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भारत सरकार

भारतीय भूवैज्ञानिक सर्वेक्षण

GOVERNMENT OF INDIA
GEOLOGICAL SURVEY OF INDIA

कर्नाटक राज्य के कूर्ग जिले में भूआकृति संख्या 48P / 15 और 16 के कुछ हिस्सों में वृहद पैमाने पर (1: 50,000) भूस्खलन संवेदनशीलता का मानचित्रण ।

(कोड सं: एल एस एम / एस आर / के और जी / 2015/099)

(कार्य सत्र २०१५-१६)

MACRO-SCALE (1:50,000) LANDSLIDE SUSCEPTIBILITY MAPPING IN PARTS OF TOPOSHEET NO. 48P/15 & 16, COORG DISTRICT, KARNATAKA

(CODE NO : LSM/SR/K&G/2015/099)

Field Season. 2015-16

By

अंकुर कुमार श्रीवास्तव, वरिष्ठ भूविज्ञानी

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2016

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GEOLOGICAL SURVEY OF INDIA

सत्यमेव जयते

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कर्नाटक राज्य के कूर्ग जिले में भूआकृति संख्या 48P / 15 और 16 के कुछ हिस्सों में वृहद पैमाने पर (1: 50,000) भूस्खलन संवेदनशीलता का मानचित्रण ।

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सारांश

भारतीय भूवैज्ञानिक सर्वेक्षण के वार्षिक कार्यक्रम वर्ष 2015-16 के अन्तर्गत भूआकृति सं 48P /15 और 16 के कुछ हिस्सों में भूस्खलन संवेदनशीलता का मानचित्रण व स्थानिक (जीआईएस आधारित) भूस्खलन डेटाबेस (50000 पैमाने पर), पर्याप्त सुदूर संवेदन और क्षेत्र आदानों का उपयोग करते हुए बनाया गया । अध्ययन क्षेत्र में मुख्य रूप से सरगुर समूह, आर्कियन युग के प्रायद्वीपीय निस्सीक परिसर और चार्नोकीट समूह की चट्टानें हैं। ग्रेनाइट और आर्कियन-प्रोटेरोज़ोइक युग के पेग्माटाइट शिराओं जैसे युवा इनट्रुसिवस बाद में पी जी सी में अंतरवेदित हुयी । सरगुर समूह के चट्टानों में गार्नेट-सिलिमनाइट शीस्ट, सिलीमेनाइट, एम्फीबोलाइट और गार्नेट युक्त ग्रूनेरिट शीस्ट ± कायनैट -अभ्रक नाइससेस शामिल हैं।

भूस्खलन संवेदनशीलता मानचित्रण, कम, मध्यम और उच्च पैमाने पर भूस्खलन के लिए अतिसंवेदनशील क्षेत्रों की पहचान करने पर ध्यान देने के साथ एक क्षेत्र में ढलान विघातों का एक गुणात्मक अध्ययन है। विषयगत परतों के रूप में विभिन्न कारक नक्शे जीआईएस मंच पर भारित बहु वर्ग सूचकांक ओवरले का उपयोग करते हुए भूस्खलन संवेदनशीलता को मान्य करने के लिए इस्तेमाल किया जा रहा है। प्री फील्ड के कार्यकलापों के अन्तर्गत भूमि उपयोग व भूमि आवरण नक्शा , सड़क, भू-आकृति विज्ञान, ढलान के गठन की सामग्री, जलनिकास, ढाल उतराई, ढाल वक्रता और ढलान पहलू नक़्शे आईआरएस लिस 3 डेटा और बहु लौकिक गूगल चित्रों के दृश्य व्याख्या के माध्यम से आर्क जीआईएस में तैयार किए गए। भूमि उपयोग व भूमि आवरण नक्शा बंजर चट्टानी ढलानों, बस्तियों, कम वनस्पति क्षेत्रों, मध्यम वनस्पति क्षेत्रों घनी वनस्पति क्षेत्रों, कम ऊंचाई वृक्षारोपण, उच्च ऊंचाई वृक्षारोपण, व्यापक कटौती ढलानों, नदी, और परती भूमि में विभाजित किया जा सकता है। अतिभारित सामग्री युक्त, नदी किनारे क्षेत्रों पर स्थित जलोढ़ मिट्टी और निचले घाटियों के क्षेत्र खेती के लिए इस्तेमाल किये जा रहे हैं। अध्ययन क्षेत्र का प्रमुख हिस्सा कम ऊंचाई वृक्षारोपण के साथ आच्छादित है। अध्ययन क्षेत्र में भूमि उपयोग व भूमि आवरण नक़्शे के अनुसार अधिकांश रूप से व्यापक कटौती ढलानों, भूस्खलन से प्रभावित हैं। अध्ययन क्षेत्र, भू-आकृति विज्ञान के संदर्भ में, पेडीप्लेन एवं पेडीमेंट काम्प्लेक्स, चोटी, जलोढ़ मैदानों, कम विच्छेदित ढलानों व मध्यम विच्छेदित ढलानों में विभाजित किया जा

सकता है। प्री फील्ड कार्यकलापों के अन्तर्गत ढलान के गठन की सामग्री नक्शा (एस ऍफ़ एम्), गूगल चित्रों का उपयोग कर और विवेकपूर्ण तरीके से ढाल भूविज्ञान, भूमि उपयोग व भूमि आवरण नक्शा और भू-आकृति नक्शे को एकीकृत करके तैयार किया गया था। यह बाद में क्षेत्र डेटा के साथ अद्यतन किया गया था। ढलान के गठन की सामग्री नक्शा, रॉक, वेदर्ड रॉक, इन -सीटू मिट्टी, ट्रांसपोर्टेड मिट्टी और लेटराइट मिट्टी में विभाजित किया जा सकता है। क्षेत्र की ढलान मोरफोमेट्री ढाल उतराई, ढाल पहलू और वक्रता द्वारा परिभाषित किया गया है। इन कारकों के लिए डेटा जी एच आर एम् सेल, केंद्रीय मुख्यालय से उत्पादित डीईएम से निकाला गया था। डीईएम के व्युत्पन्न के रूप में ढाल उतराई नक्शा, <15° से >45° के बीच पांच वर्गों में वर्गीकृत किया गया था। ऐसा देखा गया है की अधिकांश भूस्खलन 25 डिग्री से 45 डिग्री के कोण के बीच हुआ है । वक्रता नक्शा < -0.1, -0.1 to 0.1 और >0.1, 3 वर्गों 'अर्थात उत्तल, फ्लैट और अवतल ढलानों में वर्गीकृत किया गया है। कुल क्षेत्र में आठ ढलान विफलताओं के पहचान की गई। क्षेत्र की भूस्खलन में से अधिकांश लैटरिटिक सामग्री में घटित हुयी हैं, विशेष रूप से एसएच 89 के किनारे (मदिकेरी - सिद्दापुर मार्ग) मुख्य रूप से सड़कों के साथ व्यापक ढलान कट की वजह से हुई है। क्षेत्र में 90-95% भूस्खलन, डेब्रीज़ प्रकार के उथले ट्रांसलेशनल विफलता हैं, लेकिन एक भूस्खलन चट्टान गिरने के कारण हुआ था। क्षेत्र में डेब्रीज़ प्रकार के भूस्खलन मानवीय गतिविधियों और भारी वर्षा कारकों को ट्रिगर के रूप में कार्य करने के कारण उत्पन्न हुए हैं। क्षेत्र भूस्खलन / ढलान विफलताओं की पर्याप्त संख्या के अभाव में, क्षेत्र की संवेदनशीलता मॉडलिंग विश्लेषणात्मक पदानुक्रम प्रक्रिया (ऐ एच पी) का उपयोग करके की गयी है जिसमें व्यक्तिगत कारकों की रेटिंग और अंतर-भविष्यवाणी महत्व विशेषज्ञ या ज्ञान संचालित तकनीक पर ही आधारित है। यह ज्ञान आधारित रेटिंग / मात्रात्मक मीट्रिक, विभिन्न भू कारक कक्षाओं के लिए गुणात्मक जोड़ो में महत्व मैट्रिक्स पर निर्णय लेने और अंतर-भविष्यवाणी वजन के लिए अलग-अलग भू कारकों के बीच, चर्चा और स्थानीय विशेषज्ञों और इस क्षेत्र में भूस्खलन के अध्ययन में लगे हुए भूस्खलन वैज्ञानिकों से प्राप्त टिप्पणियों के माध्यम से प्राप्त करने के बाद विश्लेषणात्मक पदानुक्रम प्रक्रिया (ऐ एच पी) का उपयोग कर गणितीय विधि से आसानी से निर्धारित किया जा सकता है। लगभग 1.5% (लगभग 20 वर्ग किमी) क्षेत्र की उच्च संवेदनशीलता क्षेत्रों में गिर रही है जबकि 1% (12 वर्ग किमी) क्षेत्र मध्यम संवेदनशीलता क्षेत्र में गिर रही है। क्षेत्र के बाकी हिस्से कम संवेदनशीलता क्षेत्र में आते है। उच्च अतिसंवेदनशील क्षेत्रों में से अधिकांश भूआकृति सं 48P /16 में आ रहे हैं ।

MACRO-SCALE (1:50,000) LANDSLIDE SUSCEPTIBILITY MAPPING IN PARTS OF TOPOSHEET NO. 48P/15 & 16, COORG DISTRICT, KARNATAKA
(CODE NO : LSM/SR/K&G/2015/099)

By

Ankur Kumar Srivastava, Geologist Sr.

Harsha Sunder E., Geologist Sr.

ABSTRACT

Landslide Susceptibility Mapping in parts of Toposheets no. 48P/15 & 16 was done to prepare a seamless landslide susceptibility map and spatial (GIS-based) landslide database on 1:50000 scale using adequate remote sensing and field inputs as part of the Geological Survey of India Annual Program 2015-16. The area consists mainly of rocks of Sargur Group, Peninsular Gneissic Complex and Charnockite Group of Archaean age. Younger intrusives like granites and pegmatite veins of Archaean-Proterozoic age were later intruded into PGC. Sargur Group of rocks comprise garnet-sillimanite schist, kyanite-mica gneisses ± sillimanite, amphibolite and garnetiferous grunerite schist.

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

Pre-field maps for Land use/ Land Cover (LU LC), Roads, Geomorphology, Slope Forming Material, Drainage, Slope gradient, Slope Curvature and Slope aspect were prepared in Arc GIS through visual interpretation of IRS LISS III data and multi-temporal Google Imageries.

The area in terms of LU/LC can be divided in to barren rocky slopes, settlements, sparsely vegetated areas, moderately vegetated areas, thickly vegetated areas, low height plantations, high height plantations, extensive cut slopes, river, and fallow land. The areas along river banks is covered with alluvial material and along low lying valleys is covered with overburden material and are being used for cultivation. Major part of the area is covered with low height plantations. Extensive cut slopes in the study area are most affected by slope failures as far as Land use/Land cover is concerned. In terms of geomorphology, the area can be divided in to ridges, moderate to low dissected slopes, pediment – pedeplain complex and alluvial plains. Pre field Slope Forming Material (SFM) of the area was prepared using Google imageries and judiciously predicting slope forming material by integrating geology, LU/LC and geomorphological maps. This was later updated with field

data. Slope Forming Material in the area can be classified in to rock, weathered rock, in-situ soil, transported soil and lateritic soil. Slope morphometry of the area is defined by slope gradient, slope aspect and curvature. The data for these factors was derived from DEM provided from GHRM Cell, CHQ. For the slope gradient map as a derivative of DEM, the area was classified in to five classes ranging from <15° up to >45°. Most of the slides are observed to have occurred between 25° to 45° angle. Curvature map is classified in to 3 classes' i.e convex, flat and concave slopes corresponding to curvatures < -0.1, -0.1 to 0.1 and >0.1.

A total of eight slope failures were identified in the area. Most of the slides of the area are occurring in lateritic overburden, especially along SH 89 (Madikere – Siddapura road) primarily caused due to extensive slope cuttings along roads. About 90-95 % slides occurring in the area are shallow translational failure of debris type but one slide was recorded as rock fall. Debris slides in the area are caused due to anthropogenic activities and heavy rainfall acting as triggering factors.

As the area lacks adequate number of landslides/ slope failures, the susceptibility modelling of the area is done by using Analytical Hierarchy Process (AHP) method wherein ratings and inter-predictor weights will be given to individual factors using expert or knowledge driven techniques. This knowledge-driven ratings/ weights in quantitative metrices can easily be determined mathematically using Analytical Hierarchy Process (AHP) after preparing/ deciding on the qualitative pairwise importance matrix for different geo factor classes and amongst different geo factors for inter-predictor weights, obtained through discussion and comments received from local experts and landslide scientists engaged in landslide studies in the area. Approximately 1.5% (about 20Km^2) area is falling in high susceptibility zones while about 1% (12Km^2) area is falling in moderate susceptibility zone. Rest of the area is indicated as low susceptibility zone. Most of the high susceptible zones are falling in T.S. No. 48P/16.

MACRO-SCALE (1:50,000) LANDSLIDE SUSCEPTIBILITY MAPPING IN PARTS OF TOPOSHEET NO. 48P/15 & 16, COORG DISTRICT, KARNATAKA (CODE NO : LSM/SR/K&G/2015/099)

By

Ankur Kumar Srivastava, Geologist Sr.

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I. INTRODUCTION

1.1 Background

In India, nearly 0.42 Million Sq. Km. area is landslide-prone which is spread over 1112 Survey of India Topographic map sheets (source – GSI portal). Out of this vast expanse of landslide prone areas, till date about 60,000 Sq. Km. has been covered through landslide susceptibility mapping on basic data generation scale that is on 1:50,000 scale by GSI which leaves out a huge gap in target areas. Therefore, a thrust in this activity is imminent to reduce the gap areas in faster pace than what has been achieved so far. Accordingly, Geological Survey of India, being the nodal agency in the country for landslide studies launched National Landslide Susceptibility Mapping (NLSM) programme with an aim to produce a seamless landslide susceptibility mapping database across the country. To foster better progress rate and to improve the quality of landslide susceptibility mapping, along with requisite amount of field inputs, NLSM programme proposes to use very high-resolution Remote Sensing data for preparation of its landslide and geofactor database and GIS based landslide-dependent empirical techniques as well as knowledge based techniques (AHP) for data integration and landslide susceptibility modeling. The main purpose of this national programme is to prepare a nation-wide landslide inventory and susceptibility database for easy retrieval, use and updation in future whenever new events and large-scale changes in geo-environmental parameters are encountered.

Coorg (now Kodagu) district in Karnataka state lies in the southern part of Western Ghats with high range hills. The topography of the region is sensitive and any changes in the landuse causes landslides or slope failures affecting the population. Thus, the district along with its scenic beauty and pleasant climatic conditions is also becoming known for natural hazards. Infrastructural development in the form of laying new roads and widening of the existing roads involved the modification of slopes thereby disturbing the equilibrium attained by the nature has been disturbed. Majority of slopes along the high ways pose significant risk dominantly from rainfall-induced slope failures. (Janardhana et al., 2016).Heavy rains during monsoon season lead to slope saturation by water, decrease the effective cohesion and generates hydrostatic pressures in the soil profile ultimately resulting in slope failures.

Under the National Landslide Susceptibility mapping (NLSM) programme of Geological Survey of India (GSI), with an objective to (i) 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 geo factors of landslides using as input maps, (iii) to prepare landslide susceptibility map using multi-class index overlay method in a GIS platform. Landslide susceptibility mapping on scale 1:50,000, covering 1350.4 Sq. Km. area in parts of Coorg (now Kodagu) district was carried out under the Annual Programme of Geological Survey of India, Southern Region, vide item code no: LSM/SR/KG/2015/099 of field season 2015-16.

