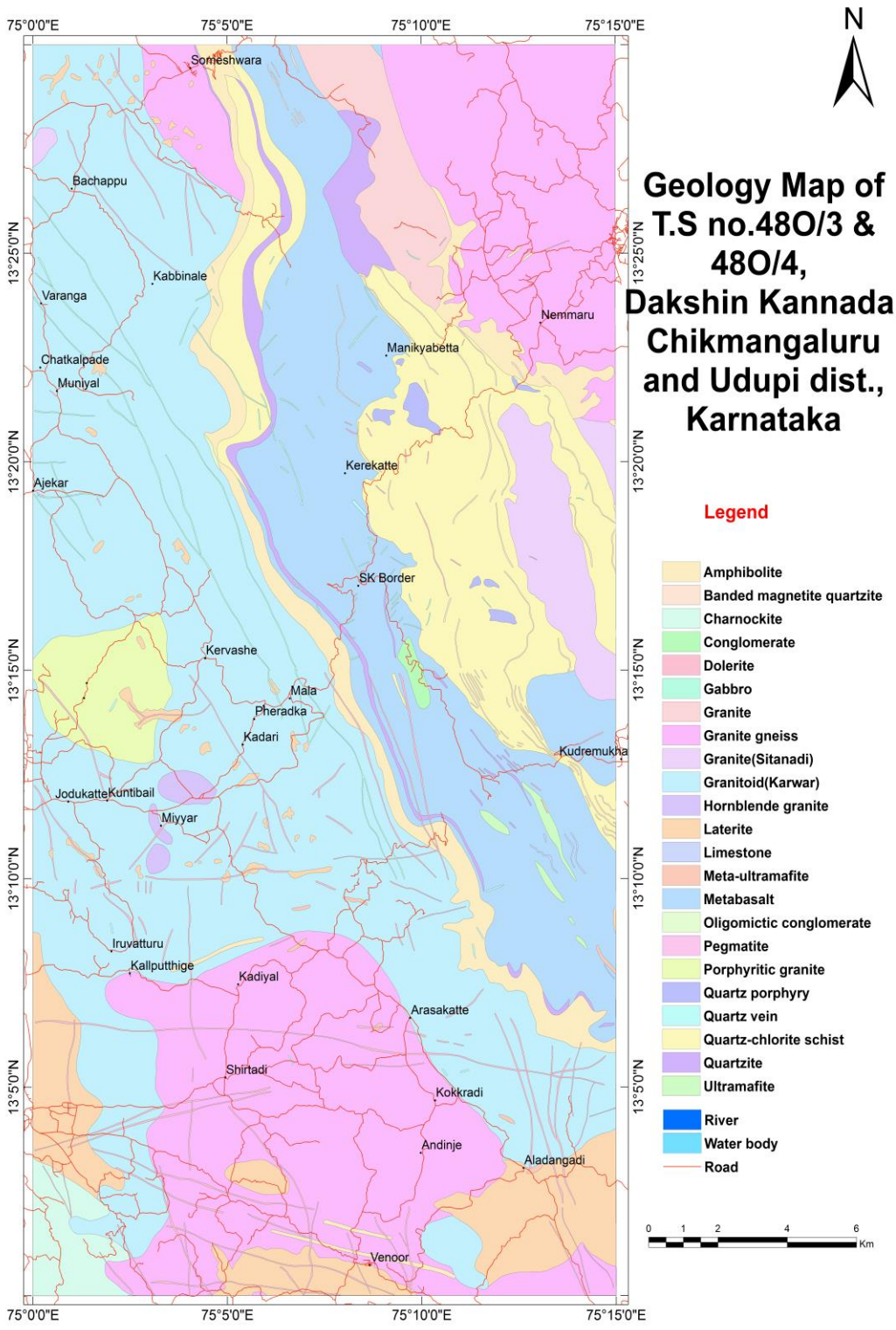


Plate 2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75°5'0"E
75°10'0"E
75°15'0"E
13°25'0"N
13°20'0"N
13°15'0"N
13°10'0"N
13°5'0"N
N
Someshwara
Bachappu
Kabbinale
Varanga
Chatkalpade
Muniyal
Ajekar
Nemmaru
Manikyabetta
Kerekatte
SK Border
Kervashe
Mala
Pheradka
Kadari
Kudremukha
Jodukatte
Kuntibail
Miyyar
Iruvatturu
Kallputthige
Kadiyal
Arasakatte
Shirtadi
Kokkradi
Andinje
Aladangadi
Venoor
Geology Map of T.S no.48O/3 & 48O/4, Dakshin Kannada Chikmangaluru and Udupi dist., Karnataka
Legend
Amphibolite
Banded magnetite quartzite
Charnockite
Conglomerate
Dolerite
Gabbro
Granite
Granite gneiss
Granite(Sitanadi)
Granitoid(Karwar)
Hornblende granite
Laterite
Limestone
Meta-ultramafite
Metabasalt
Oligomictic conglomerate
Pegmatite
Porphyritic granite
Quartz porphyry
Quartz vein
Quartz-chlorite schist
Quartzite
Ultramafite
River
Water body
Road
0 1 2 4 6
Km

Plate 3

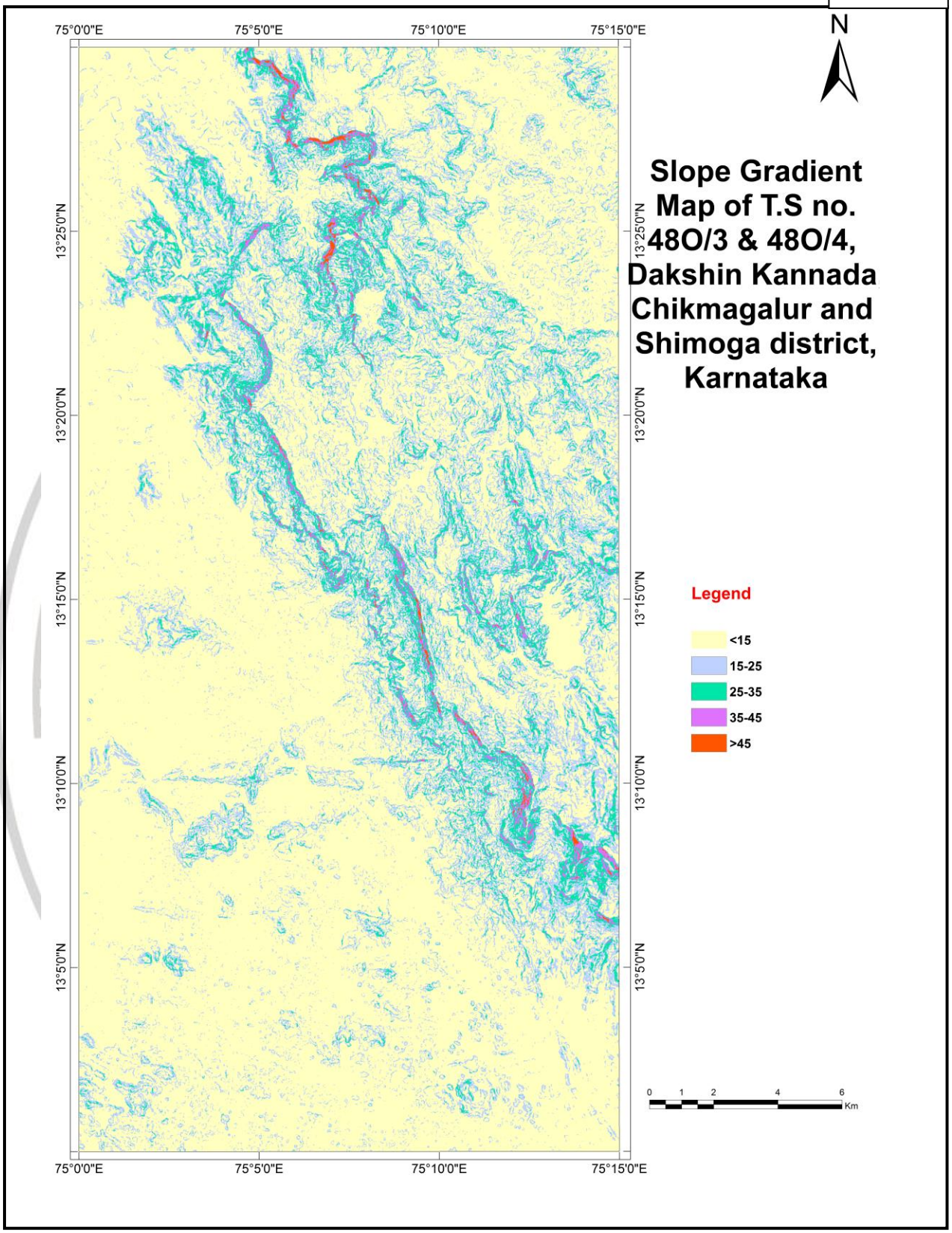
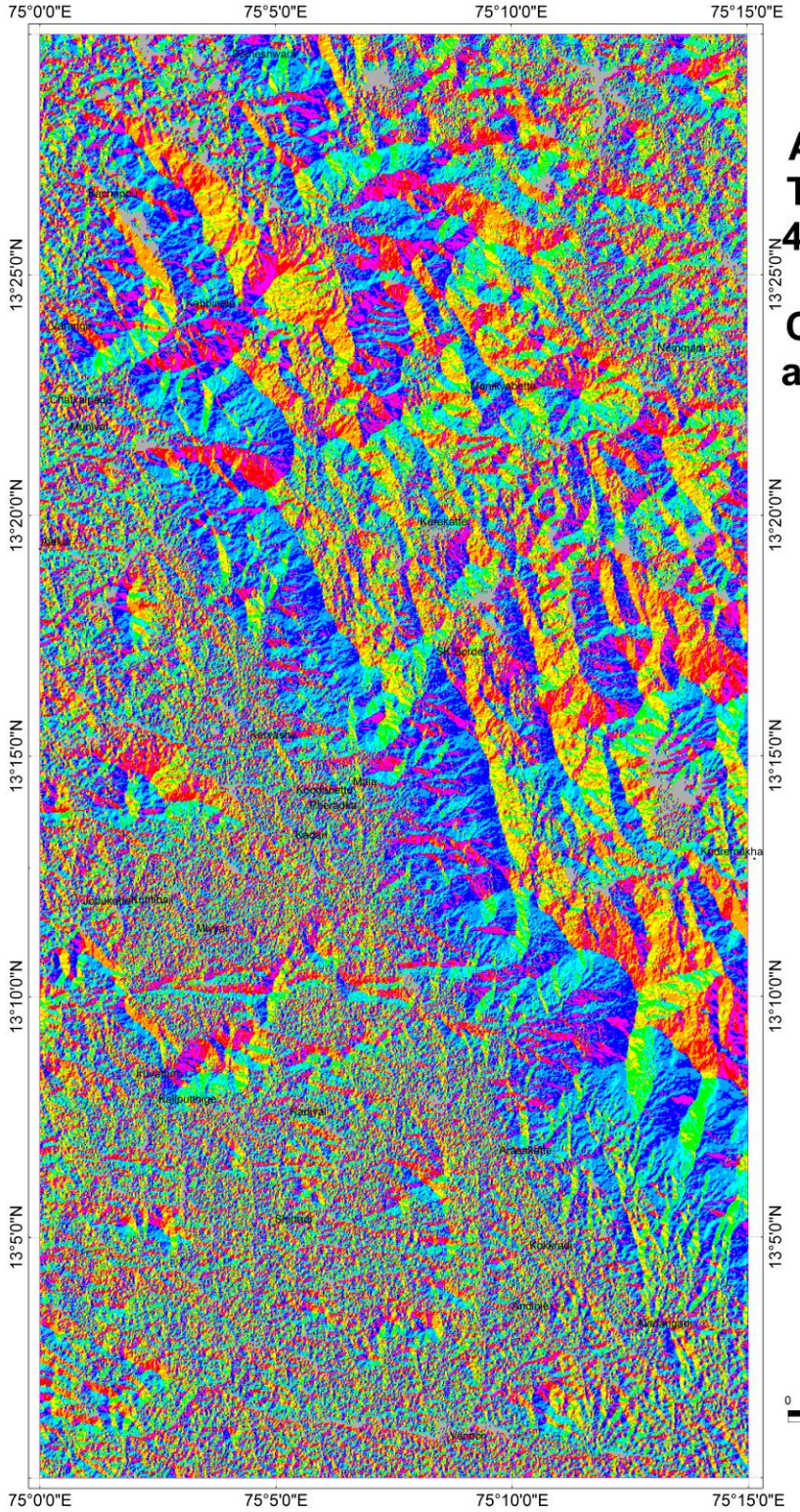

