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भारत सरकार / **GOVERNMENT OF INDIA**

भारतीय भूवैज्ञानिक सर्वेक्षण / **GEOLOGICAL SURVEY OF INDIA**

भूस्थल मानचित्र संख्या 48P/05 और 48P/09 के दक्षिण कन्नड़ और हसन जिले, कर्नाटक के आंशिक भागों का बड़े (१:५०,०००) पैमाने पर भूस्खलन संवेदनशीलता का मानचित्रण

MACRO – SCALE (1:50,000) LANDSLIDE SUSCEPTIBILITY MAPPING IN PARTS OF TOPOSHEET NOS. 48P/05 AND 48P/09, DAKSHIN KANNAD AND HASSAN DISTRICTS, KARNATAKA

मद कोड सं: / **FSP Code No:**

एल एस एम/एस आर/क और जी/२०१६/२२२ / **LSM/SR/KG/2016/111**

क्षेत्र सत्र / **Field Season:** २०१६ - २०१७ / **2016 – 2017**

द्वारा / **by**

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राज्य इकाई / **State Unit:** कर्नाटक एवं गोवा / **Karnataka & Goa**

बेंगलुरू / **Bengaluru**

२०१७ / 2017

इस प्रतिवेदन का कोई हिस्सा महानिदेशक, भारतीय भूवैज्ञानिक सर्वेक्षण की पूर्व लिखित अनुमति के बिना प्रतिलिपित नहीं किया जाना चाहिए

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FSP Code No. **LSM/SR/KG/2016/111**

Field Season: **2016 - 17**

By

Tanvi Gupta, Geologist
Sunandan Basu, Geologist

Project: NLSM
State Unit: Karnataka and Goa
Bengaluru
2017

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(FIELD SEASON: 2016 – 17)

By
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Sunandan Basu, Geologist

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कर्नाटक राज्य के दक्षिण कन्नड़ और हसन जिले में भूआकृति संख्या ४८ पी/ ०५ और ०९ के कुछ हिस्सों में वृहद पैमाने पर (1: 50,000) भूस्खलन संवेदनशीलता का मानचित्रण ।

(कोड सं: एल एस एम / एस आर / के और जी / 2016/111)

(कार्य सत्र २०१६ - १७)

द्वारा

तन्वी गुप्ता, भूवैज्ञानिक

सुनंदन बसु, भूवैज्ञानिक

सारांश

राष्ट्रीय भूस्खलन संवेदनशीलता मानचित्रण (एनएलएसएम) एक बहुत महत्वाकांक्षी और साथ ही महत्वपूर्ण योजना है जो भारतीय भूवैज्ञानिक सर्वेक्षण द्वारा २०१४ में संपूर्ण भारत में इस उद्देश्य के साथ प्रारम्भ किया गया है ; (१)- उच्च समाधानी सुदूर संवेदी आँकड़े और क्षेत्र आगत का उपयोग करते हुए भूस्खलन की विस्तृत सूची का आंकड़ाकोष (२)- स्थानिक आंकड़े और भू-कारणों को आगत मानचित्र के तौर पर इस्तेमाल करते हुए भूस्थल मानचित्र के आधार पर १:५०,००० पैमाने पर और (३)- बहु-वर्गीय सूची का उपयोग करते हुए अधोचित्र प्रणाली के जीआईएस स्तर पर भूस्खलन संवेदनशीलता मानचित्रण । भारतीय भूवैज्ञानिक सर्वेक्षण के दक्षिण क्षेत्र के मद कोड सं: एल एस एम / एस आर / के और जी / २०१५ /१११ वार्षिक कार्यक्रम २०१६ - २०१७ के अन्तर्गत भूस्थल मानचित्र संख्या ४८ पी/ ५ और ९ के दक्षिण कन्नड़ और हसन जिले के राष्ट्रीय भूस्खलन संवेदनशीलता मानचित्रण (एनएलएसएम) का कुल १५०० वर्ग किलोमीटर क्षेत्र निष्पादित किया गया । अध्यन क्षेत्र भारतीय सर्वेक्षण के भूस्थल मानचित्र संख्या ४८ पी /०५ और ४८ पी /०९ के आंशिक भागों के अन्तर्गत निहित है ।

भौगोलिक दृष्टि से इस क्षेत्र में पहाड़ी इलाके और समतल भूमी द्वारा प्रतिनिधित्व मिश्रित स्थलाकृति है जो पूर्वोत्तर भाग में 1388 मीटर समुद्र के स्तर के ऊपर से लेकर 40 मीटर समुद्र के स्तर के ऊपर नेटवाथि नदी के तट पर स्थित है। अध्ययन क्षेत्र के पूर्वी और उत्तर-पूर्वी हिस्से अधिकतर उबड़ - खाबड़ हैं जो पश्चिमी घाट के मालनाद क्षेत्र का हिस्सा हैं, जो उच्च पहाड़ियों, रैखिक चोटी और घाटियों के साथ कम से मध्यम विभाजित स्थलाकृति के द्वारा प्रतिनिधित्व हैं। शहरीकरण के रूप में काफी मानवीय हस्तक्षेप, नए आवास, सड़क

तंत्र और खनन गतिविधियों की स्थापना धीरे-धीरे और लगातार क्षेत्र की प्राकृतिक भूगोल को संशोधित कर रही है।

भूगर्भिक रूप से, अध्ययन क्षेत्र सर्गुर ग्रुप, प्रायद्वीपीय नाइसिक जटिल (पीजीसी) के पेनिन्सुलर नाइस- I, दक्षिणी ग्रानुलाईट कॉम्प्लेक्स के चर्नकोइट सूट के चट्टानों को उजागर करता है, जिसमे डोलेराइट भित्तियाँ अंतर्वेधित हैं।

क्षेत्रीय कार्य के दौरान, 16 भूस्खलन की पहचान की गई थी। सभी भूस्खलन मलबे की स्लाइड हैं और सड़क के आस-पास स्थित हैं और संभवतः सड़क के गठन के ढलानों के आगे का सिरा हटाने के कारण हो सकता है। प्राकृतिक परिस्थितियों में हुई भूस्खलन बहुत दुर्लभ हैं। 16 में से 15 भूस्खलन उथले मलबे- स्खलन हैं, जिसमें स्लिप विमान की गहराई 5 मीटर से भी कम है। स्लीप विमान की गहराई 5 मीटर से अधिक होने के साथ ही एक ही गहरी ट्रांसजेक्शन मलबे की स्लाइड है। कटौती की ढलानों की वजह से शुरु होने वाले छोटे भूस्खलन में कोई रन आउट नहीं पाया गया है क्योंकि सड़क मलबे के संचय के लिए क्षैतिज आधार प्रदान करती है।

प्री-फ़ील्ड अध्ययन के आधार पर तैयार की गई थीमैटिक मैप फ़ील्ड अध्ययनों के आधार पर सत्यापित और अपडेट किए गए थे। जीआईएस में अंतिम भूस्खलन संवेदनशीलता का नक्शा भारित मल्टीकाल्ज़ इंडेक्स ओवरले पद्धति द्वारा तैयार किया गया था। वर्तमान अध्ययन में, 63% क्षेत्र अल्प -संवेदनशील वर्ग के अंतर्गत आता है, 29% क्षेत्र मध्यम-संवेदनशील वर्ग के अंतर्गत आता है, जबकि केवल 8% क्षेत्र उच्च संवेदनशीलता वर्ग के तहत पड़ रहा है।

अध्ययन क्षेत्र के पश्चिमी, दक्षिणी और मध्य किनारे में स्थित अधिकांश क्षेत्र कम संवेदनशील वर्ग के भीतर आ रहे है, और एक छोटा सा इलाका मध्यम- संवेदनशील वर्ग के अंतर्गत गिर रहा है। दूसरी ओर, अध्ययन क्षेत्र के पूर्वी और उत्तर-पूर्वी हिस्से में स्थित क्षेत्र मध्यम संवेदनशील वर्ग के अंतर्गत आता है जिसमें उच्च संवेदनशीलत वर्ग वाले क्षेत्रों के काफी पैच हैं। अध्ययन क्षेत्र के लगभग सभी प्रमुख इलाके जैसे अप्पीनगाड़ी, बेल्टानगडी, उजरे, धर्मस्थल, नालेदी आदि कम संवेदनशीलत वर्ग के अंतर्गत आ रहे हैं। गुंडिया और मारनहल्ली जैसे इलाके मध्यम संवेदनशीलत वर्ग के अंतर्गत हैं। शिरडीगाडी जैसे बहुत कम इलाके उच्च संवेदनशीलता वर्ग के तहत हैं।

MACRO – SCALE (1:50,000) LANDSLIDE SUSCEPTIBILITY MAPPING IN PARTS OF TOPOSHEET NOS. 48P/05 AND 48P/09, DAKSHIN KANNAD AND HASSAN DISTRICTS, KARNATAKA

(FSP CODE: LSM/SR/KG/2016/111)
(FIELD SEASON: 2016 – 17)

By
Tanvi Gupta, Geologist
Sunandan Basu, Geologist

ABSTRACT

National Landslide Susceptibility Mapping (NLSM) is a very ambitious as well as important programme of GSI launched all over India in 2014 with the objective to prepare (i) landslide inventory database using high resolution remote sensing data and field inputs, (ii) toposheet wise 1:50,000 scale spatial database for geo-factors of landslide for use as input maps and (iii) landslide susceptibility map using multi class index overly method in a GIS platform. National Landslide Susceptibility Mapping (NLSM) of 1500 sq. km area was carried out in parts of Dakshin Kannad and Hassan districts, Karnataka under the annual programme of Geological Survey of India, Southern Region, vide FSP code no: LSM/SR/KG/2016/111 for the field season 2016 – 17. The study area covers two Survey of India toposheet, *viz.* 48P/05 and 48P/09.

Physiographically the area has a mixed topography represented by both hilly areas and flat terrain with altitude ranging from 1388 m above the mean sea level in the north eastern part to 40 m above mean sea level on the bank of Netravathi River. The eastern and north eastern part of the study area are mostly rugged that forms part of Malnad region of Western Ghats represented by lowly to moderately dissected topography with high hills, linear ridges and valleys. Considerable human interference in the form of urbanization, establishment of new dwellings, road network and mining activity is slowly and continuously modifying the physiography of the area.

Geologically, the study area exposes rocks of Sargur Group, Peninsular Gneisses I of Peninsular Gneissic Complex and Charnokite Suite of Southern Granulite Complex of

Archean age traversed by Dolerite dykes of Paleo – Proterozoic age.

During the field work, 16 confirmed landslides were identified. All the slides are debris slide in nature and located adjacent to the road and probably might have resulted due to removal of toe material for the formation of road. Landslides caused under natural conditions are very rare. 15 nos. out of 16 nos. landslides are shallow translational debris slides, with depth of the slip plane being less than 5 meters. Only one is deep translational debris slide, with depth of the slip plane being more than 5 meters. Smaller landslides initiated due to the cut slopes are found to have no run-out as the road provided a horizontal base for accumulation of the debris.

Thematic maps prepared during pre-field work were validated and updated based on field studies. The final landslide susceptibility map was prepared in GIS using Weighted Multiclass Index Overlay method. In the present study area, 63 % of the area falls under low susceptibility class, 29 % of the area falls under moderate susceptibility class, whereas only 8 % area falls under high susceptibility class.

The majority of the areas situated in the western, southern and central side of the study area falls under low susceptibility class with small patches of moderate susceptibility class within it. On the other hand, areas situated in eastern and north eastern side of the study area falls under moderate susceptibility class with considerable patches of areas with high susceptibility class within it. Almost all the major localities of the study area like Uppinangadi, Beltangadi, Ujre, Dharmastala, Nelyadi, etc. comes under low susceptibility class. Localities like Gundia and Maranhalli comes under moderate susceptibility class. Very few localities like Shiradigadi come under high susceptibility class.

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CHAPTER - 1

INTRODUCTION

1.1 Background Information

Geological Survey of India (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 toposheet of Survey of India on 1:50,000 scale, excluding the permafrost regions), the target achieved so far by GSI (~69,962 sq. km till FS 2015 – 16) is quite lesser. 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 at a much 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, 2013 and the Joint Secretary, Ministry of Mines has also advised GSI to revamp and fasten its endeavour of the 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.

Landslides are one of the common natural as well as man-made hazards in India. Out of the 0.42 million sq. km (12.6% of land area) landslide prone areas of the country, 0.034 million sq. km falls in parts of Karnataka & Goa state. Mostly the western parts of Karnataka and Goa districts are vulnerable to landslides.

The National Landslide Susceptibility Mapping (NLSM) programme of Geological Survey of India (GSI), was launched with the following objectives:

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

(ii) To prepare Toposheet-wise 1:50,000 scale spatial database for geofactors of landslides for use as input maps.

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

1.2 Study Area

Karnataka is a state situated in south western part of India. Karnataka is bounded by Goa in the north - west, Maharashtra in the north, Telengana in north-east, Andhra Pradesh in the east, Tamil Nadu in south - east, Kerela in south & south - west and Arabian Sea and Laccadive Sea in the western part. Karnataka possesses a total stretch of around 300 km of coast line between Mangalore, Dakshin Kannada district, Karwar and Uttar Kannada district.

The area under study covers parts of Dakshin Kannada and Hassan districts of Karnataka, hence the entire area comes under the administrative jurisdiction of Dakshin Kannada and Hassan districts. The study area falls in Survey of India toposheets 48P/05 and 48P/09 and covers an area of 1500 sq. km. The toposheet 48P/05 is bounded by longitude 75°15′ 00″ E to 75°30′ 00″ E and Latitude 12° 45′ 00″ N to 13° 00′ 00″ N whereas the toposheet 48P/09 is bounded by longitude 75°30′ 00″ E to 75°45′ 00″ E and Latitude 12° 45′ 00″ N to 13° 00′ 00″ N (Refer – Plate 1). The entire area falls under Puttur, Beltangadi (Dakshin Kannada) and Sakleshpur (Hassan) taluks. The important localities situated in the study area are Uppinangadi, Beltangadi, Ujre, Dharmastala, Gundia, Shiradighadi, Maranhalli etc. The area can be accessed by

Road, Rail, Sea and Air. Most of the area is well connected by National Highway (NH), State Highways (SH) and all weathered metal roads except the eastern and north eastern part of the area, because of the presence of Shiradi Ghat section. NH – 75 (previously known as NH – 48) (Bengaluru – Mangaluru highway) passes through the central part of the area in almost east – west direction. The nearest railway station is Kabaka - Puttur which comes under operations of South Western Railway. Nearest international airport is located at Mangaluru and sea port is located at Panambur.

1.3. Physiography

Physiographically the area has a mixed topography represented by both hilly areas and flat terrain with altitude ranging from 1388 m above the mean sea level in the north eastern part to 40 m above mean sea level on the bank of Netravathi River. The eastern and north eastern part of the study area are mostly rugged terrain that forms the part of Malnad region of Western Ghats represented by lowly to moderately dissected topography with high hills and linear ridges and valleys. Some of the prominent peaks of the area are Hosahallibetta (∆1133 m), Devarbetta (∆1281 m) and Jankalbetta (∆1388 m above mean sea level). Considerable human interference in the form of urbanization, establishment of new dwellings, road network and mining activity is slowly and continuously modifying the physiography of the area.

The area receives an average annual rainfall of around 3000 – 4000 mm. Netravati and Kumaradhari Rivers and their tributaries drain the entire area. Netravati River and its tributaries flows from north to south before changing its course form north – west to east near Pajakalla and becomes parallel to NH – 75. The Netravati River drains the northern half of the study area. Kumaradhari River and its tributaries drain the southern part of the area. It flows from north – west to east parallel to NH – 75. The drainage pattern of the area is dendritic to sub – dendritic in nature. At places, the hilly terrain of north eastern part exhibits radial to sub – radial drainage pattern.

1.4 Present Work

National Landslide Susceptibility Mapping (NLSM) of 1500 sq. km area was carried out in parts of Dakshin Kannada and Hassan district, Karnataka under the Annual Programme of Geological Survey of India, Southern Region, vide FSP code no: LSM/SR/KG/2016/111 for the field season 2016 – 17. The study area covers two

Survey of India toposheet, *viz.* 48P/05 and 48P/09. The nature and target of work envisaged for Field Season Programme of 2016 – 17 and the achievements are given in Table – 1.

Table – 1: ***Nature, quantum of work and achievement***

Nature of work	Target for FS 2016 – 17	Achievement for FS 2016 – 17
1. Pre-field preparation		
i. Preparation of Thematic maps (in GIS on scale 1:50,000)		
(a) Slope Forming Material map	1500 sq. km	1500 sq. km
(b) Geomorphology & Lineament map	1500 sq. km	1500 sq. km
(c) Slope Morphometry (slope, aspect & curvature) map	1500 sq. km	1500 sq. km
(d) Land use – Land cover map	1500 sq. km	1500 sq. km
(e) Drainage map	1500 sq. km	1500 sq. km
(f) Regolith thickness map	1500 sq. km	1500 sq. km
ii. Preparation of Landslide Inventory Map	1500 sq. km	1500 sq. km
2. Field-based studies		
(i) Field-checking of all thematic maps	1500 sq. km	1500 sq. km
(ii) Field validation of landslide inventory and collection of recent and historic landslides (using archives, old reports, road register etc)	1500 sq. km	1500 sq. km
(iii) Collection of landslide inventory and damage data as per 41 point geo parametric data sheet	1500 sq. km	1500 sq. km (16 nos. Landslide)
3. Post-field studies & modelling		
(i) Updation of thematic and inventory maps in GIS	1500 sq. km	1500 sq. km
(ii) Preparation of Landslide Susceptibility Map in GIS	1500 sq. km	1500 sq. km

Nature of work	Target for FS 2016 – 17	Achievement for FS 2016 – 17
(iii) Validation of landslide susceptibility map at important locations	1500 sq. km	1500 sq. km
4. Collection of rainfall data from available rain stations	1500 sq. km	1500 sq. km (Collected available data)

The fieldwork was carried out from 26th October 2016 to 10th March 2017. Table – 2 gives a briefing of total man days spent for the current item. Total 160 man days were spent in the field, which also includes one day of field supervision by Shri. J. Srihari, Director. The post field landslide susceptibility modelling was carried out in SU: K & G, Bengaluru.

Table – 2: ***Details of man days spent for the current item***

Name and Designation	2016			2107			Total (Days)
	Oct	Nov	Dec	Jan	Feb	Mar	
Tanvi Gupta, Geologist	--	22	26	19	7	5	79
Sunandan Basu, Geologist	05	16	25	14	10	10	80
J. Srihari, Director	--	--	--	--	01	--	01

1.5 General Geology

Geologically the area exposes rocks of Sargur Group, Peninsular Gneisses I of Peninsular Gneissic Complex and Charnokite Suite of Southern Granulite Terrain of Archean age traversed by Dolerite dykes of Paleo – Proterozoic age. The regional stratigraphy of the area (after GSI) is given below in Table – 3.

Table – 3: ***Regional Stratigraphy of the area***

Age	Supergroup	Group	Formation	Lithology
Cenozoic				Laterite
Palaeo Proterozoic		Younger Intrusive	Basic Intrusive	Dolerite
Archean	Southern Granulite Complex	Charnokite		Charnokite Pyroxene Granulite
	Peninsular Gneissic Complex (PGC)	Peninsular Gneiss – I	Gneisses	Granite Gneiss
		Sargur	Gneisses	Ultramafite Banded Magnetite Quartzite Amphibolite Garnet Silliminite Graphite Schist

Brief description the lithounits present in the study area is given below:

Sargur Complex

Sillimanite schist, amphibolite, metaultramafics and ferruginous quartzite constitute the major rock units of the Sargur Complex. These occur as lenses or enclaves in the gneisses. Garnet Sillimanite schist with or without garnet or graphite occur as lensoidal bodies within PGC. It is exposed west of Kagneri, 2 km east of Maranhalli, 3 km north and 1.5 km north – west of Kadmane. Amphibolite is dark green, massive / schistose which is rich in hornblende and plagioclase with small amount of biotite and quartz. These rocks are exposed in the north western part of given area in immediate north of Beltangadi. It is also exposed in the south eastern corner of the area around Attihalli and 2 km south – west of Mankangadde. Banded magnetite quartzite, occurring as tabular bodies within PGC, is fined grained, banded consisting of magnetite, grunerite and quartz. Linear bands of ferruginous quartzites are exposed as enclaves in gneiss in the eastern part of toposheet no. 48P/05. They are 50 – 100 m in width and few km in strike length. They have a general trend of NNW - SSE. Metaultramafics are represented by talc schist and talc chlorite schist. The rock is fine grained in texture with well-developed schistosity and has a soapy touch.

Peninsular Gneissic Complex

The rocks of this group, comprising of biotite gneiss of peninsular gneisses - I, covers major part of the area. Granite gneiss is leucocratic to mesocratic, coarse grained consisting of quartz, plagioclase and minor amount of mafic minerals. At places, they show migmatitic folding. The gneisses show well developed foliation. The strike of the foliation is N 65° W – S 65° E to NS with steep N 35° E to easterly dip of 50° – 60°. Stretching lineation trending N – S is noticed in gneisses.

Charnockite Suite

Charnockite Group of rocks consists of charnockite and pyroxene granulites. They are massive to foliated, occurring as lensoidal patches within PGC. Charnockite is fine to coarse grained, light to dark grey consisting of hypersthene, quartz, feldspar, ferromagnesian mineral with or without biotite. Pyroxene granulite is fine to medium grained, dark grey consisting of blue quartz, feldspar and ferromagnesian minerals. They occur as NNW - SSE to NS trending linear bands with in PGC throughout the area. These bands have a width of 50 – 100 m with a strike length of 1 - 10 km. It is exposed as big enclave in south eastern part of the area and 3 km west of Kadmane.

Basic Intrusive

Basic intrusive in the area is represented by dolerite dykes of Palaeo Proterozoic age. These are fine to medium grained, dark green consisting of plagioclase and pyroxene. They trend NW - SE direction having a length of 15 – 20 km.

Laterite

Thin cappings of laterite of 5 to 8 m thickness are present over granites at different places. The laterite is dark in colour with composition of limonite, goethite, and numerous quartz grains.

1.6 Methodology

For a qualitative landslide susceptibility mapping, the following methodology was adopted, which is shown as a flow diagram in Figure – 1. In literature, there are many methods of predictive mapping of landslide susceptibility. However, application of any of the prevalent methods warrants utmost care and prudence by the landslide scientists because landslide has a complex interaction with several geo-environmental spatial factors. For modelling, Multi Class Index Overlay Method is adopted using heuristic (knowledge driven) techniques where individual ratings for geofactor classes and weights of geofactor are determined with the knowledge of the terrain and after discussion with the local experts. Once the initial ratings are fixed, LOFS is determined using Analytical Hierarchy Process (AHP) after preparing the pair wise qualitative comparison matrix of all factors (Saaty, 1977). In NLSM the above methodology was carried out on GIS platform.

National Landslide Susceptibility Mapping (NLSM) includes three components; such as pre-field mapping, field validation and post field updation & landslide susceptibility modelling.

Pre-field mapping:

During pre-field period, landslide inventory and different thematic pre-field maps were prepared using different source data. The pre-field maps are as follows:

(i) **Landslide inventory**: Landslide inventory is prepared using old reports, multi temporal Google imagery and LISS III / LISS IV data as source data in Arc – GIS software.

(ii) **Slope Morphometry (Slope Angle, Curvature and Aspect):** Slope Morphometry (Slope Angle, Curvature and Aspect) pre-field maps were prepared using Carto DEM (freely downloadable from bhuvan portal; bhuvan.nrsc.gov.in) data as one of the input data sources. Though the NLSM is carried out on 1: 50,000 scale, and as the difference of slope angle is relatively lesser in Southern India compared to the mighty Himalayas, to get precise coarse resolution in Slope Angle and Curvature map, the slope morphometry maps were prepared from its original 30 m X 30 m resolution.

(iii) **Drainage map:** Drainage pre-field map was prepared using Carto DEM of 30 m X 30 m resolution.

(iv) **Land Use Land Cover map (LULC):** Land Use Land Cover (LULC) pre-field map was prepared using multi temporal Google imagery and Arc – GIS base map.

(v) **Geomorphology map:** Geomorphology pre-field map was prepared using multi temporal Google imagery, Arc – GIS base map and 1:50,000 scale NGLM legacy map.

(vi) **Slope Forming Material map (SFM):** Slope Forming Material (SFM) pre-field map was prepared using multi temporal Google imagery, Arc – GIS base map, 1:50,000 scale geological legacy map and proxies from LULC and geomorphology maps.

(vii) **Regolith Thickness map:** Regolith Thickness pre-field map was prepared using multi temporal Google imagery, proxies from geomorphology map and slope map.

Field validation of thematic maps:

During the field validation period, all the pre-field maps were validated in the field by visiting all the assessable locations and the modifications, if any, are recorded. The landslide points from pre-field landslide inventory are also checked and if any new slides are encountered in the field the existing landslide inventory is updated.

Post field updation and landslide susceptibility modelling:

After the field validations are completed, all the thematic maps were updated as per the field inputs subsequent to the updation of landslide inventory, heuristic (knowledge driven) techniques were adopted for modelling and generation of final susceptibility map of the area. For modelling using heuristic (knowledge driven) techniques, initial individual ratings for geofactor classes and weights of geofactors are fixed with the knowledge of terrain and with discussion with local experts for the entire area. Later the LOFS (Landslide Occurrence Favourability Score) is calculated using Analytical Hierarchy Process (AHP) after preparing the pair wise qualitative comparison matrix of all factors (Saaty, 1977). The steps of landslide susceptibility modelling (Refer Figure – 2) using heuristic (knowledge driven) process is as below:

- A total of eight factor maps, viz., Slope Angle, Aspect, Curvature and Drainage (derived from 30 m Carto DEM), Geomorphology and Land use – Land cover (prepared using multi-temporal Google imageries and SPOT images), Slope Forming Material and Regolith Thickness (through field-based studies and GSI 1:50,000 Geological Map as base maps) were prepared for susceptibility analysis. Besides these maps, Landslide Inventory map was also prepared using old inventory data from reports/ notes/ archives of GSI and new landslides augmented in the field.
- All the above eight maps were used for assessment of factor class ratings. However, only six thematic maps (except aspect and drainage) were considered for validation of Landslide Susceptibility Map (LSM) of the study area, due to the absence of identified factor classes in a particular map.
- All the thematic maps are converted to raster keeping field as "class" and output cell size as "50" (as NLSM is a 1:50,000 scale mapping) in GIS.
- Once all the ratings for geofactor classes and weights of geofactors are fixed, LOFS is calculated using pair wise comparison matrix and fraction rating.
- After calculation of LOFS for all the geofactor classes, LOFS maps of the geofactors are prepared in GIS.
- Once all the LOFS maps are prepared, raw landslide susceptibility score map is prepared using weighted multi class index overlay method in GIS.
- After raw landslide susceptibility score map is prepared classified landslide susceptibility map is prepared and determination of break values was carried out by assigning weightages (30% is the boundary between low to moderate susceptibility and 50% is the boundary between moderate to high susceptibility).