1.2 Study area

The study area covers parts of two SOI toposheets 48P/15 and P/16. The study area is bounded by Latitudes 12° 00' 00" and 12° 30' 00" and Longitudes 75°45'00" and 76° 00'00" (Fig. 1). It forms part of the Kodagu district which was earlier known as Coorg. It falls in the high precipitation zone with picturesque topography occupying the eastern and western slopes of the Western Ghats. It is bounded by, Hassan district on the north, Mysore district on the east, Dakshin Kannada district on the west and Kasargod district of Kerala state on the south. The study area is well connected by highways and other main roads. The Bangalore – Mangalore Highway (SH 88) and Mysore - Cannanore Highway (SH- 88A) passes through the area. Fairly good network of roads exists connecting taluk headquarters with district headquarters. Madikeri town is well connected with all the important places of the state. It is about 262 km from Bangalore (State Capital), 128 km from Mysore and 130 km from Mangalore. The nearest Railway stations are Hassan and Mysore. Nearest Airport is located at a distance of about 130 km at Mangalore.

1.3 Present work

The present work includes preparation of various thematic layers on 1:50000 scale using Arc GIS 10.1 software and Google Earth imageries. Open Series Maps of the study area were also taken into account while preparing LULC, Road and Location maps. Landslide inventory prepared in pre- field work was checked and updated in field. The pre field maps were checked and validated in field and appropriate corrections were made. The pre field maps were updated on Arc GIS software in headquarters. The final landslide susceptibility map of the study area was prepared using Analytical Hierarchy Process and then classified into low, moderate and high susceptibility zones. The nature and target of work envisaged for field season programme of 2015-16 and the achievements are given in Table 1. Details of field stay of the officers involved in the project are given in table 2.

Table1. Nature, quantum of work and achievements

Nature of Work	**Target F.S 2015-16** (sq.km.)	**Achievement**
1.Pre field map preparation		
a) Slope forming material map	1350.4	1350.4
b)Geomorphology and lineament map	1350.4	1350.4
c)Slope morphometry (slope, aspect & curvature) map	1350.4	1350.4
d)Landuse/Landcover map	1350.4	1350.4
e) Drainage map	1350.4	1350.4
f)Regolith depth map	1350.4	1350.4
ii)Preparation of landslide inventory map	1350.4	1350.4
2.Field based studies		
i)Field checking of all thematic maps	1350.4	1350.4
ii)Field validation of landslide inventory and collection of recent and historic landslides	1350.4	1350.4
iii) collection of landslide inventory and damage data as per 41 point geo -parametric sheet	As necessary	8 Nos.
iv) Validation of landslide susceptibility map at important locations	1350.4	1350.4
3. Post Field work		
i)Updation of thematic and inventory maps in GIS	1350.4	1350.4
ii)Preparation of Landslide susceptibility map in GIS	1350.4	1350.4
4.Collection of rainfall data	As necessary	Collected for 10 years

Table 2. Details of field stay

Details of Field Stay		
Name of the Officer	No of field Days **(from 01.12.2015 to 10.03.2016)** (FS 2015-16)	**Total No. of field Days since commencement of Field Season (FS2015-16)**
1. Ankur Kumar Srivastava, Senior Geologist	60	85
2. Harsha Sundar E., Senior Geologist	38	38
Shri J. Srihari, Director (Supervisory officer)	4	6

1.4 Physiography

The Western Ghats represent an anorogenic mountain range with steep escarpments to the West, parallel to the west coast of India. The topography of the area ranges from gently sloping plains on the south eastern part to rugged hilly lands, with elevations ranging from about 600 m to 1,702 m above msl. The area can be divided into two broad divisions the eastern part, a flattish rolling plain topography with isolated hills and pediment – pediplain complex and the Western and Southern part intersected by hill ranges. The hills have a general NW- SE trend. The study area is marked by ridges with steep slopes, denuded surfaces and sinuous valleys suggesting that considerable period has elapsed during the development of the landforms. The area appears to be more or less stable as far as landslides are concerned barring the anthropogenic activities. The study area is traversed by antecedent river namely Cauvery. The average annual rainfall of Coorg district is about 2800 mm and the area enjoys tropical climate. The climate is dominated by SW monsoon, starting in June ending in October providing a larger portion of annual precipitation.

1.5 General geology

The area is mainly represented by of rocks of Sargur Group, Peninsular Gneissic Complex (PGC) and Charnockite Group of Archaean age. Younger intrusives like granites and pegmatite veins of Archaean-Proterozoic age were later intruded into PGC. Sargur Group of rocks comprise garnet-sillimanite schist, kyanite-mica gneisses ± sillimanite, amphibolite and garnetiferous grunerite schist.

In the central part of the area south - east of Madikeri and around Siddapura, about 3 km wide, NW-SE trending band of kyanite-mica gneiss ± sillimanite is exposed for a strike length of about 25 Km. The rock is medium grained, bluish grey consisting of quartz, plagioclase, feldspar, kyanite, sillimanite, muscovite-mica ± graphite. Small lenses and an elongated band of garnet-sillimanite schist occur near 7 km south and 2.5 km north of Madikeri in the western part. The rock is dark grey in colour and mainly consists of biotite, quartz, sillimanite, muscovite and garnet.

Amphibolite is occurring as small patches and thin bands. The rock is medium to coarse grained and dark grey to greenish grey in colour consisting of hornblende and plagioclase feldspars with accessory garnet and quartz, which are exposed in the southwestern part of the area. Small lenses of garnetiferous grunerite schist of Sargur Group of rock is exposed within gneisses in the southwestern part. Biotite hornblende gneiss of PG-I of PGC, is the major rock type in the area with well-developed banding. They are generally coarse grained and light coloured striking NW-SE with a dip of 50^o-60^o. Charnockite group of rocks comprise charnockite and pyroxenite granulite. Charnockite, generally light to dark grey in colour is well exposed in the south of Kushalnagar over a large area as lenticular body found interfoliated with biotite gneisses and shows clear gradations towards the latter. Generally they are of intermediate variety made essentially of quartz, intermediate plagioclase, hypersthene and hornblende with accessory minerals as biotite, apatite, zircon and iron ore. Pyroxene granulite trending NNW – SSE in northern part is well exposed as narrow linear bands within the PGC. The bands are 5 to 100 m wide and the strike length ranges from 1to 3 km. The rock is dark coloured, medium to coarse grained and consists of hypersthene, diopside, plagioclase feldspar and biotite. A body of younger granite intrusive into the biotite gneisses is observed around Murnad in southwestern part. The rock is found as massive boulders and generally consists of quartz, feldspar and biotite. Few pegmatite veins of very smaller dimention trending NW – SE are seen intruding into the gneisses in the southwestern part. Thin capping of laterite measuring 5 to 8 m in thickness, occurs over the gneisses in the southwestern part. They are dark brown in colour and contain haematite, limonite, goethite and numerous quartz grains.

The gneisses show well developed foliations. The strike of the foliation is varying from N65^oW-S65^oE to E-W with steep northerly dips of 60^o-70^o. The gneisses show lineations trending N-S with plunge of 30^o-40^o towards south. Minor antiforms plunging 20^o-40^o towards SW, recorded within the PGC in northcentral part of the area. In T.S. No. 48P/16, Peninsular Gneiss-I of PGC represented by granitic gneiss occupies 75% of the area in the central and eastern part. It consists mainly of quartz, feldspar and biotite and at places appears as augen gneiss. The Charnockite Group forms a major rock unit in the SW part and comprises hornblende diopside granulite, calc granulite and charnockite and pyroxene granulite. Hornblende diopside granulite is light green consisting mainly hornblende plagioclase and diopside. It occurs as a wide body bordering with PG-I in the western and southwestern part and is exposed 2 km south and southwest of Virarajpet, 1 km west of 1195 hill. Calc granulite is coarse grained, mesocratic consisting tremolite, calc plagioclase and quartz. It occurs as thin lenses and is exposed in the northern bank of Barapole, i.e. 2 km north and NE of 778 hill, Ayyankunnu male and 2 km SW of Hudikere. Charnockite occurs over a wide area interlayered with garnet, garnetiferous sillimanite gneiss in SW corner and western part. Charnockite is coarse grained, gneissic to granulitic, mesocratic to melanocratic, consisting of feldspar, pyroxene and minor biotite. At places, it is garnet bearing, quartz is noticed in the northwest of Karokattakari. At places they range in composition from acidic to intermediate and basic types. Quartz veins trending E-W occurring within PG-I are exposed north and SE of Ponnampet, NW and SE of Gonikoppa and in the central part of the area. Small body of dolerite dyke trending NW-SE is seen exposed 1 km south of Podakeri ($12^o07'00''$: $75^o50'30''$).The foliation in charnockites and gneissosity in gneisses are the major penetrative structures which generally trend NE-SW with local variations with steep dips towards NW. In SW corner the attitude of the foliations in charnockites and garnetiferous sillimanite gneiss appears that the rocks along with amphibolite have been folded into an antiform with a SW closure. (Dey and Shankar, 1950,; BRC Iyengar, 1953, Damodaran, 1951, Damodaran, 1952)

1.6 Landuse and Landcover

The landuse/landcover of an area directly reflects the human interaction with nature. At places this interaction has exceeded the boundaries and led to man's conflict with nature resulting in the balance of nature being disturbed. This has resulted in many natural calamities – landslides being the foremost result of this over exploitation.

The study area consists of lush green forests, low height and high height plantations consisting of coffee, cardamom, black pepper, teak, silver oak etc. Besides these, paddy cultivation also forms major part of the low lying area. Settlements are observed in almost all parts of the study area, a classic example of man encroaching into the nature's territory. This often results in slope cut failures, mostly along road cuts. This is augmented by heavy rainfall in the area. The major part of the area is occupied by plantations, which is the main source of income for the people in the study area, followed by forests and cultivated land. Human habitation has seen an increase in the past decade, since the area is a popular tourist destination; creation of holiday homes and resorts in the interior parts of the forests has led to a decline in forest cover.

1.7 Methodology

The method to be followed is primarily landslide dependent following a raster-based GIS modelling approach for integration of all selected and weighted thematic maps to prepare 1:50,000 scale landslide susceptibility maps but for areas where a-prior knowledge of landslide is missing or scarce and/or insufficient, any one of the following approaches may be adopted as per priority or terrain conditions and/or after due discussion with the local experts/workers.

a) Individual ratings for geofactor classes and weights of geofactors will first be determined based on a pilot study in the adjacent smaller area/ road corridor (preferably within the study area) where well-distributed landslide data are available by using various spatial association techniques. Later such ratings and weights will be used for the entire study area for model integration using the same multiclass index overlay method. In case of availability of similar or research work in adjacent and similar terrain nearby, the ratings and weights developed are used in such work and may also be used after due discussion with the local experts.

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

Methodology adopted can be broadly classified as follows:-

Pre – field work

- During pre-field period, landslide inventory and different thematic pre-field maps are prepared using different source data. The pre-field maps are as follows:
- **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. (Plate - 10)
- **Slope Morphometry (Slope, Curvature and Aspect):** Slope Morphometry (Slope, Curvature and Aspect) pre-field maps are prepared using ASTER DEM data as source data in Arc – GIS software. As the NLSM is a 1: 50,000 scale mapping, the slope

morphometry maps are prepared after re classifying the ASTER DEM to 50 m X 50 m resolution from its original 30 m X 30 m resolution. (Plates -3,4,11)

- **Drainage map:**Drainage pre-field maps are prepared using ASTER DEM (re classified in 50 m X 50 m resolution) as source data in Arc –GIS software (Plate - 12).
- **Land Use Land Cover map (LULC):** Land Use Land Cover (LULC) pre-field map is prepared using multi temporal google imagery and Arc – GIS base map as source data in Arc – GIS software.
- **Geomorphology map:** Geomorphology pre-field map is prepared using multi temporal google imagery, Arc – GIS base map and 1:50,000 scale NGLM legacy map as source data in Arc – GIS software.
- **Slope Forming Material map (SFM):** Slope Forming Material (SFM) pre-field map is prepared using multi temporal google imagery, Arc – GIS base map, 1:50,000 scale geological legacy map and proxies from LULC and geomorphology maps as source data in Arc – GIS software.
- **Regolith Thickness map:** Regolith Thickness pre-field map is prepared using multi temporal google imagery, proxies from geomorphology map and slope map as source data in Arc – GIS software.

Field work

During the field validation period, all the pre-field maps are validated in the field by visiting all the assessable locations and the modifications are mapped. 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 work

After the field validations are done, all the thematic maps are updated as per field inputs and finalised. The landslide inventory is also updated as per field inputs. Once all the thematic maps are finalised and landslide inventory is updated, heuristic (knowledge driven) techniques are adopted for modelling and generation of final susceptibility map of the area. For modelling using heuristic (knowledge driven) techniques, individual ratings for geofactor classes and weights of geofactors will be determined using Analytical Hierarchy Process (AHP) after preparing the pair wise qualitative comparison matrix of all factors (Saaty, 1977) after due discussion with local experts and workers.

- 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).

- A total of eight factor maps, viz., Slope, Aspect, Curvature and Drainage (derived from 30 m ASTER DEM (reclassified into 50 m)), Geomorphology and Land use – Land cover (prepared using multi-temporal Google Earth imageries and SPOT images as base maps in ESRI ArcGIS 10.2), Slope Forming Material and Regolith Thickness (through field-based studies and GSI Geological map) were prepared for susceptibility analysis. Besides these maps, Landslide Inventory maps were 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.

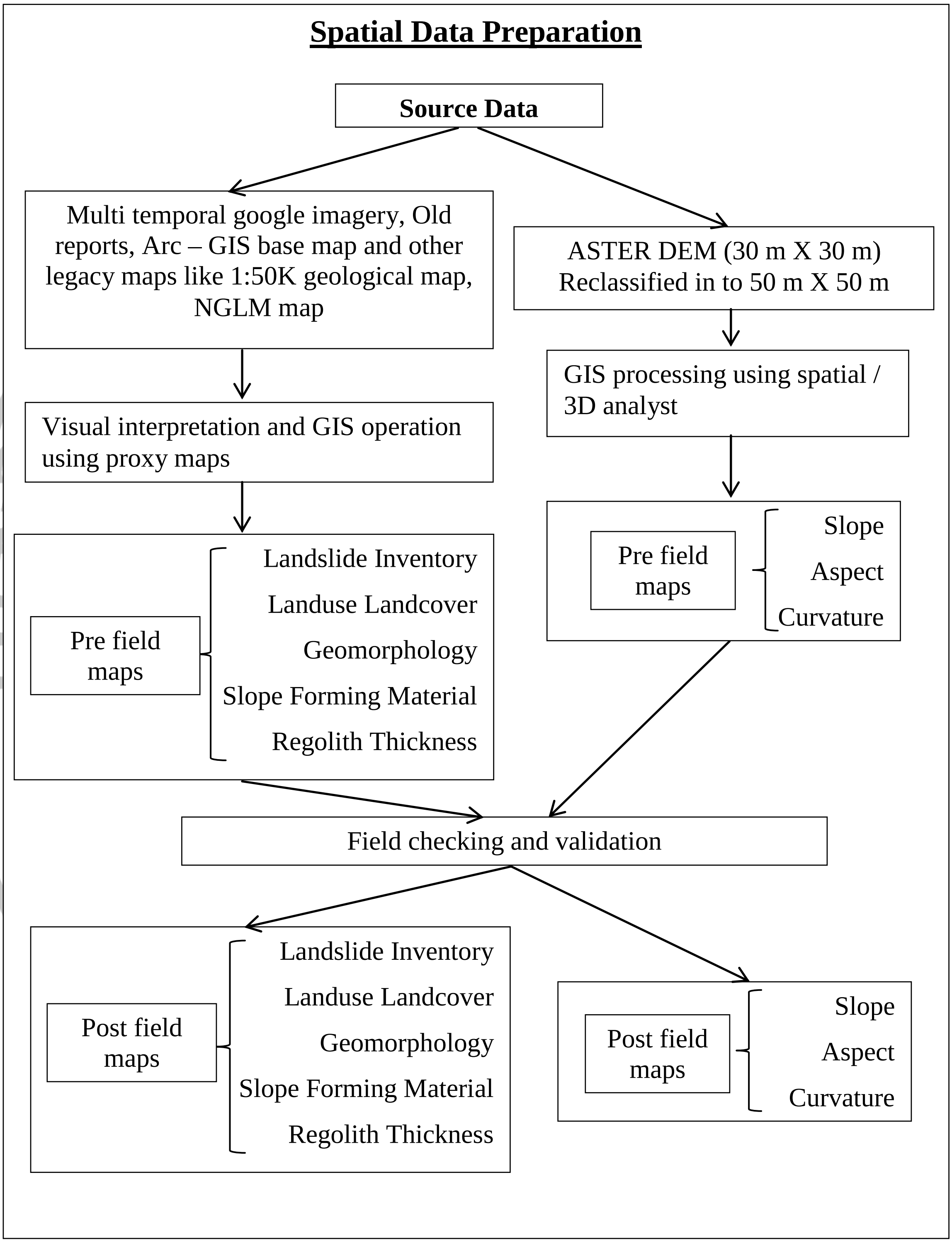
- Once all the ratings for geofactor classes and weights of geofactors are fixed, LOFS is calculated using pair wise comparison matrix and fraction rating in microsoft excel software.