N
75°0'0"E
75°5'0"E
75°10'0"E
75°15'0"E
13°25'0"N
13°20'0"N
13°15'0"N
13°10'0"N
13°5'0"N
Slope Gradient Map of T.S no. 48O/3 & 48O/4, Dakshin Kannada Chikmagalur and Shimoga district, Karnataka
Legend
<15
15-25
25-35
35-45
>45
0 1 2 4 6
Km

Plate 4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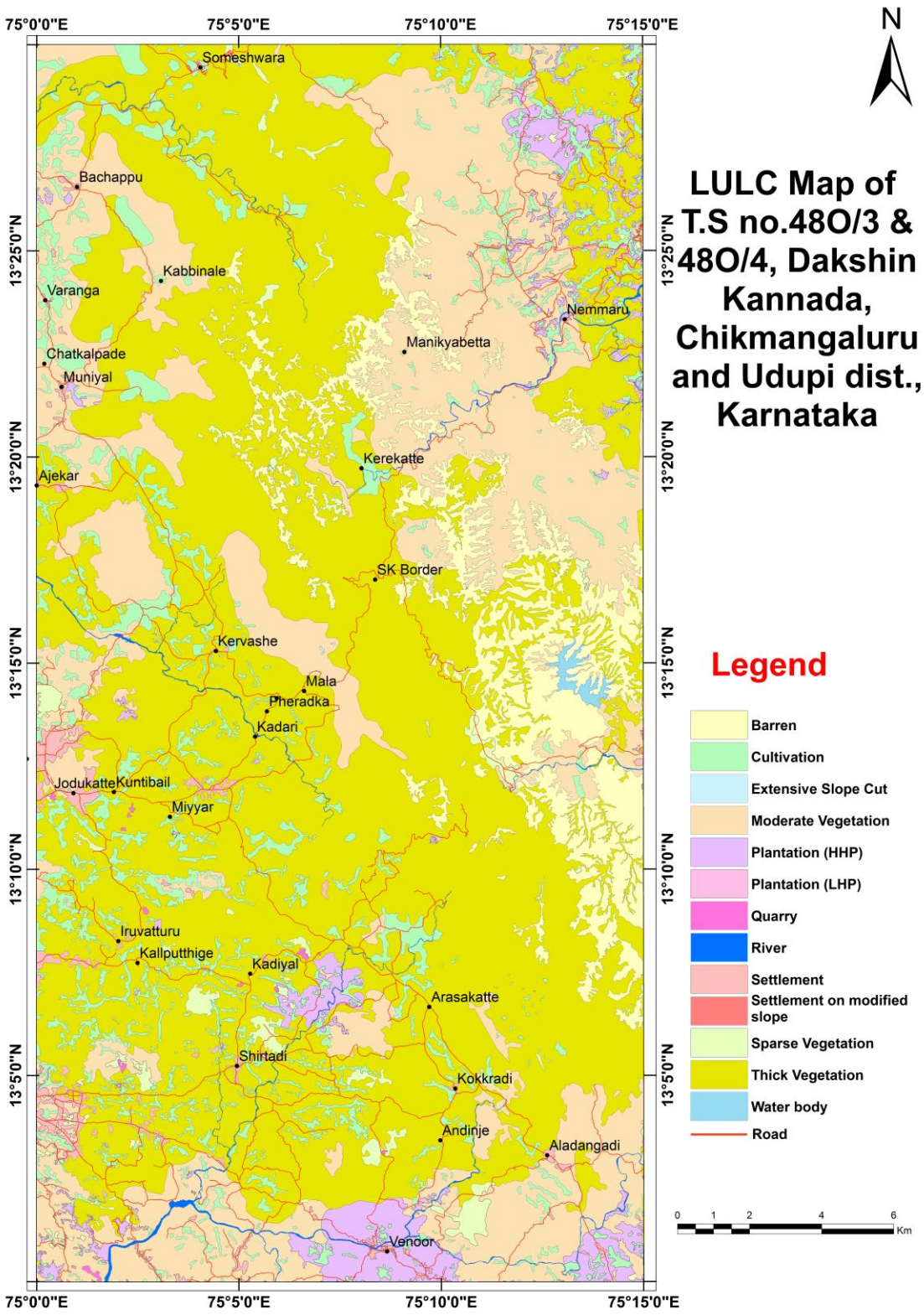
75°10'0"E
75°15'0"E
13°25'0"N
13°20'0"N
13°15'0"N
13°10'0"N
13°5'0"N
N
Aspect Map of T.S no.48O/3 & 48O/4, Dakshin Kannada, Chikmangaluru and Udupi dist., Karnataka
Legend
Flat (-1)
North (0-22.5)
Northeast (22.5-67.5)
East (67.5-112.5)
Southeast (112.5-157.5)
South (157.5-202.5)
Southwest (202.5-247.5)
West (247.5-292.5)
Northwest (292.5-337.5)
North (337.5-360)
0 1 2 4 6
Km