Figure – 1: ***Flow diagram showing process of Landslide Susceptibility Mapping***

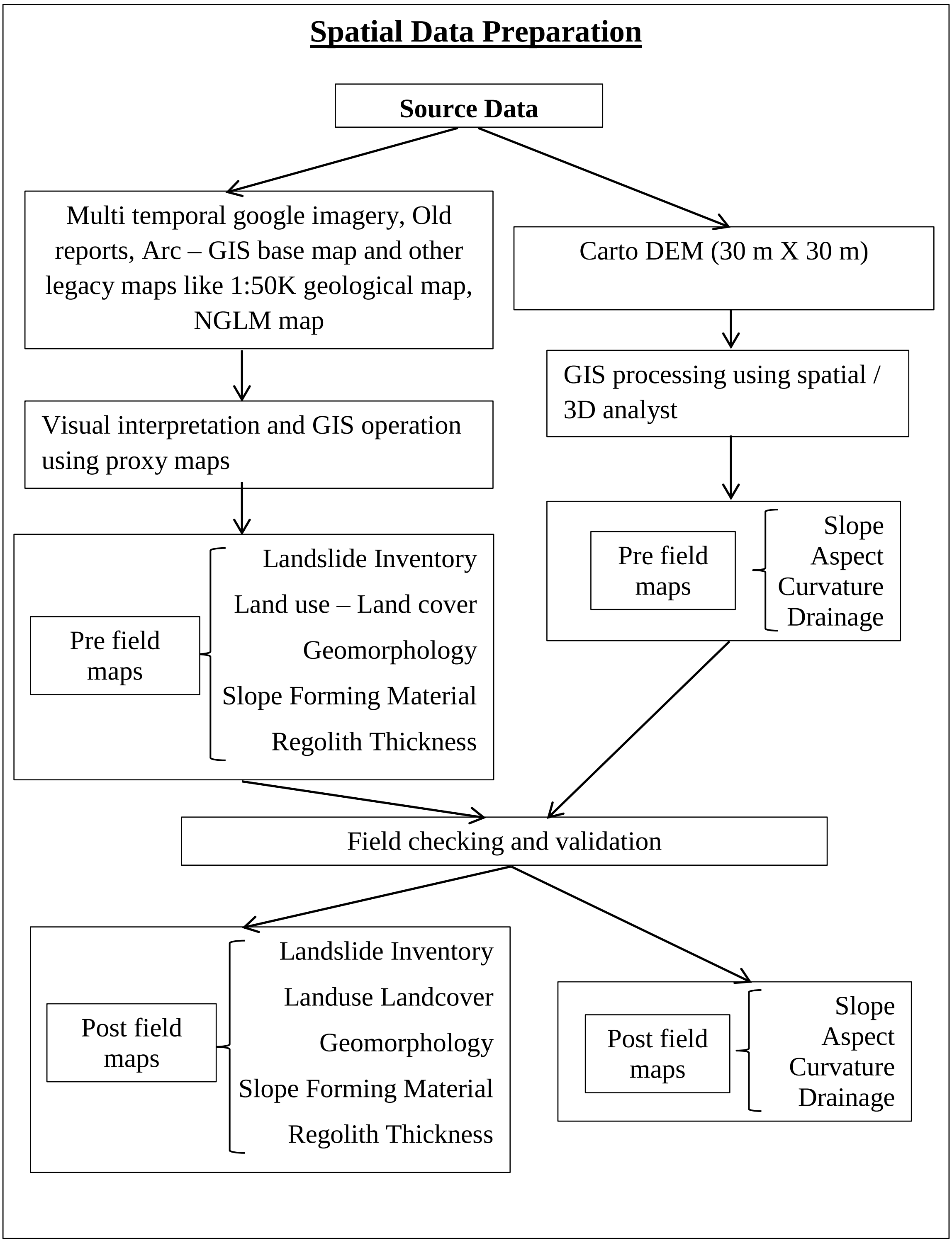
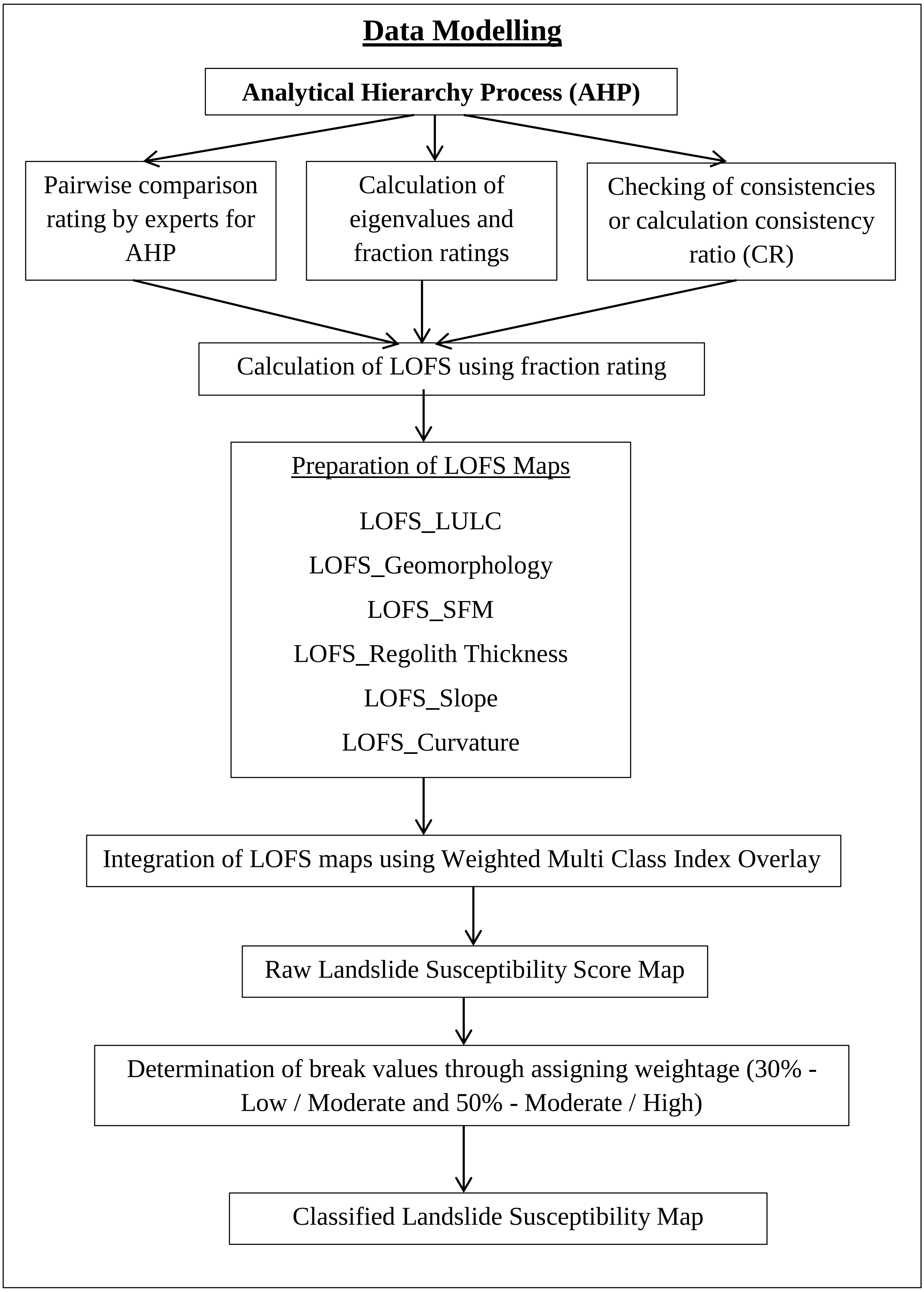


Figure – 2: ***Flow diagram showing process of knowledge driven modeling for Landslide Susceptibility Mapping***



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CHAPTER – 2

PREVIOUS WORK ON LANDSLIDE STUDIES

2.1 Landslides

The present study area covers parts of Dakshin Kannada and Hassan districts, Karnataka. During FS 2008 – 09, K.V Maruthi, Geologist (Sr.) and A.K Mishra, Geologist (Jr.), carried out preliminary Post Disaster Study of the Landslides along Shakleshpur – Subramanya Railway Section, Shakleshpur & Uppiangadi Taluk, Hassan & Dakshin Kannad Dsitricts, Karnataka. Later during FS 2010 – 11, A. K Mishra, Geologist (Sr.), U.K Pradhan, Geologist and K.V Maruthi, Geologist (Sr.) carried out Landslide Hazard Zonation on Macro Scale of Charmudi Ghat Section from Charmudi to Kotigehara, Kotigehara to Kalasa and Sakleshpur to Uppiangadi in Dakshin Kannada and Chikmanglur Districts, Karnataka. Table – 4 shows the brief details of historical landslide data for the study area.

Table – 4: ***Brief details of historical landslides of the study area***

Sl. No	Slide No	Location	TS No	Latitude (N)	Longitude (N)	Types of Slide	Casualties	Remedial Measures	Remarks
1	KA-225	NH 48	48P/9	12°49'48.5"	75°35'34.8"	Slump	Nil	Removal of trees from the crown, grading of slopes	
2	KA-226	NH 48	48P/9	12°49'49.3"	75°35'35.6"	Slump	Nil	Grading of slope, removal of trees from the crown	
3	KA-227	NH 48	48P/9	12°49'49.4"	75°35'36.8"	Slump	Nil		Slide has occurred from mid of cut slope up to the road. The slide will retrograde up to top of cut slope.

Sl. No	Slide No	Location	TS No	Latitude (N)	Longitude (N)	Types of Slide	Casualties	Remedial Measures	Remarks
4	KA-228	NH 48	48P/9	12°49'50.9"	75°35'38.4"	Slump	Nil		
5	KA-229	NH 48	48P/9	12°49'43.2"	75°36'4.7"	Slump	Nil	Large tree resting on the crown should be removed	
6	KA-230	NH 48	48P/9	12°49'45.9"	75°36'24.5"	Rock fall	Nil	Removal of loose boulders	
7	KA-231	NH 48	48P/9	12°49'45.6"	75°37'46.9"	Debris slide	Nil		
8	KA-232	NH 48	48P/9	12°54'22.5"	75°44'7.5"	Debris slide	Nil	Removal of debris, grading of slope, plantation on slope recommended	
9	KA-233	NH 48	48P/9	12°54'1.7"	75°44'7.6"	Debris slide	Nil	Plantation on slopes recommended	
10	KA-234	NH 48	48P/9	12°54'0.7"	75°44'6.4"	Debris slide	Nil	Plantation on slopes recommended	
11	KA-235	NH 48	48P/9	12°49'47.8"	75°38'50.9"	Debris slide	Nil	Retaining wall is recommended	

Sl. No	Slide No	Location	TS No	Latitude (N)	Longitude (N)	Types of Slide	Casualties	Remedial Measures	Remarks
12	KA-236	NH 48	48P/9	12°49'52.4"	75°38'50"	Debris slide	Nil	Plantation / gradation on slopes recommended	
13	KA-237	NH 48	48P/9	12°49'59.9"	75°38'59.9"	Slump	Nil		
14	KA-238	NH 48	48P/9	12°50'0.6"	75°39'9.9"	Debris slide	Nil		weathered and debris material above the bed rock has moved due to rain
15	KA-239	NH 48	48P/9	12°50'31"	75°39'15.3"	Debris slide	Nil		
16	KA-240	NH 48	48P/9	12°50'7.1"	75°39'19.6"	Debris slide	Nil		
17	KA-241	NH 48	48P/9	12°50'21.6"	75°39'34.6"	Debris slide	Nil		Earlier retaining wall is broken due to new slide. Retaining wall was constructed for length of 50 m height 5m
18	KA-242	NH 48	48P/9	12°50'22"	75°39'36.6"	Debris slide	Nil		Retaining wall was constructed for 50 meters and slide stabilised
19	KA-243	NH 48	48P/9	12°50'22.2"	75°39'41.2"	Debris slide	Nil		Old slide stabilised by retaining wall for 30 meters

Sl. No	Slide No	Location	TS No	Latitude (N)	Longitude (N)	Types of Slide	Casualties	Remedial Measures	Remarks
20	KA-244	NH 48	48P/9	12°50'22"	75°39'46.3"	Debris slide	Nil		
21	KA-245	NH 48	48P/9	12°50'27.4"	75°40'24.5"	Debris slide	Nil	Removal of debris	
22	KA-246	NH 48	48P/9	12°50'27.4"	75°40'26"	Debris slide	Nil		
23	KA-247	NH 48	48P/9	12°50'27.1"	75°40'28.7"	Debris slide	Nil		
24	KA-248	NH 48	48P/9	12°50'35.8"	75°40'38.1"	Slump	Nil		
25	KA-249	NH 48	48P/9	12°50'42.1"	75°40'36.8"	Debris slide	Nil		
26	KA-250	NH 48	48P/9	12°50'39.1"	75°40'42.1"	Debris slide	Nil		Old slide is reactivated
27	KA-251	NH 48	48P/9	12°50'40.3"	75°40'47.8"	Debris slide	Nil		

Sl. No	Slide No	Location	TS No	Latitude (N)	Longitude (N)	Types of Slide	Casualties	Remedial Measures	Remarks
28	KA-252	NH 48	48P/9	12°50'40.7"	75°40'59.3"	Debris slide	Nil		Removal of debris, grading of slopes
29	KA-253	NH 48	48P/9	12°50'41.9"	75°41'4.9"	Slump	Nil		
30	KA-254	NH 48	48P/9	12°50'43.9"	75°41'6.5"	Debris slide	Nil		
31	KA-255	NH 48	48P/9	12°50'44.9"	75°41'8.3"	Slump	Nil		
32	KA-256	NH 48	48P/9	12°50'45"	75°41'11.2"	Debris slide	Nil		One big slide of 50 meters and two small slides of smaller width. All three slides taken as one. Weathered rock has moved by overburden
33	KA-257	NH 48	48P/9	12°50'49.8"	75°41'19.7"	Slump	Nil		
34	KA-258	NH 48	48P/9	12°50'45.7"	75°41'23.6"	Debris slide	Nil		Old slide stabilised by retaining wall of 25 meters at 2 places, height 2 meters with weep holes.

Sl. No	Slide No	Location	TS No	Latitude (N)	Longitude (N)	Types of Slide	Casualties	Remedial Measures	Remarks
35	KA-259	NH 48	48P/9	12°50'54.7"	75°41'32.4"	Slump	Nil		Slump all along the road height varies from 8 to 10 meter
36	KA-260	NH 48	48P/9	12°50'46.4"	75°41'35"	Slump	Nil	Retaining wall is recommended	
37	KA-261	NH 48	48P/9	12°50'49.2"	75°41'43"	Slump	Nil		
38	KA-262	NH 48	48P/9	12°50'58.1"	75°41'47.6"	Slump	Nil		Two slide adjacent to each other taken as one
39	KA-263	NH 48	48P/9	12°51'8.8"	75°41'47.4"	Rock fall	Nil		Both rock slide and slump/slide is noticed all along the road. Rock slide is rock toppling and rock fall.
40	KA-264	NH 48	48P/9	12°51'17.9"	75°41'43.6"	Slump	Nil		
41	KA-265	NH 48	48P/9	12°51'20.7"	75°41'41.3"	Debris slide	Nil		
42	KA-266	NH 48	48P/9	12°51'28.7"	75°41'47.6"	Slump	Nil		

Sl. No	Slide No	Location	TS No	Latitude (N)	Longitude (N)	Types of Slide	Casualties	Remedial Measures	Remarks
43	KA-267	NH 48	48P/9	12°51'25.4"	75°41'54.9"	Debris slide	Nil		
44	KA-268	NH 48	48P/9	12°51'40 .3"	75°42'2"	Debris slide	Nil		
45	KA-269	NH 48	48P/9	12°51'44.3"	75°42'4.4"	Debris slide	Nil		
46	KA-270	NH 48	48P/9	12°51'46.3"	75°42'10.1"	Slump	Nil		
47	KA-271	NH 48	48P/9	12°51'51.2"	75°42'9.1"	Debris slide	Nil		Two slides taken as one slide
48	KA-272	NH 48	48P/9	12°52'4.7"	75°42'14.2"	Debris slide	Nil		
49	KA-273	NH 48	48P/9	12°52'5.2"	75°42'15.5"	Debris slide	Nil		Four slides are continuous including one old slide length of large slide is mentioned.
50	KA-274	NH 48	48P/9	12°52'5.2"	75°42'25.4"	Debris slide	Nil		

Sl. No	Slide No	Location	TS No	Latitude (N)	Longitude (N)	Types of Slide	Casualties	Remedial Measures	Remarks
51	KA-275	NH 48	48P/9	12°52'10.7"	75°42'34.9"	Debris slide	Nil		
52	KA-276	NH 48	48P/9	12°53'13.2"	75°43'19.6"	Slump	Nil		
53	KA-277	NH 48	48P/9	12°55'10.8"	75°44'51"	Slump	Nil		
54	KA-278	NH 48	48P/13	12°55'9.6"	75°45'26.1"	Slump	Nil		

2.2 Landslide Susceptibility

In the present study area no landslide susceptibility studies have been taken up previously. Only post disaster study (FS 2008 – 09) and macro scale landslide hazard zonation (FS 2010 – 11) were carried out previously.

CHAPTER – 3

LANDSLIDE INVENTORY

The generation of a landslide inventory is a tedious work as landslides occur individually and have to be identified, mapped and inventoried. Landslide inventories contain basic information about landslides such as location, classification, morphology, volume, run-out distance, activity and date of occurrence/activity, etc. Landslide inventory can be prepared through various methods such as detailed geomorphologic studies, mapping from remote sensing data and topographic maps, historical archive studies and interviews. In this study, satellite images and previous reports of GSI 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; Hansen, 1984). These signatures are mostly visible as morphological changes such as changes in slope type, break 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. The SPOT images available as a base map (up to the resolution of 30cm) and high resolution Google imageries of different time periods (from 2002 to 2015) were used as the main sources for generating the multi-temporal landslide inventory.

3.2 Inventory Mapping

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

- In Google Earth, every segment of the study area was viewed for all available time frames. As the study area falls under thick forest of Western Ghats, it is very difficult to identify landslides in Google imagery or Arc – GIS base map.

Most of the slides are very small in dimensions and should ideally be represented as a point on 1:50,000 scale. But for better representation, the slides are represented as polygons and in the process, few slide dimensions may be little bit exaggerated. Once the landslide is identified, the same is digitized as a polygon.

- The mapped polygon is then saved as .kml file and later imported to Arc GIS, wherein it is stored as polygon shapefile or geodatabase WGS 84 UTM projection (43N).
- The landslide polygons are then corrected with the help of the ESRI base map. Any shift in the spatial location of the polygon, due to shift in the multi-temporal images of Google Earth data, is adjusted manually. Few landslides were also mapped directly from SPOT data and scanned geo referenced toposheet in Arc GIS.
- For each landslide polygon, the attributes such as name, state, district, taluka, toposheet number, initiation and reactivation year based on dates of Google Earth images, slide type, slide material, length, width, surface area, cause, land use and element at risk is attached. Archival data were used for naming and defining the cause of the landslides.
- A systematic and detailed field check was then carried out to validate the pre-field map at all the accessible locations. The morphological signatures left by landslides on slopes were used to identify the shape of landslides.
- 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 – land cover, geology, regolith thickness, probable cause and damage details were also added to the inventory. The volume of mapped landslides was recalculated by multiplying the morphological parameters. Any new landslides identified were plotted in the topographic maps and were digitized as polygons and entered in a geo-database of Arc GIS.

3.3 Spatial Distribution of Landslides

In total, 54 landslides were identified during the pre-field mapping from previous GSI report inputs. But during the field work 38 landslides were removed from the pre-field data base as these slides were not traceable in the field. All of these landslides were reported along NH – 75 and caused by extensive slope cut along road, as per the historical data. Presently large scale widening work of NH – 75 is going on in the aforesaid stretch of the road where these landslides were reported earlier. Due to this widening of the highway, most of the landslides are totally removed due to fresh slope cut. Landslides were classified as either “debris/earth slide”, “debris flows”, “rock slide” or “rock flows” following the classification proposed by Varnes (1978).

During the field work, 16 confirmed landslides (Refer Plate – 11) were identified. All the slides are debris slide in nature and located adjacent to the road and probably might have resulted due to removal of toe material for the formation of road. Landslides caused under natural conditions are very rare. 15 nos. out of 16 nos. landslides are shallow translational debris slides, with depth of the slip plane being less than 5 meters. Only one is deep translational debris slide, with depth of the slip plane being more than 5 meters is mapped. Smaller landslides initiated due to the cut slopes and are found to have no run-out as the road provided a horizontal base for accumulation of the debris.

The spatial distributions of mapped landslides are given in Annexure – 2, wherein detailed inventory of 16 landslides with 41 point inventory was prepared.

3.3.1 Landslide along road sections

All the landslides adjacent the road sections are mainly caused due to toe cutting of the slope, vertical or near vertical cut slopes which are left unsupported and become prone to failure during rains. The landslides are recorded along NH – 75 (Mangaluru – Bengaluru Highway) and along State Highways. All mapped landslides are debris slides triggered by extensive slope cutting followed by heavy spells of rain. The slide material mostly consists of lateritic soil mixed with debris of weathered rock. Failures are common during rains when the exposed overburden mass resting on the cut slopes moves downward.

3.3.2 Landslide on natural slopes

In the study area no slides have been over the natural slopes.

CHAPTER – 4
LANDSLIDE SUSCEPTIBILITY ANALYSIS

This chapter deals with the material and methods of landslide susceptibility analysis using the Weighted Multiclass Index Overlay method, as recommended in the Standard Operating Procedure (SOP) of NLSM.

4.1 Background

Landslide susceptibility is a qualitative estimate of the spatial distribution of landslides, which exist or potentially may occur in an area. Although it is expected that landslides will occur more frequently in the most susceptible areas, however, in the susceptibility analysis, no time frame and magnitude of event are explicitly taken into account. A susceptibility map therefore gives only the qualitative estimation that the mapping unit (e.g., a pixel, slope unit or facet) will be affected by a future landslide source. 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 knowledge - driven methods such as Weighted Multiclass Index Overlay, individual ratings for geofactor classes and weights of geofactor are determined with the knowledge of the terrain and after discussion with the local experts. Once the initial ratings are fixed, LOFS is determined using Analytical Hierarchy Process (AHP) after preparing the pair wise qualitative comparison matrix of all factors (Saaty, 1977).

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 prior knowledge of the main causes of landslides (Guzzetti et al., 1999; Glade and Crozier, 2005). A systematic overview of the important preparatory factors required for susceptibility mapping in different scales is given in van Westen et al. (2008). A prior knowledge of the main causes of landslides in the area of interest is essential in selecting the most relevant factor out of the many known preparatory factors that can "theoretically" cause landslides (Ghosh and Carranza, 2010).

In the study area, landslides are mostly debris slides along road corridors and are relatively small in size. Out of the six thematic maps, two 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 Thematic Layers

Landslides occur when the shearing stress along the failure plane exceeds the shearing strength of rock/debris mass (Varnes, 1978). This can be affected by the changes in various parameters such as i) physical state of slope such as slope angle and slope curvature, ii) lithology or physical characteristics of slope forming mass, iii) spatial variation in thickness of regolith, iv) geomorphological forms and processes, v) land use/cover including road and other physical features mappable on 1:50,000 scale. 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 landslide susceptibility. As per the data model, some of the geo-factor themes are categorical (e.g., geomorphology, land use - land cover etc.) and others represent continuous data (e.g., slope, curvature etc.). 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 Angle

Slope Angle geofactor map has highest importance for NLSM modelling, which is carried out by using Analytical Hierarchy Process (AHP). In the scale of 0 to 9, within the geofactors, this particular geofactor is given 9 weightage by the experts.

The slope angle map of the study area was derived from Carto DEM of 30 m resolution using GIS. For depiction purpose, the slope map is finally reclassified into 5 classes (Refer Plate – 3). The Slope angle of this area varies between 0^0 and 57°. 70.09% of the study area are covered by gentle slope (<15°), 20.42% of the study area covered by slope between 15° to 25°, 8.11% of the area are covered by slope between

25° to 35°, high slope like 35° to 45° covers 1.27% area and only 0.12% area is covered by slope >45° . The areas having slope between 25° to 35° were found to be most prone to slope failures. The slope angle classes, area coverage and LOFS are shown in Table – 5.

Table – 5: ***Slope angle classes with LOFS ratings***

Sl. No	Slope Class	No. of Pixels	Area (sq. km)	% Coverage	LOFS
1.	> 15°	1129746	1050.66	70.09	0.1081
2.	15° - 25°	329120	306.08	20.42	0.2523
3.	25° - 35°	130717	121.57	8.11	1
4.	35° - 45°	20467	19.03	1.27	0.5123
5.	> 45°	1896	1.76	0.12	0.1081

Slope Curvature

Slope curvature was also derived from Carto DEM of 30 m resolution using GIS. 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 areas having high soil moisture content and receive more surface run-off but the overburden material is less or absent. Whereas most of the convex hill slope are having good amount of overburden material. So failures can be expected to occur more frequently in those convex hill slope areas than the slopes that are concave along the contour. The curvature maps were finally reclassified into three classes viz, concave, flat and convex (Refer Plate – 4). A total of 47.86 % of the map area is falling under concave and 44.08 % area comes under convex curvature slopes respectively, while only 8.06% area falls under flat category. The slope curvature classes, area coverage and LOFS are shown in Table – 6.

Table – 6: ***Slope curvature classes with LOFS ratings***

Sl. No	Curvature Class	No. of Pixels	Area (sq. km)	% Coverage	LOFS
1.	Concave	771486	717.82	47.86	0.4113
2.	Flat	129971	120.93	8.06	0.1676
3.	Convex	710489	661.07	44.08	1

4.3.2 Land use - Land cover (LULC)

Land use – Land cover geofactor map has 2nd highest importance for NLSM modelling, which is carried out by using Analytical Hierarchy Process (AHP). In the scale of 0 to 9, this particular geofactor is given 8 weightage by the experts.

During the field work total of 16 landslides were mapped in this area and all the landslides are related to modification of slope. So it is very clear that land use - land cover geofactor has a major importance on landslides of this area.

A geofactor map having weightage 8, create a major impact on the final susceptibility map. So stepwise methodology was followed and necessary modification was done with utmost care before finalization of this map. The pre-field land use - land cover (LULC) map was prepared from the google earth imagery of date 03/12/2012 and 18/11/2013, following the normal mapping procedure in google earth. The scale level around 300 m was maintained for demarcating the boundaries of different classes. At the time of demarcating extensive slope cut polygon difficulties were faced as the true width of such areas is less than 50 m. However considering the importance of this areas in mind, creation of a polygon of minimum width of little over 50 m is attempted where ever possible and by combining adjacent polygon into a single polygon. This has at places resulted in inclusion of Moderate Vegetation / Thick Vegetation areas in extensive slope cut polygons. Knowingly this discrepancy has been ignored in order to highlight the importance of extensive slope cut polygon in localising landslides.

The obtained pre-field LULC map was validated in the field in all accessible locations and all necessary corrections and modifications were carried out in the boundary and nomenclature of the LULC classes. In this way the post field LULC map of the study area was prepared. Plate – 7 shows the final LULC map of the study area. The LULC classes, area of coverage and LOFS are shown in Table – 7.