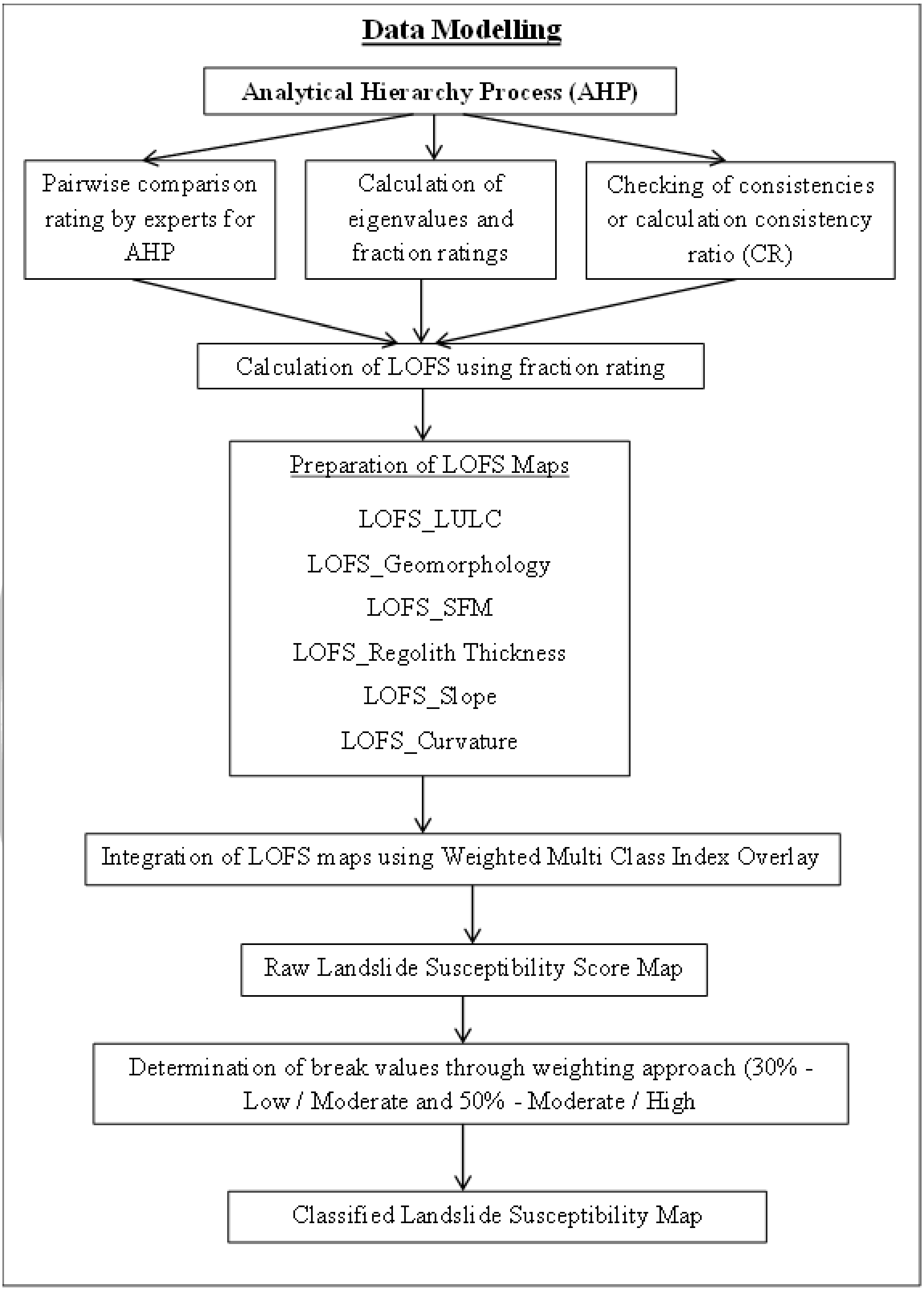
- After calculation of LOFS for all the geofactor classes LOFS maps of the geofactors are prepared using Arc – GIS software.

- Once all the LOFS maps are prepared, raw landslide susceptibility score map is prepared using weighted multi class index overlay method in Arc – GIS software.

- After raw landslide susceptibility score map is prepared classified landslide susceptibility map is prepared and determination of break values are done through weighing approach (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




Data Modelling
Analytical Hierarchy Process (AHP)
Pairwise comparison rating by experts for AHP
Calculation of eigenvalues and fraction ratings
Checking of consistencies or calculation consistency ratio (CR)
Calculation of LOFS using fraction rating
Preparation of LOFS Maps
LOFS_LULC
LOFS_Geomorphology
LOFS_SFM
LOFS_Regolith Thickness
LOFS_Slope
LOFS_Curvature
Integration of LOFS maps using Weighted Multi Class Index Overlay
Raw Landslide Susceptibility Score Map
Determination of break values through weighting approach (30% - Low / Moderate and 50% - Moderate / High
Classified Landslide Susceptibility Map

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II. PREVIOUS WORK ON LANDSLIDE STUDIES

Landslide studies in the area have been carried out only along transportation corridors (NH & SH) in the Western Ghats. Temporal data for these slides is not available as far as the study area is concerned. Landslides in the study area generally occur frequently from untreated cut slopes. These are usually small in size but pose considerable risk to life and property. Several landslides are reported along roads (Highways) every year during the monsoons indicating that the triggering factor for these slides may be rainfall besides anthropogenic activities.

Previous works on landslides in the area include:

1. "Landslide Inventory Along National Highway &State Highway Of Ghat Roads In Coorg, Dakshina Kannada, Udupi, Shimoga And Chikmagalur Districts, Karnataka" (Maruthi and Chandran, 2013).

2. "Landslide susceptibility mapping along Virajpet – Madikere – Sulya road corridor, Coorg district, Karnataka" (Maruthi and Chandran, 2013).

3. "Landslide susceptibility mapping of Madikere Town and its surrounding, Coorg district, Karnataka" (Mishra et al, 2010) in which mapping was done along road corridors with 1 km buffer on both sides of the road. The area was classified as low, moderate and highly susceptible.

4. Microscale landslide studies were carried out on Biligeri Landslide, Coorg district, Karnataka (Mishra and Dharuman, 2010).

Besides these, post hazard studies have been carried out in the area whenever there have been reports of any landslide event. These include:

5. July 2013 Landslide Event around Madikeri, Coorg district, Karnataka, when several landslides were reported around Madikeri, Coorg district. The triggering factor in almost all the cases was heavy rainfall resulting in increase in pore pressure of the overlying material leading to slippage. Unplanned expansion of habitation along with modified landuse pattern have disturbed the natural equilibrium of the area have also contributed in the occurrence of such events.

Some historical landslide data is given in table 3.

Table -3 Details of historical landslides in the study area.

Name/Location	Type	L (m)	W(m)	D(m)	History	Slope	Trigger
State Highway 88 (48P/15)	Debris slide	8.9	11.8	0.5	Old	Road cut	Rainfall
State Highway 88 (48P/15)	Debris slump	9.5	28	0.5	Old and reactivated	Road cut	Rainfall
State Highway 88 (48P/15)	Debris slump	7	10.1	0.5	New	Road cut	Rainfall
State Highway 88 (48P/15)	Debris slide	10.2	20	1	Old	Road cut	Rainfall
State Highway 88 (48P/15)	Debris slide	11.2	11.6	1	Old and reactivated	Road cut	Rainfall
State Highway 88 (48P/15)	Debris slide	10.8	11	0.5	Old and reactivated	Road cut	Rainfall
State Highway 88 (48P/15)	Debris slide	14.9	18.6	1	Old and reactivated	Road cut	Rainfall
2 kmk from Ammati towards Polibetta	Earth Slump	11	13	0.5	Old and Reactivated	Road cut	Rainfall
400 m from slide no KA-601 towards Polibetta	Debris Slump	9	12.2	0.5	Old and Reactivated	Road cut	Rainfall
2 km after polibetta(Just below Yemingadi	Debris Slump	12.8	14.9	0.5	Old and Reactivated	Road cut	Rainfall

1.5 km from slide no KA-603 on Polibetta-Siddapur road	Debris Slide	19.2	18.2	1	Old and Reactivated	Road cut	Rainfall
300-400 m from 81 no KM stone on SH-91 towards Makutta from Virajpet	Composite slide	28	18	1.5	Old and Reactivated	Road cut	Rainfall
20 m from slide no KA-593 on SH-91 towards Makutta from Virajpet	Earth Slump	14.6	15.1	0.5	New	Road cut	Rainfall
3 km from slide no KA-595 on SH-91 towards Makutta from Virajpet	Debris Slide	15.9	20.3	1	New	Road cut	Rainfall
After checkpost 1kmon SH-91 towards Makutta from Virajpet	Debris slide	19.8	23	1	New	Road cut	Rainfall
Near Muggal road cross on SH-90 from Virajpet towards Siddapur	Debris Slide	26.1	16.8	1	Old and Reactivated	Road cut	Rainfall

III. 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. and can be prepared through various methods such as detailed geomorphologic fieldwork, mapping from remote sensing data and topographic maps, historical archive studies and interviews. In this study, satellite images are used as the main source for obtaining a multi-temporal landslide inventory.

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

Preparation of the landslide inventory commenced with the search of archival data sources, particularly published and unpublished reports of GSI. The SPOT images available as a base map in ESRI Arc GIS 10.2 (up to the resolution of 30cm), high resolution Google Earth data of different time periods (from 2002 to 2015) and LISS III data were used as the main data product for generating the multi-temporal landslide inventory.

3.2 Inventory Mapping: The following steps were used for mapping a landslide polygon in Arc GIS 10.2 and building its inventory attribute.

1. In Google Earth, every segment of the study area was viewed for all available time frames. Once the landslide is identified the same is marked as a polygon. The source or the zone of depletion and the run out is marked separately.

2. The mapped polygon is then saved as .kml file and later imported to Arc GIS using „conversion" function. In Arc GIS the kml to layer conversion is first done and then the layer data is exported as a polygon shape file or directly to the geodatabase. In this study the WGS 84 UTM projection (43N) is taken for analysis.

3. The landslide polygon is 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 toposheets in Arc GIS.

4. For each landslide polygon, the attributes such as name, state, district, taluk, 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.

5. 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.

6. After identifying the landslides on the field, the morphological parameters (landslide scar length, width and depth) were noted carefully after measuring them in the field using a meter tape. Additional data such as landslide type, run-out distance, present land use, regolith thickness, 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 or points and entered in a geo-database of Arc GIS.Though in the present study area slides reported earlier which are marked on GIS using their locational attributes could not be identified and digitised due to thick vegetation cover. No slope failure could be identified using satellite imageries and Google Earth due to their small dimention and thick vegetation cover. All the slope failures observed in the field are located in the western part of the study area. During field, eight slope failures were observed along road cuts on Madikeri – Chittalli Road and Perumbadi – Makutta road. Some extensive road cuts were marked on Madikere – Suntikoppa and Madikere – Somwarpet road. An old slide was observed on Madikere – Somwarpet road, about 60 m wide and 15m high. It is a debris slide where overburden along with some rock debris has failed. These slope failures had been triggered by heavy rainfall. The failures have occurred in overburden part (around >5 m thickness) which is characterised by presence of Weathered granite and granitic soil. The triggering factor is rainfall. No landslide was observed on natural slope all the slides were located on slope cuts.

IV. LANDSLIDE SUSCEPTIBILTY ANALYSIS

This chapter comprises of the materials and methods used in landslide susceptibility analysis using Analytical Hierarchy Process (AHP) for areas deficient in landslides.

4.1 Background

Landslide susceptibility is the relative likelihood for the occurrence of landslide in an area. This does not necessarily mean that slides will essentially occur in high susceptible zones and that the low susceptible zones will not have any slides. It is only a qualitative and quantitative estimation that how a particular mapping unit, under the effect of several factors may behave in the landslide perspective. Since the study area lacks natural and sufficient number of landslides AHP method of analysis is used.

The Analytic Hierarchy Process (AHP), developed by Saaty (1981) is a method of structuring decision problems. The AHP consists of three levels of hierarchy. The first hierarchy level is the goal of the decision making, the second level involves how each of the existing criteria contributes to achievement of goal, and the third level is to find out how each of the alternatives contributes to each of the criterion. The AHP method is appropriate to be used where decisions are to be assessed quantitatively. It is assumed that human beings' natural reaction when facing a complex decision making process, is by grouping the decision elements according to common characteristics. This involves ranking the decision elements, and then comparing between each pair in each group in a form of matrix.

4.2 Selection of Preparatory Factors: For susceptibility mapping, the selection of preparatory factors for landslides depends on the scale of analysis, the characteristics of the study area, the landslide type, the failure mechanisms and the priori knowledge of the main causes of landslides (Guzzetti et al., 1999;).

A systematic overview of the important preparatory factors required for susceptibility mapping in different scales is given by Van Westen et al. (2008). A priori knowledge of the main causes of landslides in the area of interest is essential in selecting the most relevant factors out of the many known preparatory factors that can "theoretically" cause landslides (Ghosh and Carranza, 2010).

For areas where a-prior knowledge of landslide is missing or scarce and/or insufficient, any one of the following approaches may be adopted as per priority or terrain conditions and/or after due discussion with the local experts/workers.

a) Individual ratings for geofactor classes and weights of geofactors will first be determined based on a pilot study in the adjacent smaller area/ road corridor (preferably within the study area) where well-distributed landslide data are available by using various spatial association techniques. Later such ratings and weights will be used for the entire study area for model integration using the same multiclass index overlay method. In case of availability of similar or research work in adjacent and similar terrain nearby, the ratings and weights developed and used in such work may also be used after due discussion with the local experts.