Plate 5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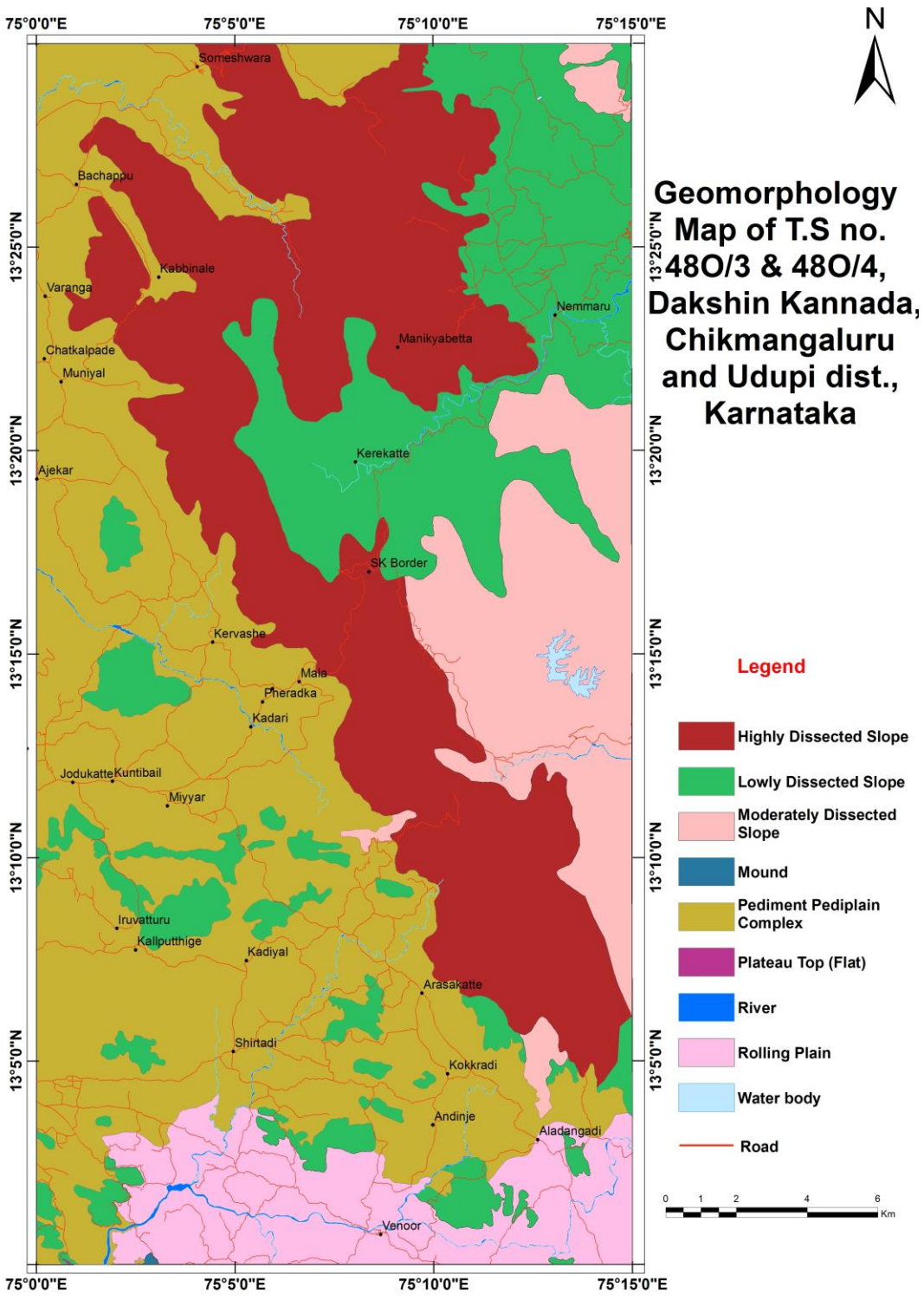
75°5'0"E
75°10'0"E
75°15'0"E
13°25'0"N
13°20'0"N
13°15'0"N
13°10'0"N
13°5'0"N
N
Someshwara
Bachappu
Kabbinale
Varanga
Nemmaru
Manikyabetta
Chatkalpade
Muniyal
Kerekatte
Ajekar
SK Border
Kervashe
Mala
Pheradka
Kadari
Jodukatte
Kuntibail
Miyyar
Iruvatturu
Kallputthige
Kadiyal
Arasakatte
Shirtadi
Kokkradi
Andinje
Aladangadi
Venoor
LULC Map of T.S no.48O/3 & 48O/4, Dakshin Kannada, Chikmangaluru and Udupi dist., Karnataka
Legend
Barren
Cultivation
Extensive Slope Cut
Moderate Vegetation
Plantation (HHP)
Plantation (LHP)
Quarry
River
Settlement
Settlement on modified slope
Sparse Vegetation
Thick Vegetation
Water body
Road
0 1 2 4 6
Km

Plate 6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75°5'0"E
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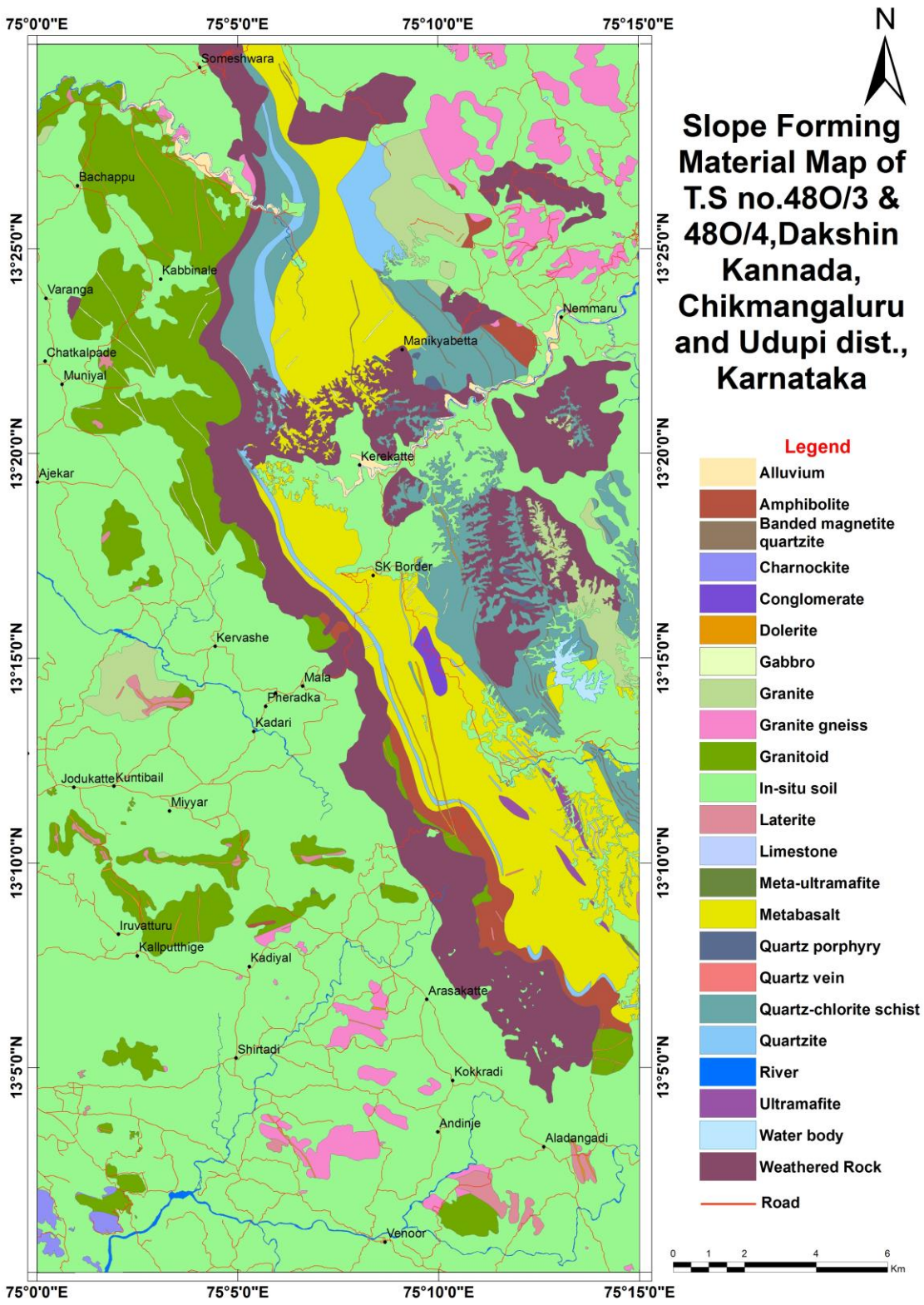
75°15'0"E
13°25'0"N
13°20'0"N
13°15'0"N
13°10'0"N
13°5'0"N
N
Someshwara
Bachappu
Kabbinale
Varanga
Nemmaru
Manikyabetta
Chatkalpade
Muniyal
Kerekatte
Ajekar
SK Border
Kervashe
Mala
Pheradka
Kadari
Jodukatte
Kuntibail
Miyyar
Iruvatturu
Kallputthige
Kadiyal
Arasakatte
Shirtadi
Kokkradi
Andinje
Aladangadi
Venoor
Geomorphology Map of T.S no. 48O/3 & 48O/4, Dakshin Kannada, Chikmangaluru and Udupi dist., Karnataka
Legend
Highly Dissected Slope
Lowly Dissected Slope
Moderately Dissected Slope
Mound
Pediment Pediplain Complex
Plateau Top (Flat)
River
Rolling Plain
Water body
Road
0 1 2 4 6
Km