Table – 7: ***LULC classes with LOFS ratings***

Sl. No	LULC Class	No. of Pixels	Area (sq. km)	% Coverage	LOFS
1.	Barren	28450	71.13	4.74	0.0626
2.	Cultivation	13701	34.25	2.28	0.0937
3.	Extensive Slope Cut	268	0.67	0.04	1.0000

Sl. No	LULC Class	No. of Pixels	Area (sq. km)	% Coverage	LOFS
4.	Fallow Land	770	1.93	0.13	0.0626
5.	Moderate Vegetation	1500	3.75	0.25	0.2912
6.	Plantation (HHP)	181459	453.65	30.25	0.1988
7.	Plantation (LHP)	17004	42.51	2.83	0.1366
8.	Quarry	10	0.03	0.00	0.2912
9.	River	5650	14.13	0.94	0.0000
10.	Settlement	18696	46.74	3.12	0.0683
11.	Sparse Vegetation	2709	6.77	0.45	0.5631
12.	Swamp	7	0.02	0.00	0.0000
13.	Thick Vegetation	329615	824.04	54.95	0.1988
14.	Water body	53	0.13	0.01	0.0000

4.3.3 Geomorphology

Geomorphology geofactor map is of moderate importance for NLSM modelling, which is carried out by using Analytical Hierarchy Process (AHP). In the scale of 0 to 9, within the geofactors, this particular geofactor is given 4 weightage by the experts. A geofactor map having weightage 4, creates a moderate impact on the final susceptibility map.

The pre - field geomorphology map was prepared from google earth imagery following normal mapping procedure in google earth. The scale level around 900 m was maintained for demarcating the boundaries of different classes. Different geomorphological landforms observed in the present study area are structural hill situated in the eastern part of the study area as Lowly Dissected Slope and Moderately Dissected Slope. Apart from the hilly areas, the western part of the study area is mostly Rolling Plain, i.e. slightly undulating surface and hence do not have direct impact on occurrences of landslides. Within the geomorphology classes, the areas having moderately dissected slope were found to be most prone to landslides.

The obtained pre-field geomorphology map was validated in the field in all accessible locations and all necessary correction and modifications were carried out in the boundary and nomenclature of the geomorphology class. In this way the post field geomorphology map of the study area was updated and finalized. Plate – 8 shows the final geomorphology map of the study area. The geomorphology classes, area of coverage and LOFS are shown in Table – 8.

Table – 8: ***Geomorphology classes with LOFS ratings***

Sl. No	Geomorphology Class	No. of Pixels	Area (Sq. km)	% Coverage	LOFS
1.	Escarpment	13128	32.82	2.19	0.0819
2.	Lowly Dissected Slope	162646	406.62	27.11	0.1947
3.	Moderately Dissected Slope	187980	469.95	31.34	0.4020
4.	Ridge - top	669	1.67	0.11	0.0000
5.	River	5650	14.13	0.94	0.0000
6.	Rolling Plain	216319	540.80	36.06	0.0000
7.	Valley Fill	13446	33.62	2.24	0.0000
8.	Water body	54	0.14	0.01	0.0000

4.3.4 Slope Forming Material (SFM)

Slope Forming Material geofactor map has 3rd highest importance for NLSM modelling, which is carried out by using Analytical Hierarchy Process (AHP). In the scale of 0 to 9, within the geofactors, this particular geofactor is given 6 weightage by the experts. A geofactor map having weightage 6, creates a relatively high impact on the final susceptibility map.

The pre-field SFM map was prepared from proxies from LULC, Geomorphology, Geological map and few inputs from google earth imagery.

The obtained pre-field SFM map was validated in the field in all accessible locations and all necessary correction and modifications were carried out in the boundary and nomenclature of the SFM class. In this way the final SFM map of the study area was prepared. Plate – 9 shows the final SFM map of the study area. The SFM classes, area of coverage and LOFS are shown in Table – 9.

Table – 9: ***SFM classes with LOFS ratings***

Sl. No	SFM Class	No. of Pixels	Area (Sq. km)	% Coverage	LOFS
1.	Amphibolite	26	0.07	0.004	0.2409
2.	Banded magnetite quartzite	44	0.11	0.007	0.0682
3.	Charnockite	1771	4.43	0.295	0.0682
4.	Dolerite	1126	2.82	0.188	0.0682
5.	Gar-bio-sill gneiss + graphite + kyanite	920	2.30	0.153	0.0682
6.	Granite gneiss	58397	145.99	9.735	0.0682
7.	In-situ soil	524778	1311.95	87.479	0.2409
8.	Meta-ultramafite	20	0.05	0.003	0.0682
9.	Pyroxene granulite	105	0.26	0.018	0.2409
10.	River	5650	14.13	0.942	0.0000
11.	Water body	54	0.14	0.009	0.0000
12.	Weathered Rock	7001	17.50	1.167	0.5437

4.3.5 Regolith Thickness

Regolith Thickness geofactor map is of moderate importance for NLSM modelling, which is carried out by using Analytical Hierarchy Process (AHP). In the scale of 0 to 9, within the geofactors, this particular geofactor is given 4 weightage by the expert. A geofactor map having weightage 4, creates a moderate impact on the final susceptibility map.

The pre-field Regolith Thickness map was prepared from proxies from LULC, Geomorphology and Slope map and few inputs were also taken from google earth imagery.

The obtained pre-field Regolith Thickness map was validated in the field in all accessible locations and all necessary corrections and modifications were carried out in the boundary and nomenclature of the Regolith Thickness class. In this way the post field Regolith Thickness map of the study area was prepared. Plate –10 shows the final Regolith Thickness map of the study area. The regolith thickness classes, area coverage and LOFS are shown in Table – 10.

Table – 10: ***Regolith Thickness classes with LOFS ratings***

Sl. No	Regolith Thickness Class	No. of Pixels	Area (Sq. km)	% Coverage	LOFS
1.	< 0.5 m	69685	174.21	11.62	0
2.	0.5 - 5 m	524503	1311.26	87.43	1
3.	River	5650	14.13	0.94	0
4.	Water body	54	0.14	0.01	0

4.4 Landslide Susceptibility Analysis

4.4.1 Procedure

Susceptibility is the propensity of an area to generate landslides. In mathematical form, landslide susceptibility is the probability of spatial occurrence of known slope failures, given a set of geo-environmental conditions (Guzzetti et al., 2005). In this study, a qualitative landslide susceptibility map was prepared by using the Weighted Multi-class Index Overlay method, as recommended in the SOP of NLSM.

The landslide susceptibility modelling can be divided into the following main themes:

- Preparation of landslide inventory and geofactor maps and preparation of GIS-based database of the geofactor maps.
- All the thematic maps are converted to raster keeping field as “class” and output cell size as “50” (as NLSM is a 1:50,000 scale mapping) in Arc – GIS software.
- Heuristic (knowledge driven) technique modelling requires fixation of individual ratings for geofactor classes and weights of geofactors for the entire area. So, these initial ratings for geofactor classes and weights of geofactors are fixed with the knowledge of terrain and after discussion with experts.
- Once all the ratings for geofactor classes and weights of geofactors are fixed, LOFS is calculated using pair wise comparison matrix and fraction rating
- After calculation of LOFS for all the geofactor classes, LOFS maps of the geofactors are prepared using GIS software.
- Once all the LOFS maps are prepared, raw landslide susceptibility score map is prepared using weighted multi class index overlay method in GIS software.

- After raw landslide susceptibility score map is prepared, a classified landslide susceptibility map is prepared and determination of break values are carried out by assigning weightage (30% is the boundary between low to moderate susceptibility and 50% is the boundary between moderate to high susceptibility).

4.4.2 Selection of Mapping Unit

After the selection of appropriate preparatory factors, the next step is selection of mapping units for the GIS based susceptibility analysis and for selecting a mapping unit importance must be given to the type of landslides in the area, mapping scale and scope of the work.

In this study, the mapping scale is 1:50,000 and preparing slope-units at this scale often do not match with the local geo-environmental setting related to slope instability. One way to overcome this is to resize the slope-units according to the present landslide size by partitioning a river basin into nested subdivisions, coarser for larger landslides and finer for smaller failures (Guzzetti et al., 1999). But, for application purposes this approach is not suitable for small and shallow landslides (Montgomery and Dietrich, 1994). Furthermore, even with GIS it is still difficult to manually digitize irregular mapping units of a very small size e.g., the slope unit of area < 1000 sq. m.

Therefore, in this work, a *pixel* was selected as the basic mapping unit for the susceptibility modelling so that the smallest landslide can be represented by a single pixel. Further, it will support the minimum resolution of Carto DEM which is also of 30 m. As an additional advantage, a pixel based mapping unit can facilitate very fast computation and processing of the raster data set in GIS and it is also the commonly used unit in the raster based analysis (Carrara et al., 1992). Hence, the 1500 sq. km study area was converted into an equal-area grid by rasterizing the polygon map using a 50 m X 50 m pixel size. But as the slope angle difference is relatively lesser in Southern India compared to the mighty Himalayas, to get precise coarse resolution in Slope Angle and Slope Curvature map, the slope morphometry maps were prepared from its original 30 m X 30 m pixel resolution.

4.4.3 Landslide Occurrence Favourability Score (LOFS)

Landslides on a particular place depend on interaction between various geofactors. In the present study area, for a qualitative landslide susceptibility analysis, for modelling, Multi Class Index Overlay Method is adopted using heuristic (knowledge driven) techniques. In heuristic (knowledge driven) technique, individual ratings for geofactor classes and weights of geofactors are determined with the knowledge of the terrain and after discussion with the local experts. Once the initial ratings are fixed, Landslide Occurrence Favourability Score (LOFS) is determined using Analytical Hierarchy Process (AHP) after preparing the pair wise qualitative comparison matrix of all factors (Saaty, 1977).

For determination of LOFS using AHP, for each geofactor one comparison matrix is calculated for the pair wise qualitative comparison of all the geofactor sub classes. In the comparison matrix, fraction rating is calculated for all the geofactor sub classes. Once all the fraction ratings are determined, maximum value within the fraction ratings is identified. Then all the fraction rating values are divided with the maximum fraction rating value to determine the LOFS for the geofactor sub classes. In this way, as the fraction ratings are divided with the maximum fraction rating value, the LOFS values are arranged in ascending order (Refer Annexure – 1).

4.4.4 Integration of Data

Figure – 1 shows the steps followed in this analysis for calculating the factor class ratings and inter predictor weights of factor maps using AHP.

- Following the methodological process shown in Figure – 1, all the maps such as LULC, Geomorphology, SFM and Regolith Thickness are digitized as a polygon shape file and converted into raster maps keeping output cell size as 50m × 50m.
- The Carto DEM derivatives such as slope angle and slope curvature are reclassified into categorical variables. Slope angle map is reclassified into five classes (<15°, 15° to 25°, 25° to 35°, 35° to 45° and >45°), whereas slope curvature map is reclassified into three classes (concave, flat and convex).
- For each geofactor class, Landslide Occurrence Favourability Score (LOFS) is determined using a pair wise comparison matrix.
- Once the LOFS values for geofactor sub classes are determined, all the LOFS values against the sub classes are compiled. Then the LOFS attributes are joined in the raster map attribute table. Finally LOFS map of the geofactor is prepared in GIS, using raster map of the geofactor as "input raster" and "geofactor_LOFS$.LOFS" as lookup field.

- For determination of Predictor Weight for the geofactor, one comparison matrix is calculated for the pair wise qualitative comparison of all the geofactors. In the comparison matrix, fraction weight is calculated for all the geofactors. Once all the fraction weights are determined, minimum value within the fraction ratings is identified. Then all the fraction weight values are divided with the minimum fraction weight value to determine the Predictor Weight or weight of geofactors. In this way, as the fraction weights are divided with the minimum fraction weight value, the Predictor Weight or weight values will be one or more than one. For each geofactor, consider the nearest whole number as its Predictor Weight or weight.
- Raw Landslide Susceptibility Score Map in GIS, is generated using the formula -
  ***Susc Score** = (LOFS_Factor1*weight of Factor1 + LOFS_Factor2*weight of Factor2 + LOFS_Factor3*weight of Factor3 + ………. + LOFS_Factor*$_n$**weight of Factor*$_n$*) / Sum of inter – predictor weight.*
- In this type of knowledge-driven models, classification break values can be determined on the basis of the logic applied while giving mutual comparison expert driven ranking. It is always thought by any expert that rank value for any factor class is ≥ 5, and it is considered that the particular factor class has higher likelihood in influencing the landslides. This rank value of "5" in a scale of "0" to "9" comes after 50% of the absolute difference values (9-0 = 9; 50% of 9 is 4.5). That is why this 50% cut-off margin or weightage can be used to determine the break raster value between "*Moderate*" and "*High*" susceptibility classes (*BrMH*). Similarly, when rank value for any factor class is ≤ 3 (lower than 30% of the absolute difference value of 9), and it is considered that the particular geofactor class has lesser likelihood in influencing any landslides. Accordingly, 30% cut-off margin or weightage can be used to determine the break values between **"***Low***"** and **"***Moderate***"** susceptibility classes (*BrLM*).

  Using the above logic the required break values can be determined by solving the following formula:

  ***BrMH** = [(Abs Diff LOFS Factor1*50)*weight of Fcator1 + (Abs Diff LOFS Factor2*50)*weight of Fcator2 + (Abs Diff LOFS Factor3*50)*weight of Fcator3 + …… + (Abs Diff LOFS Factor*$_n$**50)*weight of Fcator*$_n$*] / Sum of inter – predictor weight*

BrLM *= [(Abs Diff LOFS Factor1*30)*weight of Fcator1 + (Abs Diff LOFS Factor2*30)*weight of Fcator2 + (Abs Diff LOFS Factor3*30)*weight of Fcator3 + …… + (Abs Diff LOFS* $Factor_n$*30)*weight of* $Fcator_n$*] / Sum of inter – predictor weight*

- Once break values (BrMH and BrLM) are calculated, Classified Landslide Susceptibility Map is prepared by reclassifying the Raw Landslide Susceptibility Score Map. For reclassification, three classes are chosen and in break values, 2nd topmost value is given as the first value (Class 1), 1st topmost value is given as the second value (Class 2) and third value (Class 3) is given as one. Now the Raw Landslide Susceptibility Score Map is classified into the following categories: Class 1 stands for "*Low Susceptibility*", Class 2 stands for "*Moderate Susceptibility*" and Class 3 stands for "*High Susceptibility*" (Refer Plate – 12.1 and 12.2).

CHAPTER – 5

LANDSLIDE SUSCEPTIBILITY MAP

5.1 Discussion and Susceptibility Map

The landslide susceptibility map (Refer Plate – 12) of toposheet nos. 48P/05 and 48P/09 was prepared using weighted multiclass index overlay method. The susceptibility is expressed in terms of the relative proneness to initiation of a landslide in a pixel (the mapping unit) under the given geo - environmental conditions. Table – 11 shows the area coverage and percentage with respect to different susceptibility classes for the present study area.

Table – 11: ***Landslide Susceptibility classes with area coverage***

Sl. No	**Landslide Susceptibility Class**	**No. of Pixels**	**Area (sq. km)**	**% Coverage**
1.	Low	375045	937.61	62.52 (~63)
2.	Moderate	176399	441.00	29.41 (~29)
3.	High	48407	121.02	8.07 (~8)

In the present study area, 63 % of the area falls under low susceptibility class, 29 % of the area falls under moderate susceptibility class whereas only 8 % area falls under high susceptibility class.

The majority of the areas situated in the western, southern and central side of the study area falls under low susceptibility class with small patches of areas with moderate susceptibility class within it. On the other hand, areas situated in eastern and north eastern side of the study area falls under moderate susceptibility class with considerable patches of areas with high susceptibility class within it. Almost all the major localities of the study area like Uppinangadi, Beltangadi, Ujre, Dharmastala, Nelyadi etc. comes under low susceptibility class. Localities like Gundia and Maranhalli comes under moderate susceptibility class. Very few localities like Shiradigadi come under high susceptibility class.

The distribution of the susceptibility classes shows a very clear indication. In the landslide susceptibility modelling, the slope angle, land use – land cover and geomorphology map played a major role in generation of the final landslide susceptibility map. The western part of the study area is having relatively gentle topography falls under dominantly low susceptibility class with small patches of moderate susceptibility class within it. Slope angle wise the majority of the area falls under <15° slope angle class. Geomorphologically most of these areas come under dominantly rolling plain class. Land use – land cover wise the western part of the study area shows classes like Plantation (both HHP & LHP), cultivation, settlement etc. All these geofactor classes have relatively lower ratings within the individual geofactor map, thus the LOFS values of these geofactor classes are towards lower side. So, in the landslide susceptibility modelling, while carrying out data integration, these lower LOFS values contributes for the overall low susceptibility class of the area. On the contrary, the eastern and north eastern side of the study area, which is part of Shiradi Ghat section of the Western Ghats, shows rugged topography and slope angle wise these areas have higher slope classes (slope range varies from approx. 15° to 58°). Geomorphologically, most of this area comes under lowly dissected slope and moderately dissected slope class. In land use – land cover map the dominant classes are thick vegetation, barren along with extensive slope cut. Lowly dissected slope and thick vegetation has moderate rating within geomorphology and land use – land cover geofactors respectively and barren has low rating in land use – land cover geofactor. On the other hand the extensive slope cut is having the highest rating within land use – land geofactor. Moderately dissected slope has relatively higher rating in geomorphology geofactor and dominant slope angle classes (15° to 25°, 25° to 35° and 35° to 45°) of these area has relatively higher ratings within slope angle geofactor. Moreover, within the geofactor classes, slope angle and land use – land cover has highest and 2nd highest weightage. So, these higher ratings of the geofactor classes contribute to the higher LOFS values for these geofactor classes within the individual geofactor. Similarly, the higher weightage of the geofactors contribute to the higher predictor weight or weight of the particular geofactor within the all the geofactors. So, in the landslide susceptibility modelling, while carrying out data integration, these higher LOFS and predictor weight of geofactor classes and geofactors respectively, contribute to the overall high to moderate susceptibility class of the area.

Although there is no provision of direct validation of the pre-field map in the field, an attempt was made to determine the success rate of the landslide susceptibility map by overlapping the landslide points on the landslide susceptibility map in GIS software. In this exercise, it was observed that out of total 16 landslides, 13 landslides (81%) falls within the high susceptibility class and 3 landslides (19%) falls under moderate susceptibility class. This clearly indicates that the landslide susceptibility model fits perfectly in the present study area.

CHAPTER – 6

SUMMARY AND RECOMMENDATIONS

Macro scale (1:50,000) landslide susceptibility mapping in parts of SOI toposheet no. 48P/05 and 48P/09, covering parts of Dakshin Kannada and Hassan districts, Karnataka for an area of 1500 sq. km was carried out during field season 2016 – 17. In this study, a qualitative landslide susceptibility map was prepared by using the weighted multi class index overlay method, as recommended in the SOP of NLSM. The mapping unit used is a pixel of 50 m x 50 m grid. The outcome of the study is enumerated below:

- A multi – temporal landslide inventory map of the study area is prepared using old reports data, multi temporal google imagery from 2002 to 2016, LISS III / LISS IV data and field inputs. Most of the landslides are smaller in dimension and triggered due to toe cutting of the slope (extensive slope cut) for road construction, hence, are found in the vicinity of roads.
- The prepared landslide inventory map of the study area contains a total of 16 nos. of landslides, all of which are debris slide in nature.
- The no. of landslides in the study area are very few and of very small scale, hence, ideally can not to be taken into consideration for a 1:50,000 scale mapping. Though in google earth with high zoom the landslides are mapped as polygon but when representing in 1:50,000 scale landslide inventory map (Refer Plate – 11) the landslides are represented as point only, as the polygons are not visible in 1:50,000 scale.

Heuristic (knowledge driven) technique modelling requires fixation of individual ratings for geofactor classes and weights of geofactors for the entire area. So, these initial ratings are fixed with the knowledge of terrain and with discussion with local experts for Analytical Hierarchy Process (AHP).

Once all the ratings for geofactor classes and weights of geofactors are fixed, LOFS is calculated for all classes using pair wise comparison matrix and fraction rating and LOFS maps of the geofactors are prepared using GIS software.

Based on the landslide characteristics, a total of eight factor maps, viz., Slope Morphometry (Slope Angle, Slope Aspect, Slope Curvature) and Drainage (derived from 30 m Carto DEM), Geomorphology, Land use – Land cover, Slope Forming Material and Regolith Thickness maps were prepared for susceptibility analysis. All the above eight maps were used for assessment of factor class ratings. However, only six thematic maps (except aspect and drainage) were considered for validation of Landslide Susceptibility Analysis (LSA) of the study area due to the absence of identified factor classes in a particular map. The detail study of the thematic map and landslide inventory map shows the following:

- In the Slope Morphometry maps, in case of slope angle, approx. 70% of the area is occupied by slope angle class of <15° followed by slope class of 15° to 25° which occupies approx. 20% of the area. In case of slope curvature, the distribution is much better. Concave and Convex class covers most of the area with an area coverage of 48% and 44% respectively.
- In the Land use - Land cover map, thick vegetation occupies approx. 55% of the area followed by Plantation (HHP) which occupies approx. 30% of the area.
- In the Geomorphology map, Rolling Pain occupies approx. 36% area followed by Moderately Dissected Slope and Lowly Dissected Slope that occupies 31% and 27% of the area respectively.
- In Slope Forming Material map, approx. 88% of the area is occupied by In-situ Soil class.
- In Regolith Thickness map, approx. 87% of the area is covered by 0.5 m – 5 m thickness class.

For understanding the relative importance of every geofactor that is specific to the terrain, inter-predictor weights were calculated for the six geofactors. Analysis of the inter-predictor weights has shown that:

- Slope Angle class has the maximum importance amongst all the geofactors.
- Land use – Land cover class has the second most importance followed by Slope Forming Material, Geomorphology and Regolith Thickness classes in descending order amongst all the geofactors.
- Slope Curvature class has the least importance amongst all the geofactors.

Using these six geofactor classes, the final Landslide Susceptibility Map (LSM) is generated. Analysis of the LSM has shown that:

- About 63% of the area falls under low susceptibility class, 29% of the area falls under moderate susceptibility class, whereas only 8% area falls under high susceptibility class.
- The majority of the areas situated in the western, southern and central side of the study area falls under low susceptibility class with small patches of areas with moderate susceptibility class within it. On the other hand, areas situated in eastern and north eastern side of the study area falls under moderate susceptibility class with considerable patches of under high susceptibility class within it.
- Almost all the major localities of the study area like Uppinangadi, Beltangadi, Ujre, Dharmastala, Nelyadi etc. comes under low susceptibility class. Localities like Gundia and Maranhalli comes under moderate susceptibility class. Very few localities like Shiradigadi come under high susceptibility class.
- Most of the area that falls under high susceptibility class are mostly devoid of any major localities due to presence of the Shiradi Ghat section.

Usability of the output map

The prepared landslide susceptibility map is useful be for the following aspects:

- Perspective planning for future developmental activities (like construction of new projects) in the classified low susceptibility zones.
- Identification and delineation of target areas for meso - scale (1:5,000/10,000) or detailed site specific studies.
- The prepared landslide inventory database along with the landslide susceptibility map can meaningfully serve as a contributing parameter for the geo-hazard assessment and evaluation of the area.
- The landslide susceptibility map when combined with temporal data can be effectively used for assessing the landslide hazard and risk scenario of the area.

Limitations

Every methodology tends to have its own limitations and constraints. Similarly, during the study, a few constraints in terms of the methodology adopted for this study were also identified which are enumerated below:

- The mapping of the nature and extent of the slope forming material based on observations at accessible stretches may not depict the true picture on all hill slopes. Subsequently, the regolith thickness map is very subjective since the regolith thickness along a slope is visually estimated on the basis of its exposure in a section and extrapolated to adjacent areas considering the terrain morphology.
- The assumption of the methodology that the relations between spatial factors and past / present landslides are relevant to the occurrence of future landslides may not always hold true in nature.
- The generated Landslide Susceptibility Map (LSM) is prepared considering the slope conditions prevalent at the time of study. However, the dynamicity of the studied hill slopes is greatly increased by the rapidly changing land use – land cover pattern through the augmentation of new settlements, deforestation, alignment of new roads and widening of the existing ones, etc. Therefore, the generated LSM may require periodic updation and re-evaluation.
- 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.
- Limitations in understanding the terrain and its landslide characteristics thereby affecting the selection of preparatory factors are also probable.

In spite of the above, the generated landslide susceptibility map of the area is the first level spatial database on regional scale which can form the basis of landslide hazard and risk evaluation indicating the vulnerability and the elements at risk.

Recommendations

Based on the evaluation of the geofactors and understanding their relative importance that are specific to the terrain, as well as considering the scale of the study and the observations made in the field, the following generic recommendations are suggested:

- Future developmental planning like expansion of township, development of infrastructure, etc., may be carried out in the designated low susceptibility zones, i.e. in and around localities like Uppinangadi, Beltangadi, Ujre, Dharmastala, Nelyadi etc.
- The areas situated in eastern and north eastern side of the study area falls under moderate susceptibility class with considerable patches of areas under high susceptibility class within it. So, construction of public or personal utility projects should be avoided in highly susceptible areas.
- The lifeline of the study area is NH – 75 connecting Mangaluru to Bengaluru passes through the area. An approx. 70 km stretch of this very important communication corridor falls within the study area. A conclusion derived from the generated Landslide Susceptibility Map (LSM) indicates that a stretch of 32 km (from Gundia to Devihalli) of the road corridor falls under mostly moderate susceptibility zones along with few stretches of both high and low susceptibility zones. The areas lies in toposheet no 48P/09, between Gundia and Devihalli and this part of Western Ghats is locally known as Shiradi Ghat section. Regular monitoring may be taken up for these road corridors to avoid future slope failures.
- Within this stretch of 32 km road corridor, 15 nos. of landslide incidences have been reported and all of the landslides are result of the toe cutting of the slope for road construction. Although most of the landslides are inactive in nature, four are presently active. A detail site specific study of these landslides can be taken up to get an idea about the actual conditions.
- The assessment of the landslide susceptibility is extremely important for such high vulnerable areas because it gives basic construction standards for new roads or buildings, helps to assess the impact of future landslides and can also be used to locate key facilities like hospitals, fire stations, etc. As a general recommendation, if end users intend to use only the susceptibility map for land use planning, then no public or personal utility projects should be considered in highly susceptible areas, strict building safety regulations should be followed in moderate susceptible areas and constructions with simple slope

stability measures be allowed in low susceptible areas. This is a general recommendation related to the landslide susceptibility based on the present land use condition. However the susceptibility values can be lowered if proper mitigation measures are adopted such that a high susceptible area can be made less vulnerable to landslides. Therefore, it is recommended that the susceptibility map should be interpreted accordingly and the degree of susceptibility or hazard in response of mitigation measures should be worked out judiciously. In this regard cost - benefit analysis may be carried out for better planning.

- Landslide Susceptibility Mapping (LSM) is very useful in identifying various zones susceptible to landslides in landslide affected areas. Therefore, it is recommended to give the LSM studies its due importance in respect of preventive / remedial measures to treat these landslides by civil engineers in consultation with land use and town planners.
- The susceptibility map is generally meant for regional application because the information shown is on 1:50,000 scale; 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. Areas falling under high susceptibility should be given due attention while executing civil constructions.
- In the event if a disaster strikes, then loss would be immense if buildings are not safely and properly located. The only economical way of reducing "at least" the loss of life is by making people aware of the inherent risk. Therefore, it is recommended that more priority should be given in increasing awareness amongst people through Community Based Disaster Management Programme (CBDMP).
- 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.
- The villages or communities located in and around high susceptible areas should be given priority in holding CBDMP.