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

For susceptibility analysis six factor maps were prepared that are considered to be the main spatial causal factors for landslides in the area, out of the six 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 Geo-factor Themes:

In general, the factors which influence whether a landslide will occur typically include slope angle, climate, weathering, water content, vegetation, overloading, geology, and slope stability. How these factors interrelate is important in understanding what causes landslides along with an understanding of the impact humans have on these factors by altering natural processes. Mentioned below are the factors that have been taken into account for estimating landslide susceptibility in an area using GIS. As per data model is concerned, some of the geo-factor themes are categorical (e.g., geomorphology, aspect etc.) and others represent continuous data (e.g., slope, elevation 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: Mainly slope morphometry is defined by slope gradient and curvature. The data for these factors was derived from DEM provided from GHRM Cell, CHQ which was originally supplied from NRSC. Slope gradient and slope curvature for the study area was generated on Arc GIS10.1 using spatial analyst tool. 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. Failures can be expected to occur more frequently in those areas than the slopes that are convex along the contour. For the slope gradient map as a derivative of DEM, the area was classified in to five classes ranging from <15° up to > 45°. Most of the area (about 92%) falls in low slope range i.e < 15° class. About 2.8% of the area falls in factor class 25° to 35°, which is having maximum weightage according to the ratings given in AHP. The area coverage in pixels along with LOFS and rank is given in table 3.

Curvature map is classified in to three classes' i.e convex, flat and concave slopes. Most of the area (about 99%) falls in flat slope range i.e -0.1 to +0.1curvature. The convex slope class which is given the maximum weightage in the area covers only 0.017% of the area. The area coverage in pixels along with LOFS and rank is given in table 4.

Table 4- LOFS map and area coverage in pixels for Slope gradient of T.S No. 48P/15 & 16

CLASS	Rank	LOFS	Area coverage (Pixels)	Area covered (%)
<15	2	0.1081	50201	92.60238
15-25	4	0.2523	27198	5.035175
25-35	8	1.0000	15211	2.816017
35-45	6	0.5123	1428	0.264366
>45	2	0.1081	142	0.026289

Table 5 -LOFS map and area coverage in pixels for Slope curvature of T.S No. 48P/15 & 16

CLASS	Rank	LOFS	Area coverage (Pixels)	Area covered (%)
Concave	4	0.4113	2232	0.411019
Flat	2	0.1676	541852	99.5713
Convex	6	1.0000	96	0.017678

4.3.2 Geomorphology: Geomorphology map was prepared in Arc GIS through visual interpretation of IRS LISS III data and multi-temporal Google Imageries of the area. NGLM data supplied by GHRM cell was also taken into account while preparing the geomorphology map of the study area. The obtained pre field map was checked and validated in field. In terms of geomorphology the area was grouped into six classes namely ridge top, moderately dissected slopes, low dissected slopes, pediment – pediplain complex, alluvial plains and water body. The dissected slopes (high, moderate or low) were mapped based on visual interpretation by taking topographic ruggedness and presence of drainages as criteria. Most of the area (about 79%) falls in low dissected slopes followed by pediment – pediplain complex (18%) and moderately dissected slope (1.28%). Moderately dissected slope is given maximum weightage using AHP method and has coverage of about 1.28% area. The area coverage for each class in pixels, LOFS and rank is given in table 5.
The details of geomorphic features are given as follows:

Ridge: This is the topmost part of the hills/mountains which is formed by the intersection of two escarpments from the opposite directions (NGLM Manual, 2010).

Scarp (Escarpment): A long, more or less continuous cliff or relatively steep slope face facing in one general direction, breaking the general continuity of the land by separating two level or gently sloping surfaces, and produced by erosion or by faulting. Depending on the degree of dissection it can be classified in to highly/moderately/low dissected escarpments.

Pediment: A broad, flat or gently sloping, rock floored erosion surface or plain of low relief, typically developed by sub aerial agents (including running water) in an arid or semiarid region at the base of an abrupt and receding mountain front or plateau escarpment, and underlain by bedrock (occasionally by older alluvial deposits) that may be bare but more often partly mantled with a and discontinuous veneer of alluvium derived from the upland masses and in transit across the surface. (NGLM Manual, 2010)

Pediplain: Pediplain is a broad, relatively flat rock surface formed by the joining of several pediments. Pediplain is usually formed in arid or semi-arid climates and may have a thin veneer of sediments. (NGLM Manual, 2010)

Pediment - Pediplain complex: A complex landform where both pediplain and pediments occur and it is difficult to separate them. These are observed near Guddehosur (Photo - 6).

Alluvial plain: A level or gently sloping tract or a slightly undulating land surface produced by extensive deposition of alluvium, usually adjacent to a river that periodically overflows its banks; it may be situated on a flood plain, a delta, or alluvial fan. (NGLM Manual,2010)

Table 6 -LOFS, rank and area coverage in pixels for Geomorphology of T.S No. 48P/15 & 16

Class	Rank	LOFS	Area coverage (pixels)	Area covered (%)
Pediment Pediplain Complex	**0**	**0**	**97749**	**18.0963**
Lowly Dissected Slope	**4**	**0.19466**	**429272**	**79.47127**
Moderately Dissected Slope	**6**	**0.40197**	**6922**	**1.281472**
Ridge-top	**0**	**0**	**417**	**0.077199**
Water body	**0**	**0**	**5817**	**1.076903**
Alluvial Plain	**0**	**0**	**7**	**0.001296**

4.3.3 Land Use & Land Cover

The land use and land cover (LULC) map was prepared from the Google Earth data considering 2012 situation. Following the normal mapping procedure in Google Earth, first the polylines of different land use/cover were drawn and the same were imported in Arc GIS through kml to feature conversion. In Arc GIS the features were converted into polygons and then again exported to Google Earth through layer to kml conversion. Each polygon was named as per its LULC class and reconverted into a shape file through kml to layer conversion. The obtained pre-field LULC map was checked in the field in all accessible locations. The area in terms of LU/LC can be classified in to ten classes: Barren, cultivation, settlements, sparse vegetated areas, thick vegetated areas, river, plantation, extensive slope cuts and fallow land. The areas along river banks is covered with alluvial material and along low lying valleys is covered with overburden material and are being used for cultivation (Photo-9). Major part of the area (about 60.5%) is covered with low height plantations (Photo-11) that include coffee, tea, cardamom, black pepper and oranges followed by cultivation (17%). About 15% of the study area consists of thick forests (Photo-13). Settlements (Photo-14) (3%) in the area are widely distributed and are a vital cause in disturbing the natural equilibrium of slopes. LULC factor class 'Extensive road cut' is observed to be most vulnerable sites for slope failures. The area coverage of each factor class in pixels, LOFS and rank is given in table 6. The maximum weightage is given to extensive slope cut (Photo-10) followed by sparse vegetation.

Table 7 – LOFS, rank and area coverage in pixels for Landuse/Landcover of T.S No. 48P/15 & 16.

Class	Rank	LOFS	Area coverage (Pixels)	Area covered (%)
Cultivation	2	0.0937	95407	17.66273
Extensive Slope Cut	9	1.0000	134	0.024807
Fallow Land	1	0.0626	639	0.118298
Plantation (HHP)	4	0.1988	11274	2.087159
Plantation (LHP)	3	0.1366	327326	60.59797
Thick Vegetation	4	0.1988	81091	15.0124
Sparse Vegetation	7	0.5631	405	0.074978
Water body	0	0.0000	5817	1.076903
Settlement	1	0.0683	16911	3.130739
Barren	1	0.0626	1180	0.218454

4.3.4 Slope Forming Material (SFM):

Slope Forming Material (SFM) map was prepared in Arc GIS 10.1 through visual interpretation of multi-temporal Google Imageries of the area and collection of data for material present on slopes. The study area in terms of Slope Forming Material (SFM) is classified in to four classes: Rock, weathered rock, In-situ soil & laterite.

On slopes, barren rock (Photo-17) is present at places where the slope gradient in general is more than 35°, most of the study area (about 73%) is covered by In-situ, granitic soil (Photo-18) followed by rock (24.7%). The factor class rock includes overlying material less than 0.5m in thickness. For this class different rock names are taken from the geological map of the study area given by GSI. Laterite (Photo-15) is observed in patches near Virajpet, Birunani and Srimangala. Weathered rock (Photo-16) is also observed along road cuts near Perumbadi, Boyikere and Kondangeri. In the eastern part of the area the in-situ soil is observed to be blackish in colour representing the underlying lithology i.e charnockites. The weathered rock factor class is given maximum weightage using AHP and the area covered by it is 0.11% of the study area. The area covered in pixels, LOFS and rank is given in table 7.

Table 8 –LOFS, rank and area coverage in pixels for Slope forming material of T.S No. 48P/15 & 16.

Class	Rank	LOFS	Area coverage (pixels)	Area covered (%)
In-situ soil	4	0.2409	398215	73.72168
Granite gneiss	1	0.0682	81197	15.03203
Granite	1	0.0682	381	0.070535
Gar-bio-sill gneiss + graphite + kyanite	1	0.0682	715	0.132368
Garnet-sillimanite-kyanite gneiss	1	0.0682	17831	3.301059
Hornblende-diopside gneiss	1	0.0682	11548	2.137885
Quartz vein	1	0.0682	20	0.003703
Pegmatite	1	0.0682	10	0.001851
Charnockite	1	0.0682	12931	2.39392
Dolerite	1	0.0682	8	0.001481
Amphibolite	4	0.2409	3	0.000555
Laterite	4	0.2409	8538	1.580643
Calc granulite	4	0.2409	41	0.00759
Pyroxene granulite	4	0.2409	477	0.088307

Transported Soil	**3**	**0.1506**	**1858**	**0.343972**
Weathered Rock	**6**	**0.5437**	**594**	**0.109967**
Water body	**0**	**0**	**5817**	**1.076903**

4.3.5 Regolith Thickness: Depth of Overburden is directly controlled by slope forming material (SFM), geomorphology, land use & land cover and slope gradient. During field work, regolith/overburden depth is estimated by observing road cuts, forest trenches and nala sections wherever available. An attempt is made to get the approximate overburden depth and it is observed that in low dissected hill slope with low slope gradient, the overburden depth is relatively more (approx. 2-5 m or >5m) where as in low dissected slopes having steeper slope gradient, the overburden depth varies from 1-2m to occasionally upto 5m range. In the study area it can be classified in to three classes: <0.5 m, 0.5m to 5 m and 5m to 10m. Along the moderate and steep slopes depth of overburden, in general, is less while along major weathered profiles, regolith thickness is more, these areas are more prone to landslides. Regolith depth of <0.5m depth (Photo-19) is observed on rocky, steep slopes. This is then included into rock itself. Major part of the study area has a regolith depth of 0.5m to 5m (Photo-20). Some places have regolith depths of more than 5m (Photo - 21) like west of Hudikere and west of Makkanduru. The factor class 0.5m to 5m is given the maximum weightage for landslide occurrence using AHP. The area covered by each factor class in terms of pixels, LOFS and rank is given in table -8.

Table – 9 LOFS, rank and area coverage in pixels for Regolith Thickness of T.S No. 48P/15 & 16

CLASS	Rank	LOFS	Area coverage (Pixels)	Area covered (%)
<0.5m	**0**	**0**	**140106**	**25.93787**
0.5-5m	**7**	**1**	**398969**	**73.86126**
5-10m	**4**	**0.322961**	**1109**	**0.20531**
>10m	**2**	**0.136266**	**0**	**0**

4.4 Landslide Susceptibility Analysis (AHP)

Landslides or rather slope failures in the study area are concentrated mainly along roads and other transportation corridors. Recording these slope failures which are a result of anthropogenic activities and considering them for susceptibility zonation of the study area would be highly biased. Since very few, almost negligible amount of slides are observed elsewhere in the area, the normal method of modeling cannot be used here. In this situation, ratings and inter-predictor weights can only be determined using expert or knowledge driven techniques by implementing one of the following alternatives or by combining knowledge derived from attempting all the alternatives.

Alternative 1: Finalisation of ratings and weights in a smaller neighbouring area-

If landslide inventory data is available in a smaller catchment or road-corridor within or adjacent to the proposed study area (or Toposheet), attempts should be made to determine terrain-specific ratings and weights of geofactors through a pilot study in that particular pilot study area. This can be executed by employing different spatial association analysis such as determination of Yule's Co-efficient, Distance Distribution Analysis etc. The ratings and weights determined so far through that pilot study can then be utilised for the entire study area where landslide data is not available. Since NLSM aims to develop and utilise terrain-specific ratings and weights, this seems to be the best approximation of terrain-specific importance of geofactors.

Alternative 2: Finalisation of ratings and weights using expert opinion and Analytical Hierarchy Process (AHP)-

In a situation of complete non-availability of landslide inventory data, there is absolutely no remedy other than utilising complete expert or knowledge driven ratings and weights into susceptibility modeling despite its subjectivity. However, this knowledge-driven ratings/ weights in quantitative matrices can easily be determined mathematically using AHP (Saaty, 1977; Ghosh et al., 2011; Yalcin et al., 2011; Kayastha et al., 2013), after preparing/ deciding on the qualitative pairwise importance matrix for different geofactor classes and amongst different geofactors for inter-predictor weights, obtained so far through discussion and comments received from local experts and landslide scientists engaged in landslide investigation of the area. The procedures of application of AHP through some examples are demonstrated through some illustration below.

In line of the above proposition, for determining the terrain-specific knowledge-driven ratings and weights through application of AHP, a mandate form/ questionnaire is prepared, where all the concerned landslide scientists, other geologists working in similar terrain and all experts of the concerned Region may submit their mandate/ answer in a semi-quantitative term by rating each geofactor theme separately. While giving the semi-quantitative rating in a scale of 1-9 for each geofactor theme, the mutual relative importance for influencing/ causing a single proposition that is **land sliding** in this case should be taken into account. A particular geofactor class having higher rating would be considered as more instrumental in influencing land sliding. For example, if we classify our slopes into 5 classes say 0-15, 15-25, 25-35, 35-45 and >45 and give semi-quantitative rating as 2, 4, 8, 6, 1 then it will be presumed that for land sliding, slope class 25-35 is the most important among all other classes.

4.4.1 Methodology: The Analytic Hierarchy Process (AHP), developed by Saaty (1981) is a method of structuring decision problems. The AHP consists of three levels of hierarchy. The first hierarchy level is the goal of the decision making, the second level involves how each of the existing criteria contributes to achievement of goal, and the third level is to find out how each of the alternatives contributes to each of the criteria.

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

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

CI= maks eigen value-n/n-1 Eq-1

$maks.eigenvalue = \sum_{\iota} wi.\mathrm{ci}$ Eq-2

The consistency ratio is then calculated as,

$CR = CI / RI$ Eq-3

Where, n is the amount of items compared, w*i* is the weight, ci is the sum of column, CR is the

Consistency Ratio, CI is the Consistency Index and RI is the Random Consistency Index.

If $CR \geq 10\%$, the data acquired is inconsistent and If $CR < 10\%$, the data acquired is consistent. The ratio-scale form is used as an input. The values in the ratio are organized in a matrix, which is called the pairwise comparison matrix. In the AHP method, the scale range 1–9 is assumed. It is limited to a ratio-scale 1–9 because according to the research conducted by Miller, human beings cannot simultaneously compare more than seven objects. The Standard Preference Scale used is given in table:

Preference Level	**Numerical Value**
Equally Preferred	1
Equally to Moderately Preferred	2
Moderately Preferred	3
Moderately to Strong Preferred	4
Strongly Preferred	5
Strongly to Very Strongly Preferred	6
Very Strongly Preferred	7
Very Strongly to Extremely Preferred	8
Extremely Preferred	9

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

Example of LULC for calculation of LOFS is given in table:

Example-Calculation of LOFS For LULC

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

Table-10: Generic Table showing mutual comparison rank of LULC factor classes.

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

Table-11: Table showing matrix of mutual comparison ranks of LULC classes given rank >0.