Plate 7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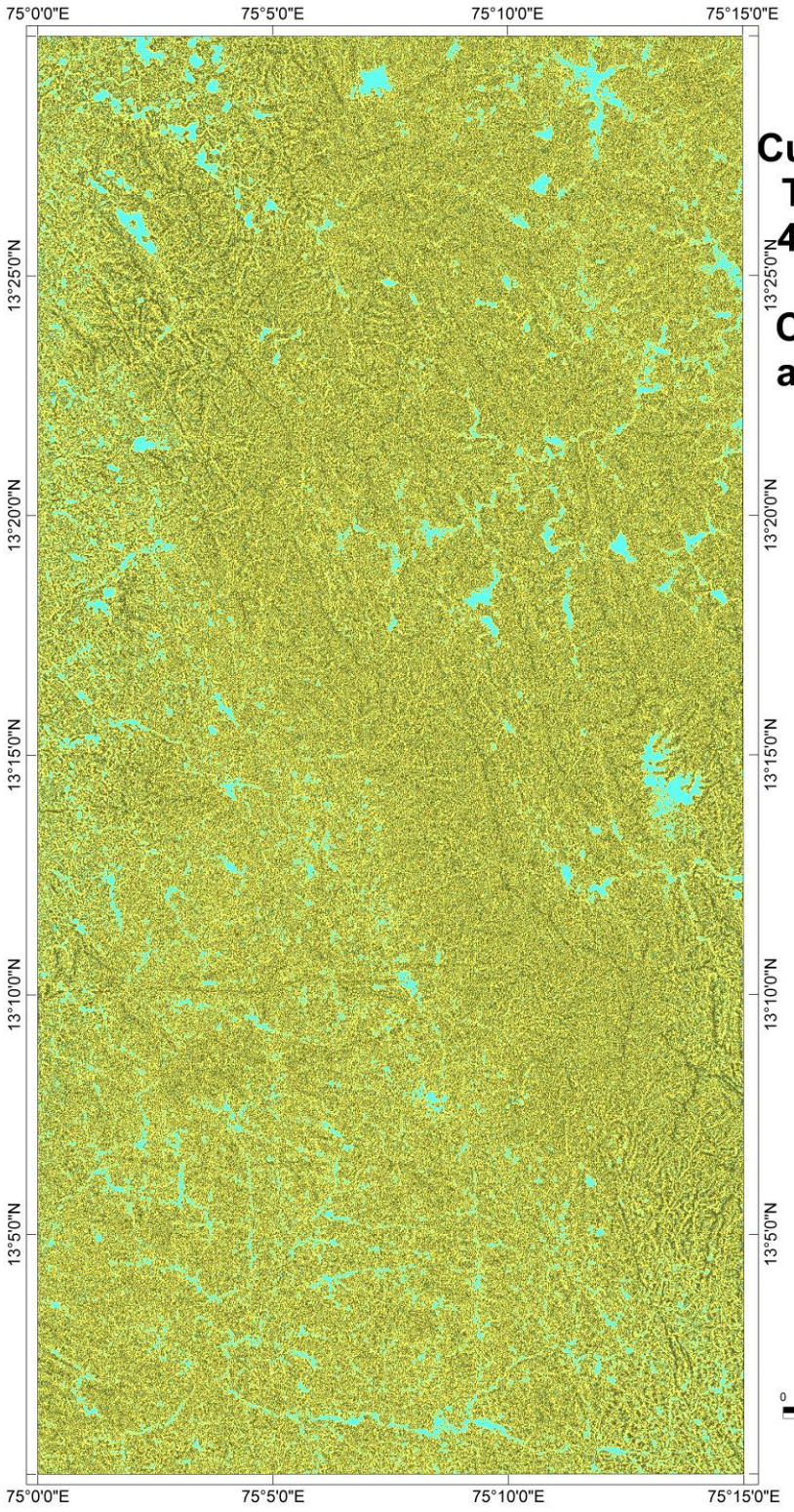
75°5'0"E
75°10'0"E
75°15'0"E
13°25'0"N
13°20'0"N
13°15'0"N
13°10'0"N
13°5'0"N
N
Someshwara
Bachappu
Kabbinale
Varanga
Chatkalpade
Muniyal
Ajekar
Nemmaru
Manikyabetta
Kerekatte
SK Border
Kervashe
Mala
Pheradka
Kadari
Jodukatte
Kuntibail
Miyyar
Iruvatturu
Kallputthige
Kadiyal
Arasakatte
Shirtadi
Kokkradi
Andinje
Aladangadi
Venoor
Slope Forming Material Map of T.S no.48O/3 & 48O/4,Dakshin Kannada, Chikmangaluru and Udupi dist., Karnataka
Legend
Alluvium
Amphibolite
Banded magnetite quartzite
Charnockite
Conglomerate
Dolerite
Gabbro
Granite
Granite gneiss
Granitoid
In-situ soil
Laterite
Limestone
Meta-ultramafite
Metabasalt
Quartz porphyry
Quartz vein
Quartz-chlorite schist
Quartzite
River
Ultramafite
Water body
Weathered Rock
Road
0 1 2 4 6
Km

Plate 8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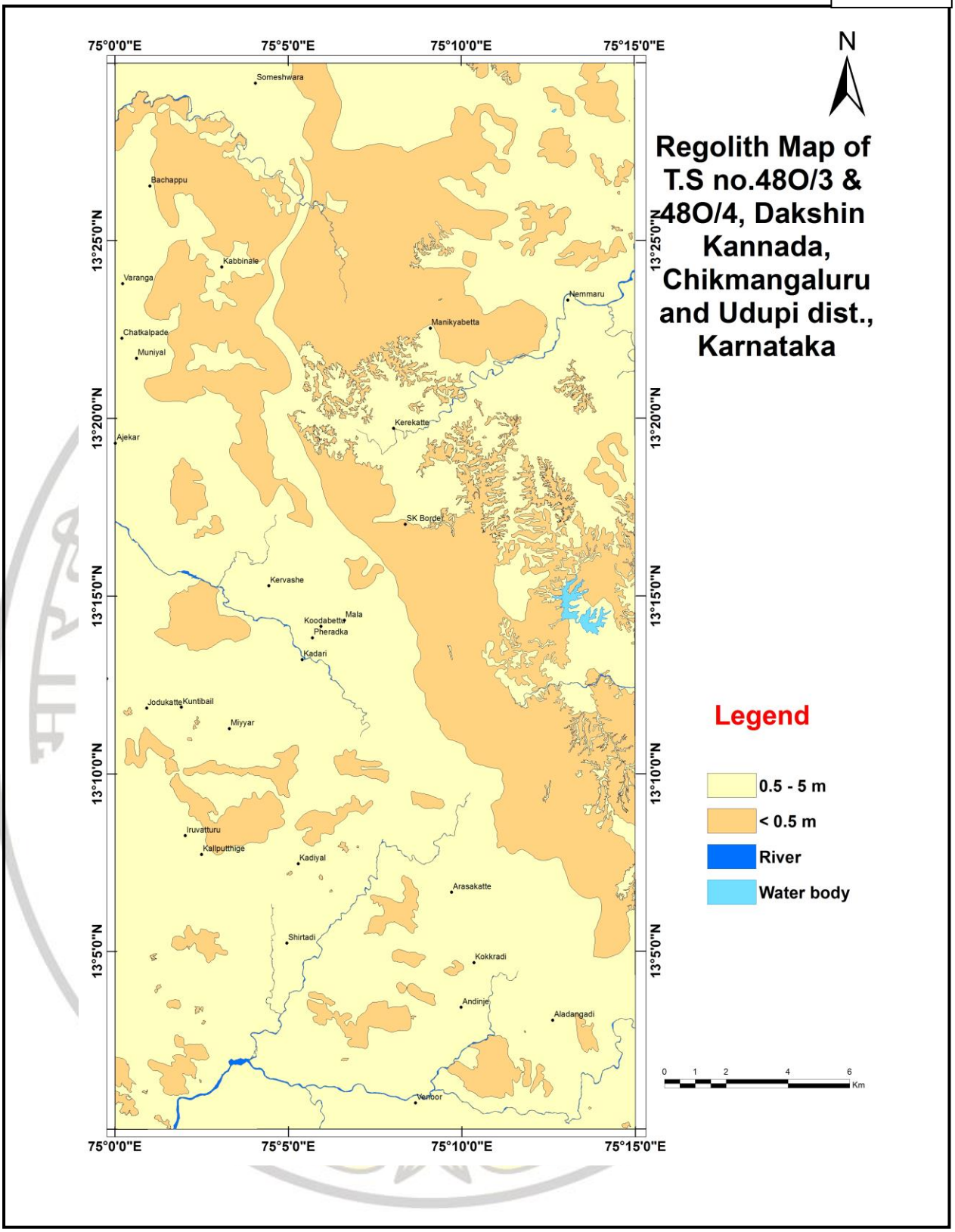
75°5'0"E
75°10'0"E
75°15'0"E
13°25'0"N
13°20'0"N
13°15'0"N
13°10'0"N
13°5'0"N
N
Curvature Map of T.S no.48O/3 & 48O/4, Dakshin Kannada, Chikmangaluru and Udupi dist., Karnataka
Legend
Concave
Flat
Convex
0 1 2 4 6
Km