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LOCALITY INDEX

Sl. No.	Village Name	Toposheet No.	Latitude (N)	Longitude (E)
1	Agani	48P/09	12°58'54.11"	75°40'54.48"
2	Alankaru	48P/05	12°46'47.63"	75°21'3.94"
3	Amblitadka	48P/09	12°56'6.71"	75°31'36.13"
4	Attihali	48P/09	12°45'51.83"	75°43'42.95"
5	Bandaru	48P/05	12°53'21.48"	75°17'46.69"
6	Bandihole	48P/05	12°53'24.71"	75°28'40.43"
7	Beltangadi	48P/05	12°59'26.87"	75°16'26.4"
8	Chinhalli	48P/09	12°49'45.47"	75°44'29.76"
9	Chogadamaranhalli	48P/09	12°53'45.23"	75°42'0.73"
10	Devihalli	48P/09	12°54'16.92"	75°44'4.54"
11	Dharmastala	48P/05	12°56'59.99"	75°22'58.07"
12	Gerukatte	48P/05	12°56'41.99"	75°15'33.48"
13	Golitattu	48P/05	12°50'51.72"	75°21'43.19"
14	Gundia	48P/09	12°49'32.51"	75°34'20.65"
15	Gurjanhalli	48P/09	12°55'14.15"	75°41'30.49"
16	Guruvayanakere	48P/05	12°59'8.87"	75°15'37.43"
17	Guttillade	48P/05	12°48'13.32"	75°19'31.08"
18	Hanubalu	48P/09	12°59'56.75"	75°42'16.9"
19	Hirebandadi	48P/05	12°48'42.48"	75°16'9.13"
20	Hongadahalla	48P/09	12°47'36.59"	75°41'51"
21	Honnekalu	48P/09	12°55'22.8"	75°42'14.76"
22	Hoshalli	48P/09	12°48'31.67"	75°43'45.12"
23	Hudarkare	48P/09	12°54'20.87"	75°41'18.95"
24	Jarigeball	48P/05	12°56'3.12"	75°15'22.68"
25	Kadmane	48P/09	12°54'40.67"	75°40'18.83"
26	Kanchana	48P/05	12°49'46.56"	75°20'2.39"
27	Kayartadka	48P/05	12°55'58.79"	75°26'29.74"
28	Koyyuru	48P/05	12°56'57.83"	75°18'20.88"
29	Kumaradi	48P/09	12°55'53.04"	75°43'39.71"

Sl. No.	Village Name	Toposheet No.	Latitude (N)	Longitude (E)
30	Kuppettu	48P/05	12°53'14.63"	75°15'8.26"
31	Kuthur	48P/09	12°45'26.63"	75°34'29.63"
32	Kutrapadi	48P/05	12°45'7.92"	75°28'53.39"
33	Kyamanhalli	48P/09	12°58'24.24"	75°43'2.99"
34	Magallu	48P/09	12°57'25.19"	75°44'29.76"
35	Makangadde	48P/09	12°59'27.6"	75°37'0.83"
36	Maranhalli	48P/09	12°52'40.07"	75°43'7.69"
37	Mata	48P/05	12°50'21.12"	75°16'27.47"
38	Narimogaru	48P/05	12°45'18.36"	75°15'10.07"
39	Nekladi	48P/05	12°58'46.55"	75°25'12.35"
40	Nelgalli	48P/09	12°59'17.88"	75°38'13.91"
41	Nelyadi	48P/05	12°50'16.08"	75°24'19.06"
42	Nerala	48P/05	12°47'40.2"	75°27'20.89"
43	Neriya	48P/05	12°59'53.52"	75°26'58.91"
44	Nidle	48P/05	12°55'41.15"	75°24'22.69"
45	Pijakkala	48P/05	12°50'48.47"	75°18'23.76"
46	Puduvettu	48P/05	12°56'46.32"	75°24'27"
47	Rekya	48P/05	12°49'33.6"	75°28'5.52"
48	Sharavur	48P/05	12°45'28.08"	75°20'48.84"
49	Shiradi	48P/09	12°49'48.36"	75°31'41.15"
50	Sullia	48P/05	12°50'26.88"	75°17'58.91"
51	Ujre	48P/05	12°59'49.55"	75°19'11.99"
52	Uppinangadi	48P/05	12°50'16.44"	75°15'13.32"
52	Utseramane	48P/09	12°53'30.11"	75°42'9.35"

SYNOPSIS OF WORK DONE

1	**Title of the report**	Macro – scale (1:50,000) Landslide Susceptibility Mapping in parts of toposheet nos. 48P/05 and 48P/09, Dakshin Kannad and Hassan districts, Karnataka.
2	**FSP Code No**	LSM/SR/KG/2016/111
3	**Field Season**	2016 - 17
4	**Date of Commencement**	26th October 2016
5	**Date of Completion**	10th March 2017
6	**Officers associated with the investigation and no. of days spent in the field**	Tanvi Gupta, Geologist (79 days) Sunandan Basu, Geologist (80 days)
7	**Quantum of work done**	

1. Pre-field preparation	
(i) Slope Forming Material map	1500 sq. km
(ii) Geomorphology & Lineament map	1500 sq. km
(iii) Slope Morphometry (slope, aspect & curvature) map	1500 sq. km
(iv) Land use - Land cover map	1500 sq. km
(v) Drainage map	1500 sq. km
(vi) Regolith thickness map	1500 sq. km
(vii) Preparation of Landslide Inventory Map	1500 sq. km
2. Field-based studies	
(i) Field-checking of all thematic maps	1500 sq. km
(ii) Field validation of landslide inventory and collection of recent and historic landslides (using archives, old reports, road register etc.)	1500 sq. km (16 Nos.)
(iii) Collection of landslide inventory and damage data as per 41 point geo parametric data sheet	1500 sq. km
3. Post-field studies & modelling	
(i) Updation of thematic and inventory maps in GIS	1500 sq. km
(ii) Preparation of Landslide Susceptibility Map in GIS	1500 sq. km
(iii) Validation of landslide susceptibility map at important locations	1500 sq. km
4. Collection of rainfall data from available rain stations	1500 sq. km (Collected available data)

8	**Expenditure**	

POL (Rs.)	33,480.00
Wages (Rs.)	1,06,288.00
OC (Rs.)	91,629.00
Total (Rs.)	**2,31,397.00**

FIVE POINT PROFORMA

Title of the report: Macro – scale (1:50,000) Landslide Susceptibility Mapping in parts of toposheet nos. 48P/05 and 48P/09, Dakshin Kannad and Hassan 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 for FS 2016 – 17 to prepare seamless landslide susceptibility map.
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 No: LSM/SR/KG/2016/111
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.	26th October 2016 2 officers spent total 159 man days at the field 1. Tanvi Gupta, Geologist – 79 days 2. Sunandan Basu, Geologist – 80 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

ANNEXURES

Annexure – 1: LOFS Calculations

Geofactor: Land Use Land Cover (LULC)

Rank of LULC Classes

Sl No	Class Name	Code	Rank
1	Barren	B	**1**
2	Barren Sand	BS	0
3	Cultivation	CL	**2**
4	Extensive Slope Cut	ESC	**9**
5	Fallow Land	FL	**1**
6	Moderate Vegetation	MV	**5**
7	Plantation (HHP)	HHP	**4**
8	Plantation (LHP)	LHP	**3**
9	Quarry	QR	**5**
10	Settlement	S	**1**
11	Settlement on modified slope	SM	**7**
12	Swamp	SW	0
13	Thick Vegetation	TV	**4**
14	Sparse Vegetation	SV	**7**
15	Water body	WB	0
16	Salt Pan	SP	0

Geofactor: Land Use Land Cover (LULC)

Matrix of Pairwise Ratings of LULC Class

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 Column	**49.00**	**38.50**	**3.00**	**49.00**	**15.18**	**21.58**	**29.50**	**15.48**	**49.00**	**6.96**	**21.58**	**6.96**

Geofactor: Land Use Land Cover (LULC)

Estimated Eigen values, fraction rate and LOFS for LULC classes

LULC	B	CL	ESC	FL	MV	HHP	LHP	QR	S	SM	TV	SV	Sum Rows	Frac Weight	LOFS
B	0.0204	0.0130	0.0370	0.0204	0.0132	0.0116	0.0113	0.0129	0.0204	0.0205	0.0116	0.0205	0.2128	0.0177	0.0626
CL	0.0408	0.0260	0.0417	0.0408	0.0165	0.0154	0.0169	0.0161	0.0408	0.0239	0.0154	0.0239	0.3184	0.0265	0.0937
ESC	0.1837	0.2078	0.3332	0.1837	0.3293	0.2780	0.2373	0.3229	0.1837	0.4309	0.2780	0.4309	3.3994	0.2833	1.0000
FL	0.0204	0.0130	0.0370	0.0204	0.0132	0.0116	0.0113	0.0129	0.0204	0.0205	0.0116	0.0205	0.2128	0.0177	0.0626
MV	0.1020	0.1039	0.0666	0.1020	0.0659	0.0927	0.1017	0.0646	0.1020	0.0479	0.0927	0.0479	0.9899	0.0825	0.2912
HHP	0.0816	0.0779	0.0555	0.0816	0.0329	0.0463	0.0678	0.0323	0.0816	0.0359	0.0463	0.0359	0.6759	0.0563	0.1988
LHP	0.0612	0.0519	0.0476	0.0612	0.0220	0.0232	0.0339	0.0215	0.0612	0.0287	0.0232	0.0287	0.4644	0.0387	0.1366
QR	0.1020	0.1039	0.0666	0.1020	0.0659	0.0927	0.1017	0.0646	0.1020	0.0479	0.0927	0.0479	0.9899	0.0825	0.2912
S	0.0204	0.0130	0.0370	0.0204	0.0132	0.0116	0.0113	0.0323	0.0204	0.0205	0.0116	0.0205	0.2322	0.0194	0.0683
SM	0.1429	0.1558	0.1111	0.1429	0.1976	0.1853	0.1695	0.1938	0.1429	0.1436	0.1853	0.1436	1.9143	0.1595	0.5631
TV	0.0816	0.0779	0.0555	0.0816	0.0329	0.0463	0.0678	0.0323	0.0816	0.0359	0.0463	0.0359	0.6759	0.0563	0.1988
SV	0.1429	0.1558	0.1111	0.1429	0.1976	0.1853	0.1695	0.1938	0.1429	0.1436	0.1853	0.1436	1.9143	0.1595	0.5631

Geofactor: Land Use Land Cover (LULC)

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	0.0177	0.0133	0.0315	0.0177	0.0165	0.0141	0.0129	0.0165	0.0194	0.0228	0.0141	0.0228	0.2192	12.3591
CL	0.0355	0.0265	0.0354	0.0355	0.0206	0.0188	0.0193	0.0206	0.0387	0.0266	0.0188	0.0266	0.3229	12.1696
ESC	0.1596	0.2123	0.2833	0.1596	0.4125	0.3379	0.2709	0.4125	0.1742	0.4786	0.3379	0.4786	3.7177	13.1239
FL	0.0177	0.0133	0.0315	0.0177	0.0165	0.0141	0.0129	0.0165	0.0194	0.0228	0.0141	0.0228	0.2192	12.3591
MV	0.0887	0.1061	0.0567	0.0887	0.0825	0.1126	0.1161	0.0825	0.0968	0.0532	0.1126	0.0532	1.0496	12.7240
HHP	0.0709	0.0796	0.0472	0.0709	0.0412	0.0563	0.0774	0.0412	0.0774	0.0399	0.0563	0.0399	0.6984	12.4001
LHP	0.0532	0.0531	0.0405	0.0532	0.0275	0.0282	0.0387	0.0275	0.0581	0.0319	0.0282	0.0319	0.4718	12.1921
QR	0.0887	0.1061	0.0567	0.0887	0.0825	0.1126	0.1161	0.0825	0.0968	0.0532	0.1126	0.0532	1.0496	12.7240
S	0.0177	0.0133	0.0315	0.0177	0.0165	0.0141	0.0129	0.0412	0.0194	0.0228	0.0141	0.0228	0.2439	12.6068
SM	0.1241	0.1592	0.0944	0.1241	0.2475	0.2253	0.1935	0.2475	0.1355	0.1595	0.2253	0.1595	2.0954	13.1358
TV	0.0709	0.0796	0.0472	0.0709	0.0412	0.0563	0.0774	0.0412	0.0774	0.0399	0.0563	0.0399	0.6984	12.4001
SV	0.1241	0.1592	0.0944	0.1241	0.2475	0.2253	0.1935	0.2475	0.1355	0.1595	0.2253	0.1595	2.0954	13.1358
Sum CV														151.33
Mean Consistency Vector (Mean CV) = Total CV/ Nos. Of factor class (151.33/12) =														12.6109
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

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**

Geofactor Maps

Weightage of Geofactor Maps

Sl No	Factor Map Name	Code	Weightage
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 Map

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 Map

Estimated Eigen values, fraction rate and Weight for Factor Map

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 Map

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 – 2: 41 Point Geo-parametric Data Format for Landslides

1	Name	KAR/HAS/48P09/2016/01
2	Latitude (N) (DMS)	12° 49' 45.885"
3	Longitude (E) (DMS)	75° 37' 47.305"
4	Toposheet No	48P09
5	Village Name	East of Shiradigadi
6	Road	NH - 75
7	Geomorphic Process	Gravitational
8	Geomorphic Form	Moderately 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	Rock
17	Thickness	< 0.5 m
18	Landuse	Extensive Slope Cut
19	Hydrology	Damp
20	Erosion	Toe Erosion
21	Susceptibility	High
22	Risk	Moderate
23	Landslide Length	10 m
24	Landslide Width	18 m
25	Landslide Height	8 m
26	Landslide Run Out	*Data Not Available*
27	Landslide Material	Debris
28	Movement Type	Slide
29	Failure Depth	3 m
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	85°
37	Triggering Factor	Anthropogenic
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/HAS/48P09/2016/02
2	Latitude (N) (DMS)	12° 49' 47.250"
3	Longitude (E) (DMS)	75° 38' 4.870"
4	Toposheet No	48P09
5	Village Name	East of Shiradigadi
6	Road	NH - 75
7	Geomorphic Process	Gravitational
8	Geomorphic Form	Moderately 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	Rock
17	Thickness	< 0.5 m
18	Landuse	Extensive Slope Cut
19	Hydrology	Damp
20	Erosion	Toe Erosion
21	Susceptibility	High
22	Risk	Moderate
23	Landslide Length	15 m
24	Landslide Width	8 m
25	Landslide Height	12 m
26	Landslide Run Out	*Data Not Available*
27	Landslide Material	Debris
28	Movement Type	Slide
29	Failure Depth	3 m
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	45°
36	Downslope	85°
37	Triggering Factor	Anthropogenic
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/HAS/48P09/2016/03
2	Latitude (N) (DMS)	12° 49' 46.581"
3	Longitude (E) (DMS)	75° 38' 6.108"
4	Toposheet No	48P09
5	Village Name	East of Shiradigadi
6	Road	NH - 75
7	Geomorphic Process	Gravitational
8	Geomorphic Form	Moderately 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	Rock
17	Thickness	< 0.5 m
18	Landuse	Extensive Slope Cut
19	Hydrology	Damp
20	Erosion	Toe Erosion
21	Susceptibility	High
22	Risk	Moderate
23	Landslide Length	6 m
24	Landslide Width	15 m
25	Landslide Height	4 m
26	Landslide Run Out	*Data Not Available*
27	Landslide Material	Debris
28	Movement Type	Slide
29	Failure Depth	5 m
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	45°
36	Downslope	85°
37	Triggering Factor	Anthropogenic
38	Casualties	*Data Not Available*
39	Geo Scientific Cause	Toe cutting of the slope
40	Remedial Measures	Retaining wall with weep holes
41	Remarks	The slide is almost removed as the toe part of the slide is cut due to road construction and widening. This is the case with most of the previously reported slides which are removed due to road construction and widening.

1	Name	KAR/HAS/48P09/2016/04
2	Latitude (N) (DMS)	12° 49' 41.854"
3	Longitude (E) (DMS)	75° 38' 24.434"
4	Toposheet No	48P09
5	Village Name	East of Shiradigadi
6	Road	NH - 75
7	Geomorphic Process	Gravitational
8	Geomorphic Form	Moderately 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	Rock
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	25 m
24	Landslide Width	30 m
25	Landslide Height	18 m
26	Landslide Run Out	*Data Not Available*
27	Landslide Material	Debris
28	Movement Type	Slide
29	Failure Depth	5 m
30	Landslide Activity	Active
31	Landslide Distribution	Retrogressive & Wiedning
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	Anthropogenic
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/HAS/48P09/2016/05
2	Latitude (N) (DMS)	12° 49' 59.207"
3	Longitude (E) (DMS)	75° 38' 52.582"
4	Toposheet No	48P09
5	Village Name	East of Shiradigadi
6	Road	NH - 75
7	Geomorphic Process	Gravitational
8	Geomorphic Form	Moderately 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	Rock
17	Thickness	< 0.5 m
18	Landuse	Extensive Slope Cut
19	Hydrology	Damp
20	Erosion	Toe Erosion
21	Susceptibility	High
22	Risk	Moderate
23	Landslide Length	8 m
24	Landslide Width	15 m
25	Landslide Height	6 m
26	Landslide Run Out	*Data Not Available*
27	Landslide Material	Debris
28	Movement Type	Slide
29	Failure Depth	3 m
30	Landslide Activity	Inactive
31	Landslide Distribution	Wiedning
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	Anthropogenic
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/HAS/48P09/2016/06
2	Latitude (N) (DMS)	12° 49' 59.912"
3	Longitude (E) (DMS)	75° 38' 53.815"
4	Toposheet No	48P09
5	Village Name	East of Shiradigadi
6	Road	NH - 75
7	Geomorphic Process	Gravitational
8	Geomorphic Form	Moderately 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	Rock
17	Thickness	< 0.5 m
18	Landuse	Extensive Slope Cut
19	Hydrology	Damp
20	Erosion	Toe Erosion
21	Susceptibility	High
22	Risk	Moderate
23	Landslide Length	20 m
24	Landslide Width	20 m
25	Landslide Height	15 m
26	Landslide Run Out	*Data Not Available*
27	Landslide Material	Rock
28	Movement Type	Slide
29	Failure Depth	4 m
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	35°
36	Downslope	75°
37	Triggering Factor	Anthropogenic
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/HAS/48P09/2016/07
2	Latitude (N) (DMS)	12° 50' 0.345"
3	Longitude (E) (DMS)	75° 38' 59.297"
4	Toposheet No	48P09
5	Village Name	East of Shiradigadi
6	Road	NH - 75
7	Geomorphic Process	Gravitational
8	Geomorphic Form	Moderately 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	Rock
17	Thickness	< 0.5 m
18	Landuse	Extensive Slope Cut
19	Hydrology	Damp
20	Erosion	Toe Erosion
21	Susceptibility	High
22	Risk	Moderate
23	Landslide Length	10 m
24	Landslide Width	15 m
25	Landslide Height	8 m
26	Landslide Run Out	*Data Not Available*
27	Landslide Material	Debris
28	Movement Type	Slide
29	Failure Depth	2 m
30	Landslide Activity	Inactive
31	Landslide Distribution	Wiedning
32	Landslide Style	Single
33	Landslide Mechanism	Shallow Translational Failure
34	Landslide Initiation	*Data Not Available*
35	Upslope	45°
36	Downslope	85°
37	Triggering Factor	Anthropogenic
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/HAS/48P09/2016/08
2	Latitude (N) (DMS)	12° 50' 2.996"
3	Longitude (E) (DMS)	75° 39' 14.123"
4	Toposheet No	48P09
5	Village Name	East of Shiradigadi
6	Road	NH - 75
7	Geomorphic Process	Gravitational
8	Geomorphic Form	Moderately 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	Rock
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	25 m
24	Landslide Width	30 m
25	Landslide Height	17 m
26	Landslide Run Out	*Data Not Available*
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	40°
36	Downslope	80°
37	Triggering Factor	Anthropogenic
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/HAS/48P09/2016/09
2	Latitude (N) (DMS)	12° 50' 4.441"
3	Longitude (E) (DMS)	75° 39' 15.406"
4	Toposheet No	48P09
5	Village Name	East of Shiradigadi
6	Road	NH - 75
7	Geomorphic Process	Gravitational
8	Geomorphic Form	Moderately 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	Rock
17	Thickness	< 0.5 m
18	Landuse	Extensive Slope Cut
19	Hydrology	Damp
20	Erosion	Toe Erosion
21	Susceptibility	High
22	Risk	Moderate
23	Landslide Length	12 m
24	Landslide Width	30 m
25	Landslide Height	8 m
26	Landslide Run Out	*Data Not Available*
27	Landslide Material	Debris
28	Movement Type	Slide
29	Failure Depth	4 m
30	Landslide Activity	Inactive
31	Landslide Distribution	Wiedning
32	Landslide Style	Single
33	Landslide Mechanism	Shallow Translational Failure
34	Landslide Initiation	*Data Not Available*
35	Upslope	40°
36	Downslope	75°
37	Triggering Factor	Anthropogenic
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/HAS/48P09/2016/10
2	Latitude (N) (DMS)	12° 50' 7.291"
3	Longitude (E) (DMS)	75° 39' 19.892"
4	Toposheet No	48P09
5	Village Name	East of Shiradigadi
6	Road	NH - 75
7	Geomorphic Process	Gravitational
8	Geomorphic Form	Moderately 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	Rock
17	Thickness	< 0.5 m
18	Landuse	Extensive Slope Cut
19	Hydrology	Damp
20	Erosion	Toe Erosion
21	Susceptibility	High
22	Risk	Moderate
23	Landslide Length	15 m
24	Landslide Width	25 m
25	Landslide Height	12 m
26	Landslide Run Out	*Data Not Available*
27	Landslide Material	Debris
28	Movement Type	Slide
29	Failure Depth	3 m
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	85°
37	Triggering Factor	Anthropogenic
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/HAS/48P09/2016/11
2	Latitude (N) (DMS)	12° 50' 22.120"
3	Longitude (E) (DMS)	75° 39' 35.167"
4	Toposheet No	48P09
5	Village Name	East of Shiradigadi
6	Road	NH - 75
7	Geomorphic Process	Gravitational
8	Geomorphic Form	Moderately 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	Rock
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	35 m
24	Landslide Width	100 m
25	Landslide Height	25 m
26	Landslide Run Out	*Data Not Available*
27	Landslide Material	Debris
28	Movement Type	Slide
29	Failure Depth	5 m
30	Landslide Activity	Active
31	Landslide Distribution	Retrogressive & Wiedning
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	Anthropogenic
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/HAS/48P09/2016/12
2	Latitude (N) (DMS)	12° 50' 27.389"
3	Longitude (E) (DMS)	75° 40' 25.020"
4	Toposheet No	48P09
5	Village Name	South - West of Maranahalli
6	Road	NH - 75
7	Geomorphic Process	Gravitational
8	Geomorphic Form	Moderately 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	Rock
17	Thickness	< 0.5 m
18	Landuse	Extensive Slope Cut
19	Hydrology	Damp
20	Erosion	Toe Erosion
21	Susceptibility	High
22	Risk	Moderate
23	Landslide Length	30 m
24	Landslide Width	80 m
25	Landslide Height	18 m
26	Landslide Run Out	*Data Not Available*
27	Landslide Material	Debris
28	Movement Type	Slide
29	Failure Depth	6 m
30	Landslide Activity	Inactive
31	Landslide Distribution	Wiedning
32	Landslide Style	Single
33	Landslide Mechanism	Shallow Translational Failure
34	Landslide Initiation	*Data Not Available*
35	Upslope	35°
36	Downslope	70°
37	Triggering Factor	Anthropogenic
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/HAS/48P09/2016/13
2	Latitude (N) (DMS)	12° 50' 27.547"
3	Longitude (E) (DMS)	75° 40' 28.555"
4	Toposheet No	48P09
5	Village Name	South - West of Maranahalli
6	Road	NH - 75
7	Geomorphic Process	Gravitational
8	Geomorphic Form	Moderately 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	Rock
17	Thickness	< 0.5 m
18	Landuse	Extensive Slope Cut
19	Hydrology	Damp
20	Erosion	Toe Erosion
21	Susceptibility	High
22	Risk	Moderate
23	Landslide Length	40 m
24	Landslide Width	70 m
25	Landslide Height	25 m
26	Landslide Run Out	*Data Not Available*
27	Landslide Material	Debris
28	Movement Type	Slide
29	Failure Depth	8 m
30	Landslide Activity	Inactive
31	Landslide Distribution	Retrogressive
32	Landslide Style	Single
33	Landslide Mechanism	Deep Translational Failure
34	Landslide Initiation	*Data Not Available*
35	Upslope	40°
36	Downslope	85°
37	Triggering Factor	Anthropogenic
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/HAS/48P09/2016/14
2	Latitude (N) (DMS)	12° 50' 34.036"
3	Longitude (E) (DMS)	75° 40' 37.652"
4	Toposheet No	48P09
5	Village Name	South - West of Maranahalli
6	Road	NH - 75
7	Geomorphic Process	Gravitational
8	Geomorphic Form	Moderately 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	Rock
17	Thickness	< 0.5 m
18	Landuse	Extensive Slope Cut
19	Hydrology	Damp
20	Erosion	Toe Erosion
21	Susceptibility	High
22	Risk	Moderate
23	Landslide Length	15 m
24	Landslide Width	35 m
25	Landslide Height	13 m
26	Landslide Run Out	*Data Not Available*
27	Landslide Material	Debris
28	Movement Type	Slide
29	Failure Depth	4 m
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	45°
36	Downslope	85°
37	Triggering Factor	Anthropogenic
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/HAS/48P09/2016/15
2	Latitude (N) (DMS)	12° 50' 36.183"
3	Longitude (E) (DMS)	75° 40' 38.059"
4	Toposheet No	48P09
5	Village Name	South - West of Maranahalli
6	Road	NH - 75
7	Geomorphic Process	Gravitational
8	Geomorphic Form	Moderately 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	Rock
17	Thickness	< 0.5 m
18	Landuse	Extensive Slope Cut
19	Hydrology	Damp
20	Erosion	Toe Erosion
21	Susceptibility	High
22	Risk	Moderate
23	Landslide Length	20 m
24	Landslide Width	40 m
25	Landslide Height	12 m
26	Landslide Run Out	*Data Not Available*
27	Landslide Material	Debris
28	Movement Type	Slide
29	Failure Depth	5 m
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	45°
36	Downslope	70°
37	Triggering Factor	Anthropogenic
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/48P09/2016/16
2	Latitude (N) (DMS)	12° 56' 46.062"
3	Longitude (E) (DMS)	75° 24' 10.888"
4	Toposheet No	48P05
5	Village Name	West of Puduvettu
6	Road	Dharmasthala - Nekladi Road
7	Geomorphic Process	Gravitational
8	Geomorphic Form	Lowly Dissected Slope
9	Rock	Granite Gneiss
10	Weathering	Moderate
11	Rock Character	Massive
12	Dip Foliation	70°
13	Dip Direction Foliation	263°
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	High
23	Landslide Length	8 m
24	Landslide Width	18 m
25	Landslide Height	5 m
26	Landslide Run Out	*Data Not Available*
27	Landslide Material	Debris
28	Movement Type	Slide
29	Failure Depth	3 m
30	Landslide Activity	Active
31	Landslide Distribution	Retrogressive & Wiedning
32	Landslide Style	Single
33	Landslide Mechanism	Shallow Translational Failure
34	Landslide Initiation	*Data Not Available*
35	Upslope	40°
36	Downslope	85°
37	Triggering Factor	Anthropogenic
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