LULC	B	CL	ESC	FL	MV	HHP	LHP	QR	S	SM	TV	SV	Sum rows	Frac rate	LOFS
B	0.020	0.013	0.037	0.020	0.013	0.012	0.011	0.013	0.020	0.021	0.012	0.021	0.213	0.018	0.063
CL	0.041	0.026	0.042	0.041	0.016	0.015	0.017	0.016	0.041	0.024	0.015	0.024	0.318	0.027	0.094
ESC	0.184	0.208	0.333	0.184	0.329	0.278	0.237	0.323	0.184	0.431	0.278	0.431	3.399	0.283	1.000
FL	0.020	0.013	0.037	0.020	0.013	0.012	0.011	0.013	0.020	0.021	0.012	0.021	0.213	0.018	0.063
MV	0.102	0.104	0.067	0.102	0.066	0.093	0.102	0.065	0.102	0.048	0.093	0.048	0.990	0.082	0.291
HHP	0.082	0.078	0.056	0.082	0.033	0.046	0.068	0.032	0.082	0.036	0.046	0.036	0.676	0.056	0.199
LHP	0.061	0.052	0.048	0.061	0.022	0.023	0.034	0.022	0.061	0.029	0.023	0.029	0.464	0.039	0.137
QR	0.102	0.104	0.067	0.102	0.066	0.093	0.102	0.065	0.102	0.048	0.093	0.048	0.990	0.082	0.291
S	0.020	0.013	0.037	0.020	0.013	0.012	0.011	0.032	0.020	0.021	0.012	0.021	0.232	0.019	0.068
SM	0.143	0.156	0.111	0.143	0.198	0.185	0.169	0.194	0.143	0.144	0.185	0.144	1.914	0.160	0.563
TV	0.082	0.078	0.056	0.082	0.033	0.046	0.068	0.032	0.082	0.036	0.046	0.036	0.676	0.056	0.199
SV	0.143	0.156	0.111	0.143	0.198	0.185	0.169	0.194	0.143	0.144	0.185	0.144	1.914	0.160	0.563
														Max	0.283

Table-12: Table Showing Fraction rate and LOFS values.

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

Table-13: Table showing estimation of consistency vector (CV).

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

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

Table-14: Table showing calculation of consistency index (CI) and consistency ratio (CR).

In the same manner for all the 6 factor maps calculation of LOFS and consistency ratio (CR) was done. After calculation of LOFS values for all the factor classes of all the factor maps,

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

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

Factor	Slope	Curvature	SFM	LULC	Geom	RT	Sum rows	Frac rate	Weight	Weight W N
Slope	0.45283	0.296296	0.45112	0.51597	0.36734	0.367347	2.450919	0.408486	12.64217	13
Curvature	0.056604	0.037037	0.02255	0.03685	0.02040	0.020408	0.193869	0.032311	1	1
SFM	0.113208	0.185185	0.11278	0.08599	0.18367	0.183673	0.864517	0.144086	4.459293	4
LULC	0.226415	0.259259	0.33834	0.25798	0.30612	0.306122	1.69425	0.282375	8.73917	9
Geom	0.075472	0.111111	0.03759	0.05159	0.06122	0.061224	0.398223	0.06637	2.054087	2
RT	0.075472	0.111111	0.03759	0.05159	0.06122	0.061224	0.398223	0.06637	2.054087	2

Table-15: Table showing mutual comparison of individual factor maps and weights.

Once the LOFS values for geofactor sub classes are determined, all the LOFS values against the sub classes are compiled in an excel sheet. Then the LOFS attributes are joined in the raster map attribute table using “join and relates” option. Finally LOFS map of the geofactor is prepared with the help of “Lookup” command in Arc – GIS, using raster map of the geofactor as “input raster” and “geofactor_LOFS$LOFS” as lookup field.

For determination of Predictor Weight for the the geofactor, one comparison matrix is calculated in microsoft excel software 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 using the “MIN” command in excel software. 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.

For generation of “Raw Landslide Susceptibility Score Map” in Arc – GIS, “raster calculation” command under map algebra is used. For “Raw Landslide Susceptibility Score Map” the following formula is used.

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 det 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 using reclassify command in Arc – GIS. In reclassification window, three classes is chosen and in break values, 2nd topmost value 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*" (Plate- 9).

V. LANDSLIDE SUSCEPTIBILITY MAP

Landslide susceptibility map thus obtained after generating LOFS maps for all the factor classes and using Weighted Multiclass Index Overlay method thus generating raw susceptibility score map which is classified into low, moderate and high susceptible areas so that it can be understood easily by the common man. The susceptibility is expressed in terms of the relative proneness of an area to initiation of a landslide or slope failure in a pixel (the mapping unit) under the given geo-environmental conditions. Approximately 1.5% (about 20Sq. Km.) area is falling in high susceptibility zones while about 1% (12 Sq. Km.) area is falling in moderate susceptibility zone. Rest of the area is indicated as low susceptibility zone. Most of the high susceptible zones fall in TS No.48P/16.

The hill NE of Virajpet town falls in High to Moderate susceptibility zone. This hill is densely inhabited and slope is modified at several places for building houses and some public utility buildings. This has increased the susceptibility index of this area.

Some areas in the South – West part of study area are falling in high susceptibility zones, primarily Perumbadi – Makutta road and Brahmgiri Ghat reserved forest. In terms of LULC theses road sections are affected by anthropogenic activities, namely slope disturbance and deforestation. In terms of geomorphology this area falls under low dissected slopes. Slope gradient in this area ranges between 25° to 45° and more which is having maximum rating. Since slope gradient has been attributed with the maximum weightage these areas have been classified into high susceptible zones.

Besides these some part of Chittalli – Madikeri road exhibits high susceptibility zones. Road section in this area is highly disturbed due to plantations on slopes and habitation. Some perennial streams are also present in the area which cut across the roads. These streams grow in size and flow during monsoons. This increases the proneness of the area in terms of slope failure. As far as slope morphometry is concerned, the area has slope gradient between 25° to 45°, thus making it highly susceptible to landslides. This area also has a history of slope failures and some extensive slope cuts.

In the NE part of the study area, some high susceptibility zones near Hullitalla and Kandanakolli are observed. On the road sections in this area, weathered granite is exposed, besides the slope gradient is also high here. In terms of landuse the area has dense settlements along the road, making the slopes unstable. Thus the area falls under high susceptibility zone. Besides these some sporadic patches of high susceptible zones are noticed east of Suntikoppa and south-east of Siddapura which may be due to anthropogenic activities like deforestation, slope disturbance and modification. Some parts NE of Maldare like Siddeshwara betta fall in high susceptible zones which may be attributed to Steep slope gradient.

Some parts like SW of Hattihole and SE of Rasulpura fall into moderate susceptibility zones. These areas, in terms of LULC fall into sparsely vegetated areas, in terms of Geomorphology, the area falls in low dissected slopes, while in terms of slope gradient, it falls in 15° to 35° category. The moderate susceptibility index may be attributed to sparse vegetation (rating 7) and high weightage given to slope gradient. Some areas north of Birunani and Mrityunjaya temple also fall in moderate susceptibility zones which may be attributed to slope gradient which is categorised into 25° to 35° category.

Most of the study area (about 97%) is categorised into low susceptibility zone. This may be attributed to presence of low lying areas which abound in cultivation and low height plantations. In addition to this most of the area has slope gradients less than 15° which renders the area stable. Since the area has abundant vegetation the slope forming material, at most places is bounded by penetrating roots of these plants. This also provides stability to area as far as slope failure is concerned.

VI. CONCLUSIONS AND RECOMMENDATIONS

About 3% (32 Sq. Km.) area is grouped under Moderate to High susceptibility zone in toposheet no.'s 48P/15 & P/16. Most of this area lies around transportation corridors and extensive slope cut areas besides hills with steep slopes are also grouped under moderate to high susceptible zones.

The susceptibility map thus obtained using Analytical hierarchy process (AHP) gives a qualitative indication in the study area about particular mapping units (pixel in this case having 50m * 50m resolution) being susceptible to landslide occurrence under the cumulative effect of geo factors under consideration. This does not have any time connotation and it is assumed that the same geo-environmental conditions will prevail in the future that augmented the present slope failures. These conditions may change with time and so will the susceptibility index of the area. The areas categorised under high and moderate zones are enlisted below in brief:

The hill NW of Virajpet is densely inhabited with slope modifications for construction of houses and civil structures. This hill falls under moderate to high susceptible zone. Though the surrounding areas are covered under low susceptibility zones but still due to anthropogenic activities this hill has a possibility of slope failure occurrence in future under the influence of factors like rainfall, weathering etc. Since the area is densely populated slope failures may cause great damage to life and property. This has to be conveyed to the concerned authorities and preventive measures like slope terracing, retaining walls etc. should be taken up. A detailed study of the hill may also be taken up.

Similarly, road sections on the Perumbadi – Makutta road have been observed to have weathered rock and also steep slope gradients. This area also has possibility of slope failures as indicated by susceptibility map. Heavy rainfall and deforestation may lead to loosening of the overburden which may slide. Preventive measures like slope stabilisation and conservation of forests need to be taken up so that the highway is kept safe from any damage.

The road between Chittalli and Madikeri also has several locations where the landslide susceptibility is high. The area has a history of slope failures and regular recurrence of slides. The area also has running streams that cut across the roads during rainy season which pose considerable risk to the road. Proper drainage along the road and diversion of drainage on the top of the slope should be done. Slope stability measures are also required to minimise the risk.

The road connecting Madikeri to Makkanduru, Kandanakolli and Hattihole also falls in the high susceptibility zone. This area also has a history of slope failures along road sections during rainy season. Though the surrounding areas are grouped under low susceptible zones but this part on the road section requires slope stability measures and proper drainage to avoid slope failures.

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 studied hillslopes. 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 relation/s between spatial factors and past/present landslides are relevant to the occurrence of future landslides may not always hold true in nature.

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

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.

Spatio-temporal prediction of a landslide is still difficult on macro-scale; hence questions can be raised about the predictive capability of a susceptibility map given the uncertainty in the occurrence of a landslide.

Limitations in understanding the terrain and its landslide characteristics thereby affecting the selection of preparatory factors are also probable.

Inspite 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:

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

Landslide susceptibility mapping is useful in identifying potential landslide hazard zones but remedial measures to protect/treat the slide is of prime concern. In order to make these studies user friendly, the town planner/district administration should consult the report and landslide protection work should be undertaken in consultation with civil engineers.

In the event if a disaster strikes, the loss would be immense if buildings are not safely and properly located. Awareness among people is of utmost importance to reduce the loss of lives and property.

The awareness should include information about the potential danger, its identification and its communication; the physical significance of hazard and inherent uncertainties; ways to reduce landslide risk and the available local mitigation options.

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LOCALITY INDEX

Locality name	Latitude	Longitude
Ayyankunnu male	12° 02' 8.65" N	75° 46' 19.32" E
Birunani	12° 1' 1.418" N	75° 52' 35.526" E
Chittalli	12° 22' 9.497" N	75° 50' 1.683" E
Devamachi	12° 14' 8.442" N	75° 59' 43.953" E
Gonikoppa	12° 11' 0.248" N	75° 55' 56.982" E
Guddehosur	12° 26' 39.339" N	75° 55' 27.081" E
Hattihole	12° 29' 14.816" N	75° 47' 43.309" E
Hudikere	12° 5' 2.115" N	75° 56' 24.002" E
Hullitalla	12° 22' 4.464" N	75° 47' 14.067" E
Kandanakolli	12° 28' 25.355" N	75° 46' 52.206" E
Karikattakary	12° 00'12.5" N	75°45' 26.11" E
Kushalnagar	12°27'37.69" N	75°57' 39.16" E
Makkanduru	12° 27' 32.283" N	75° 46' 1.005" E
Makutta	12° 04' 25.4" N	75° 43' 38.71" E
Madikeri	12° 25' 28.04" N	75° 44' 17.32" E
Murnad	12° 19' 5.433" N	75° 45' 18.784" E
Perumbadi	12° 8' 41.547" N	75° 47' 49.391" E
Ponnampet	12° 8' 45.366" N	75° 56' 45.553" E
Siddapura	12° 17' 47.915" N	75° 52' 23.718" E
Somwarpet	12° 35' 40.28" N	75° 44' 17.32" E
Suntikoppa	12° 27' 7.003" N	75° 49' 47.004" E
T. Shettigere	12° 2' 3.569" N	75° 58' 16.813" E
Virajpet	12° 11' 53.447" N	75° 48' 13.607" E

SYNOPSIS OF WORK DONE

1	**Title of the report**	Macro-Scale (1:50,000) Landslide Susceptibility Mapping In Parts Of Toposheet No. 48P/15 & 16, Coorg District, Karnataka.
2	**FSP Code No**	LSM/SR/KG/2015/099
3	**Field Season**	2015 - 16
4	**Date of Commencement**	23rd September 2015
5	**Date of Completion**	29th February 2016
6	**Officers associated with the investigation and no. of days spent in the field**	Ankur Kumar Srivastava, Senior Geologist (85 days) Harsha Sunder E., Senior Geologist (38 days)
7	**Quantum of work done**	

1. Pre-field preparation	
(i) Slope Forming Material map	1350.4 sq. km
(ii) Geomorphology & Lineament map	1350.4 sq. km
(iii) Slope Morphometry (slope, aspect & curvature) map	1350.4 sq. km
(iv) Landuse / Landcover map	1350.4 sq. km
(v) Drainage map	1350.4 sq. km
(vi) Regolith thickness map	1350.4 sq. km
(vii) Preparation of Landslide Inventory Map	1350.4 sq. km
2. Field-based studies	
(i) Field-checking of all thematic maps	1350.4 sq. km
(ii) Field validation of landslide inventory and collection of recent and historic landslides (using archives, old reports, road register etc.)	1350.4 sq. km
(iii) Collection of landslide inventory and damage data as per 41 point geo parametric data sheet	08 nos.
(iv) Validation of landslide susceptibility map at important locations	1350.4 sq. km
3. Post-field studies & modelling	
(i) Updation of thematic and inventory maps in GIS	1350.4 sq. km
(ii) Preparation of Landslide Susceptibility Map in GIS	1350.4 sq. km
4. Collection of rainfall data from available rain stations	Collected available data

8	**Expenditure**

Wages (Rs.)	39040.00
OC (Rs.)	24250.00
Total (Rs.)	**63290.00**

FIVE POINT PROFORMA

Title of the report: Macro-Scale (1:50,000) Landslide Susceptibility Mapping In Parts Of Toposheet No. 48P/15 & 16, Coorg District, Karnataka.	
1. Background of the investigation at whose instance or with what particular objective in view the investigation was undertaken	Item document no FSP Code No: LSM/SR/KG/2015/099 Item No: 176 Project No: NLSM - VI
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.	Item document no FSP Code No: LSM/SR/KG/2015/099 Item No: 179 Project No: NLSM - VI
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.	23rd September 2015 2 officers spent total 123 man days at the field
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. The work was carried out under the supervision of Shri J. Srihari, Director.
Date: Place: Bengaluru	Shri J. Srihari Director