Plate 9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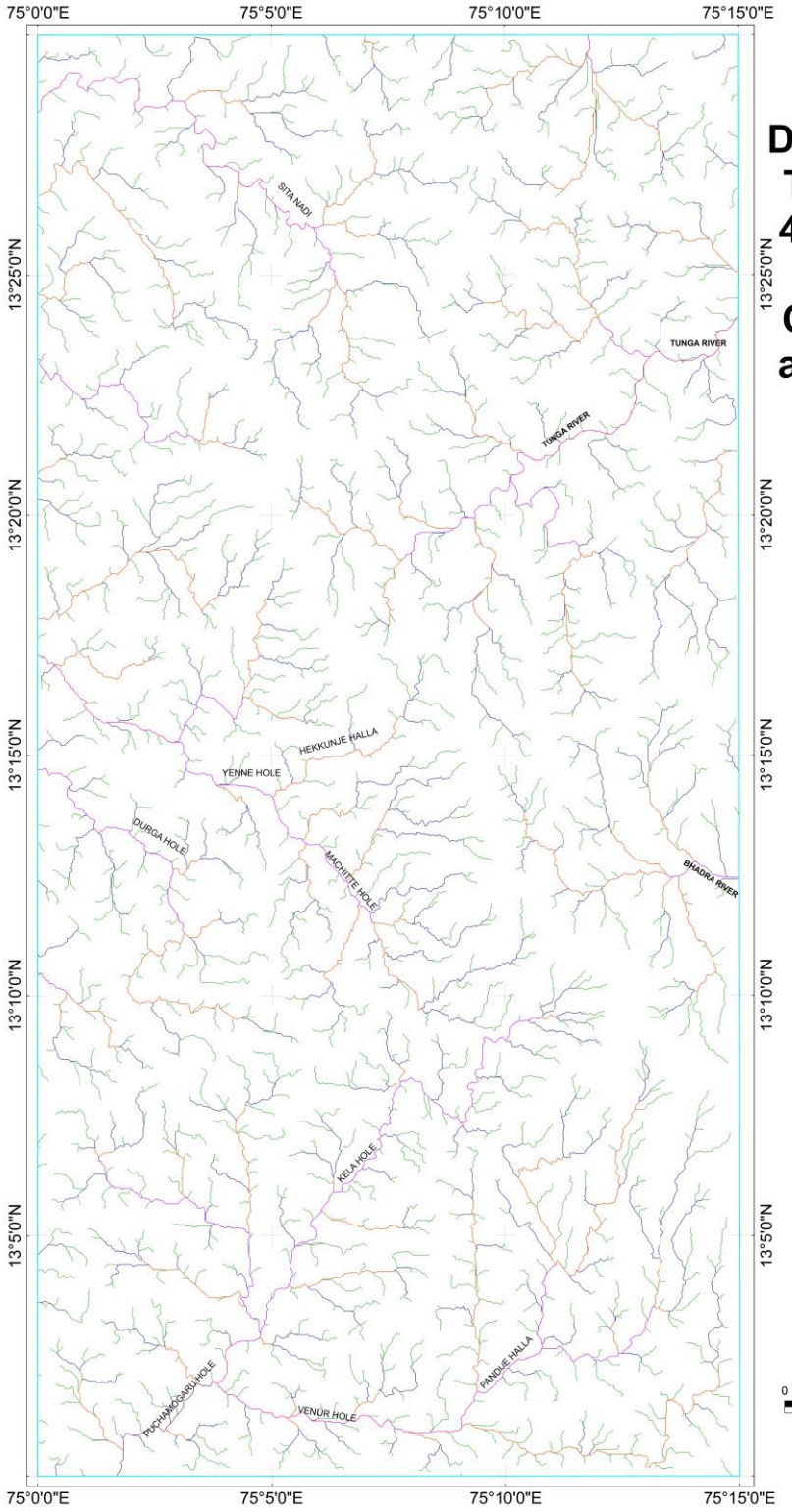
75°5'0"E
75°10'0"E
75°15'0"E
13°25'0"N
13°20'0"N
13°15'0"N
13°10'0"N
13°5'0"N
N
Regolith Map of T.S no.48O/3 & 48O/4, Dakshin Kannada, Chikmangaluru and Udupi dist., Karnataka
Someshwara
Bachappu
Kabbinale
Varanga
Nemmaru
Manikyabetta
Chatkalpade
Muniyal
Kerekatte
Ajekar
SK Border
Kervashe
Koodabettu
Mala
Pheradka
Kadari
Jodukatte
Kuntibail
Miyyar
Iruvatturu
Kallputthige
Kadiyal
Arasakatte
Shirtadi
Kokkradi
Andinje
Aladangadi
Venoor
Legend
0.5 - 5 m
< 0.5 m
River
Water body
0 1 2 4 6
Km

Plate 10



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Drainage Map of T.S no.48O/3 & 48O/4, Dakshin Kannada, Chikmangaluru and Udupi dist., Karnataka