Annexure – 3: Field Data Collection Sheet

Location No	TS No	Locality / Village	Latitude	Longitude	Geomorphological Process	Geomorphological form	Weathering	Overburden Type	Overburden Thickness	Land use Type	Hydrological Condition	Erosion	Susceptibility Assessment of Slope	Qualitative Risk Assessment
1a	48P/ 5	East of Uppinangady	12^0 50' 11" E	75^0 15' 36" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
2a	48P/ 5	NW of Kaskar	12^0 50' 14" E	75^0 16' 04" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
3a	48P/ 5	NE of Mata NH-75	12^0 50' 24" E	75^0 16' 33" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
4a	48P/ 5	N of Naikuli	12^0 50' 30" E	75^0 16' 46" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Settlement	Damp	Toe erosion by Nala and River	Low	Low or absent
5a	48P/ 5	W of Sulia NH-75	12^0 50' 28" E	75^0 17' 43" N	Gravitational	Rolling Plane	Moderate	Granite gneiss	>0.5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
6a	48P/ 5	N of Sulia	12^0 50' 41" E	75^0 17' 59" N	Gravitational	Lowly dissected slope	Moderate	Granite gneiss	>0.5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent

Location No	TS No	Locality / Village	Latitude	Longitude	Geomorphological Process	Geomorphological form	Weathering	Overburden Type	Overburden Thickness	Land use Type	Hydrological Condition	Erosion	Susceptibility Assessment of Slope	Qualitative Risk Assessment
7a	48P/ 5	NE of Pijakkala NH-75	12^0 50' 57" E	75^0 18' 42" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
8a	48P/ 5	N of Nirkatte NH-75	12^0 50' 56" E	75^0 19' 31" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
9a	48P/ 5	N of Nirkatte NH-75	12^0 50' 58" E	75^0 19' 60" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
10a	48P/ 5	E of Nirkatte NH-75	12^0 50' 54" E	75^0 20' 29" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Moderate	Low or absent
11a	48P/ 5	W of Golitattu NH-75	12^0 50' 51" E	75^0 21' 18" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Low	Low or absent
12a	48P/ 5	Golitattu NH-75	12^0 50' 43" E	75^0 22' 4" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Settlement	Damp	Toe erosion by Nala and River	Low	Low or absent

Location No	TS No	Locality / Village	Latitude	Longitude	Geomorphological Process	Geomorphological form	Weathering	Overburden Type	Overburden Thickness	Land use Type	Hydrological Condition	Erosion	Susceptibility Assessment of Slope	Qualitative Risk Assessment
13a	48P/ 5	E of Golitattu NH-75	12^0 50' 30" E	75^0 22' 39" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
14a	48P/ 5	N of Nelyadi NH-75	12^0 50' 21" E	75^0 23' 23" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
15a	48P/ 5	Nelyadi	12^0 50' 09" E	75^0 24' 25" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Settlement	Damp	Toe erosion by Nala and River	Low	Low or absent
16a	48P/ 5	Maanaguddi	12^0 49' 39" E	75^0 25' 23" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
17a	48P/ 5	E of Mannaguddi	12^0 49' 33" E	75^0 26' 2" N	Gravitational	Lowly dissected slope	Moderate	In situ soil	0.5-5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Low	Low or absent
18a	48P/ 5	E of Mannaguddi	12^0 49' 28" E	75^0 26' 31" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Low	Low or absent

Location No	TS No	Locality / Village	Latitude	Longitude	Geomorphological Process	Geomorphological form	Weathering	Overburden Type	Overburden Thickness	Land use Type	Hydrological Condition	Erosion	Susceptibility Assessment of Slope	Qualitative Risk Assessment
19a	48P/ 5	W of Rekya NH-75	12^0 49' 18" E	75^0 27' 23" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Low	Low or absent
20a	48P/ 5	W of Nusibaltia NH-75	12^0 49' 05" E	75^0 27' 40" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Low	Low or absent
21a	48P/ 5	Rekya NH-75	12^0 49' 26" E	75^0 27' 59" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
22a	48P/ 5	E of Rekya NH-75	12^0 49' 38" E	75^0 28' 34" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
23a	48P/ 5	W of Udhane NH-75	12^0 49' 43" E	75^0 28' 57" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Moderate	Low or absent
24a	48P/ 5	Udhane	12^0 49' 47" E	75^0 29' 39" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Moderate	Low or absent

Location No	TS No	Locality / Village	Latitude	Longitude	Geomorphological Process	Geomorphological form	Weathering	Overburden Type	Overburden Thickness	Land use Type	Hydrological Condition	Erosion	Susceptibility Assessment of Slope	Qualitative Risk Assessment
25a	48P/ 5	SE of Managuddi	12^0 49' 13" E	75^0 26' 21" N	Gravitational	Lowly dissected slope	Moderate	In situ soil	0.5-5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Low	Low or absent
26a	48P/ 5	NE of Ichilampadi	12^0 48' 49" E	75^0 26' 45" N	Gravitational	Lowly dissected slope	Moderate	In situ soil	0.5-5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Low	Low or absent
27a	48P/ 5	N of Ichilampadi	12^0 48' 16" E	75^0 27' 3" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
28a	48P/ 5	Ichilampadi	12^0 47' 40" E	75^0 27' 20" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
29a	48P/ 5	W of Goliadka	12^0 47' 16" E	75^0 27' 58" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
30a	48P/ 5	Goliadka	12^0 47' 5" E	75^0 28' 27" N	Gravitational	Lowly dissected slope	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent

Location No	TS No	Locality / Village	Latitude	Longitude	Geomorphological Process	Geomorphological form	Weathering	Overburden Type	Overburden Thickness	Land use Type	Hydrological Condition	Erosion	Susceptibility Assessment of Slope	Qualitative Risk Assessment
31a	48P/ 5	Kallugudde	12^0 47' 44" E	75^0 28' 28" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
32a	48P/ 5	SE of Kallugudde	12^0 47' 31" E	75^0 29' 05" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
33a	48P/ 5	N of Kallugudde	12^0 48' 03" E	75^0 28' 35" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Settlement	Damp	Toe erosion by Nala and River	Low	Low or absent
34a	48P/ 5	N of Kallugudde	12^0 48' 23" E	75^0 28' 42" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
35a	48P/ 5	Peradka	12^0 46' 27" E	75^0 28' 20" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Settlement	Damp	Toe erosion by Nala and River	Low	Low or absent
36a	48P/ 5	SW of Peradka	12^0 46' 07" E	75^0 28' 03" N	Gravitational	Lowly dissected slope	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent

Location No	TS No	Locality / Village	Latitude	Longitude	Geomorphological Process	Geomorphological form	Weathering	Overburden Type	Overburden Thickness	Land use Type	Hydrological Condition	Erosion	Susceptibility Assessment of Slope	Qualitative Risk Assessment
37a	48P/5	NW of Kutrapadi	12^0 45' 34" E	75^0 28' 08" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Cultivation	Damp	Toe erosion by Nala and River	Low	Low or absent
38a	48P/5	Minadi	12^0 46' 00" E	75^0 28' 43" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
39a	48P/5	SE of Minadi	12^0 45' 46" E	75^0 29' 20" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Settlement	Damp	Toe erosion by Nala and River	Low	Low or absent
40a	48P/5	E of Kutrapadi	12^0 45' 7" E	75^0 29' 43" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
41a	48P/5	S of Nattibail	12^0 49' 52" E	75^0 15' 14" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Settlement	Damp	Toe erosion by Nala and River	Low	Low or absent
42a	48P/5	Bettodi	12^0 49' 38" E	75^0 15' 35" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Settlement	Damp	Toe erosion by Nala and River	Low	Low or absent

Location No	TS No	Locality / Village	Latitude	Longitude	Geomorphological Process	Geomorphological form	Weathering	Overburden Type	Overburden Thickness	Land use Type	Hydrological Condition	Erosion	Susceptibility Assessment of Slope	Qualitative Risk Assessment
43a	48P/5	NW of Barla	12^0 49' 15" E	75^0 15' 50" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
44a	48P/5	N of hirebandadi	12^0 48' 48" E	75^0 15' 59" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
45a	48P/5	W of Hirebabdadi	12^0 48' 36" E	75^0 15' 50" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Settlement	Damp	Toe erosion by Nala and River	Low	Low or absent
46a	48P/5	N of Boleme	12^0 48' 17" E	75^0 15' 37" N	Gravitational	Lowly dissected slope	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
47a	48P/5	W of Muguli	12^0 48' 20" E	75^0 16' 19" N	Gravitational	Lowly dissected slope	Moderate	In situ soil	0.5-5m	Sparse Vegetation	Damp	Toe erosion by Nala and River	Moderate	Low or absent
48a	48P/5	S of Muguli	12^0 48' 04" E	75^0 16' 46" N	Gravitational	Lowly dissected slope	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent

Location No	TS No	Locality / Village	Latitude	Longitude	Geomorphological Process	Geomorphological form	Weathering	Overburden Type	Overburden Thickness	Land use Type	Hydrological Condition	Erosion	Susceptibility Assessment of Slope	Qualitative Risk Assessment
49a	48P/ 5	S of Bandaru	12^0 48' 10" E	75^0 17' 13" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (LHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
50a	48P/ 5	N of Budu	12^0 48' 10" E	75^0 17' 48" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Settlement	Damp	Toe erosion by Nala and River	Low	Low or absent
51a	48P/ 5	SE of Kajkar	12^0 50' 05" E	75^0 16' 20" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
52a	48P/ 5	SE of Kajkar	12^0 49' 52" E	75^0 16' 52" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
53a	48P/ 5	NW of Kemmar	12^0 49' 40" E	75^0 17' 10" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Settlement	Damp	Toe erosion by Nala and River	Low	Low or absent
54a	48P/ 5	NW of Kemmar	12^0 49' 23" E	75^0 17' 36" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent

Location No	TS No	Locality / Village	Latitude	Longitude	Geomorphological Process	Geomorphological form	Weathering	Overburden Type	Overburden Thickness	Land use Type	Hydrological Condition	Erosion	Susceptibility Assessment of Slope	Qualitative Risk Assessment
55a	48P/ 5	Kemmar	12^0 48' 58" E	75^0 17' 53" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Settlement	Damp	Toe erosion by Nala and River	Low	Low or absent
56a	48P/ 5	Kemmar	12^0 48' 29" E	75^0 18' 8" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Settlement	Damp	Toe erosion by Nala and River	Low	Low or absent
57a	48P/ 5	E of Koila	12^0 48' 08" E	75^0 18' 27" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
58a	48P/ 5	Kinnimajlu	12^0 47' 50" E	75^0 18' 53" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Settlement	Damp	Toe erosion by Nala and River	Low	Low or absent
59a	48P/ 5	SW of Miyyala	12^0 47' 28" E	75^0 19' 24" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Settlement	Damp	Toe erosion by Nala and River	Low	Low or absent
60a	48P/ 5	E of Amba	12^0 47' 06" E	75^0 19' 03" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (LHP)	Damp	Toe erosion by Nala and River	Low	Low or absent

Location No	TS No	Locality / Village	Latitude	Longitude	Geomorphological Process	Geomorphological form	Weathering	Overburden Type	Overburden Thickness	Land use Type	Hydrological Condition	Erosion	Susceptibility Assessment of Slope	Qualitative Risk Assessment
61a	48P/ 5	SE of Amba	12^0 46' 46" E	75^0 18' 59" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
62a	48P/ 5	NW of Budattaru	12^0 46' 23" E	75^0 18' 48" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
63a	48P/ 5	SW of Budattaru	12^0 46' 04" E	75^0 18' 53" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
64a	48P/ 5	NE of Parangaji	12^0 46' 31" E	75^0 18' 17" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Settlement	Damp	Toe erosion by Nala and River	Low	Low or absent
65a	48P/ 5	S of Kalleri	12^0 46' 58" E	75^0 19' 51" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Settlement	Damp	Toe erosion by Nala and River	Low	Low or absent
66a	48P/ 5	W of Kaniya	12^0 49' 48" E	75^0 17' 42" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Moderate	Low or absent

Location No	TS No	Locality / Village	Latitude	Longitude	Geomorphological Process	Geomorphological form	Weathering	Overburden Type	Overburden Thickness	Land use Type	Hydrological Condition	Erosion	Susceptibility Assessment of Slope	Qualitative Risk Assessment
67a	48P/ 5	E of Kaniya	12^0 49' 44" E	75^0 18' 9" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
68a	48P/ 5	N of Paroli	12^0 49' 36" E	75^0 18' 51" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
69a	48P/ 5	NW of Kijana	12^0 49' 54" E	75^0 19' 09" N	Gravitational	Rolling Plane	High	Weathered rock	>0.5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
70a	48P/ 5	NE of Paroli	12^0 49' 28" E	75^0 19' 04" N	Gravitational	Rolling Plane	High	Weathered rock	>0.5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
71a	48P/ 5	N of Aruve	12^0 49' 10" E	75^0 19' 26" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
72a	48P/ 5	S of Ana	12^0 48' 44" E	75^0 19' 36" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent

Location No	TS No	Locality / Village	Latitude	Longitude	Geomorphological Process	Geomorphological form	Weathering	Overburden Type	Overburden Thickness	Land use Type	Hydrological Condition	Erosion	Susceptibility Assessment of Slope	Qualitative Risk Assessment
73a	48P/ 5	E of Guttilade	12^0 48' 15" E	75^0 19' 38" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Moderate	Low or absent
74a	48P/ 5	E of Kinnimajlu	12^0 47' 55" E	75^0 19' 22" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
75a	48P/ 5	NW of Alankaru	12^0 46' 59" E	75^0 20' 38" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
76a	48P/ 5	SE of Alankaru	12^0 46' 38" E	75^0 21' 19" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Settlement	Damp	Toe erosion by Nala and River	Low	Low or absent
77a	48P/ 5	Kunturu	12^0 46' 25" E	75^0 22' 03" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Settlement	Damp	Toe erosion by Nala and River	Low	Low or absent
78a	48P/ 5	Kunturu	12^0 46' 33" E	75^0 22' 38" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Settlement	Damp	Toe erosion by Nala and River	Low	Low or absent

Location No	TS No	Locality / Village	Latitude	Longitude	Geomorphological Process	Geomorphological form	Weathering	Overburden Type	Overburden Thickness	Land use Type	Hydrological Condition	Erosion	Susceptibility Assessment of Slope	Qualitative Risk Assessment
79a	48P/ 5	SE of Kunturu	12^0 46' 23" E	75^0 23' 13" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
80a	48P/ 5	SE of Kunturu	12^0 46' 10" E	75^0 23' 53" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Low	Low or absent
81a	48P/ 5	N of Padavu	12^0 46' 20" E	75^0 24' 33" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Settlement	Damp	Toe erosion by Nala and River	Low	Low or absent
82a	48P/ 5	W of Balya	12^0 46' 23" E	75^0 25' 05" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Low	Low or absent
83a	48P/ 5	SE of Balya	12^0 45' 59" E	75^0 25' 49" N	Gravitational		Moderate	In situ soil	0.5-5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Low	Low or absent
84a	48P/ 5	SE of Hosmatha	12^0 45' 21" E	75^0 26' 29" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent

Location No	TS No	Locality / Village	Latitude	Longitude	Geomorphological Process	Geomorphological form	Weathering	Overburden Type	Overburden Thickness	Land use Type	Hydrological Condition	Erosion	Susceptibility Assessment of Slope	Qualitative Risk Assessment
85a	48P/ 5	S of Kalmala Gudde	12^0 45' 08" E	75^0 27' 23" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Settlement	Damp	Toe erosion by Nala and River	Low	Low or absent
86a	48P/ 5	N of Mannaguddi	12^0 50' 52" E	75^0 25' 4" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
87a	48P/ 5	SE of Kokkada Devi	12^0 51' 09" E	75^0 24' 35" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Settlement	Damp	Toe erosion by Nala and River	Low	Low or absent
88a	48P/ 5	Kokkada	12^0 51' 34" E	75^0 24' 26" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Settlement	Damp	Toe erosion by Nala and River	Low	Low or absent
89a	48P/ 5	Kokkada	12^0 51' 38" E	75^0 23' 55" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Settlement	Damp	Toe erosion by Nala and River	Low	Low or absent
90a	48P/ 5	W of Kokkada Devn	12^0 51' 49" E	75^0 22' 54" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent

Location No	TS No	Locality / Village	Latitude	Longitude	Geomorphological Process	Geomorphological form	Weathering	Overburden Type	Overburden Thickness	Land use Type	Hydrological Condition	Erosion	Susceptibility Assessment of Slope	Qualitative Risk Assessment
91a	48P/ 5	NW of Kokkada	12^0 52' 14" E	75^0 22' 32" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
92a	48P/ 5	SE of Patrame	12^0 52' 36" E	75^0 22' 35" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Sparse Vegetation	Damp	Toe erosion by Nala and River	Moderate	Low or absent
93a	48P/ 5	SE of Patrame	12^0 52' 58" E	75^0 22' 18" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Settlement	Damp	Toe erosion by Nala and River	Low	Low or absent
94a	48P/ 5	S of Patrame	12^0 53' 26" E	75^0 21' 54" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
95a	48P/ 5	NW of Patrame	12^0 53' 56" E	75^0 21' 41" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
96a	48P/ 5	W of Ulia	12^0 54' 26" E	75^0 21' 53" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent

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97a	48P/ 5	NW of Ulia	12^0 54' 51" E	75^0 21' 50" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Low	Low or absent
98a	48P/ 5	S of Golitattu	12^0 50' 21.1" E	75^0 21' 48" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
99a	48P/ 5	S of Thirle	12^0 49' 48" E	75^0 21' 48" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
100a	48P/ 5	SW of Paleri	12^0 49' 15" E	75^0 21' 20" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
101a	48P/ 5	Perla	12^0 49' 13" E	75^0 20' 48" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
102a	48P/ 5	W of Perla	12^0 49' 08" E	75^0 20' 33" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent

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103a	48P/ 5	SW of Perla	12^0 48' 42" E	75^0 20' 26" N	Gravitational	Lowly dissected slope	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
104a	48P/ 5	S of Meluru	12^0 48' 32" E	75^0 20' 09" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
105a	48P/ 5	NW of Paleri	12^0 49' 42" E	75^0 21' 19" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
106a	48P/ 5	NW of Perla	12^0 49' 22" E	75^0 20' 32" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
107a	48P/ 5	N of Perla	12^0 49' 52' E	75^0 20' 35" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
108a	48P/ 5	NE of Kanchana	12^0 50' 11" E	75^0 20' 22" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent

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109a	48P/ 5	N of Kanchana	12^0 50' 22" E	75^0 20' 06" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
110a	48P/ 5	NW of Koppadabail	12^0 49' 55" E	75^0 22' 44" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Settlement	Damp	Toe erosion by Nala and River	Low	Low or absent
111a	48P/ 5	N of Koppadabail	12^0 49' 36" E	75^0 22' 60" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
112a	48P/ 5	S of Koppadabail	12^0 49' 04" E	75^0 23' 15" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
113a	48P/ 5	S of Koppadabail	12^0 48' 18" E	75^0 23' 20" N	Gravitational	Lowly dissected slope	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
114a	48P/ 5	S of Kodiadka	12^0 48' 05" E	75^0 22' 54" N	Gravitational	Lowly dissected slope	Moderate	In situ soil	0.5-5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Low	Low or absent

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115a	48P/ 5	NE of Surilubail	12^0 47' 33" E	75^0 22' 13" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
116a	48P/ 5	SW of Surilubail	12^0 46' 58" E	75^0 21' 42" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
117a	48P/ 5	Alankaru	12^0 46' 29" E	75^0 21' 09" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Settlement	Damp	Toe erosion by Nala and River	Low	Low or absent
118a	48P/ 5	NE of Sharavaru	12^0 45' 42" E	75^0 21' 10" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
119a	48P/ 5	S of Sharavaru	12^0 45' 10" E	75^0 20' 53" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
120a	48P/ 5	SW of Mannagudi	12^0 49' 41" E	75^0 24' 45" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Settlement	Damp	Toe erosion by Nala and River	Low	Low or absent

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121a	48P/ 5	SW of Mannagudi	12^0 49' 08" E	75^0 24' 45" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
122a	48P/ 5	SW of Mannagudi	12^0 48' 42" E	75^0 24' 31" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
123a	48P/ 5	SW of Mannagudi	12^0 48' 10" E	75^0 24' 46" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
124a	48P/ 5	S of Mannagudi	12^0 47' 38" E	75^0 25' 01" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
125a	48P/ 5	S of Mannagudi	12^0 47' 20" E	75^0 25' 21" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
126a	48P/ 5	NW of Balya	12^0 46' 44" E	75^0 25' 13" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Settlement	Damp	Toe erosion by Nala and River	Low	Low or absent

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127a	48P/ 5	SW of Kalladka	12^0 51' 54" E	75^0 25' 14" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
128a	48P/ 5	NW of Kalladka	12^0 52' 33" E	75^0 25' 10" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
129a	48P/ 5	S of Nidle	12^0 53' 02" E	75^0 24' 40" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Low	Low or absent
130a	48P/ 5	S of Nidle RF	12^0 53' 23" E	75^0 24' 10" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Low	Low or absent
131a	48P/ 5	S of Nidle	12^0 54' 04" E	75^0 24' 18" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
132a	48P/ 5	S of Nidle	12^0 54' 50" E	75^0 24' 11" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Moderate	Low or absent

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133a	48P/ 5	S of Nidle	12^0 55' 09" E	75^0 24' 06" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Low	Low or absent
134a	48P/ 5	S of Nidle	12^0 55' 33" E	75^0 24' 15" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
135a	48P/ 5	N of Nidle	12^0 56' 0" E	75^0 24' 13" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Low	Low or absent
136a	48P/ 5	N of Nidle	12^0 56' 35" E	75^0 23' 55" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Low	Low or absent
137a	48P/ 5	SE of Dharmastala	12^0 57' 04" E	75^0 23' 39" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Low	Low or absent
138a	48P/ 5	NE of Dharmastala	12^0 57' 14" E	75^0 23' 08" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Settlement	Damp	Toe erosion by Nala and River	Low	Low or absent

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139a	48P/ 5	NW of Dharmastala	12^0 57' 30" E	75^0 22' 37" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Moderate	Low or absent
140a	48P/ 5	NW of Dharmastala	12^0 57' 49" E	75^0 22' 07" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
141a	48P/ 5	NW of Dharmastala	12^0 58' 16" E	75^0 21' 39" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Settlement	Damp	Toe erosion by Nala and River	Low	Low or absent
142a	48P/ 5	NW of Dharmastala	12^0 58' 38" E	75^0 21' 20" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Low	Low or absent
143a	48P/ 5	NW of Dharmastala	12^0 58' 59" E	75^0 20' 59" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
144a	48P/ 5	SE of Ujre	12^0 59' 21" E	75^0 20' 37" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent

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145a	48P/ 5	SE of Ujre	12^0 59' 18" E	75^0 20' 04" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Settlement	Damp	Toe erosion by Nala and River	Low	Low or absent
146a	48P/ 5	Ujre	12^0 59' 46" E	75^0 19' 39" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Settlement	Damp	Toe erosion by Nala and River	Low	Low or absent
147a	48P/ 5	Ujre	12^0 59' 45" E	75^0 19' 06" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Settlement	Damp	Toe erosion by Nala and River	Low	Low or absent
148a	48P/ 5	W of Ujre	12^0 59' 42" E	75^0 18' 30" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
149a	48P/ 5	W of Ujre	12^0 59' 33" E	75^0 17' 48" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
150a	48P/ 5	E of Beltangadi	12^0 59' 34" E	75^0 17' 12" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Settlement	Damp	Toe erosion by Nala and River	Low	Low or absent

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151a	48P/5	Beltangadi	12^0 59' 21" E	75^0 16' 45" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Settlement	Damp	Toe erosion by Nala and River	Low	Low or absent
152a	48P/5	Beltangadi	12^0 59' 23" E	75^0 16' 08" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Settlement	Damp	Toe erosion by Nala and River	Low	Low or absent
153a	48P/5	Guruvayanakere	12^0 59' 16" E	75^0 15' 23" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
154a	48P/5	Guruvayanakere	12^0 58' 57" E	75^0 15' 10" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Settlement	Damp	Toe erosion by Nala and River	Low	Low or absent
155a	48P/5	NW of Kuttiyar	12^0 58' 26" E	75^0 15' 20" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Settlement	Damp	Toe erosion by Nala and River	Low	Low or absent
156a	48P/5	Machchina	12^0 57' 58" E	75^0 15' 25" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent

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157a	48P/ 5	N of kalya	12^0 57' 27" E	75^0 15' 38" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
158a	48P/ 5	N of Gerukatte	12^0 56' 50" E	75^0 15' 40" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
159a	48P/ 5	S of Gerukatte	12^0 56' 20" E	75^0 15' 35" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Settlement	Damp	Toe erosion by Nala and River	Low	Low or absent
160a	48P/ 5	SE of Jarigebail	12^0 55' 41" E	75^0 15' 32" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
161a	48P/ 5	S of Jarigebail	12^0 55' 16" E	75^0 15' 21" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
162a	48P/ 5	S of Jarigebail	12^0 54' 51" E	75^0 15' 06" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent

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163a	48P/5	N of Kupettu	12^0 54' 09" E	75^0 15' 11" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
164a	48P/5	Kupettu	12^0 53' 10" E	75^0 15' 08" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Extensive slope cut	Damp	Toe erosion by Nala and River	Moderate	Low or absent
165a	48P/5	SE of Kupettu	12^0 52' 52" E	75^0 15' 26" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
166a	48P/5	SE of Kupettu	12^0 52' 31" E	75^0 15' 56" N	Gravitational	Rolling Plane	High	Weathered rock	>0.5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
167a	48P/5	SE of Kupettu	12^0 52' 05" E	75^0 16' 14" N	Gravitational	Rolling Plane	High	Weathered rock	>0.5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
168a	48P/5	NW of Indamogru	12^0 51' 44" E	75^0 16' 42" N	Gravitational	Rolling Plane	High	Weathered rock	>0.5m	Plantation (LHP)	Damp	Toe erosion by Nala and River	Low	Low or absent

Location No	TS No	Locality / Village	Latitude	Longitude	Geomorphological Process	Geomorphological form	Weathering	Overburden Type	Overburden Thickness	Land use Type	Hydrological Condition	Erosion	Susceptibility Assessment of Slope	Qualitative Risk Assessment
169a	48P/5	NW of Indamogru	12^0 51' 40" E	75^0 17' 07" N	Gravitational	Rolling Plane	Moderate	Granite gneiss	>0.5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
170a	48P/5	Indamogru	12^0 51' 29" E	75^0 17' 29" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Settlement	Damp	Toe erosion by Nala and River	Low	Low or absent
171a	48P/5	Indamogru	12^0 51' 38" E	75^0 18' 04" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
172a	48P/5	NE of Arrabi	12^0 50' 42" E	75^0 15' 29" N	Gravitational	Rolling Plane	High	Weathered rock	>0.5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
173a	48P/5	N of Yenmadi	12^0 50' 56" E	75^0 16' 01" N	Gravitational	Rolling Plane	High	Weathered rock	>0.5m	Settlement	Damp	Toe erosion by Nala and River	Low	Low or absent
174a	48P/5	NW of Buleri	12^0 51' 26" E	75^0 16' 23" N	Gravitational	Rolling Plane	High	Weathered rock	>0.5m	Settlement	Damp	Toe erosion by Nala and River	Low	Low or absent