Date	Location	T.S. No.	Locality	Latitude	Longitude	Geomproc	Geomform	Rock	Weathering	RockCharac	Strucdata	Fault/lineament	Overburden type	Overburden depth	Landuse type	Hydrological condition	Susceptibility assessment of slope	Qualitative risk assessment
01.11.2015	VP/01A	48P/16	Virajpet	12.17	75.81	Gravitational	Lowly dissected						Insitu-soil	0-5m	Settlement	Damp	Stable	Low or absent
01.11.2015	VP/02A	48P/16	Bittangala	12.17	75.82	Gravitational	Lowly dissected						Insitu-soil	0-5m	Agriculture	Damp	Stable	Low or absent
01.11.2015	VP/03A	48P/16	Bittangala	12.17	75.85	Gravitational	Pediment Pediplain complex	Laterite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
01.11.2015	VP/04A	48P/16	Kolathodu	12.17	75.86	Gravitational	Lowly dissected	Weathered Granite/Laterite					Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
01.11.2015	VP/05A	48P/16	Kolathodu-Gonikoppal Road	12.17	75.88	Gravitational	Lowly dissected	Weathered Granite					Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
01.11.2015	VP/06A	48P/16	Hatur	12.17	75.89	Gravitational	Pediment Pediplain complex						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
01.11.2015	VP/07A	48P/16	Kaikery	12.17	75.91	Gravitational	Pediment Pediplain complex						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
01.11.2015	VP/08A	48P/16	Gonikoppal	12.18	75.94	Gravitational	Pediment Pediplain complex	Argillite	High	Jointed			Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
01.11.2015	VP/09A	48P/16	Gonikoppal-Ponnampet Road	12.18	75.96	Gravitational	Lowly dissected	Weathered Granite					Insitu-soil	0-5m	Sparsely vegetated	Damp	Stable	Low or absent
01.11.2015	VP/10A	48P/16	Gonikoppal-Ponnampet Road	12.17	75.96	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
01.11.2015	VP/11A	48P/16	Tittimatti	12.22	76.00	Gravitational	Hill top						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
01.11.2015	VP/12A	48P/16	Tittimatti-Devarapura Road	12.20	75.97	Gravitational	Hill top						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
01.11.2015	VP/13A	48P/16	Devarapura Junction	12.20	75.96	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
02.11.2015	VP/14A	48P/16	Hatur	12.17	75.88	Gravitational	Lowly dissected	Weathered Granite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
02.11.2015	VP/15A	48P/16	Hatur-Ponnampet Road	12.15	75.89	Gravitational	Pediment Pediplain complex						Insitu-soil	0-5m	Agriculture	Damp	Stable	Low or absent
02.11.2015	VP/16A	48P/16	Hatur-Ponnampet Road	12.13	75.89	Gravitational	Pediment Pediplain complex						Insitu-soil	0-5m	Agriculture	Damp	Stable	Low or absent
02.11.2015	VP/17A	48P/16	Hatur-Ponnampet Road	12.13	75.92	Gravitational	Pediment Pediplain complex						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
02.11.2015	VP/18A	48P/16	Hatur-Ponnampet Road	12.13	75.93	Gravitational	Lowly dissected	Granitic boulders	High				Insitu-soil	0-5m	Agriculture/LHP	Damp	Stable	Low or absent
02.11.2015	VP/19A	48P/16	Ponnampet	12.12	75.94	Gravitational	Pediment Pediplain complex						Insitu-soil	0-5m	Agriculture	Damp	Stable	Low or absent
02.11.2015	VP/20A	48P/16	Ponnampet-Hudikere Road,S	12.10	75.94	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
02.11.2015	VP/21A	48P/16	Hudikere SH 89	12.07	75.94	Gravitational	Pediment Pediplain complex						Insitu-soil	0-5m	Agriculture	Damp	Stable	Low or absent
02.11.2015	VP/22A	48P/16	S.Shattikere Road	12.13	75.91	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
02.11.2015	VP/23A	48P/16		12.13	75.90	Gravitational	Hill top	Granite	Moderate				Insitu-soil	0-5m	Moderately vegetated	Wet	Stable	Low or absent
02.11.2015	VP/24A	48P/16	Shettikere	12.12	75.89	Gravitational	Pediment Pediplain complex						Insitu-soil	0-5m	Sparsely vegetated	Damp	Stable	Low or absent
02.11.2015	VP/25A	48P/16	Bittangala Junction, Shettiker	12.12	75.88	Gravitational	Hill top	Laterite					Insitu-soil	0-5m	Agriculture/LHP	Damp	Stable	Low or absent
02.11.2015	VP/26A	48P/16	Koupandra	12.13	75.86	Gravitational	Hill top						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
02.11.2015	VP/27A	48P/16	Koupandra	12.15	75.84	Gravitational	Pediment Pediplain complex						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
03.11.2015	VP/28A	48P/16	Sungatpet (Ammatti road) SH	12.20	75.81	Gravitational	Lowly dissected	Granite	Moderate				Insitu-soil	0-5m	Settlement	Damp	Stable	Low or absent
03.11.2015	VP/29A	48P/16	Kumbethodu	12.20	75.82	Gravitational	Pediment Pediplain complex						Insitu-soil	0-5m	Agriculture	Damp	Stable	Low or absent
03.11.2015	VP/30A	48P/16	SH 91	12.22	75.83	Gravitational	Extensive Cut Slope	Weathered Granite					Lithomarge	0-5m	LHP, agriculture on downslope	Damp	Stable	Low or absent
03.11.2015	VP/31A	48P/16	Karatti SH 91	12.23	75.85	Gravitational	Lowly dissected	Laterite					Lithomarge/ 0.5mt Insitu soil	0-5m	LHP, agriculture on downslope	Damp	Stable	Low or absent
03.11.2015	VP/32A	48P/16	Ammati	12.23	75.87	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
03.11.2015	VP/33A	48P/16		12.23	75.88	Gravitational	Lowly dissected	Granitic boulders					Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
03.11.2015	VP/34A	48P/16	Pollipeta	12.23	75.90	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
03.11.2015	VP/35A	48P/16	Pollipeta	12.23	75.93	Gravitational	Extensive Cut Slope	Granitic boulders					Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
03.11.2015	VP/36A	48P/16	Tittimatti-Pollibetta road	12.22	75.95	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
03.11.2015	VP/37A	48P/16	Tittimatti road	12.22	75.97	Gravitational	Lowly dissected	Granitic boulders					Insitu-soil	0-5m	Moderately vegetated	Damp	Stable	Low or absent
03.11.2015	VP/38A	48P/16	Tittimatti road	12.22	75.99	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
04.11.2015	VP/39A	48P/16	Gonikoppa-Ammati road	12.17	75.90	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
04.11.2015	VP/40A	48P/16	Gonikoppa-Ammati road	12.18	75.91	Gravitational	Pediment Pediplain complex						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
04.11.2015	VP/41A	48P/16	Gonikoppa-Ammati road	12.20	75.90	Gravitational	Pediment Pediplain complex						Insitu-soil	0-5m	Agriculture	Damp	Stable	Low or absent
04.11.2015	VP/42A	48P/16	Gonikoppa-Ammati road	12.22	75.88	Gravitational	Lowly dissected						Insitu-soil/Lithomarge	0-5m	Agriculture	Damp	Stable	Low or absent
04.11.2015	VP/43A	48P/16	Gonikoppa-Ammati road	12.22	75.87	Gravitational	Pediment Pediplain complex						Insitu-soil	0-5m	Agriculture	Damp	Stable	Low or absent

Date	Location	T.S. No.	Locality	Latitude	Longitude	Geomproc	Geomform	Rock	Weathering	RockCharac	Strucdata	Fault/lineament	Overburden type	Overburden depth	Landuse type	Hydrological condition	Susceptibility assessment of slope	Qualitative risk assessment
04.11.2015	VP/44A	48P/16	Ammati-Hatur road	12.22	75.83	Gravitational	Lowly dissected						Insitu-soil	0-5m	Moderately vegetated	Damp	Stable	Low or absent
04.11.2015	VP/45A	48P/16		12.20	75.84	Gravitational	Extensive Cut Slope						Lithomarge	0-5m	LHP	Damp	Stable	Low or absent
04.11.2015	VP/46A	48P/16	Ammati-Hatur road	12.20	75.85	Gravitational	Lowly dissected						Lithomarge	0-5m	Sparsely vegetated	Damp	Stable	Low or absent
04.11.2015	VP/47A	48P/16	Ammati-Hatur road	12.18	75.86	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
04.11.2015	VP/48A	48P/16	Ammati-Hatur road	12.18	75.87	Gravitational	Pediment Pediplain complex						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
05.11.2015	VP/49A	48P/16	Kukloor	12.20	75.79	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
05.11.2015	VP/50A	48P/16	Kukloor	12.22	75.78	Gravitational	Pediment Pediplain complex						Insitu-soil	0-5m	Agriculture	Damp	Stable	Low or absent
05.11.2015	VP/51A	48P/16	Kadanur	12.22	75.77	Gravitational	Extensive Cut Slope						Lithomarge	0-5m	Moderately vegetated/Agriculture on down slope	Damp	Stable	Low or absent
05.11.2015	VP/52A	48P/16		12.22	75.76	Gravitational	Pediment Pediplain complex						Insitu-soil	0-5m	Agriculture	Damp	Stable	Low or absent
05.11.2015	VP/53A	48P/16	Kadanga	12.22	75.75	Gravitational	Extensive Cut Slope	Laterite	High				Lithomarge	0-5m	LHP	Damp	Stable	Low or absent
05.11.2015	VP/54A	48P/16	Bellmodu	12.23	75.75	Gravitational	Lowly dissected	Laterite	High				Lithomarge	0-5m	LHP	Damp	Stable	Low or absent
05.11.2015	VP/55A	48P/16	Nalkeri	12.23	75.76	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
05.11.2015	VP/56A	48P/16	Mytadi road	12.23	75.77	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
05.11.2015	VP/57A	48P/16	Mytadi	12.23	75.78	Gravitational	Pediment Pediplain complex						Insitu-soil	0-5m	Agriculture	Damp	Stable	Low or absent
05.11.2015	VP/58A	48P/16	Mytadi	12.23	75.79	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
05.11.2015	VP/59A	48P/16	Devangere	12.23	75.80	Gravitational	Lowly dissected	Granitic boulders					Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
05.11.2015	VP/60A	48P/16	Devangere	12.23	75.82	Gravitational	Hill top	Laterite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
05.11.2015	VP/61A	48P/16		12.22	75.80	Gravitational	Pediment Pediplain complex						Insitu-soil	0-5m	Agriculture	Damp	Stable	Low or absent
05.11.2015	VP/62A	48P/16	Chikpet	12.20	75.80	Gravitational	Hill top	Laterite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
06.11.2015	VP/63A	48P/16	Virajpet	12.17	75.80	Gravitational	Pediment Pediplain complex						Insitu-soil	5-10m	Agriculture	Damp	Stable	Low or absent
06.11.2015	VP/64A	48P/16	Perumbadi	12.17	75.79	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
06.11.2015	VP/65A	48P/16	Perumbadi	12.13	75.79	Gravitational	Lowly dissected	Granite	Low to fresh				Insitu-soil	0-5m	Moderately vegetated/LHP	Damp	Stable	Low or absent
06.11.2015	VP/66A	48P/16	Perumbadi	12.13	75.79	Gravitational	Lowly dissected	Granite gneiss	Moderate		F1 N60W		Insitu-soil	0-5m	Densely vegetated	Damp	Stable	Low or absent
06.11.2015	VP/67A	48P/16		0.00	0.00	Gravitational	Lowly dissected	Granite gneiss	Moderate		J1 N45W/75NE, J2 N20W, J3 S70W/70		Insitu-soil	0-5m	Densely vegetated	Damp	Stable	Low or absent
06.11.2015	VP/68A	48P/16		12.12	75.79	Gravitational	Lowly dissected	Granite gneiss	low to fresh	Jointed-low			Insitu-soil	0-5m	Densely vegetated	Damp	Stable	Low or absent
06.11.2015	VP/69A	48P/16	Methkiayapara	12.10	75.79	Gravitational	Lowly dissected	Granite gneiss	low to fresh	Jointed-low			Insitu-soil	0-5m	Densely vegetated	Damp	Stable	Low or absent
06.11.2015	VP/70A	48P/16		12.10	75.78	Gravitational	Lowly dissected	Granite gneiss	High	Jointed-moderate			Insitu-soil	0-5m	Densely vegetated	Damp	Meta stable	Moderate
06.11.2015	VP/71A	48P/16		12.15	75.81	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
06.11.2015	VP/72A	48P/16	70m North of VP/71A	0.00	0.00													
07.11.2015	VP/73A	48P/16		12.37	75.82	Gravitational	Lowly dissected	Granite gneiss	High				Insitu-soil	5-10m	LHP	Damp	Meta stable	Moderate
07.11.2015	VP/74A	48P/16		12.37	75.82	Gravitational	Lowly dissected	Granite gneiss	Moderate		J1 N65E/S83, J2 N35W/30NE							
07.11.2015	VP/75A	48P/16		12.38	75.81	Gravitational	Lowly dissected	Granite gneiss	High	Jointed-high			Insitu-soil	5-10m	LHP	Damp	Meta stable	Moderate
07.11.2015	VP/76A	48P/16	Madikeri	12.40	75.74													
15.11.2015	VP/77A	48P/16		12.15	75.83	Gravitational	Pediment Pediplain complex						Insitu-soil	5-10m	Agriculture	Damp	Stable	Low or absent
15.11.2015	VP/78A	48P/16		12.12	75.84	Gravitational	Lowly dissected	Granite gneiss	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
15.11.2015	VP/79A	48P/16		12.12	75.85	Gravitational	Pediment Pediplain complex	Granite gneiss	Moderate		N5W, J1-E-W/85S		Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
15.11.2015	VP/80A	48P/16		12.12	75.85	Gravitational	Lowly dissected	Granite gneiss	Moderate	Jointed-low			Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
15.11.2015	VP/81A	48P/16		12.10	75.85	Gravitational	Lowly dissected	Granite gneiss	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
15.11.2015	VP/82A	48P/16		12.10	75.84	Gravitational	Pediment Pediplain complex	Granite gneiss	Moderate	Jointed-low	J1-E-W/Sub vertical		Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
15.11.2015	VP/83A	48P/16		12.10	75.86	Gravitational	Hill top						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
15.11.2015	VP/84A	48P/16	Kuttandi	12.10	75.87	Gravitational	Hill top	Laterite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
15.11.2015	VP/85A	48P/16		12.12	75.87	Gravitational	Lowly dissected	Granite gneiss	Moderate				Insitu-soil	0-5m	Moderately vegetated	Damp	Stable	Low or absent
16.11.2015	VP/86A	48P/16		12.07	75.94	Gravitational	Lowly dissected	Laterite					Insitu-soil	0-5m	Moderately vegetated	Damp	Stable	Low or absent
16.11.2015	VP/87A	48P/16		12.05	75.96	Gravitational	Pediment Pediplain complex	Granite gneiss	High				Insitu-soil	5-10m	LHP	Damp	Stable	Low or absent
16.11.2015	VP/88A	48P/16		12.03	75.97	Gravitational	Lowly dissected	Laterite					Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
16.11.2015	VP/89A	48P/16	T.Shettigere	12.03	75.96	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
16.11.2015	VP/90A	48P/16	T.Shettigere	12.02	75.95	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent