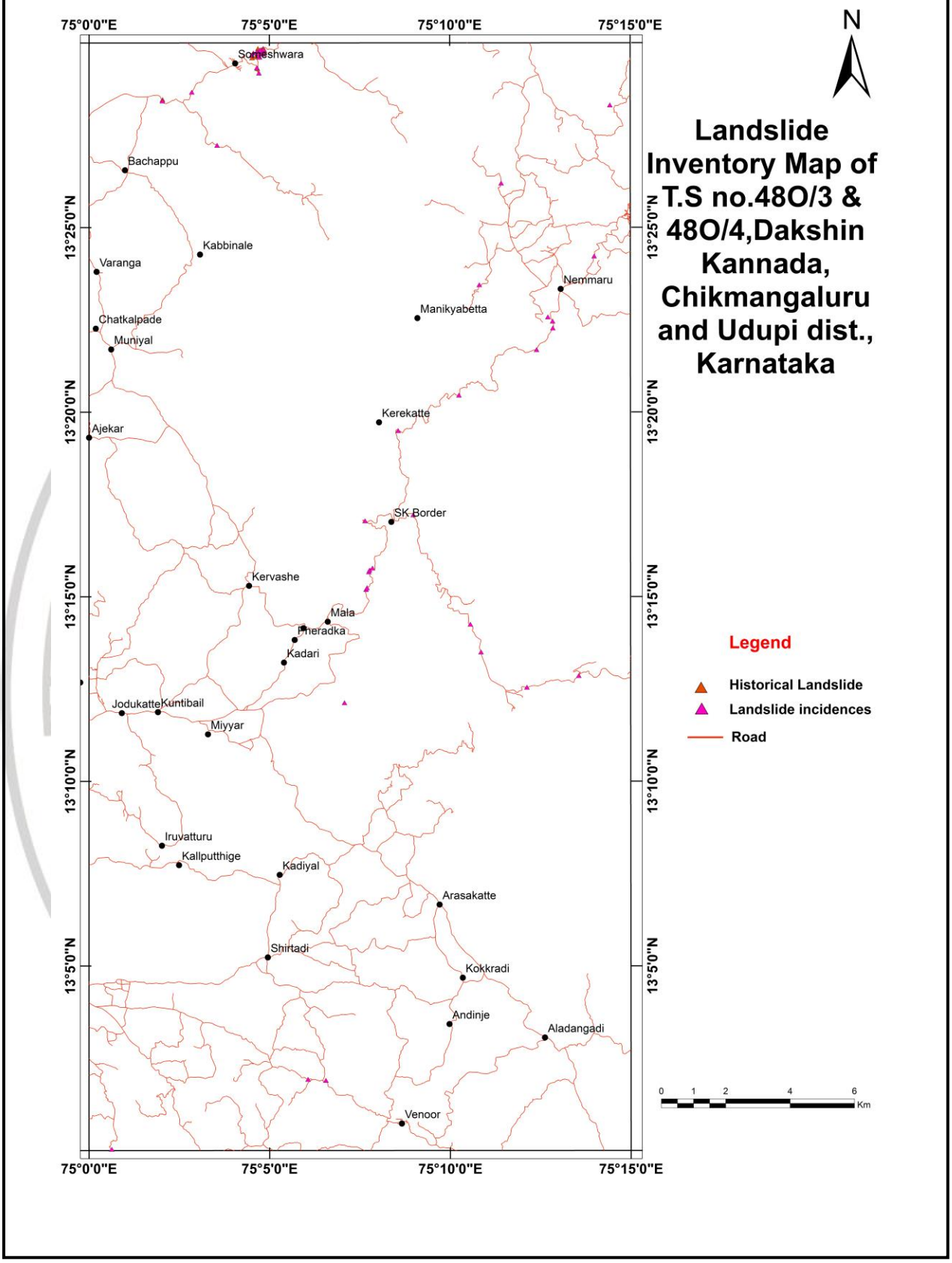
Legend

Stream Order

- 1st Order
- 2nd Order
- 3rd Order
- 4th Order
- 5th Order
- 6th Order

0 1 2 4 6 Km

Plate 11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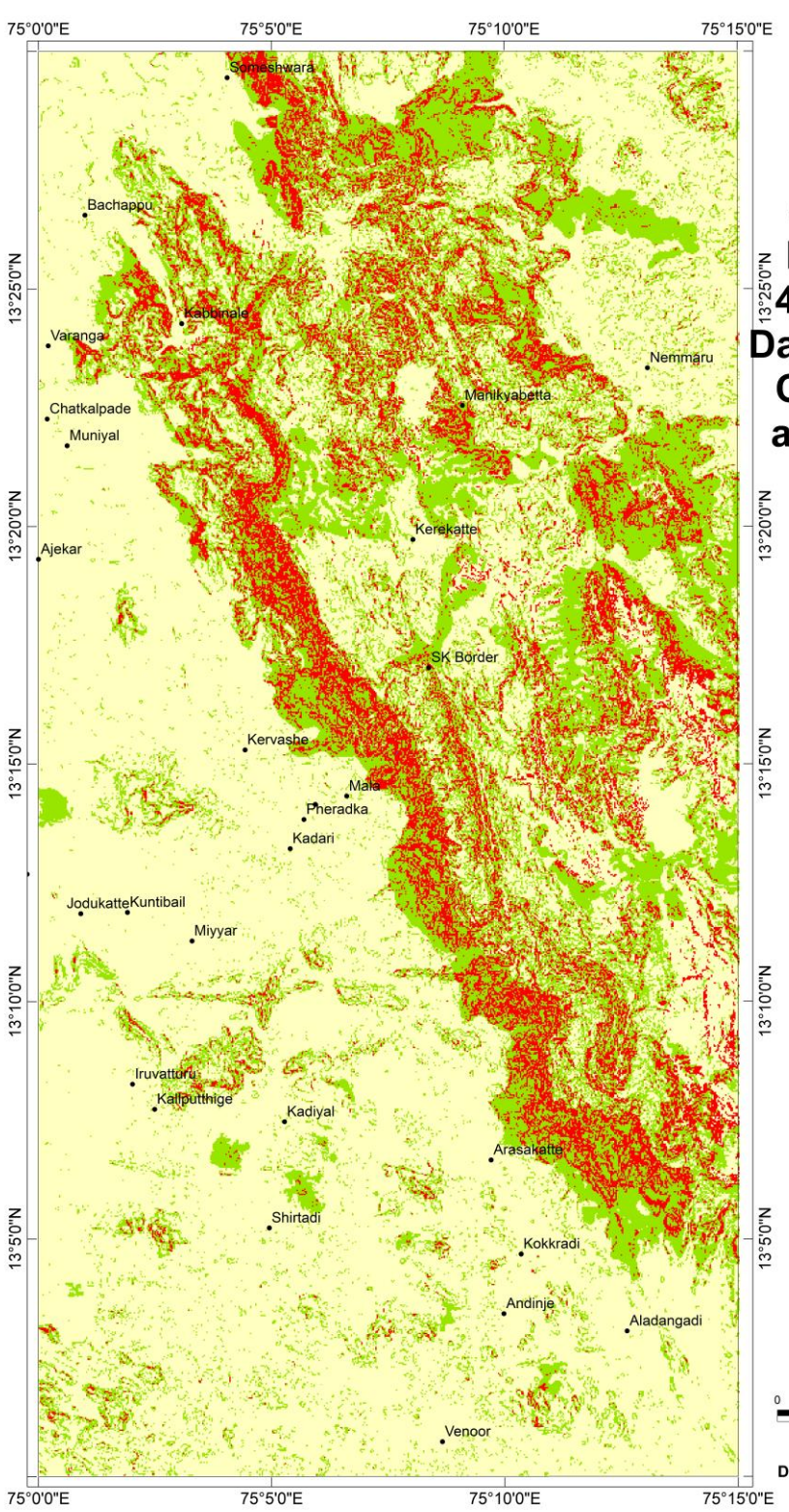
75°5'0"E
75°10'0"E
75°15'0"E
13°25'0"N
13°20'0"N
13°15'0"N
13°10'0"N
13°5'0"N
N
Someshwara
Bachappu
Kabbinale
Varanga
Chatkalpade
Muniyal
Ajekar
Manikyabetta
Nemmaru
Kerekatte
SK Border
Kervashe
Mala
Kheradka
Kadari
Jodukatte
Kuntibail
Miyyar
Iruvatturu
Kallputthige
Kadiyal
Arasakatte
Shirtadi
Kokkradi
Andinje
Aladangadi
Venoor
Landslide Inventory Map of T.S no.48O/3 & 48O/4,Dakshin Kannada, Chikmangaluru and Udupi dist., Karnataka
Legend
Historical Landslide
Landslide incidences
Road
0 1 2 4 6
Km

Plate 12



Susceptibility Map of T.S no. 48O/3 & 48O/4, Dakshin Kannada, Chikmangaluru and Udupi dist., Karnataka