Location No	TS No	Locality / Village	Latitude	Longitude	Geomorphological Process	Geomorphological form	Weathering	Overburden Type	Overburden Thickness	Land use Type	Hydrological Condition	Erosion	Susceptibility Assessment of Slope	Qualitative Risk Assessment
175a	48P/ 5	NE of Indamogu	12^0 52' 03" E	75^0 18' 24" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
176a	48P/ 5	W of Votechar	12^0 52' 19" E	75^0 18' 39" N	Gravitational	Lowly dissected slope	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
177a	48P/ 5	Paravarkotya	12^0 49' 46" E	75^0 30' 34" N	Gravitational	Valley fill	Moderate	In situ soil	0.5-5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Moderate	Low or absent
178a	48P/ 5	SW of Shiradi	12^0 49' 37" E	75^0 31' 13" N	Gravitational	Valley fill	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
179a	48P/ 5	S of Shiradi	12^0 49' 41" E	75^0 31' 40" N	Gravitational	Valley fill	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
180a	48P/ 5	SW of Denjiroli	12^0 49' 57" E	75^0 32' 24" N	Gravitational	Valley fill	Moderate	In situ soil	0.5-5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Low	Low or absent

Location No	TS No	Locality / Village	Latitude	Longitude	Geomorphological Process	Geomorphological form	Weathering	Overburden Type	Overburden Thickness	Land use Type	Hydrological Condition	Erosion	Susceptibility Assessment of Slope	Qualitative Risk Assessment
181a	48P/ 5	SE of Bandaru	12^0 52' 59" E	75^0 18' 12" N	Gravitational	Rolling Plane	High	Weathered rock	>0.5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
182a	48P/ 5	Bandaru	12^0 53' 22" E	75^0 18' 02" N	Gravitational	Rolling Plane	High	Weathered rock	>0.5m	Plantation (LHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
183a	48P/ 5	NW of Bandaru	12^0 53' 37" E	75^0 17' 40" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
184a	48P/ 5	NW of Bandaru	12^0 53' 45" E	75^0 17' 11" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Settlement	Damp	Toe erosion by Nala and River	Low	Low or absent
185a	48P/ 5	W of Bandaru	12^0 53' 38" E	75^0 16' 43" N	Gravitational	Rolling Plane	High	Weathered rock	>0.5m	Settlement	Damp	Toe erosion by Nala and River	Low	Low or absent
186a	48P/ 5	SW of Bandaru	12^0 53' 9" E	75^0 16' 35" N	Gravitational	Rolling Plane	High	Weathered rock	>0.5m	Settlement	Damp	Toe erosion by Nala and River	Low	Low or absent

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187a	48P/5	Denjiroli	12^0 50' 01" E	75^0 32' 49" N	Gravitational	Valley fill	Moderate	In situ soil	0.5-5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Low	Low or absent
188a	48P/5	E of Denjiroli	12^0 50' 10" E	75^0 33' 26" N	Gravitational	Valley fill	Moderate	In situ soil	0.5-5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Low	Low or absent
189a	48P/5	SE of Addola	12^0 49' 59" E	75^0 33' 51" N	Gravitational	Valley fill	Moderate	In situ soil	0.5-5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Low	Low or absent
190a	48P/5	Gundia	12^0 49' 41" E	75^0 34' 15" N	Gravitational	Valley fill	Moderate	In situ soil	0.5-5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Low	Low or absent
191a	48P/5	E of Gundia	12^0 49' 39" E	75^0 34' 47" N	Gravitational	Valley fill	Moderate	In situ soil	0.5-5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Low	Low or absent
192a	48P/5	E of Gundia	12^0 49' 45" E	75^0 35' 08" N	Gravitational	Moderately dissected slope	Moderate	Granite gneiss	>0.5m	Extensive slope cut	Damp	Toe erosion by Nala and River	Low	Low or absent

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193a	48P/ 5	W of Shiradigadi	12^0 49' 49" E	75^0 35' 32" N	Gravitational	Moderately dissected slope	Moderate	Granite gneiss	>0.5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Moderate	Low or absent
194a	48P/ 5	W of Shiradigadi	12^0 49' 43" E	75^0 36' 01" N	Gravitational	Moderately dissected slope	Moderate	Granite gneiss	>0.5m	Thick Vegetation	Damp	Toe erosion by Nala and River	High	Low or absent
195a	48P/ 5	W of Shiradigadi	12^0 49' 47" E	75^0 36' 21" N	Gravitational	Moderately dissected slope	Moderate	Granite gneiss	>0.5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Low	Low or absent
196a	48P/ 5	E of Shiradigadi	12^0 49' 46" E	75^0 36' 58" N	Gravitational	Moderately dissected slope	Moderate	Granite gneiss	>0.5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Moderate	Low or absent
197a	48P/ 5	E of Shiradigadi	12^0 49' 46" E	75^0 37' 34" N	Gravitational	Rolling Plane	Moderate	Granite gneiss	>0.5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Moderate	Low or absent
197b	48P/ 5	SE of Shiradigadi	12^0 49' 26" E	75^0 37' 39" N	Gravitational	Moderately dissected slope	Moderate			Thick Vegetation	Damp	Toe erosion by Nala and River	Low	Low or absent

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198a	48P/ 5	N of Votechar	12^0 52' 45" E	75^0 18' 49" N	Gravitational	Rolling Plane	High	Weathered rock	>0.5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
199a	48P/ 5	N of Ittur	12^0 52' 59" E	75^0 19' 13" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
200a	48P/ 5	N of Ittur	12^0 53' 15" E	75^0 19' 36" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
201a	48P/ 5	N of Ittur	12^0 53' 43" E	75^0 19' 43" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
202a	48P/ 5	SE of Baipadi	12^0 54' 04" E	75^0 19' 31" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
203a	48P/ 5	E of Baipadi	12^0 54' 33" E	75^0 19' 07" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent

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204a	48P/5	NE of Baipadi	12^0 54' 52" E	75^0 19' 17" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Low	Low or absent
205a	48P/5	S of Belal	12^0 55' 23" E	75^0 19' 21" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
206a	48P/5	S of Belal	12^0 55' 34" E	75^0 19' 45" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Low	Low or absent
207a	48P/5	N of Belal	12^0 56' 21" E	75^0 19' 49" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Settlement	Damp	Toe erosion by Nala and River	Low	Low or absent
208a	48P/5	N of Belal	12^0 56' 51" E	75^0 19' 55" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Low	Low or absent
209a	48P/5	N of Belal	12^0 57' 15" E	75^0 19' 30" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Settlement	Damp	Toe erosion by Nala and River	Low	Low or absent

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210a	48P/ 5	S of Ujre	12^0 57' 47" E	75^0 19' 13" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
211a	48P/ 5	S of Ujre	12^0 58' 20" E	75^0 19' 12" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
212a	48P/ 5	S of Ujre	12^0 58' 47" E	75^0 19' 22" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Settlement	Damp	Toe erosion by Nala and River	Low	Low or absent
213a	48P/ 5	SE of Jjre	12^0 59' 13" E	75^0 19' 37" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Settlement	Damp	Toe erosion by Nala and River	Low	Low or absent
214a	48P/ 5	W of Baipadi	12^0 54' 20" E	75^0 18' 34" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Settlement	Damp	Toe erosion by Nala and River	Low	Low or absent
215a	48P/ 5	NW of Baipadi	12^0 54' 39" E	75^0 18' 11" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent

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216a	48P/ 5	E of Pambelu	12^0 55' 05" E	75^0 17' 54" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
217a	48P/ 5	S of Adurperal	12^0 55' 36" E	75^0 17' 39" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
218a	48P/ 5	N of Adurperal	12^0 56' 12" E	75^0 17' 37" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Settlement	Damp	Toe erosion by Nala and River	Low	Low or absent
219a	48P/ 5	N of Adurperal	12^0 56' 33" E	75^0 17' 33" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
220a	48P/ 5	Koyyuru	12^0 56' 47" E	75^0 17' 60" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
221a	48P/ 5	Koyyuru	12^0 56' 47" E	75^0 18' 27" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent

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222a	48P/ 5	NE of Koyyuru	12^0 57' 11" E	75^0 18' 38" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
223a	48P/ 5	N of Koyyuru	12^0 57' 39" E	75^0 18' 20" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
224a	48P/ 5	N of Koyyuru	12^0 58' 07" E	75^0 18' 10" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Settlement	Damp	Toe erosion by Nala and River	Low	Low or absent
225a	48P/ 5	SE of Beltangadi	12^0 58' 26" E	75^0 17' 45" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Low	Low or absent
226a	48P/ 5	SE of Beltangadi	12^0 58' 56" E	75^0 17' 30" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
227a	48P/ 5	S of Gundia	12^0 49' 24" E	75^0 34' 09" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Low	Low or absent

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228a	48P/ 5	E of Derane	12^0 48' 59" E	75^0 34' 01" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Low	Low or absent
229a	48P/ 5	SE of Derane	12^0 48' 29" E	75^0 34' 04" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Low	Low or absent
230a	48P/ 5	N of Anila	12^0 47' 48" E	75^0 34' 20" N	Gravitational	Lowly dissected slope	Moderate	In situ soil	0.5-5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Moderate	Low or absent
231a	48P/ 5	Anila	12^0 47' 21" E	75^0 34' 27" N	Gravitational	Lowly dissected slope	Moderate	In situ soil	0.5-5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Low	Low or absent
232a	48P/ 5	W of Manimunda	12^0 46' 45" E	75^0 34' 33" N	Gravitational	Lowly dissected slope	Moderate	In situ soil	0.5-5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Low	Low or absent
233a	48P/ 5	W of Bagpuni	12^0 46' 20" E	75^0 34' 34" N	Gravitational	Lowly dissected slope	Moderate	In situ soil	0.5-5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Low	Low or absent

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234a	48P/ 5	N of Kuthur	12^0 45' 51" E	75^0 34' 36" N	Gravitational	Lowly dissected slope	Moderate	In situ soil	0.5-5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Low	Low or absent
235a	48P/ 5	Kuthur	12^0 45' 28" E	75^0 34' 21" N	Gravitational	Lowly dissected slope	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
236a	48P/ 5	E of Kuthur	12^0 45' 22" E	75^0 34' 53" N	Gravitational	Lowly dissected slope	Moderate	In situ soil	0.5-5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Low	Low or absent
237a	48P/ 5	S of Kaparbail	12^0 45' 03" E	75^0 35' 25" N	Gravitational	Lowly dissected slope	Moderate	In situ soil	0.5-5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Low	Low or absent
238a	48P/ 5	Nidle	12^0 55' 44" E	75^0 24' 29" N	Gravitational	Rolling Plane	Moderate	Granite gneiss	>0.5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
239a	48P/ 5	SE of Nidle	12^0 55' 32" E	75^0 24' 47" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent

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240a	48P/ 5	N of Kalanja	12^0 55' 16" E	75^0 25'07" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
241a	48P/ 5	N of Kalanja	12^0 55' 16" E	75^0 25' 24" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
242a	48P/ 5	NE of Kalanja	12^0 55' 09" E	75^0 25' 49" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
243a	48P/ 5	SE of Kalanja	12^0 54' 53" E	75^0 26' 07" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
244a	48P/ 5	SE of Kalanja	12^0 54' 23" E	75^0 26' 22" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
245a	48P/ 5	SE of Kalanja	12^0 53' 52" E	75^0 26' 15" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent

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246a	48P/ 5	S of Kayartadka	12^0 53' 50" E	75^0 26' 48" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
247a	48P/ 5	S of Kayartadka	12^0 54' 30" E	75^0 26' 43" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
248a	48P/ 5	S of Kayartadka	12^0 55' 02" E	75^0 26' 40" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	High	Low or absent
249a	48P/ 5	S of Kayartadka	12^0 55' 35" E	75^0 26' 22" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
250a	48P/ 5	NE of Kalanja	12^0 55' 33" E	75^0 25' 41" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
251a	48P/ 5	W of Kayartadka	12^0 55' 50" E	75^0 26' 06" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent

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252a	48P/ 5	N of Kayartadka	12^0 56' 24" E	75^0 26' 18" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
253a	48P/ 5	S of Kedampotta	12^0 57' 3" E	75^0 26' 24" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
254a	48P/ 5	N of Kedampotta	12^0 57' 37" E	75^0 26' 33" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
255a	48P/ 5	N of Miyar	12^0 58' 10" E	75^0 26' 38" N	Gravitational	Moderately dissected slope	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
256a	48P/ 5	N of Nidval	12^0 58' 20" E	75^0 26' 11" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
257a	48P/ 5	SE of Pilikala	12^0 59' 00" E	75^0 26' 02" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Settlement	Damp	Toe erosion by Nala and River	Low	Low or absent

Location No	TS No	Locality / Village	Latitude	Longitude	Geomorphological Process	Geomorphological form	Weathering	Overburden Type	Overburden Thickness	Land use Type	Hydrological Condition	Erosion	Susceptibility Assessment of Slope	Qualitative Risk Assessment
258a	48P/ 5	NW of Neriya	12^0 59' 35" E	75^0 26' 24" N	Gravitational	Moderately dissected slope	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
259a	48P/ 5	SW of Kalladka	12^0 52' 01" E	75^0 25' 30" N	Gravitational	Lowly dissected slope	Moderate	In situ soil	0.5-5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Low	Low or absent
260a	48P/ 5	W of Mundriyal	12^0 52' 20" E	75^0 26' 05" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
261a	48P/ 5	Mundriyal	12^0 51' 56" E	75^0 26' 20" N	Gravitational	Lowly dissected slope	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
262a	48P/ 5	SE of Mundriyal	12^0 51' 31" E	75^0 26' 58" N	Gravitational	Lowly dissected slope	Moderate	In situ soil	0.5-5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Low	Low or absent
263a	48P/ 5	Arasinamakki	12^0 52' 19" E	75^0 27' 39" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent

Location No	TS No	Locality / Village	Latitude	Longitude	Geomorphological Process	Geomorphological form	Weathering	Overburden Type	Overburden Thickness	Land use Type	Hydrological Condition	Erosion	Susceptibility Assessment of Slope	Qualitative Risk Assessment
264a	48P/5	NE of Arasinamakki	12^0 52' 34" E	75^0 28' 03" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
265a	48P/5	SW of Bandihole	12^0 53' 05" E	75^0 28' 17" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
266a	48P/5	Bandihole	12^0 53' 20" E	75^0 28' 43" N	Gravitational	Valley fill	Moderate	In situ soil	0.5-5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Low	Low or absent
267a	48P/5	NW of Kallaje	12^0 53' 48" E	75^0 29' 07" N	Gravitational	Moderately dissected slope	Moderate	Granite gneiss	>0.5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Low	Low or absent
268a	48P/5	N of Kallaje	12^0 54' 17" E	75^0 29' 33" N	Gravitational	Moderately dissected slope	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Moderate	Low or absent
269a	48P/5	W of Narimogaru	12^0 45' 17" E	75^0 15' 04" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Settlement	Damp	Toe erosion by Nala and River	Moderate	Low or absent

Location No	TS No	Locality / Village	Latitude	Longitude	Geomorphological Process	Geomorphological form	Weathering	Overburden Type	Overburden Thickness	Land use Type	Hydrological Condition	Erosion	Susceptibility Assessment of Slope	Qualitative Risk Assessment
270a	48P/ 5	Narimogaru	12^0 45' 15" E	75^0 15' 29" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Settlement	Damp	Toe erosion by Nala and River	Low	Low or absent
271a	48P/ 5	NE of Narimogaru	12^0 45' 33" E	75^0 15' 38" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
272a	48P/ 5	NW of Vattemundur	12^0 45' 48" E	75^0 15' 48" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Settlement	Damp	Toe erosion by Nala and River	Low	Low or absent
273a	48P/ 5	N of Vattemundur	12^0 46' 40" E	75^0 16' 08" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
274a	48P/ 5	SE of Narimogaru	12^0 45' 07" E	75^0 15' 51" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Moderate	Low or absent
275a	48P/ 5	E of Narimogaru	12^0 45' 02" E	75^0 16' 20" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	High	Low or absent

Location No	TS No	Locality / Village	Latitude	Longitude	Geomorphological Process	Geomorphological form	Weathering	Overburden Type	Overburden Thickness	Land use Type	Hydrological Condition	Erosion	Susceptibility Assessment of Slope	Qualitative Risk Assessment
276a	48P/ 5	Holaradi	12^0 45' 03" E	75^0 16' 55" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Settlement	Damp	Toe erosion by Nala and River	High	Low or absent
277a	48P/ 5	N of Holaradi	12^0 45' 30" E	75^0 16' 53" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	High	Low or absent
278a	48P/ 5	Viramangla	12^0 45' 50" E	75^0 17' 15" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	High	Low or absent
279a	48P/ 5	E of Shiradigadi	12^0 49' 44" E	75^0 38' 13" N	Gravitational	Moderately dissected slope	Moderate	Granite gneiss	>0.5m	Thick Vegetation	Damp	Toe erosion by Nala and River	High	Low or absent
280a	48P/ 5	E of Shiradigadi	12^0 49' 51" E	75^0 38' 50" N	Gravitational	Moderately dissected slope	Moderate	Granite gneiss	>0.5m	Thick Vegetation	Damp	Toe erosion by Nala and River	High	Low or absent
281a	48P/ 5	E of Shiradigadi	12^0 50' 06" E	75^0 39' 19" N	Gravitational	Moderately dissected slope	Moderate	Granite gneiss	>0.5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Moderate	Low or absent

Location No	TS No	Locality / Village	Latitude	Longitude	Geomorphological Process	Geomorphological form	Weathering	Overburden Type	Overburden Thickness	Land use Type	Hydrological Condition	Erosion	Susceptibility Assessment of Slope	Qualitative Risk Assessment
281b	48P/ 6	SE of Shiradigadi	12^{0} 49' 39" E	75^{0} 39' 36" N	Gravitational	Moderately dissected slope	Moderate						Moderate	
282a	48P/ 5	NE of Shiradigadi	12^{0} 50' 22" E	75^{0} 39' 45" N	Gravitational	Moderately dissected slope	Moderate	Granite gneiss	>0.5m	Extensive slope cut	Damp	Toe erosion by Nala and River	Moderate	Low or absent
283a	48P/ 5	SW of Maranhalli	12^{0} 50' 22" E	75^{0} 40' 14" N	Gravitational	Moderately dissected slope	Moderate	Granite gneiss	>0.5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Moderate	Low or absent
284a	48P/ 5	SW of Maranhalli	12^{0} 50' 40" E	75^{0} 40' 45" N	Gravitational	Moderately dissected slope	Moderate	Granite gneiss	>0.5m	Extensive slope cut	Damp	Toe erosion by Nala and River	Moderate	Low or absent
285a	48P/ 5	SW of Maranhalli	12^{0} 50' 45" E	75^{0} 41' 12" N	Gravitational	Moderately dissected slope	Moderate	Granite gneiss	>0.5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Low	Low or absent
286a	48P/ 5	SW of Maranhalli	12^{0} 50' 49" E	75^{0} 41' 38" N	Gravitational	Moderately dissected slope	Moderate	Granite gneiss	>0.5m	Extensive slope cut	Damp	Toe erosion by Nala and River	Moderate	Low or absent

Location No	TS No	Locality / Village	Latitude	Longitude	Geomorphological Process	Geomorphological form	Weathering	Overburden Type	Overburden Thickness	Land use Type	Hydrological Condition	Erosion	Susceptibility Assessment of Slope	Qualitative Risk Assessment
287a	48P/5	SW of Maranhalli	12^0 51' 29" E	75^0 41' 47" N	Gravitational	Moderately dissected slope	Moderate	Granite gneiss	>0.5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Low	Low or absent
288a	48P/5	SW of Maranhalli	12^0 51' 49" E	75^0 42' 8" N	Gravitational	Moderately dissected slope	Moderate	Granite gneiss	>0.5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Low	Low or absent
289a	48P/5	SW of Maranhalli	12^0 52' 20" E	75^0 42' 24" N	Gravitational	Moderately dissected slope	Moderate	Granite gneiss	>0.5m	Extensive slope cut	Damp	Toe erosion by Nala and River	Moderate	Low or absent
290a	48P/5	SW of Maranhalli	12^0 52' 20" E	75^0 42' 43" N	Gravitational	Moderately dissected slope	Moderate	Granite gneiss	>0.5m	Settlement	Damp	Toe erosion by Nala and River	Low	Low or absent
291a	48P/5	Maranhalli	12^0 52' 37" E	75^0 42' 36" N	Gravitational	Moderately dissected slope	Moderate	In situ soil	0.5-5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Moderate	Low or absent
292a	48P/5	NW of Maranhalli	12^0 53' 09" E	75^0 42' 27" N	Gravitational	Moderately dissected slope	High	Weathered rock	>0.5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Moderate	Low or absent

Location No	TS No	Locality / Village	Latitude	Longitude	Geomorphological Process	Geomorphological form	Weathering	Overburden Type	Overburden Thickness	Land use Type	Hydrological Condition	Erosion	Susceptibility Assessment of Slope	Qualitative Risk Assessment
292b	48P/ 5	N of Malaikumari	12^0 53' 07" E	75^0 41' 58" N	Gravitational	Moderately dissected slope	High	Weathered rock	>0.5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Moderate	Low or absent
293a	48P/ 5	N of Utseramane	12^0 53' 48" E	75^0 42' 07" N	Gravitational	Lowly dissected slope	High	Weathered rock	>0.5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Moderate	Low or absent
294a	48P/ 5	Chogadainapa halii	12^0 54' 0" E	75^0 41' 31" N	Gravitational	Moderately dissected slope	High	Weathered rock	>0.5m	Settlement	Damp	Toe erosion by Nala and River	Low	Low or absent
295a	48P/ 5	S of Hudarkare	12^0 54' 02" E	75^0 41' 08" N	Gravitational	Moderately dissected slope	Moderate	In situ soil	0.5-5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Low	Low or absent
296a	48P/ 5	N of Maranhalli	12^0 52' 53" E	75^0 43' 14" N	Gravitational	Moderately dissected slope	Moderate	In situ soil	0.5-5m	Plantation (LHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
297a	48P/ 5	Heggadde	12^0 53' 31" E	75^0 43' 34" N	Gravitational	Lowly dissected slope	Moderate	In situ soil	0.5-5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Low	Low or absent

Location No	TS No	Locality / Village	Latitude	Longitude	Geomorphological Process	Geomorphological form	Weathering	Overburden Type	Overburden Thickness	Land use Type	Hydrological Condition	Erosion	Susceptibility Assessment of Slope	Qualitative Risk Assessment
298a	48P/ 5	Devihalli	12^0 54' 03" E	75^0 44' 08" N	Gravitational	Lowly dissected slope	Moderate	In situ soil	0.5-5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Low	Low or absent
299a	48P/ 5	NE of Devihalli	12^0 54' 50" E	75^0 44' 22" N	Gravitational	Lowly dissected slope	Moderate	In situ soil	0.5-5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Low	Low or absent
300a	48P/ 5	N of Kesganhalli	12^0 55' 10" E	75^0 44' 57" N	Gravitational	Lowly dissected slope	Moderate	In situ soil	0.5-5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Low	Low or absent
301a	48P/ 5	SE of Magallu	12^0 56' 54" E	75^0 44' 54" N	Gravitational	Lowly dissected slope	Moderate	In situ soil	0.5-5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Low	Low or absent
302a	48P/ 5	Magallu	12^0 54' 22" E	75^0 44' 37" N	Gravitational	Lowly dissected slope	Moderate	In situ soil	0.5-5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Low	Low or absent
303a	48P/ 5	NE of Kumbahalli	12^0 56' 52" E	75^0 44' 09" N	Gravitational	Lowly dissected slope	Moderate	In situ soil	0.5-5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Low	Low or absent

Location No	TS No	Locality / Village	Latitude	Longitude	Geomorphological Process	Geomorphological form	Weathering	Overburden Type	Overburden Thickness	Land use Type	Hydrological Condition	Erosion	Susceptibility Assessment of Slope	Qualitative Risk Assessment
304a	48P/ 5	Kumbahalli	12^0 56' 17" E	75^0 43' 54" N	Gravitational	Lowly dissected slope	Moderate	In situ soil	0.5-5m	Plantation (LHP)	Damp	Toe erosion by Nala and River	Moderate	Low or absent
305a	48P/ 5	Kumbahalli	12^0 56' 1" E	75^0 43' 34" N	Gravitational	Lowly dissected slope	Moderate	In situ soil	0.5-5m	Plantation (LHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
306a	48P/ 5	W of Ganadhalli	12^0 57' 46" E	75^0 44' 07" N	Gravitational	Lowly dissected slope	Moderate	In situ soil	0.5-5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Low	Low or absent
307a	48P/ 5	SE of Kyarmanhalli	12^0 58' 9" E	75^0 43' 27" N	Gravitational	Lowly dissected slope	Moderate	In situ soil	0.5-5m	Plantation (LHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
308a	48P/ 5	NE of Kyarmanhalli	12^0 58' 56" E	75^0 43' 08" N	Gravitational	Lowly dissected slope	Moderate	In situ soil	0.5-5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Low	Low or absent
309a	48P/ 5	NE of Jambaraddi	12^0 59' 22" E	75^0 42' 45" N	Gravitational	Lowly dissected slope	Moderate	In situ soil	0.5-5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Low	Low or absent

Location No	TS No	Locality / Village	Latitude	Longitude	Geomorphological Process	Geomorphological form	Weathering	Overburden Type	Overburden Thickness	Land use Type	Hydrological Condition	Erosion	Susceptibility Assessment of Slope	Qualitative Risk Assessment
310a	48P/ 5	S of Hanubalu	12^0 59' 48" E	75^0 42' 13" N	Gravitational	Lowly dissected slope	Moderate	In situ soil	0.5-5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Moderate	Low or absent
311a	48P/ 5	NE of Makkkipallu	12^0 59' 51" E	75^0 42' 56" N	Gravitational	Lowly dissected slope	Moderate	In situ soil	0.5-5m	Plantation (LHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
312a	48P/ 5	N of Madnapur	12^0 59' 48" E	75^0 43' 58" N	Gravitational	Lowly dissected slope	Moderate	In situ soil	0.5-5m	Plantation (LHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
313a	48P/ 5	Jambaraddi	12^0 59' 00" E	75^0 42' 19" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Low	Low or absent
314a	48P/ 5	S of Kyamanhalli	12^0 57' 58" E	75^0 42' 46" N	Gravitational	Lowly dissected slope	Moderate	In situ soil	0.5-5m	Settlement	Damp	Toe erosion by Nala and River	Low	Low or absent
315a	48P/ 5	Kalhalli	12^0 57' 52" E	75^0 46' 56" N	Gravitational	Lowly dissected slope	Moderate	In situ soil	0.5-5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Low	Low or absent

Location No	TS No	Locality / Village	Latitude	Longitude	Geomorphological Process	Geomorphological form	Weathering	Overburden Type	Overburden Thickness	Land use Type	Hydrological Condition	Erosion	Susceptibility Assessment of Slope	Qualitative Risk Assessment
316a	48P/5	NE of Ganadhalli	12^0 58' 09" E	75^0 44' 14" N	Gravitational	Lowly dissected slope	Moderate	In situ soil	0.5-5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Low	Low or absent
317a	48P/5	S of Mittodi	12^0 50' 04" E	75^0 28' 06" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Moderate	Low or absent
318a	48P/5	Gudrabadi	12^0 50' 51" E	75^0 27' 36" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Low	Low or absent
319a	48P/5	S of Arasinmakki	12^0 51' 38" E	75^0 27' 19" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
320a	48P/5	NE of Indateru	12^0 55' 31" E	75^0 30' 33" N	Gravitational	Lowly dissected slope	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
320b	48P/5	SE of Indateru	12^0 54' 53" E	75^0 31' 14" N	Gravitational	Lowly dissected slope	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Moderate	Low or absent