N

Legend

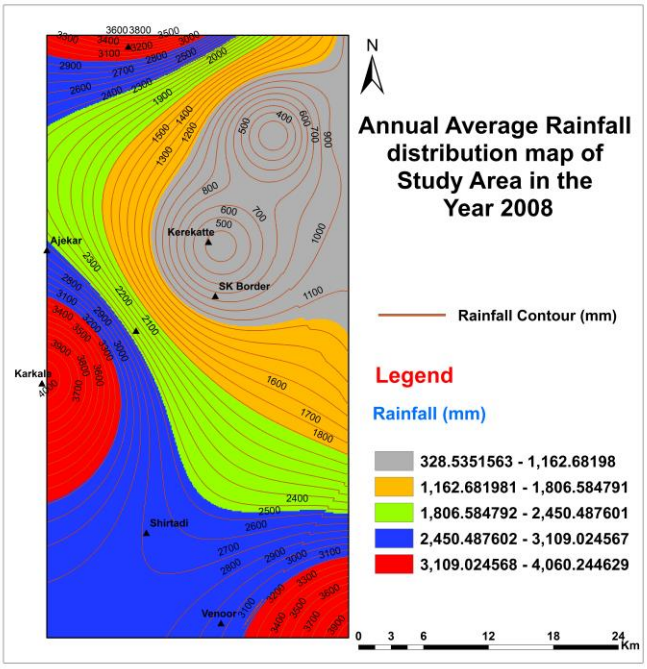
SUSCEPTIBILITY

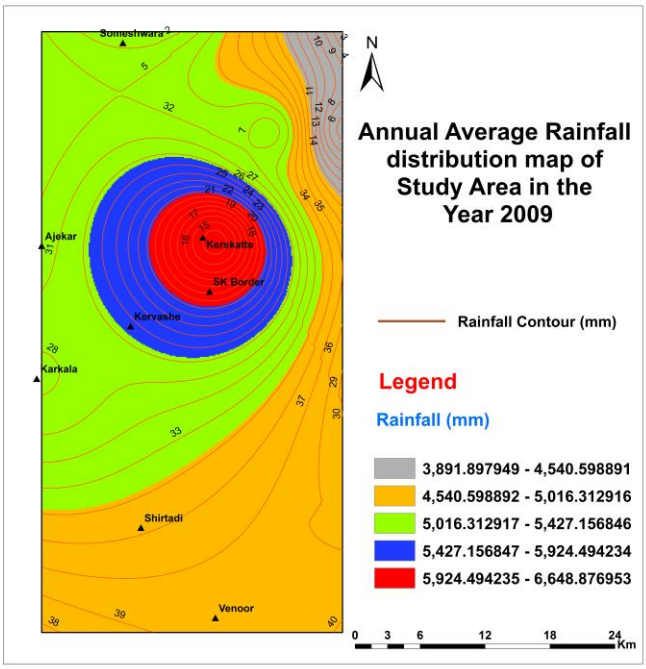
- Low
- Medium
- High

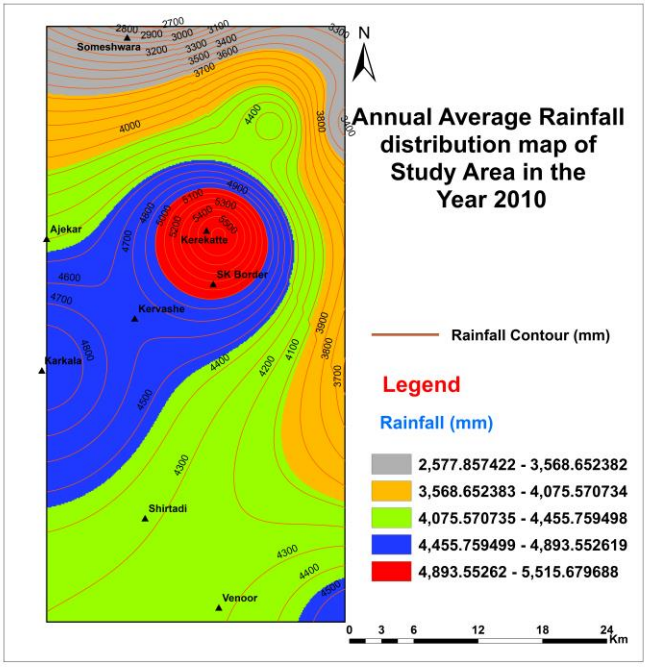
0 1 2 4 6 Km

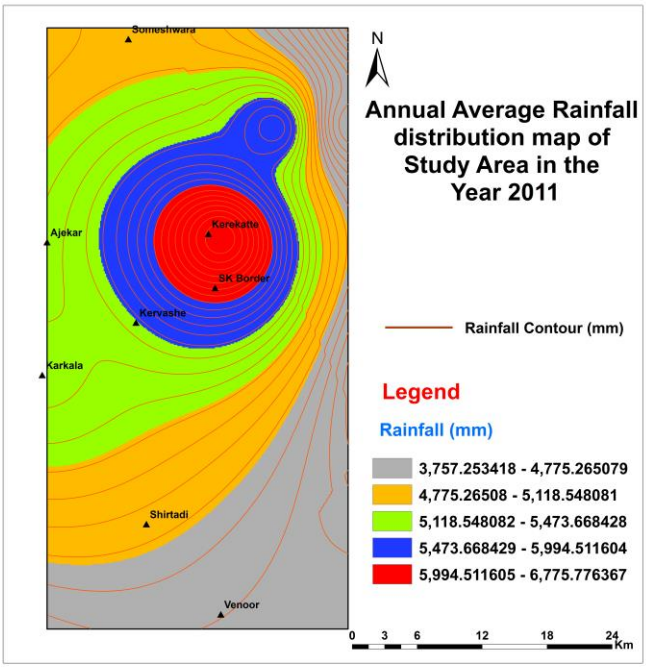
Prepared by:
Dr. Zameer Ahmad Khan, Geologist
Kapil Singh, Geologist

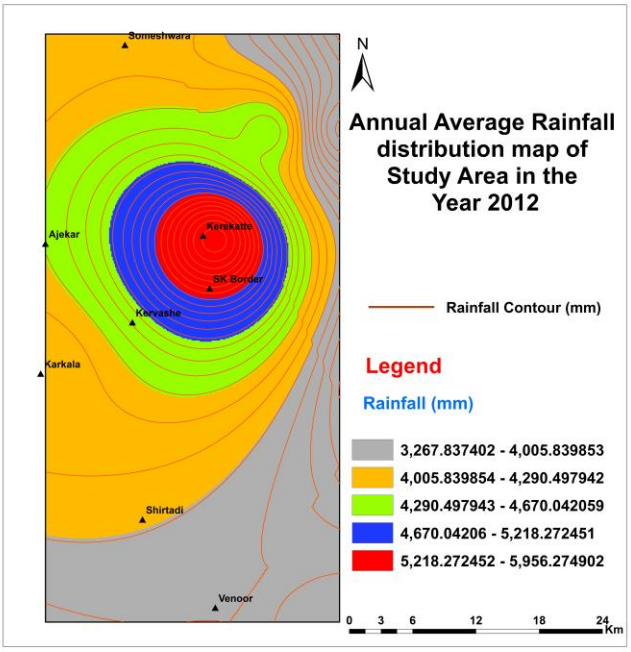
Annual Average Rainfall Distribution from 2008- 2017