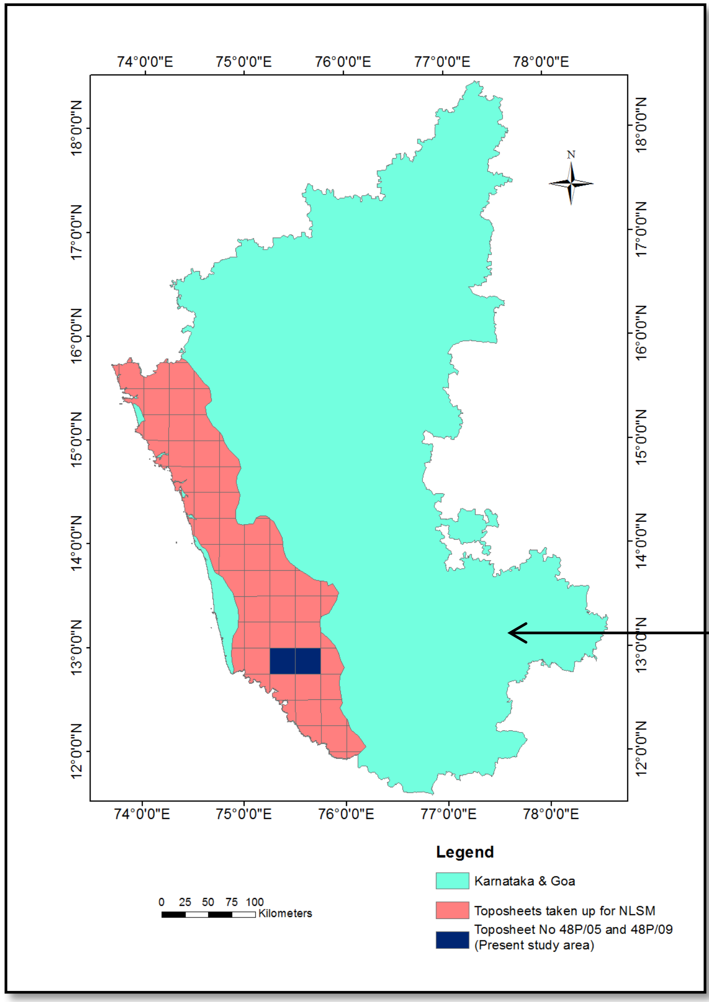
Location No	TS No	Locality / Village	Latitude	Longitude	Geomorphological Process	Geomorphological form	Weathering	Overburden Type	Overburden Thickness	Land use Type	Hydrological Condition	Erosion	Susceptibility Assessment of Slope	Qualitative Risk Assessment
321a	48P/ 5	Mucheradka	12^0 55' 50" E	75^0 30' 51" N	Gravitational	Valley fill	Moderate	In situ soil	0.5-5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Low	Low or absent
321b	48P/ 5	N of Indateru	12^0 56' 29" E	75^0 30' 03" N	Gravitational	Lowly dissected slope	Moderate	In situ soil	>0.5m	Barren	Damp	Toe erosion by Nala and River	Low	Low or absent
322a	48P/ 5	SE of Arasinmakki	12^0 52' 26" E	75^0 28' 14" N	Gravitational	Lowly dissected slope	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
323a	48P/ 5	NW of Durgadevn	12^0 52' 35" E	75^0 29' 08" N	Gravitational	Lowly dissected slope	Moderate	In situ soil	0.5-5m	Thick Vegetation	Damp	Toe erosion by Nala and River	Low	Low or absent
324a	48P/ 5	Durgadevn	12^0 52' 08" E	75^0 29' 56" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
325a	48P/ 5	Sonandur	12^0 51' 31" E	75^0 30' 29" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Settlement	Damp	Toe erosion by Nala and River	Low	Low or absent

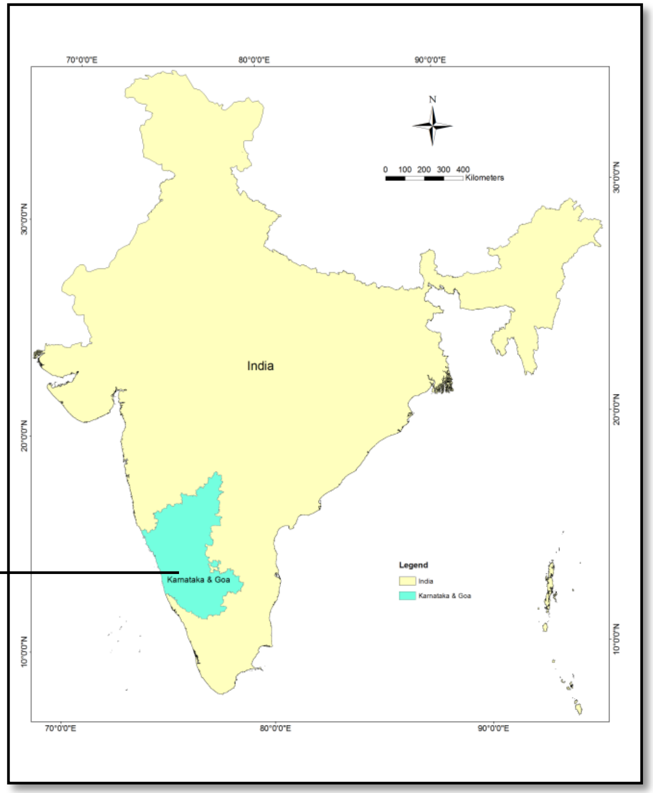
Location No	TS No	Locality / Village	Latitude	Longitude	Geomorphological Process	Geomorphological form	Weathering	Overburden Type	Overburden Thickness	Land use Type	Hydrological Condition	Erosion	Susceptibility Assessment of Slope	Qualitative Risk Assessment
326a	48P/5	Kaida	12^0 50' 43" E	75^0 30' 39" N	Gravitational		Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
327a	48P/5	Puduvettu	12^0 56' 49" E	75^0 24' 27" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
328a	48P/5	W of Bolmanaru	12^0 57' 39" E	75^0 24' 46" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (LHP)	Damp	Toe erosion by Nala and River	Low	Low or absent
329a	48P/5	S of Nekladi	12^0 58' 21" E	75^0 25' 02" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (LHP)	Damp	Toe erosion by Nala and River	Moderate	Low or absent
330a	48P/5	S of Kurumadkam	12^0 59' 32" E	75^0 24' 58" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (LHP)	Damp	Toe erosion by Nala and River	Moderate	Low or absent
331a	48P/5	Posolige	12^0 57' 39" E	75^0 23' 08" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Moderate	Low or absent

Location No	TS No	Locality / Village	Latitude	Longitude	Geomorphological Process	Geomorphological form	Weathering	Overburden Type	Overburden Thickness	Land use Type	Hydrological Condition	Erosion	Susceptibility Assessment of Slope	Qualitative Risk Assessment
332a	48P/ 6	Posolige	12^0 58' 17" E	75^0 23' 12" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Moderate	Low or absent
333a	48P/ 7	S of Kulanjilodi	12^0 58' 58" E	75^0 22' 57" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Moderate	Low or absent
334a	48P/ 8	W of Posolige	12^0 58' 04" E	75^0 22' 16" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Settlement	Damp	Toe erosion by Nala and River	Moderate	Low or absent
335a	48P/ 9	W of Posolige	12^0 58' 55" E	75^0 22' 20" N	Gravitational	Rolling Plane	Moderate	In situ soil	0.5-5m	Plantation (HHP)	Damp	Toe erosion by Nala and River	Moderate	Low or absent

PLATES

Plate – 1: Location Map of the study area

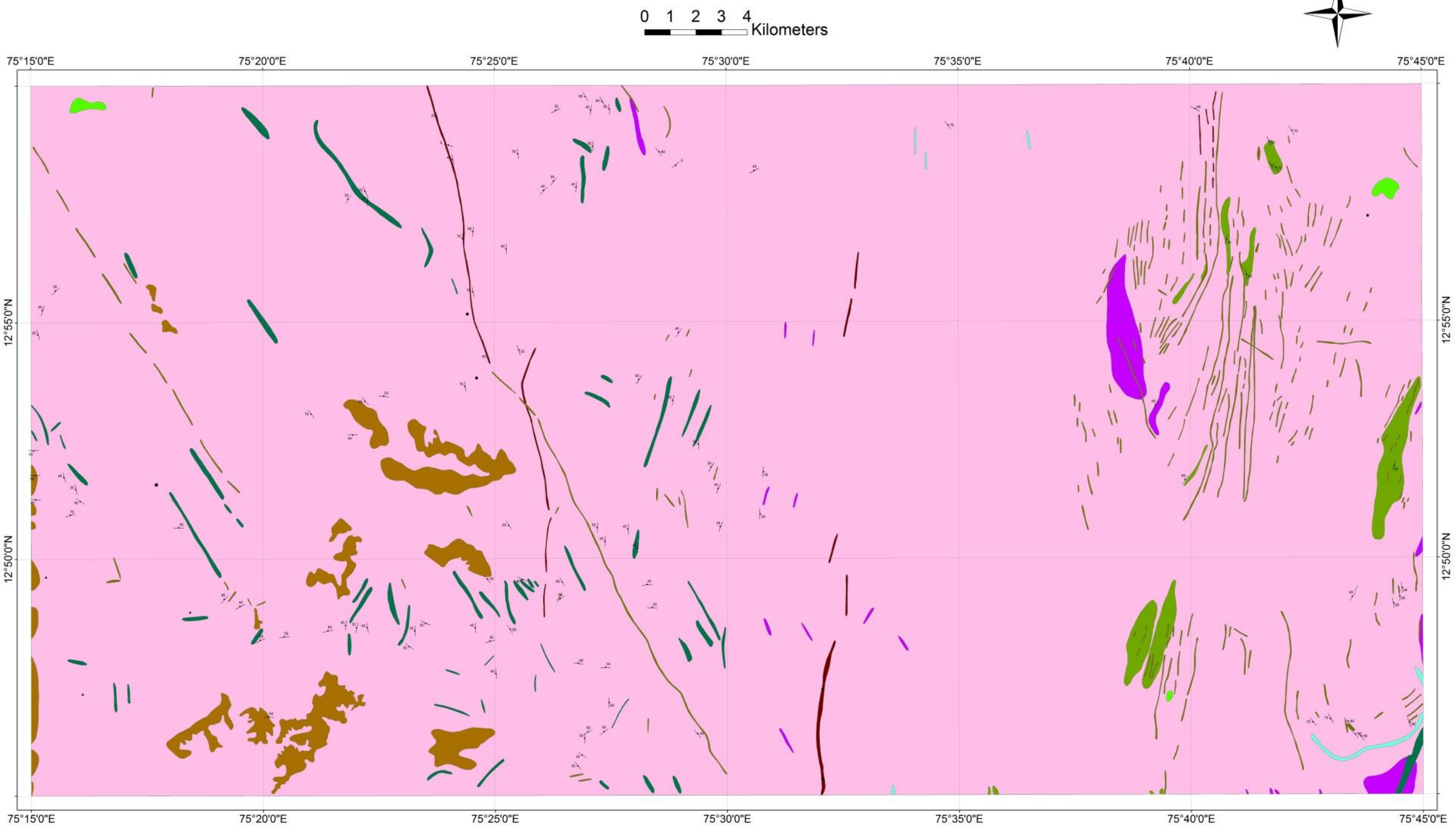




Sl No	TS No	Latitude (N)		Longitude (E)	
		From	To	From	To
1	48P/05	12°45’00”	13°00’00”	75°15’00”	75°30’00”
2	48P/09	12°45’00”	13°00’00”	75°30’00”	75°45’00”

Prepared by:
Tanvi Gupta, Geologist
Sunandan Basu, Geologist

Plate - 2: Geological Map of Toposheet No. 48P/05 & 48P/09



Legend

- Laterite
- Dolerite
- Charnockite
- Pyroxene Granulite
- Granite Gneiss
- Ultramafite
- Amphibolite
- Banded Magnetite Quartzite
- Garnet - Silliminite - Graphite Schist

Structural Symbols

45 Foliation

Mineral Symbols

- Beryl
- Corundum
- Iron Ore
- Kyanite

Prepared by:
Tanvi Gupta, Geologist
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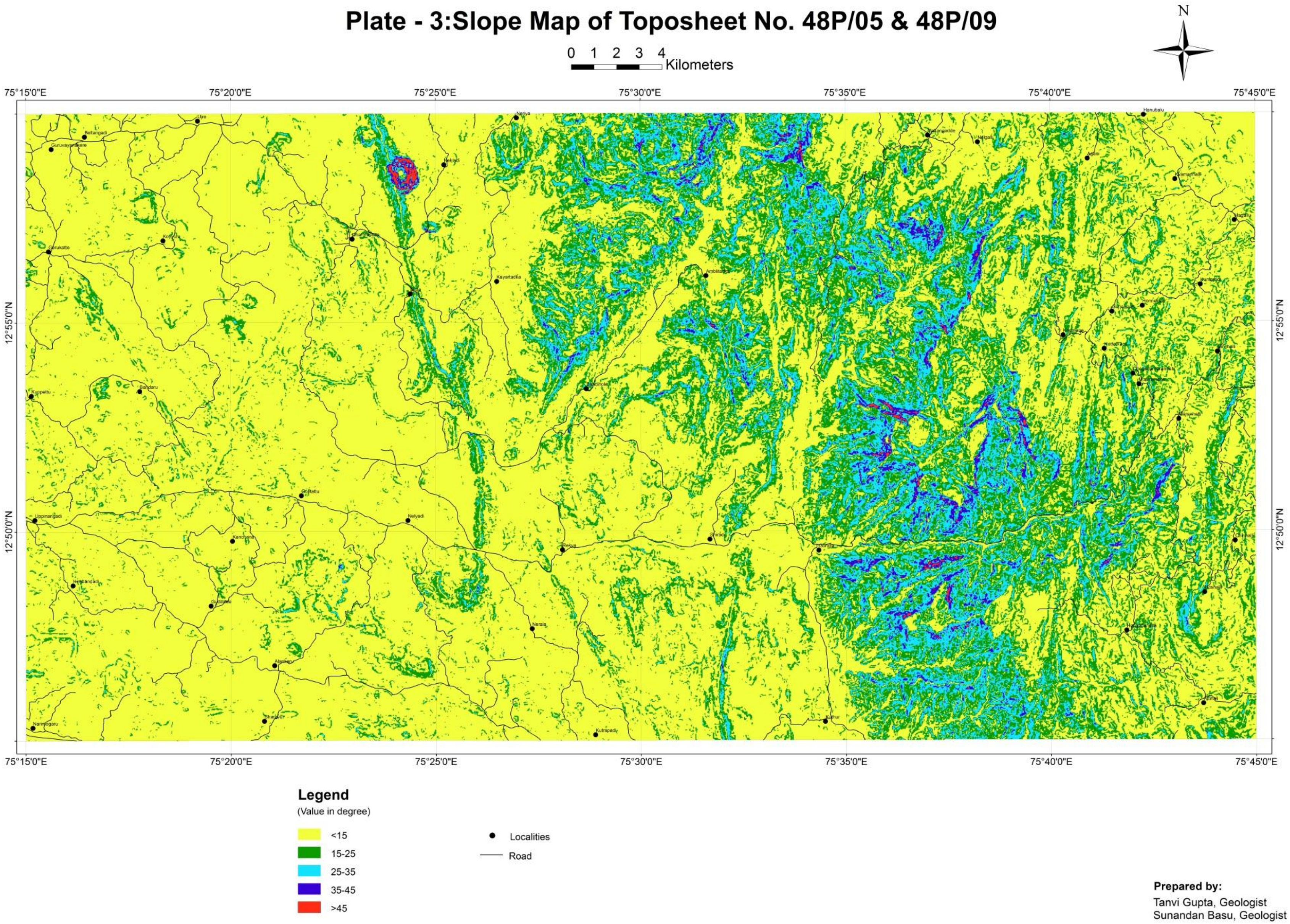
Plate - 3:Slope Map of Toposheet No. 48P/05 & 48P/09



Prepared by:
Tanvi Gupta, Geologist
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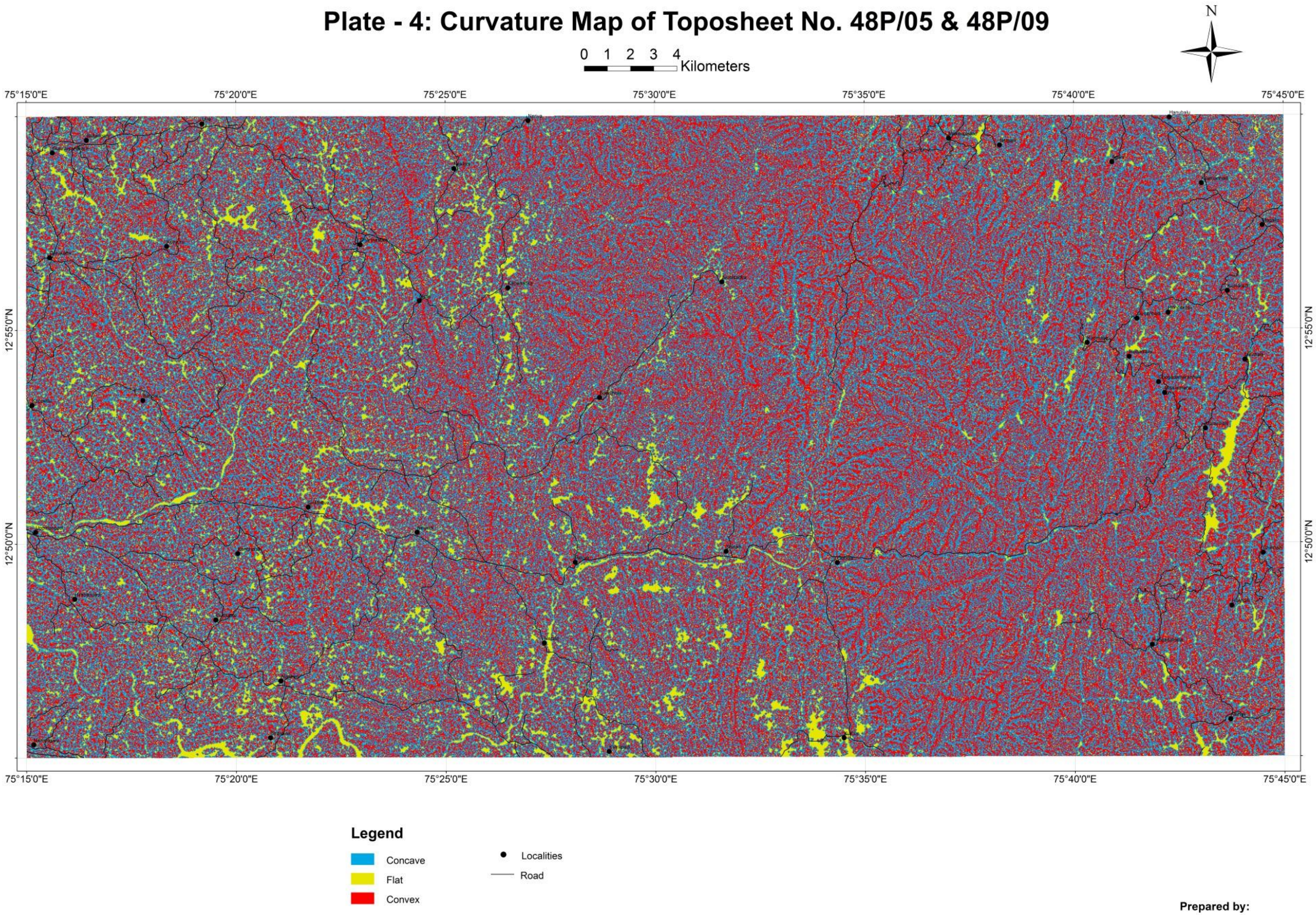
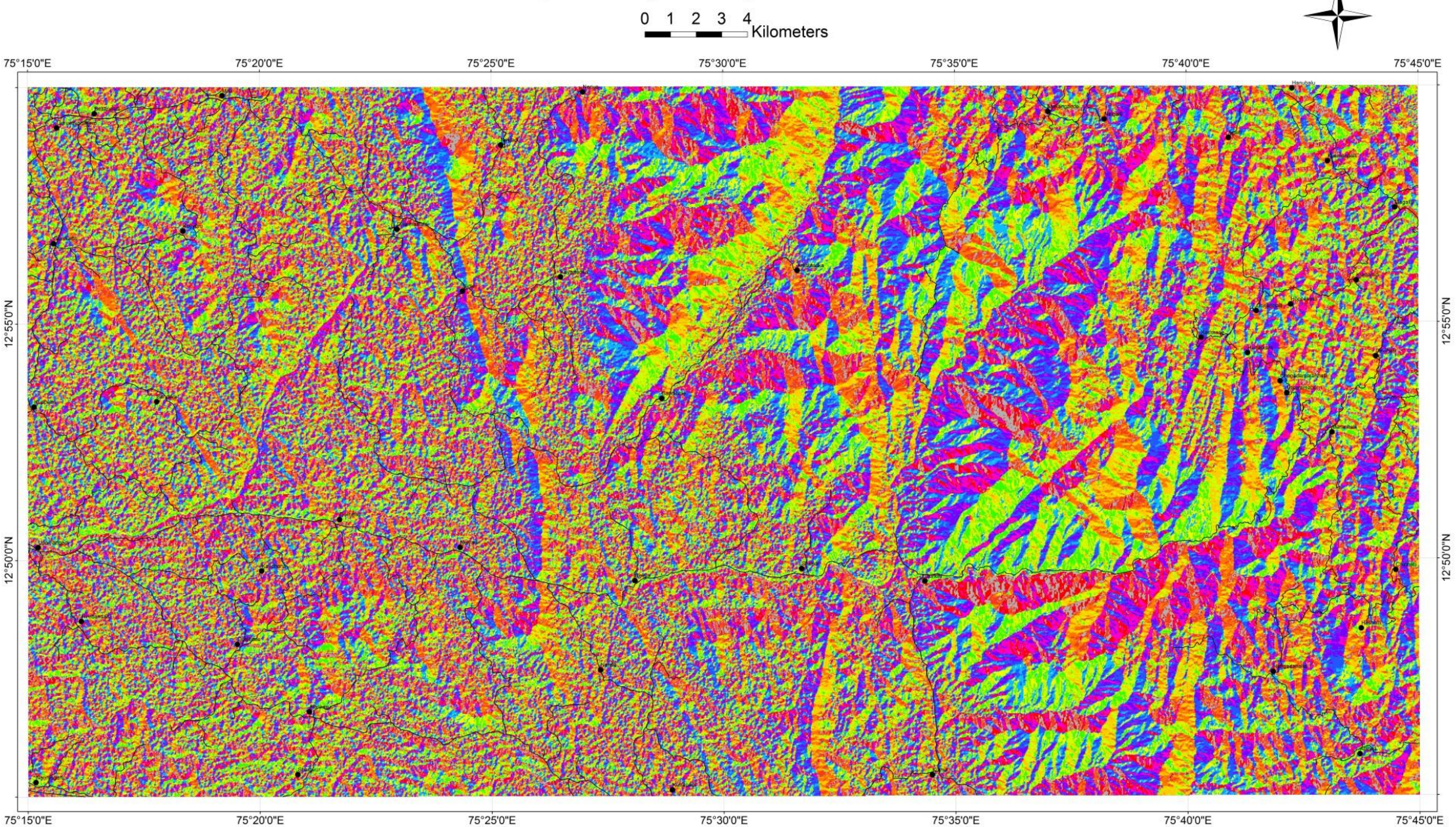
Plate - 4: Curvature Map of Toposheet No. 48P/05 & 48P/09