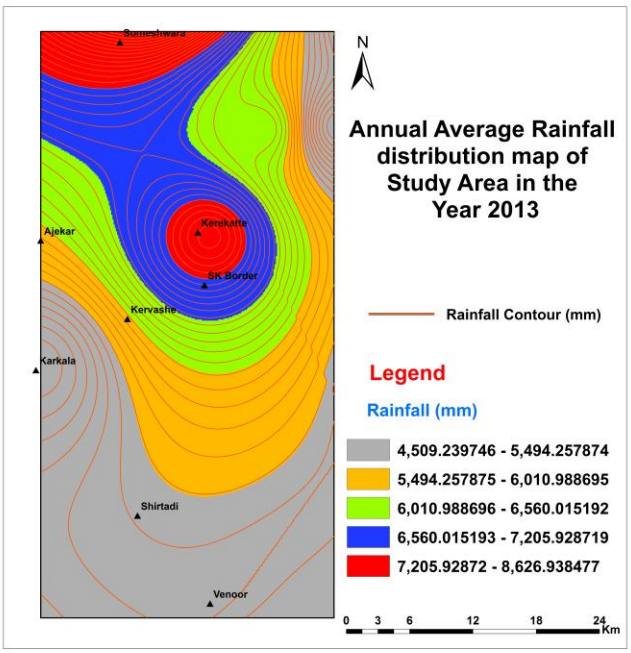


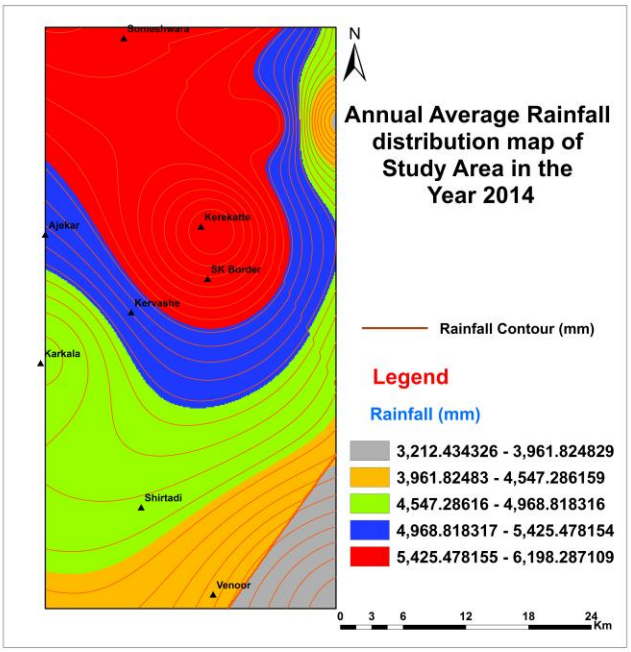


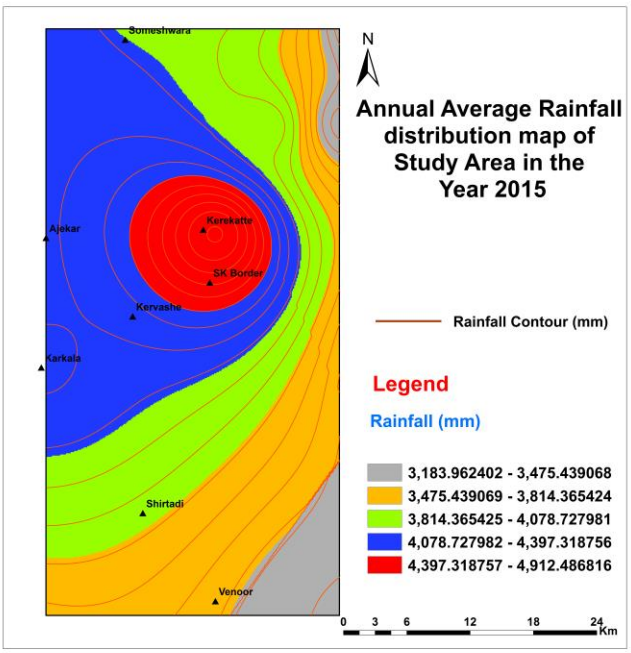


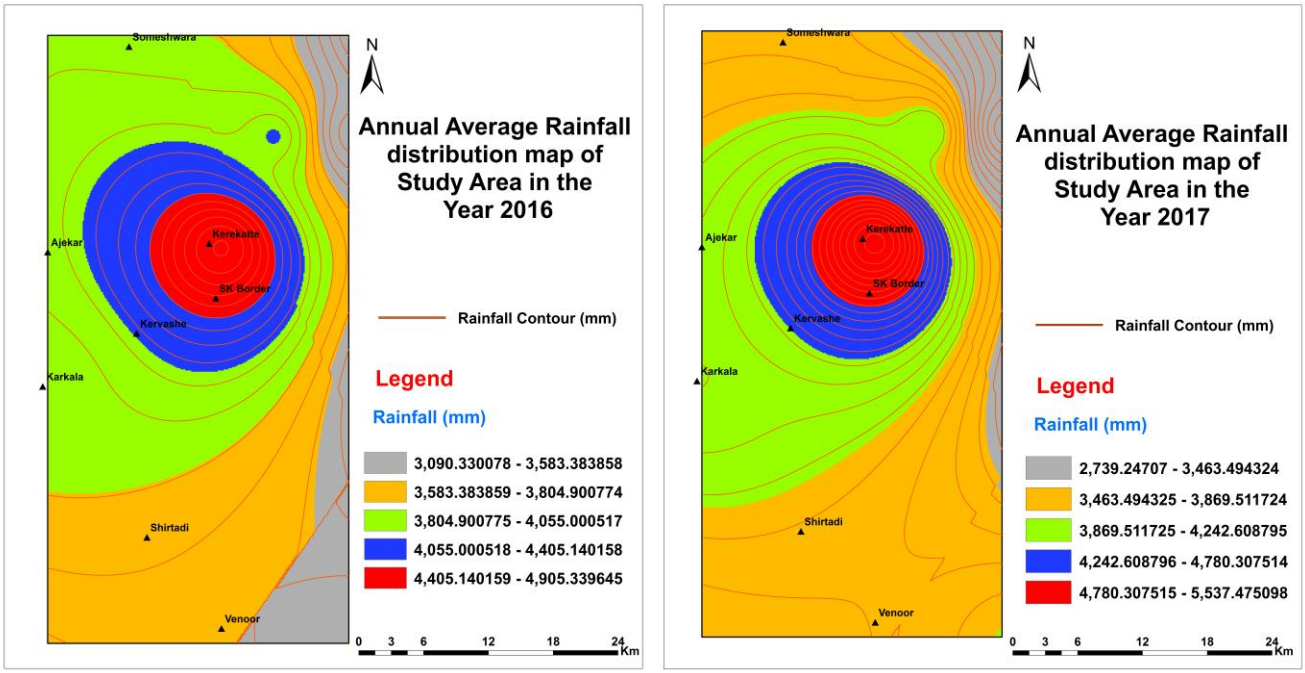



Someshwara
Ajekar
Kerekatte
SK Border
Kervashe
Karkala
Shirtadi
Venoor
N
Annual Average Rainfall distribution map of Study Area in the Year 2012
Rainfall Contour (mm)
Legend
Rainfall (mm)
3,267.837402 - 4,005.839853
4,005.839854 - 4,290.497942
4,290.497943 - 4,670.042059
4,670.04206 - 5,218.272451
5,218.272452 - 5,956.274902
0 3 6 12 18 24 Km


Someshwara
Ajekar
Kerekatte
SK Border
Kervashe
Karkala
Shirtadi
Venoor
N
Annual Average Rainfall distribution map of Study Area in the Year 2013
Rainfall Contour (mm)
Legend
Rainfall (mm)
4,509.239746 - 5,494.257874
5,494.257875 - 6,010.988695
6,010.988696 - 6,560.015192
6,560.015193 - 7,205.928719
7,205.92872 - 8,626.938477
0 3 6 12 18 24 Km


Someshwara
Ajekar
Kerekatte
SK Border
Kervashe
Karkala
Shirtadi
Venoor
N
Annual Average Rainfall distribution map of Study Area in the Year 2014
Rainfall Contour (mm)
Legend
Rainfall (mm)
3,212.434326 - 3,961.824829
3,961.82483 - 4,547.286159
4,547.28616 - 4,968.818316
4,968.818317 - 5,425.478154
5,425.478155 - 6,198.287109
0 3 6 12 18 24 Km


Someshwara
Ajekar
Kerekatte
SK Border
Kervashe
Karkala
Shirtadi
Venoor
N
Annual Average Rainfall distribution map of Study Area in the Year 2015
Rainfall Contour (mm)
Legend
Rainfall (mm)
3,183.962402 - 3,475.439068
3,475.439069 - 3,814.365424
3,814.365425 - 4,078.727981
4,078.727982 - 4,397.318756
4,397.318757 - 4,912.486816
0 3 6 12 18 24 Km



Source: *Deputy Commissioner & District Magistrate's Office of Mangaluru, Shimoga, Chikmangalur and Udupi*

Photo 1: Extensive cut slope in in-situ soil between Kunetad and Panjali road section. TS O/4

Photo 2: Extensive cut slope in soil along Solapur-Mangalore Highway (NH-13). TS O/3

Photo 3: Extensive cut slope Near Bhagvati Nature camp. TS O/3

Photo 4: Extensive cut slope near Makkimane Extensive cut with overturned trees. TS O/4

Photo 5: Rock quarry Near Hosmar.TS O/4

Photo 6: Remotely sensed Thick Vegetation cover from Renjala-Nallur road sction. TS O/3

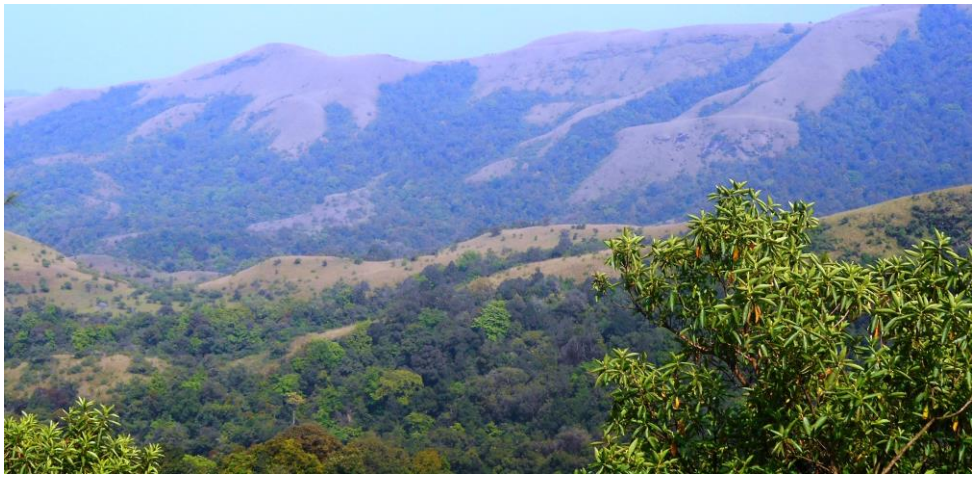


Photo 7: Remotely sensed barren patches on SH-66 towards Kerekatte with moderately dissected slope. TS O/3

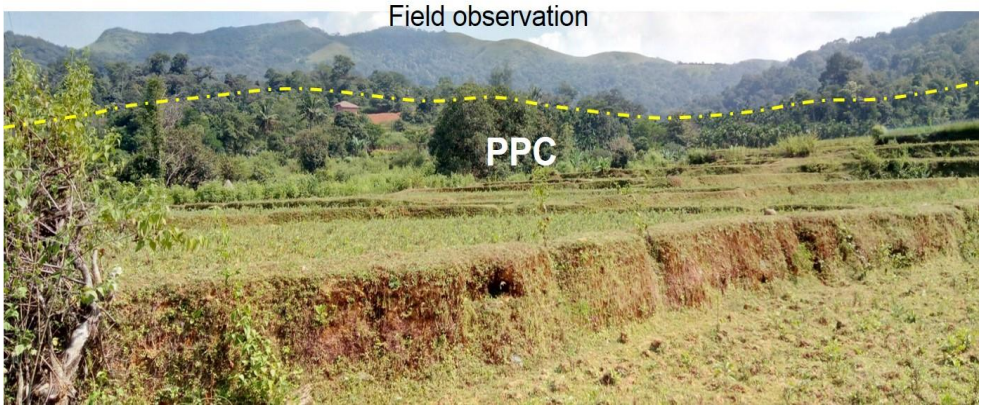


Photo 8: Pediment-Pediplain Complex near Solapur-Mangalore road section TS O/3

Photo 9: Exposed rock near Belandur (Abandoned Quarry) TS O/4

Photo 10: Laterite Quarry near Ramabail. O/4

Photo 11: Regolith thickness less than 0.5m along the SH 37 near Nellikar. TS O/3

Photo 12: Regolith thickness greater than 0.5m near Sunkadamkki on NH-13 TS O/3

Photo 13: Road cracks adjacent to a failure along NH-13 towards Nemmaru. TS O/3

Photo 14: Disruption of retention wall along SK border -Kalasa road section. TS O/3

Photo 15: Bulging of retention wall with inclined vegetation growth along SK border -Kalasa road section. TS O/3

Photo 16: Benching of slope along Allallige – Hosmar road section. TS O/4

Photo 17: Cut slope/Slide along Mulluru - SK Border Road section (left) and Kerekatte - Harebail Road section (Right). TS O/3

Photo 18: Subsidence along Bhagavati - Kalasa Road section (NH13). TS O/3

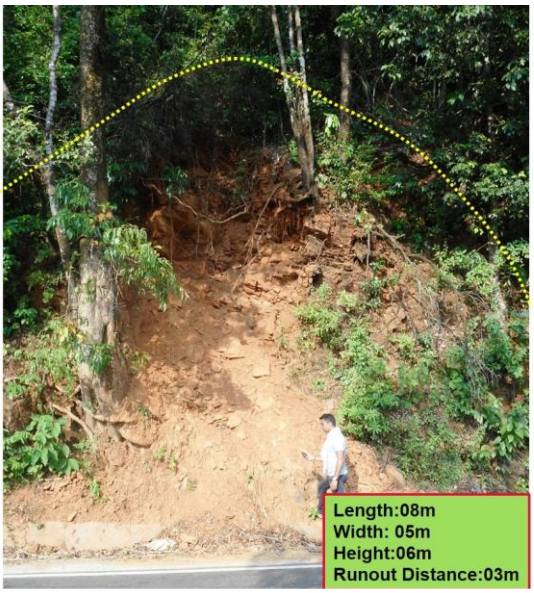


Photo 19: Landslide along Kundapur-Agumbe Road section. TS O/3