Prepared by:
Tanvi Gupta, Geologist
Sunandan Basu, Geologist

Plate - 5: Aspect Map of Toposheet No. 48P/05 & 48P/09



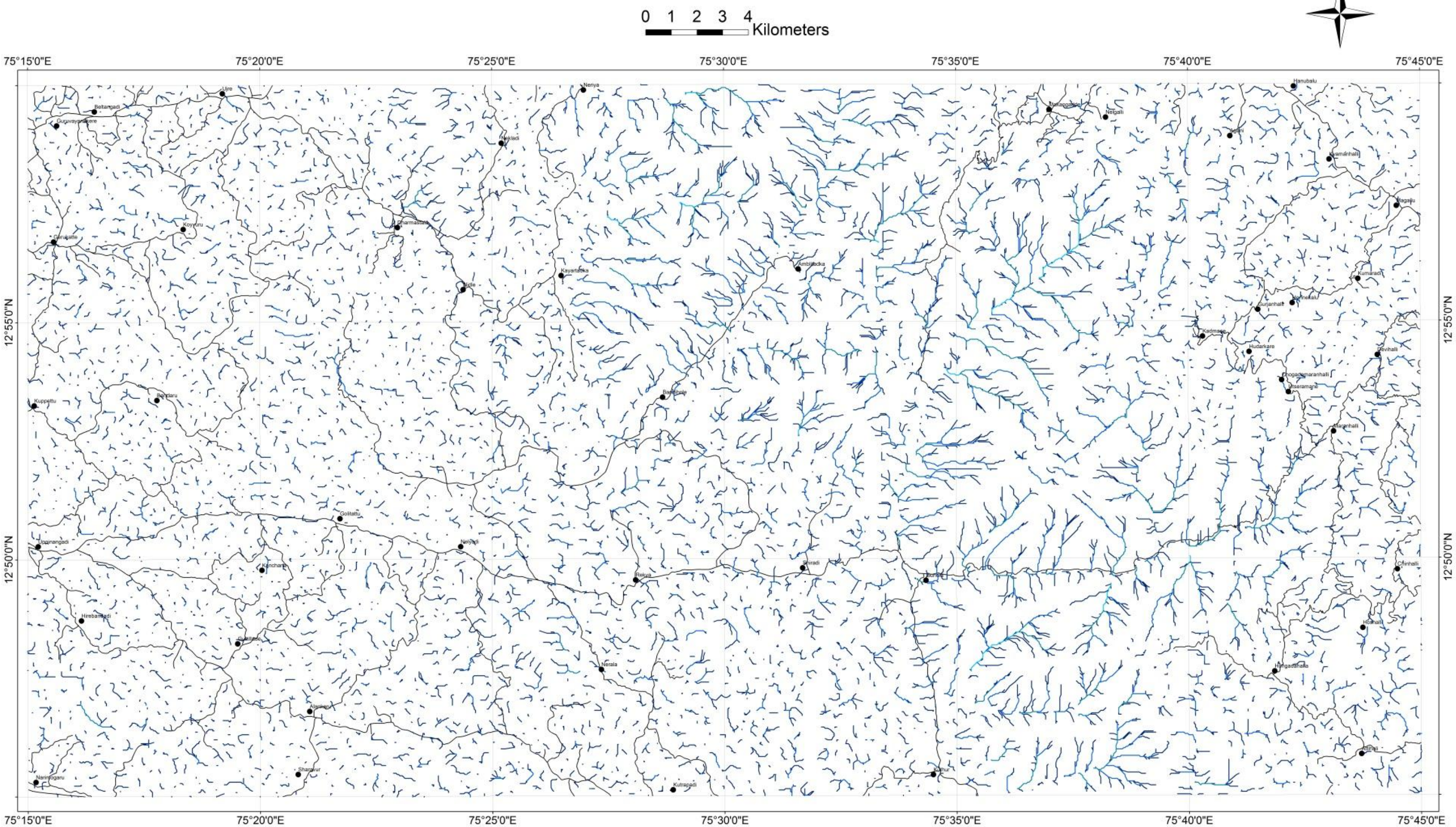
Legend

NNE
NE
ENE
ESE
SE
SSE
SSW
SW
WSW
WNW
NW
NNW

Localities
Road

Prepared by:
Tanvi Gupta, Geologist
Sunandan Basu, Geologist

Plate - 6: Drainage Map of Toposheet No. 48P/05 & 48P/09



Legend

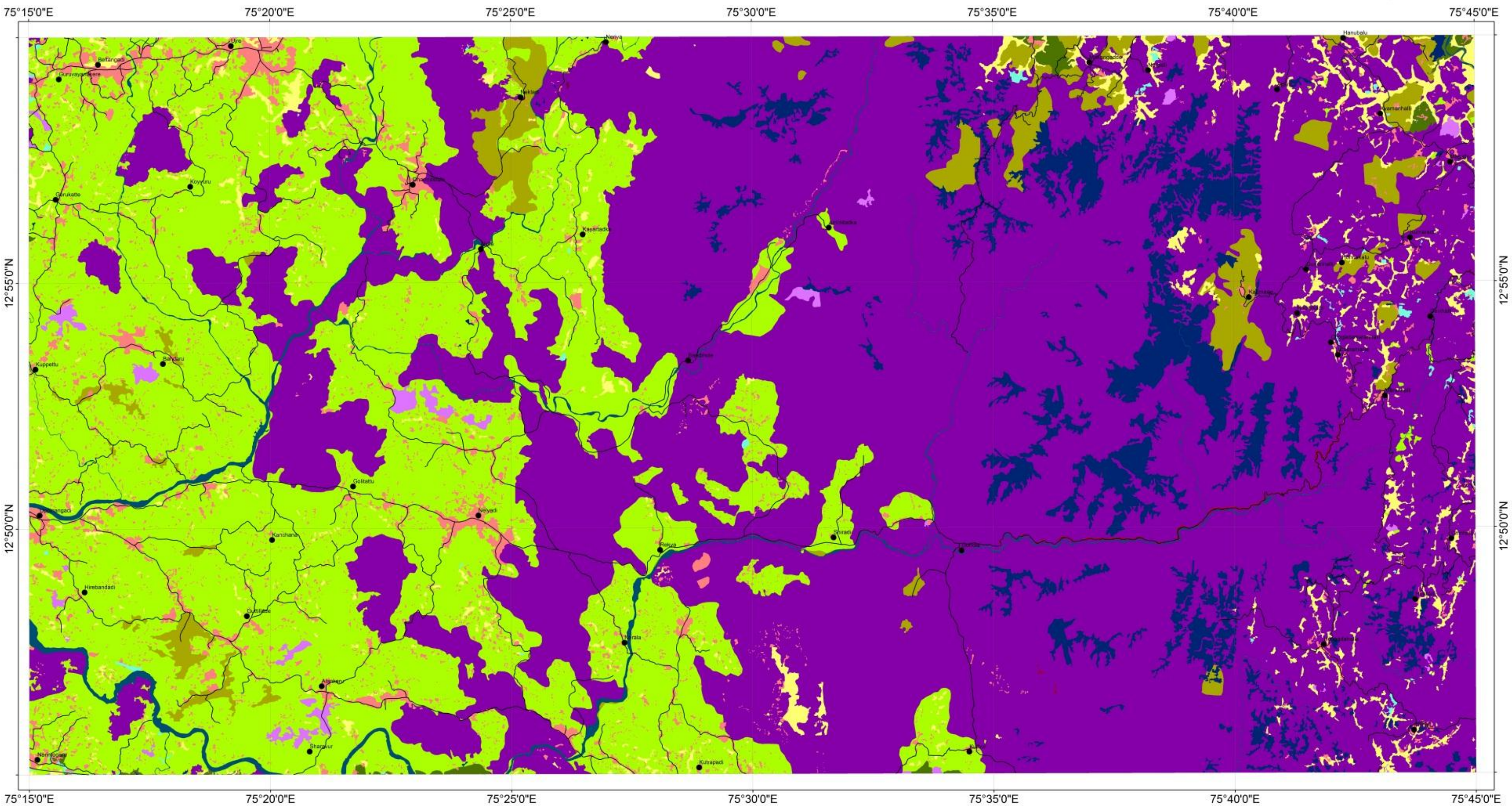
- 3rd order
- 4th Order
- 5th Order
- 6th Order
- Localities
- Road

Prepared by:
Tanvi Gupta, Geologist
Sunandan Basu, Geologist

Plate - 7:Land Use Land Cover Map of Toposheet No. 48P/05 & 48P/09

N

0 1 2 3 4 Kilometers



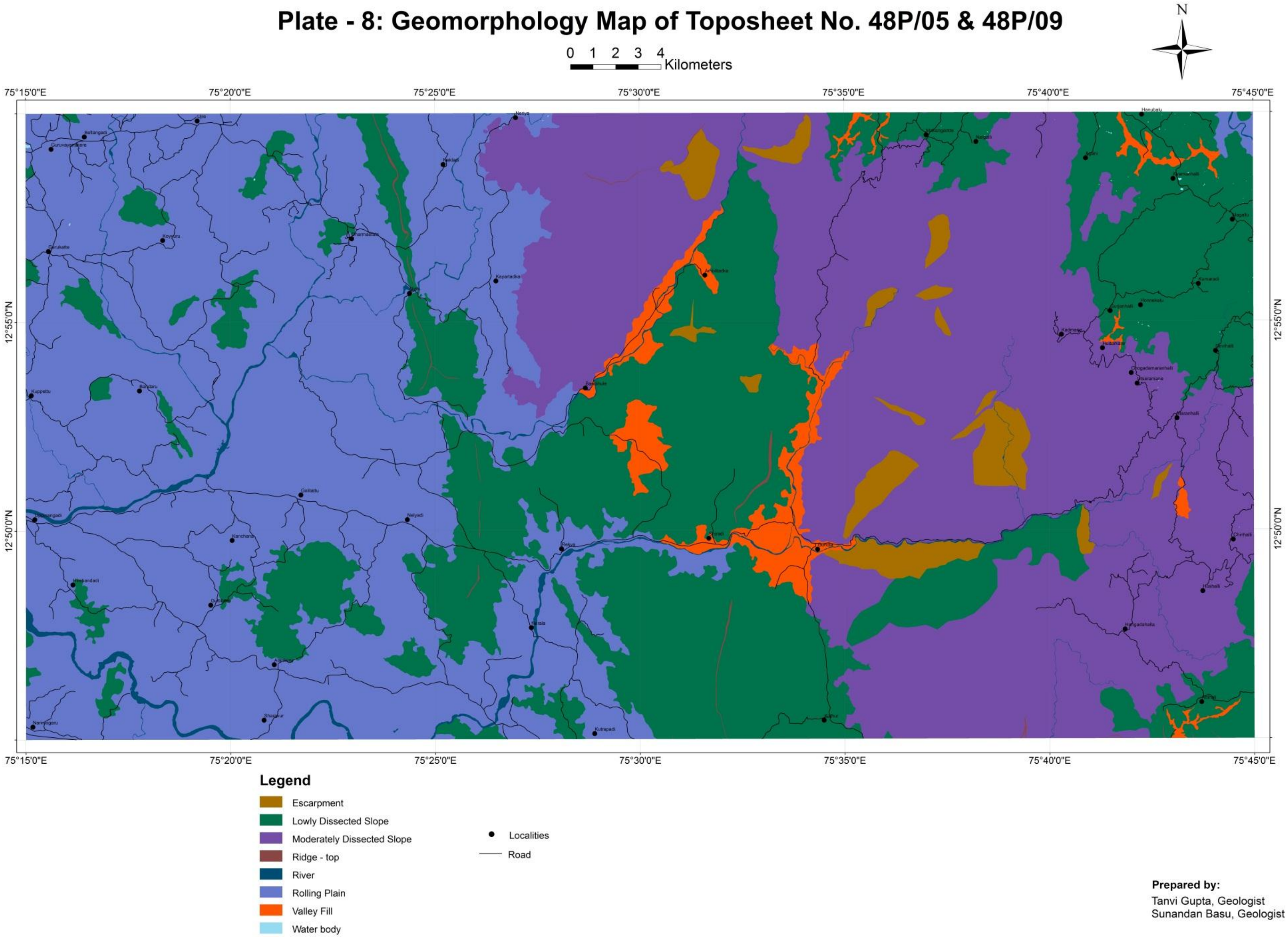
Legend

- Barren
- Cultivation
- Extensive Slope Cut
- Fallow Land
- Moderate Vegetation
- Plantation (HHP)
- Plantation (LHP)
- Quarry
- River
- Settlement
- Sparse Vegetation
- Swamp
- Thick Vegetation
- Water body

- Localities
- Road

Prepared by:
Tanvi Gupta, Geologist
Sunandan Basu, Geologist

Plate - 8: Geomorphology Map of Toposheet No. 48P/05 & 48P/09

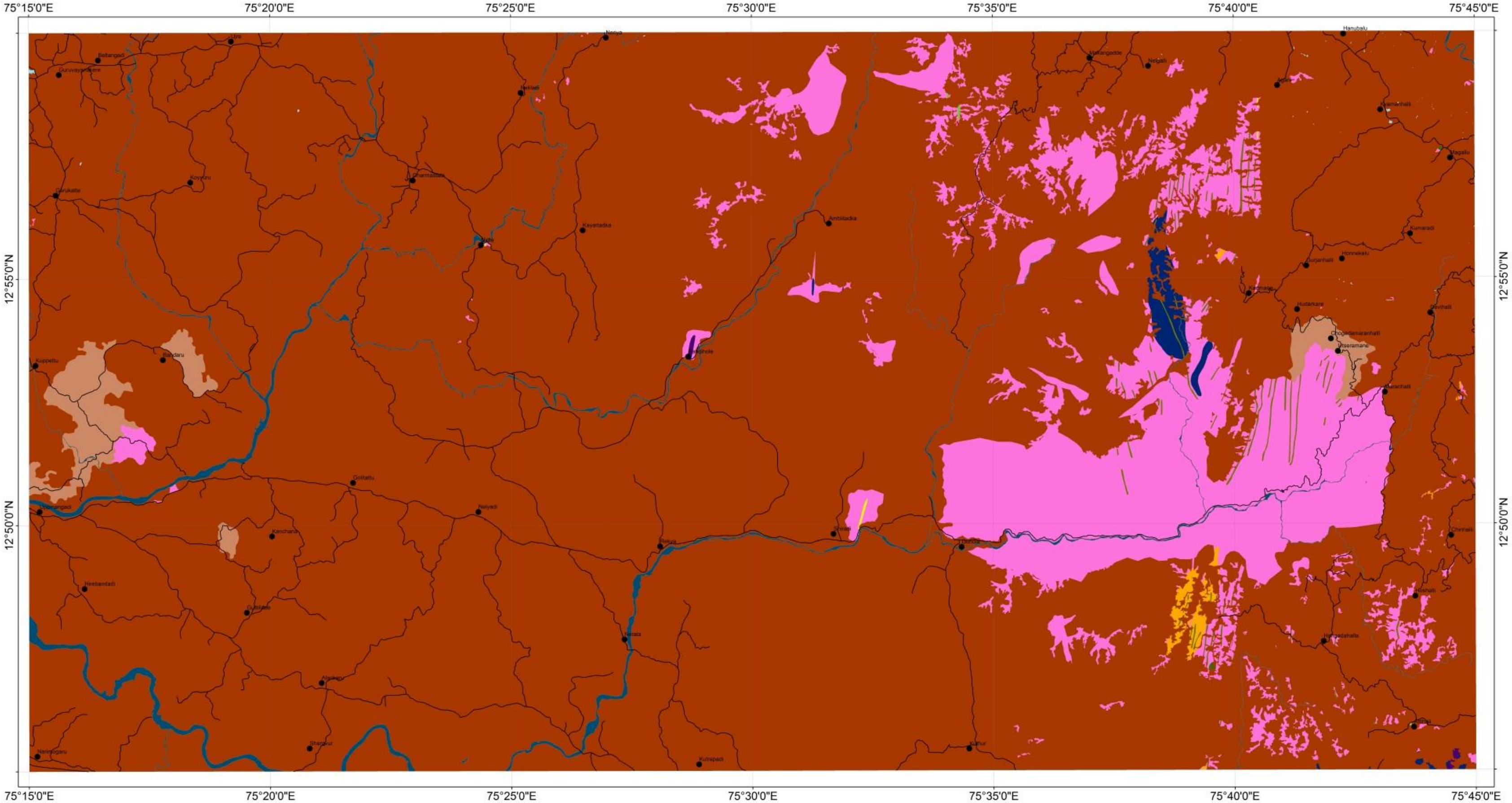


Prepared by:
Tanvi Gupta, Geologist
Sunandan Basu, Geologist

Plate - 9: Slope Forming Material Map of Toposheet No. 48P/05 & 48P/09

N

0 1 2 3 4 Kilometers

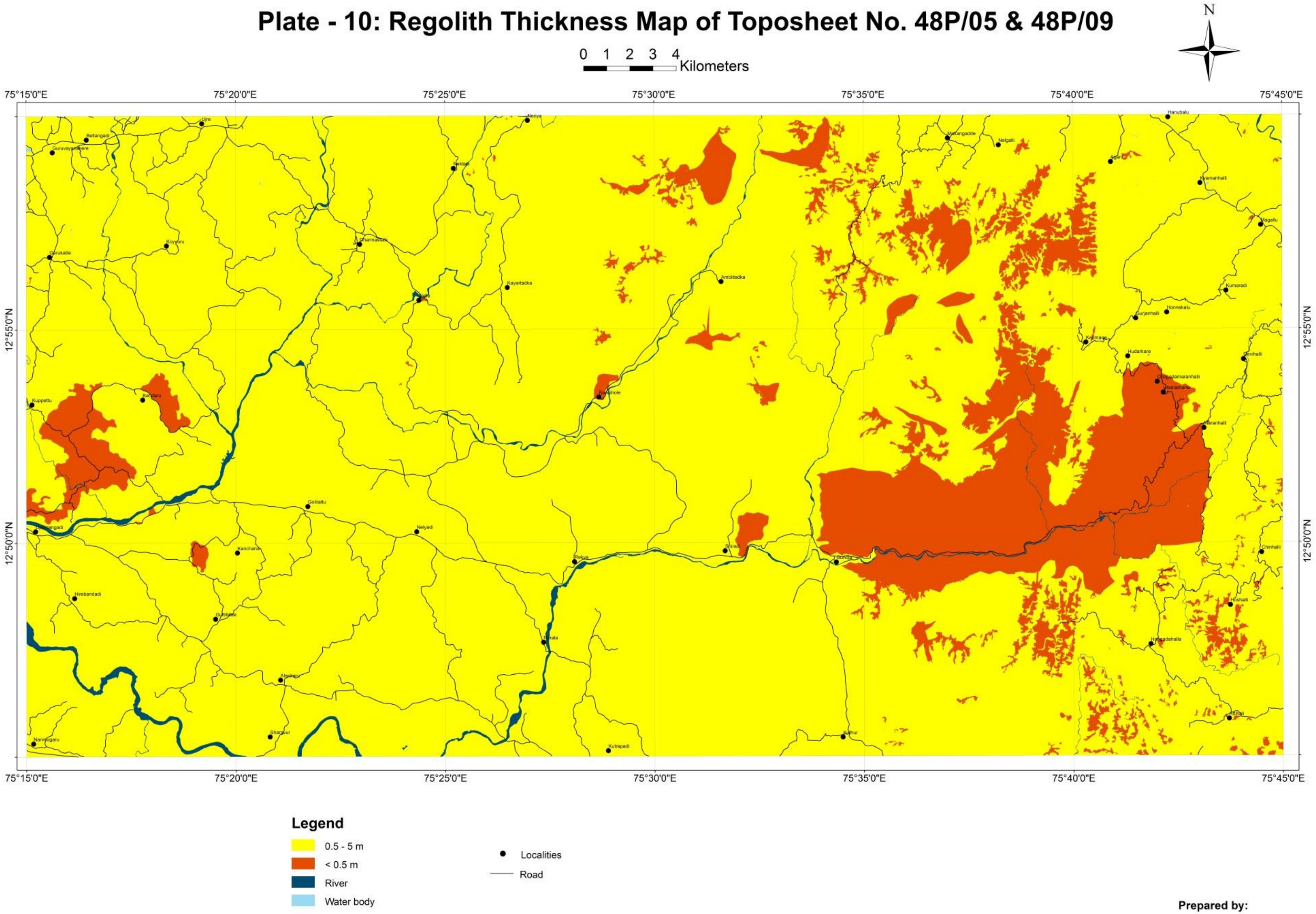


Legend

- Amphibolite
- Banded magnetite quartzite
- Charnockite
- Dolerite
- Gar-bio-sill gneiss + graphite + kyanite
- Granite gneiss
- In-situ soil
- Meta-ultramafite
- Pyroxene granulite
- Weathered Rock
- River
- Water body
- Localities
- Road

Prepared by:
Tanvi Gupta, Geologist
Sunandan Basu, Geologist

Plate - 10: Regolith Thickness Map of Toposheet No. 48P/05 & 48P/09



Prepared by:
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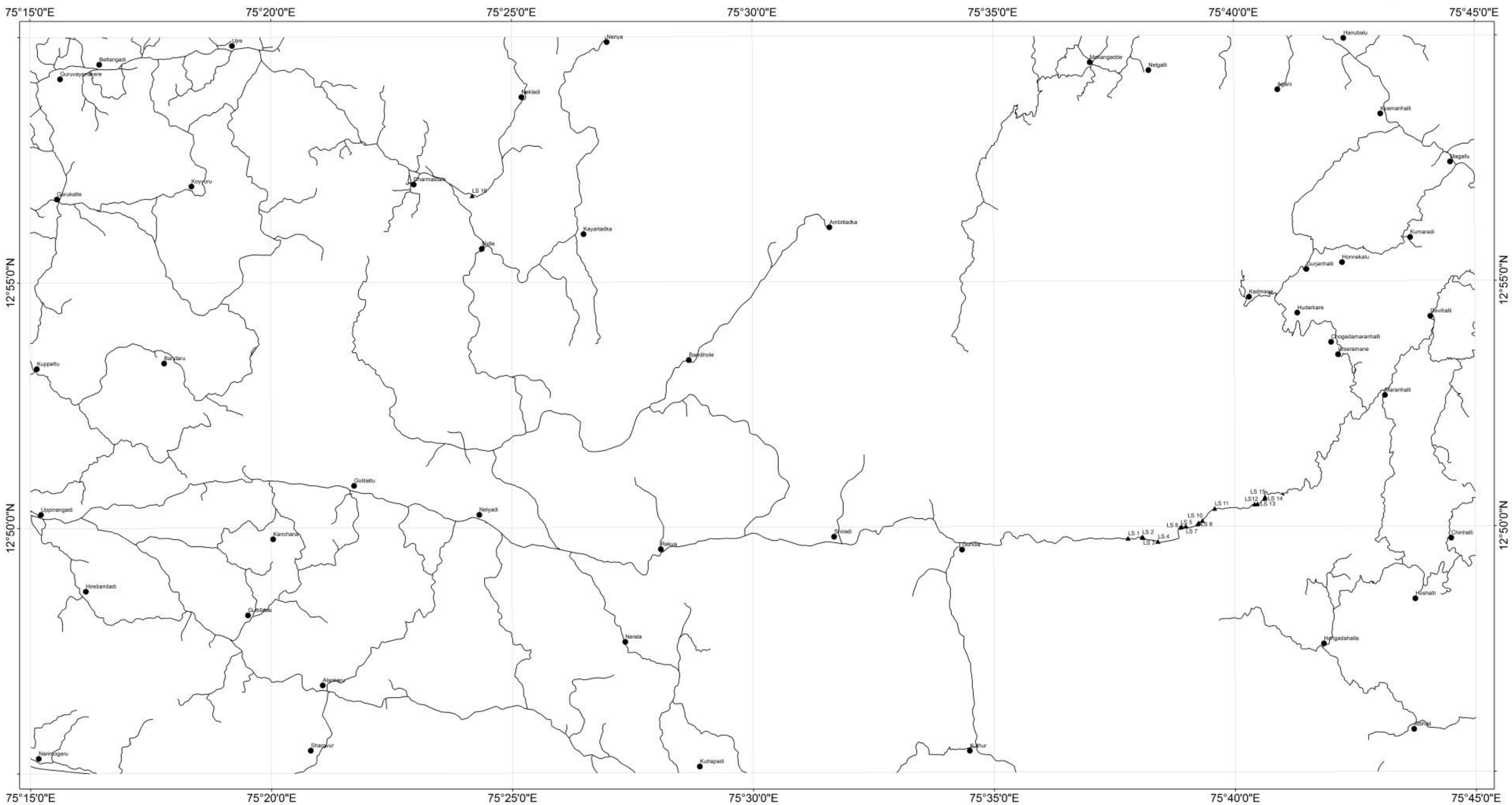
Plate - 11: Landslide Inventory of Toposheet No. 48P/05 & 48P/09

0 1 2 3 4 Kilometers

N



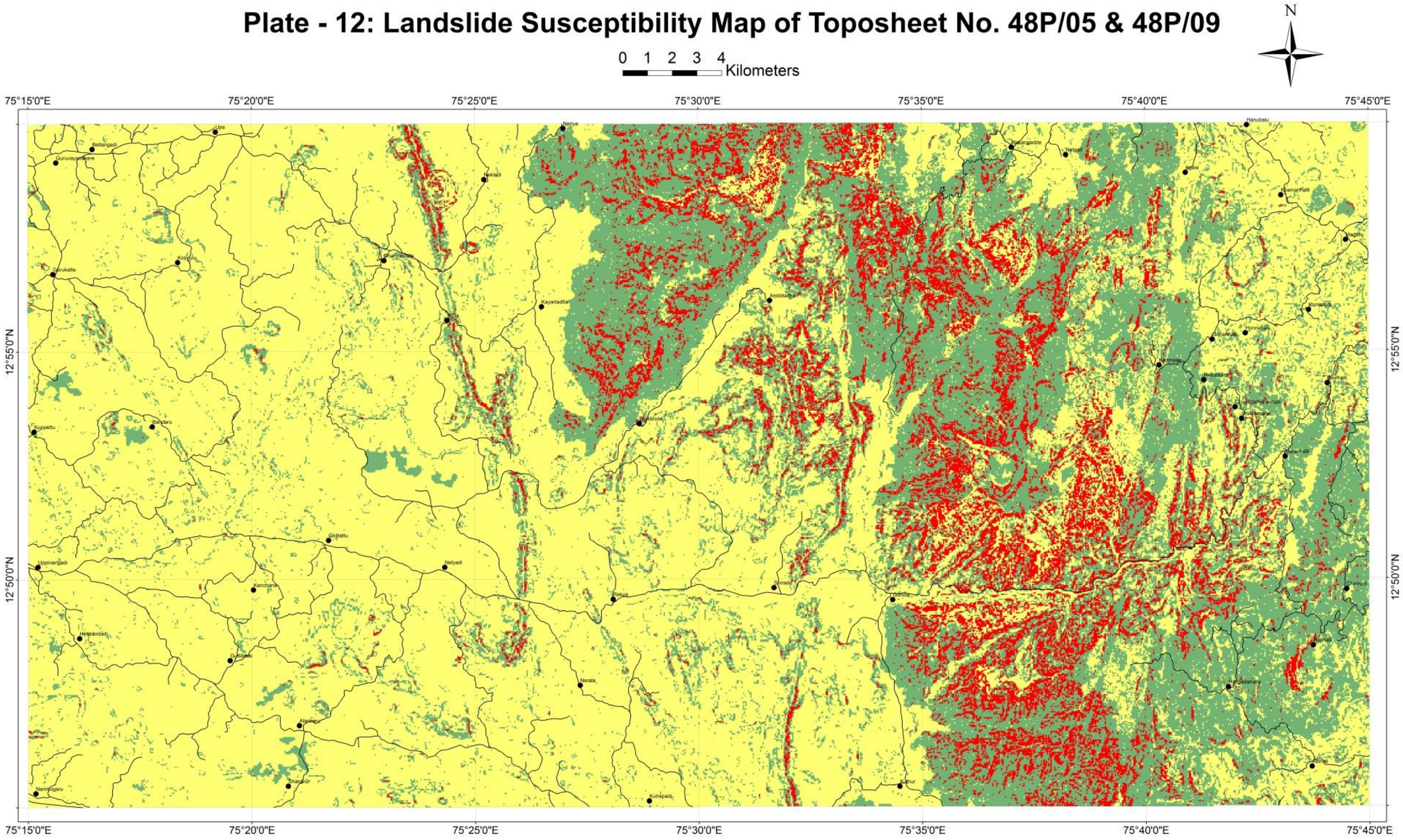
Legend

- ▲ Landslide
- ● Localities
- ─ Road

Prepared by:

Tanvi Gupta, Geologist
Sunandan Basu, Geologist

Plate - 12: Landslide Susceptibility Map of Toposheet No. 48P/05 & 48P/09



Legend

Low

Moderate

High

Localities

Road

Prepared by:

Tanvi Gupta, Geologist
Sunandan Basu, Geologist

PHOTOGRAPHS

Photo – 1: Land Use varieties near Mata village, showing both High Height Plantation (HHP) and Cultivation (Toposheet No 48P/05).

Photo – 2: Modification of slope for High Height Plantation (HHP) in the south east of Kuppettu village (Toposheet No 48P/05).

Photo – 3: Extensive Slope Cut along NH – 75 (formally known as NH – 48) in the east of Uppinangadi (Toposheet No 48P/05).

Photo – 4: Extensive Slope Cut near Indamogru Village (Toposheet No 48P/05). The material has already started moving due to rain.

Photo – 5: Granite gneiss present as slope forming material near Sullia village (Toposheet No 48P/05).

Photo – 6: Weathered Rock present as slope forming material near Bandaru Village (Toposheet No 48P/05).

Photo – 7: In – situ soil present as slope forming material near Gerukatte village (Toposheet No 48P/05).

Photo – 8: View of Valley Fill area near Kadmane village (Toposheet No – 48P/09).

Photo – 9: View of Lowly Dissected Slope near Nidle village (Toposheet No 48P/05).

Photo – 10: View of Moderately Dissected Slope in north of Gundia (Toposheet No – 48P/09).

Photo – 11: View of debris slide along NH – 75 (formally known as NH – 48) in the east of Shradigadi (Slide Name – KAR/HAS/48P09/2016/01) (Toposheet No – 48P/09).

Photo – 12: View of debris slide along NH – 75 (formally known as NH – 48) in the east of Shradigadi (Slide Name – KAR/HAS/48P09/2016/03) (Toposheet No – 48P/09). The slide is almost wholly removed for maintenance of the NH.

Photo – 13: View of debris slide along NH – 75 (formally known as NH – 48) in the east of Shradigadi (Slide Name – KAR/HAS/48P09/2016/04) (Toposheet No – 48P/09).

Photo – 14: View of debris slide along NH – 75 (formally known as NH – 48) in the east of Shradigadi (Slide Name – KAR/HAS/48P09/2016/05) (Toposheet No – 48P/09).

Photo – 15: View of debris slide along NH – 75 (formally known as NH – 48) in the east of Shradigadi (Slide Name – KAR/HAS/48P09/2016/11) (Toposheet No – 48P/09). The retaining wall has started to collapse due to movement that clearly suggests that the slide is active.

Photo – 16: View of debris slide in the west of Puduvettu (Slide Name – KAR/DK/48P09/2016/16) (Toposheet No – 48P/05).