Date	Location	T.S. No.	Locality	Latitude	Longitude	Geomproc	Geomform	Rock	Weathering	RockCharac	Strucdata	Fault/lineament	Overburden type	Overburden depth	Landuse type	Hydrological condition	Susceptibility assessment of slope	Qualitative risk assessment
16.11.2015	VP/91A	48P/16	Birunani road	12.02	75.93	Gravitational	Lowly dissected	Granite	Moderate	Jointed	J1-N-S/W20, J2-E-N/N85		Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
17.11.2015	VP/92A	48P/16		12.20	75.78	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	0-5m	Moderately vegetated	Damp	Stable	Low or absent
17.11.2015	VP/93A	48P/16		12.18	75.78	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
17.11.2015	VP/94A	48P/16		12.18	75.77	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	0-5m	Densely vegetated	Damp	Stable	Low or absent
17.11.2015	VP/95A	48P/16	Kottoli	12.18	75.76	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
17.11.2015	VP/96A	48P/16	Kottoli	12.18	75.76	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
17.11.2015	VP/97A	48P/16		12.18	75.78	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
17.11.2015	VP/98A	48P/16		12.18	75.79	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
19.11.2015	VP/99A	48P/16	Mugutageri	12.12	75.95	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
19.11.2015	VP/100A	48P/16	Chikkanandur	12.10	75.97	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
19.11.2015	VP/101A	48P/16	Chikkanandur	12.10	76.00	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
19.11.2015	VP/102A	48P/16		12.15	75.95	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
20.11.2015	VP/103A	48P/16		12.13	75.96	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
20.11.2015	VP/104A	48P/16	Kirgoor	12.13	75.98	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
20.11.2015	VP/105A	48P/16		12.13	75.99	Gravitational	Pediment Pediplain complex	Laterite	High				Insitu-soil	5-10m	Agriculture	Damp	Stable	Low or absent
20.11.2015	VP/106A	48P/16		12.15	76.00	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
03.12.2015	VP/107A	48P/15	Injinikera	12.27	75.86	Gravitational	Lowly dissected	Laterite					Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
03.12.2015	VP/108A	48P/15		12.28	75.89	Gravitational	Lowly dissected	Laterite					Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
03.12.2015	VP/109A	48P/15		12.30	75.92	Gravitational	Lowly dissected	Laterite					Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
03.12.2015	VP/110A	48P/15		12.30	75.93	Gravitational	Lowly dissected	Pyroxene Granulite	low to fresh	Jointed	f-N50W/75NE, J1-N-S/85W, J2-N30W/44S		Insitu-soil	0-5m	Moderately vegetated	Damp	Stable	Low or absent
04.12.2015	VP/111A	48P/15	Mardare	12.32	75.94	Gravitational	Lowly dissected	Laterite					Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
04.12.2015	VP/112A	48P/15		12.32	75.96	Gravitational	Lowly dissected	Laterite					Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
04.12.2015	VP/113A	48P/15	Mardare	12.32	75.97	Gravitational	Lowly dissected	Granite	High				Insitu-soil	0-5m	Densely vegetated	Damp	Stable	Low or absent
04.12.2015	VP/114A	48P/15		12.32	75.98	Gravitational	Lowly dissected	Granite	High				Insitu-soil	0-5m	Densely vegetated	Damp	Stable	Low or absent
06.12.2015	VP/115A	48P/15		12.33	75.98	Gravitational	Lowly dissected	Granite	High				Insitu-soil	0-5m		Damp	Stable	Low or absent
06.12.2015	VP/116A	48P/15	Siddapura	12.28	75.88	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
06.12.2015	VP/117A	48P/15		12.27	75.90	Gravitational	Lowly dissected	Granite	Moderate	Sheared	N30W/70E		Insitu-soil	0-5m	Moderately vegetated	Damp	Stable	Low or absent
06.12.2015	VP/118A	48P/15		12.25	75.91	Gravitational	Lowly dissected	Granite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
06.12.2015	VP/119A	48P/16		12.23	75.91	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
06.12.2015	VP/120A	48P/16	Polibetta	12.23	75.92	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
06.12.2015	VP/121A	48P/15	Chennayinkote	12.27	75.94	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
06.12.2015	VP/122A	48P/15	Hundi	12.28	75.93	Gravitational	Lowly dissected	Granitic boulders					Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
06.12.2015	VP/123A	48P/15		12.28	75.92	Gravitational	Lowly dissected	Granitic boulders	Low to fresh	Massive			Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
06.12.2015	VP/124A	48P/15	Maldare	12.30	75.94	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
06.12.2015	VP/125A	48P/15		12.30	75.95	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
06.12.2015	VP/126A	48P/15		12.28	75.95	Gravitational	Lowly dissected	Granitic boulders	Moderate				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
06.12.2015	VP/127A	48P/15	Chennayinkote	12.27	75.95	Gravitational	Lowly dissected						Insitu-soil	0-5m	Densely vegetated	Damp	Stable	Low or absent
06.12.2015	VP/128A	48P/16	Polibetta	12.22	75.93	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
06.12.2015	VP/129A	48P/16		12.22	75.93	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
06.12.2015	VP/130A	48P/16		12.20	75.93	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
07.12.2015	VP/131A	48P/15		12.37	75.82	Gravitational	Lowly dissected	Meta Basalt	Low to fresh	Jointed-moderate	J1:N50E/83S, J2:N20E/5E, J3:N30W/72W			0-5m	LHP	Damp	Stable	Low or absent
07.12.2015	VP/132A	48P/15		12.37	75.82	Gravitational	Lowly dissected	Granite	High	Jointed	J1:N60E/70W		Insitu-soil	0-5m	Densely vegetated	Damp	Meta stable	Moderate
07.12.2015	VP/133A	48P/15	Chettelli	12.35	75.84	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
07.12.2015	VP/134A	48P/15		12.35	75.85	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
07.12.2015	VP/135A	48P/15	Ontiyangadi	12.32	75.86	Gravitational	Pediment Pediplain complex						Insitu-soil	5-10m	Agriculture	Damp	Stable	Low or absent
07.12.2015	VP/136A	48P/15	Nelliahudikere	12.30	75.87	Gravitational	Lowly dissected	Granite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
08.12.2015	VP/137A	48P/16		12.15	75.77	Gravitational	Lowly dissected	Granite	High				Insitu-soil	0-5m	Moderately vegetated	Damp	Stable	Low or absent
08.12.2015	VP/138A	48P/16		12.15	75.77	Gravitational	Lowly dissected	Granite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
08.12.2015	VP/139A	48P/16		12.15	75.77	Gravitational	Lowly dissected	Granite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Moderate
08.12.2015	VP/140A	48P/16		12.15	75.78	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	0-5m	Moderately vegetated	Damp	Stable	Low or absent
08.12.2015	VP/141A	48P/16		12.17	75.79	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	0-5m	Moderately vegetated/LHP	Damp	Stable	Low or absent
08.12.2015	VP/142A	48P/16		12.10	75.78	Gravitational		Granite gneiss	High				Insitu-soil	5-10m	Densely vegetated	Damp	Meta stable	Moderate
09.12.2015	VP/143A	48P/15		12.25	75.83	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
09.12.2015	VP/144A	48P/15	Ontangadi	12.27	75.82	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
09.12.2015	VP/145A	48P/15		12.27	75.81	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
09.12.2015	VP/146A	48P/15		12.28	75.80	Gravitational	Pediment Pediplain complex						Insitu-soil	5-10m	Agriculture	Damp	Stable	Low or absent
09.12.2015	VP/147A	48P/15		12.30	75.79	Gravitational	Lowly dissected	Laterite					Insitu-soil	5-10m	LHP	Damp	Stable	Low or absent
09.12.2015	VP/148A	48P/15		12.30	75.77	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent

Date	Location	T.S. No.	Locality	Latitude	Longitude	Geomproc	Geomform	Rock	Weathering	RockCharac	Strucdata	Fault/lineament	Overburden type	Overburden depth	Landuse type	Hydrological condition	Susceptibility assessment of slope	Qualitative risk assessment
09.12.2015	VP/149A	48P/15		12.32	75.75	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	0-5m	Settlement	Damp	Stable	Low or absent
09.12.2015	VP/150A	48P/15		12.28	75.79	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
09.12.2015	VP/151A	48P/15		12.28	75.76	Gravitational	Lowly dissected	Granite	High				Insitu-soil	5-10m	LHP	Damp	Meta stable	Moderate
09.12.2015	VP/152A	48P/15	Halgunda	12.27	75.79	Gravitational	Lowly dissected	Laterite						0-5m	LHP	Damp	Stable	Low or absent
09.12.2015	VP/153A	48P/15		12.25	75.80	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
10.12.2015	VP/154A	48P/15		12.27	75.83	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
10.12.2015	VP/155A	48P/15		12.28	75.83	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
10.12.2015	VP/156A	48P/15		12.28	75.82	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
10.12.2015	VP/157A	48P/15		12.30	75.83	Gravitational	River	Granite gneiss	Moderate				Insitu-soil/Alluvium	5-10m	LHP	Damp	Stable	Low or absent
10.12.2015	VP/158A	48P/15		12.27	75.84	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
10.12.2015	VP/159A	48P/15		12.27	75.85	Gravitational	Pediment Pediplain complex	Laterite	High				Insitu-soil	5-10m	LHP	Damp	Stable	Low or absent
10.12.2015	VP/160A	48P/15		12.27	75.85	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
10.12.2015	VP/161A	48P/15		12.27	75.87	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
11.12.2015	VP/162A	48P/16		12.22	75.98	Gravitational	Lowly dissected	Granite gneiss					Insitu-soil	0-5m	Densely vegetated	Damp	Stable	Low or absent
11.12.2015	VP/163A	48P/16		12.23	75.98	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
11.12.2015	VP/164A	48P/16		12.25	75.97	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	0-5m	Densely vegetated	Damp	Stable	Low or absent
11.12.2015	VP/165A	48P/16		12.23	75.99	Gravitational	Lowly dissected						Insitu-soil	0-5m	Moderately vegetated/LHP	Damp	Stable	Low or absent
11.12.2015	VP/166A	48P/16		12.23	75.99	Gravitational	Pediment Pediplain complex						Insitu-soil	5-10m	Agriculture/Settlement	Damp	Stable	Low or absent
21.12.2015	VP/167A	48P/16		12.13	75.85	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
21.12.2015	VP/168A	48P/16		12.13	75.85	Gravitational	Lowly dissected	Granite gneiss					Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
21.12.2015	VP/169A	48P/16		12.12	75.85	Gravitational	Lowly dissected	Granitic boulders	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
21.12.2015	VP/170A	48P/16		12.12	75.86	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
21.12.2015	VP/171A	48P/16		12.10	75.86	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
21.12.2015	VP/172A	48P/16		12.10	75.86	Gravitational	Lowly dissected	Granite gneiss	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
21.12.2015	VP/173A	48P/16		12.08	75.86	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
21.12.2015	VP/174A	48P/16		12.08	75.85	Gravitational	Lowly dissected	Granitic boulders	Moderate				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
21.12.2015	VP/175A	48P/16	Kuttandi	12.10	75.86	Gravitational	Lowly dissected	Granitic boulders	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
21.12.2015	VP/176A	48P/16		12.08	75.87	Gravitational	Lowly dissected	Granitic boulders	High				Insitu-soil	0-5m	Sparsely vegetated	Damp	Stable	Low or absent
21.12.2015	VP/177(1)A	48P/16	Kutta	12.08	75.87	Gravitational	Pediment Pediplain complex						Insitu-soil	5-10m	Sparsely vegetated/LHP	Damp	Stable	Low or absent
21.12.2015	VP/177A	48P/16		12.08	75.88	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
21.12.2015	VP/178A	48P/16		12.08	75.88	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
21.12.2015	VP/179A	48P/16		12.08	75.89	Gravitational	Lowly dissected	Laterite					Insitu-soil	5-10m		Damp	Stable	Low or absent
21.12.2015	VP/180A	48P/16		12.07	75.90	Gravitational	Lowly dissected						Insitu-soil	5-10m	Densely vegetated	Damp	Stable	Low or absent
21.12.2015	VP/181A	48P/16		12.07	75.90	Gravitational	Lowly dissected	Laterite					Insitu-soil	0-5m	Densely vegetated/LHP	Damp	Stable	Low or absent
21.12.2015	VP/182A	48P/16		12.10	75.88	Gravitational	Lowly dissected	Laterite					Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
22.12.2015	VP/183A	48P/16		12.02	75.93	Gravitational	Lowly dissected	Laterite					Insitu-soil	0-5m	Densely vegetated	Damp	Stable	Low or absent
22.12.2015	VP/184A	48P/16		12.03	75.92	Gravitational	Lowly dissected	Laterite					Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
22.12.2015	VP/185A	48P/16		12.03	75.91	Gravitational	Lowly dissected	Laterite					Insitu-soil	5-10m	LHP	Damp	Stable	Low or absent
22.12.2015	VP/186A	48P/16		12.02	75.89	Gravitational	Pediment Pediplain complex						Insitu-soil		LHP	Damp	Stable	Low or absent
22.12.2015	VP/187A	48P/16	Birunani	12.02	75.87	Gravitational	Lowly dissected	Granite gneiss	Moderate				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
22.12.2015	VP/188A	48P/16		12.02	75.88	Gravitational	Lowly dissected	Granite gneiss	Moderate					0-5m	LHP	Damp	Stable	Low or absent
22.12.2015	VP/189A	48P/16		12.03	75.86	Gravitational	Lowly dissected	Granite gneiss					Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
22.12.2015	VP/190A	48P/16		12.03	75.85	Gravitational	Lowly dissected	Laterite						5-10m	LHP	Damp	Stable	Low or absent
22.12.2015	VP/191A	48P/16		12.05	75.84	Gravitational	Lowly dissected	Laterite					Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
22.12.2015	VP/192A	48P/16		12.05	75.83	Gravitational	Lowly dissected	Granite gneiss					Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
22.12.2015	VP/193A	48P/16		12.02	75.98	Gravitational	Lowly dissected	Laterite					Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
22.12.2015	VP/194A	48P/16	Srimangala	12.00	75.99	Gravitational	Lowly dissected	Laterite					Insitu-soil	0-5m	Settlement	Damp	Stable	Low or absent
22.12.2015	VP/195A	48P/16		12.00	76.00	Gravitational	Lowly dissected	Laterite					Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
23.12.2015	VP/196A	48P/16	Srimangala-Irupu falls road	12.00	75.99	Gravitational	Lowly dissected	Granite gneiss	Moderate				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
23.12.2015	VP/197A	48P/16		12.00	76.00	Gravitational	Lowly dissected	Laterite					Insitu-soil	5-10m	LHP	Damp	Stable	Low or absent
23.12.2015	VP/198A	48P/16		12.33	75.86	Gravitational	Lowly dissected	Laterite					Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
24.12.2015	VP/199A	48P/16		12.35	75.88	Gravitational	Lowly dissected	Laterite					Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
24.12.2015	VP/200A	48P/16		12.40	75.91	Gravitational	Pediment Pediplain complex						Insitu-soil	5-10m	Agriculture	Damp	Stable	Low or absent
08.01.2016	VP/201A	48P/15	Nelliahudikere	12.32	75.85	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
08.01.2016	VP/202A	48P/15		12.32	75.84	Gravitational	Lowly dissected	Granite	High				Insitu-soil	0-5m	LHP	Damp	Unstable	Low or absent
08.01.2016	VP/203A	48P/15		12.32	75.83	Gravitational	Lowly dissected	Granite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent

Date	Location	T.S. No.	Locality	Latitude	Longitude	Geomproc	Geomform	Rock	Weathering	RockCharac	Strucdata	Fault/lineament	Overburden type	Overburden depth	Landuse type	Hydrological condition	Susceptibility assessment of slope	Qualitative risk assessment
08.01.2016	VP/204A	48P/15		12.33	75.82	Gravitational	Lowly dissected	Granite gneiss	Moderate				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
08.01.2016	VP/205A	48P/15		12.33	75.81	Gravitational	Lowly dissected	Granite gneiss	Moderate				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
08.01.2016	VP/206A	48P/15		12.00	75.00	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
08.01.2016	VP/207A	48P/15		12.33	75.78	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
08.01.2016	VP/208A	48P/15		12.35	75.76	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
08.01.2016	VP/209A	48P/15	Hakkatur	12.35	75.76	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	5-10m	Settlement/LHP	Damp	Stable	Low or absent
08.01.2016	VP/210A	48P/15	Hakkatur	12.33	75.76	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
08.01.2016	VP/211A	48P/15		12.32	75.76	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
08.01.2016	VP/212A	48P/15	Murnad	12.30	75.75	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
09.01.2016	VP/213A	48P/15	Chittalli	12.37	75.84	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
09.01.2016	VP/214A	48P/15	Chittalli	12.38	75.85	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	5-10m	LHP/HHP	Damp	Stable	Low or absent
09.01.2016	VP/215A	48P/15		12.38	75.84	Gravitational	Pediment Pediplain complex						Insitu-soil	5-10m	Agriculture/Settlement	Damp	Stable	Low or absent
09.01.2016	VP/216A	48P/15		12.40	75.83	Gravitational	Lowly dissected	Granite	Moderate	Jointed-moderate	J1:N60E/86S, J2:N30W/13W		Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
09.01.2016	VP/217A	48P/15		12.42	75.83	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
09.01.2016	VP/218A	48P/15	Suntikoppa	12.43	75.82	Gravitational	Pediment Pediplain complex	Laterite	High				Insitu-soil	5-10m	Agriculture/Settlement	Damp	Stable	Low or absent
09.01.2016	VP/219A	48P/15		12.43	75.87	Gravitational	Lowly dissected	Laterite					Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
10.01.2016	VP/220A	48P/15	Siddapura	12.30	75.89	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
10.01.2016	VP/221A	48P/15		12.32	75.89	Gravitational	Lowly dissected	Granitic boulders					Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
10.01.2016	VP/222A	48P/15		12.32	75.90	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	0-5m	Moderately vegetated	Damp	Stable	Low or absent
10.01.2016	VP/223A	48P/15		12.33	75.91	Gravitational	Lowly dissected						Insitu-soil	0-5m	Agriculture/Settlement	Damp	Stable	Low or absent
10.01.2016	VP/224A	48P/15	Ammanatodu	12.33	75.92	Gravitational	Lowly dissected						Insitu-soil	0-5m	Moderately vegetated	Damp	Stable	Low or absent
10.01.2016	VP/225A	48P/15		12.32	75.92	Gravitational	Lowly dissected						Insitu-soil	0-5m	Moderately vegetated/LHP	Damp	Stable	Low or absent
10.01.2016	VP/226A	48P/15		12.32	75.89	Gravitational	Lowly dissected	Granitic boulders	Moderate		N20W/34NW		Insitu-soil	0-5m	Moderately vegetated/HHP	Damp	Stable	Low or absent
10.01.2016	VP/227A	48P/15		12.32	75.93	Gravitational	Lowly dissected	Granite gneiss			f1:N30W/52SW		Insitu-soil	0-5m	HHP	Damp	Stable	Low or absent
11.01.2016	VP/228A	48P/15	Valnuru	12.35	75.87	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
12.01.2016	VP/229A	48P/15		12.33	75.86	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
12.01.2016	VP/230A	48P/15		12.37	75.85	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	5-10m	HHP	Damp	Stable	Low or absent
12.01.2016	VP/231A	48P/15		12.37	75.85	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
12.01.2016	VP/232A	48P/15		12.37	75.87	Gravitational	Pediment Pediplain complex						Insitu-soil	5-10m	LHP	Damp	Stable	Low or absent
12.01.2016	VP/233A	48P/15		12.35	75.87	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
12.01.2016	VP/234A	48P/15		12.35	75.89	Gravitational	Lowly dissected	Granitic boulders	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
12.01.2016	VP/235A	48P/15		12.35	75.90	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
12.01.2016	VP/236A	48P/15		12.37	75.89	Gravitational	Lowly dissected	Laterite	High		N23W/78W, J1: N60E		Insitu-soil	0-5m	Moderately vegetated	Damp	Stable	Low or absent
12.01.2016	VP/237A	48P/15		12.37	75.88	Gravitational	Lowly dissected	Granite	High				Insitu-soil	5-10m	LHP	Damp	Stable	Low or absent
13.01.2016	VP/238A	48P/15	Dubare camp	12.37	75.90	Fluvial		Granite gneiss	Moderate	Jointed-low			Younger loose debris	5-10m	Settlement	Wet	Stable	Low or absent
13.01.2016	VP/239A	48P/15	Dubare	12.37	75.90	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	5-10m	Moderately vegetated	Damp	Stable	Low or absent
13.01.2016	VP/240A	48P/15		12.38	75.90	Gravitational	Lowly dissected	Granite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
13.01.2016	VP/241A	48P/15		12.38	75.89	Gravitational	Lowly dissected	Granite gneiss	Moderate		N75E		Insitu-soil	0-5m	Moderately vegetated	Damp	Stable	Low or absent
13.01.2016	VP/242A	48P/15	Chiklihole dam	12.38	75.88	Gravitational	Lowly dissected	Granite gneiss	High				Insitu-soil	0-5m	Moderately vegetated	Damp	Stable	Low or absent
13.01.2016	VP/243A	48P/15		12.40	75.86	Gravitational	Lowly dissected	Granite	High				Insitu-soil	0-5m	LHP/Settlement	Damp	Stable	Low or absent
13.01.2016	VP/244A	48P/15	Kambibana	12.42	75.87	Fluvial	Alluvial flood plain		High				Insitu-soil	5-10m	LHP/Settlement	Damp	Stable	Low or absent
13.01.2016	VP/245A	48P/15	Kodagaralli	12.43	75.85	Gravitational	Lowly dissected		High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
13.01.2016	VP/246A	48P/15	Suntikoppa-Kushalnagar roa	12.43	75.84	Gravitational	Lowly dissected		High				Insitu-soil	0-5m		Damp	Stable	Low or absent
18.01.2016	VP/247A	48P/15	Kushalnagar	12.43	75.93	Gravitational	Lowly dissected	Granite gneiss/Pyroxene granulite	Moderate	Jointed-moderate, sheared	J1: E-W/87S, J2: N40W/8W, J3: N20W/76E		Insitu-soil	0-5m	Settlement	Damp	Stable	Low or absent
19.01.2016	VP/248A	48P/15	Madikeri	12.43	75.76	Gravitational	Lowly dissected	Granite	High	Sheared	N30W/53SE		Insitu-soil	0-5m	Settlement	Damp	Stable	Low or absent
19.01.2016	VP/249A	48P/15		12.42	75.78	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
19.01.2016	VP/250A	48P/15		12.42	75.78	Gravitational	Lowly dissected	Granite	High				Saprolite	0-5m	Moderately vegetated	Damp	Meta stable	Moderate
19.01.2016	VP/251A	48P/15		12.43	75.79	Gravitational	Lowly dissected		High				Insitu-soil	0-5m	Moderately vegetated	Damp	Stable	Low or absent
19.01.2016	VP/252A	48P/15		12.43	75.80	Gravitational	Lowly dissected		High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
19.01.2016	VP/253A	48P/15		12.42	75.80	Gravitational	Lowly dissected		High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
19.01.2016	VP/254A	48P/15		12.42	75.79	Gravitational	Lowly dissected	Granite	Moderate	Jointed-moderate	J1: N65W/88N, J2: N25E/73SE, N50W		Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
19.01.2016	VP/255A	48P/15		12.42	75.80	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	0-5m	LHP	Damp	Meta stable	Moderate

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19.01.2016	VP/256A	48P/15		12.40	75.79	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
19.01.2016	VP/257A	48P/15		12.40	75.79	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
19.01.2016	VP/258A	48P/15		12.40	75.78	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
19.01.2016	VP/259A	48P/15		12.40	75.76	Gravitational	Lowly dissected	Granite	Low to fresh				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
20.01.2016	VP/260A	48P/16		12.20	75.76	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
20.01.2016	VP/261A	48P/16		12.23	75.76	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
20.01.2016	VP/262A	48P/15		12.25	75.76	Gravitational	Lowly dissected	Granite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
20.01.2016	VP/263A	48P/15		12.27	75.76	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
20.01.2016	VP/264A	48P/15		12.27	75.76	Gravitational	Lowly dissected	Granite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
20.01.2016	VP/265A	48P/15		12.27	75.77	Fluvial	Alluvial flood plain						Alluvium	5-10m	Sparsely vegetated	Wet	Stable	Low or absent
20.01.2016	VP/266A	48P/15		12.27	75.77	Gravitational	Lowly dissected	Meta Basalt	Moderate	Jointed-moderate	J1: N18W/25W, J2: N35W/73E, J3: N60E/76NE		Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
20.01.2016	VP/267A	48P/15		12.28	75.78	Gravitational	Lowly dissected	Granite	Moderate				Insitu-soil	0-5m	Moderately vegetated	Wet	Stable	Low or absent
20.01.2016	VP/268A	48P/15		12.27	75.78	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
20.01.2016	VP/269A	48P/15		12.25	75.78	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
22.01.2016	VP/270A	48P/15	Kondangeri	12.30	75.80	Gravitational	Lowly dissected		High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
22.01.2016	VP/271A	48P/15		12.32	75.80	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
22.01.2016	VP/272A	48P/15		12.32	75.80	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
22.01.2016	VP/273A	48P/15		12.33	75.79	Gravitational	Lowly dissected	Granite	Moderate				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
22.01.2016	VP/274A	48P/15		12.32	75.79	Gravitational	Lowly dissected	Granite	Moderate				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
22.01.2016	VP/275A	48P/15		12.33	75.78	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
22.01.2016	VP/276A	48P/15		12.32	75.79	Gravitational	Lowly dissected	Granite	Moderate				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
23.01.2016	VP/277A	48P/15	Maragodu	12.32	75.78													
23.01.2016	VP/278A	48P/15	Maragodu	12.33	75.79	Gravitational	Lowly dissected						Insitu-soil	0-5m	Settlement/LHP	Dry	Stable	Low or absent
23.01.2016	VP/279A	48P/15		12.33	75.80	Gravitational	Lowly dissected						Insitu-soil/Lithomarge	0-5m	LHP	Dry	Stable	Low or absent
23.01.2016	VP/280A	48P/15		12.35	75.79	Gravitational	Lowly dissected	Granite gneiss	Moderate				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
25.01.2016	VP/281A	48P/15		12.35	75.79	Gravitational	Lowly dissected	Granite gneiss	Moderate				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
25.01.2016	VP/282A	48P/15		12.35	75.79	Gravitational	Lowly dissected	Granite gneiss	Moderate				Insitu-soil	0-5m	LHP	Dry	Stable	Low or absent
25.01.2016	VP/283A	48P/15		12.37	75.80	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
25.01.2016	VP/284A	48P/15		12.37	75.80	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
25.01.2016	VP/285A	48P/15		12.38	75.80	Gravitational	Lowly dissected	Granite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
25.01.2016	VP/286A	48P/15		12.38	75.80	Gravitational	Lowly dissected	Granite	High	Jointed-moderate	J1: N65E/80N, J2: N35W/58SW, J3: N25W/28NE		Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
25.01.2016	VP/287A	48P/15	Chittalli-Madikeri road	12.38	75.79	Gravitational	Lowly dissected	Laterite	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
26.01.2016	VP/288A	48P/15	Madikeri-Sowmvarpet road	12.43	75.75	Gravitational	Lowly dissected	Granite gneiss	Moderate		f1: N35W/53S		Insitu-soil	0-5m	Moderately vegetated	Damp	Stable	Low or absent
26.01.2016	VP/289A	48P/15		12.43	75.76	Gravitational	Lowly dissected	Granite gneiss	High				Insitu-soil	0-5m	LHP/Settlement			
26.01.2016	VP/290A	48P/15		12.43	75.76	Gravitational	Lowly dissected	Granite gneiss	High				Saprolite	0-5m		Damp	Stable	Low or absent
26.01.2016	VP/291A	48P/15		12.45	75.76	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
26.01.2016	VP/292A	48P/15	Makkandur	12.45	75.77	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
26.01.2016	VP/293A	48P/15		12.45	75.77	Gravitational	Lowly dissected				N50W/48S		Insitu-soil	5-10m	LHP	Damp	Meta stable	Low or absent
26.01.2016	VP/294A	48P/15		12.47	75.78	Gravitational	Lowly dissected	Granite gneiss	High				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
26.01.2016	VP/295A	48P/15		12.47	75.79	Gravitational	Lowly dissected						Insitu-soil	5-10m	LHP	Damp	Stable	Low or absent
26.01.2016	VP/296A	48P/15		12.48	75.80	Gravitational	Lowly dissected	Granite	High				Insitu-soil	5-10m	LHP	Damp	Stable	Low or absent
26.01.2016	VP/297A	48P/15		12.48	75.82	Gravitational	Lowly dissected	Dolerite dyke					Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
07.02.2016	VP/297(a)A	48P/16		0.00	0.00	Gravitational	Lowly dissected	Granite gneiss	Moderate	Jointed-moderate	f1: 90/24N				Moderately vegetated/Settlement	Damp	Stable	Low or absent
16.02.2016	VP/298A	48P/15		12.43	75.75	Gravitational	Extensive Cut Slope	Granite gneiss	Moderate	Jointed					Sparsely vegetated	Damp	Meta stable	Moderate
16.02.2016	VP/299A	48P/15		12.43	75.76	Gravitational	Lowly dissected						Insitu-soil	0-5m	Sparsely vegetated			
16.02.2016	VP/300A	48P/15		12.45	75.78	Gravitational	Lowly dissected	Granite	Moderate				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
16.02.2016	VP/301A	48P/15		12.45	75.77	Gravitational	Lowly dissected	Granite gneiss	Low to fresh									
16.02.2016	VP/302A	48P/15		12.48	75.81	Gravitational	Lowly dissected	Granite gneiss	Moderate				Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
16.02.2016	VP/303A	48P/15		12.48	75.79	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
16.02.2016	VP/304A	48P/15		12.48	75.78	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
16.02.2016	VP/305A	48P/15		12.47	75.79													
16.02.2016	VP/306A	48P/15		12.47	75.78													
16.02.2016	VP/307A	48P/15		12.47	75.79													

Tabular Field Data Collection sheet **Annexure - I**

Date	Location	T.S. No.	Locality	Latitude	Longitude	Geomproc	Geomform	Rock	Weathering	RockCharac	Strucdata	Fault/lineament	Overburden type	Overburden depth	Landuse type	Hydrological condition	Susceptibility assessment of slope	Qualitative risk assessment
16.02.2016	VP/308A	48P/15		12.45	75.79	Gravitational	Lowly dissected	Dolerite dyke					Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
16.02.2016	VP/309A	48P/15		12.47	75.80													
16.02.2016	VP/310A	48P/15		12.47	75.80													
16.02.2016	VP/311A	48P/15		12.47	75.81													
16.02.2016	VP/312A			0.00	0.00													
16.02.2016	VP/313A			0.00	0.00													
17.02.2016	VP/314A	48P/15	Makkandur	12.43	75.79	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
17.02.2016	VP/315A	48P/15		12.45	75.78	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	
17.02.2016	VP/316A	48P/15		12.45	75.78	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
17.02.2016	VP/317A	48P/15		12.45	75.77	Gravitational	Lowly dissected				N30E/9ESE		Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
17.02.2016	VP/318A	48P/15		12.47	75.76	Gravitational	Lowly dissected	Granite gneiss	Moderate					0m	LHP		Stable	Low or absent
17.02.2016	VP/319A	48P/15		12.45	75.77	Gravitational	Lowly dissected	Granite gneiss	Moderate					0m	Agriculture	Damp	Stable	Low or absent
17.02.2016	VP/320A	48P/15		12.43	75.77	Gravitational	Lowly dissected						Insitu-soil	5-10m				
17.02.2016	VP/321A	48P/15		12.43	75.80	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
17.02.2016	VP/322A	48P/15		12.43	75.81	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
17.02.2016	VP/323A	48P/15		12.45	75.83	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
17.02.2016	VP/324A	48P/15		12.47	75.83	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
17.02.2016	VP/325A	48P/15		12.47	75.83	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
17.02.2016	VP/326A	48P/15		12.48	75.82	Fluvial	Terrace						Alluvium	0-5m		Damp	Stable	Low or absent
17.02.2016	VP/327A	48P/15		12.48	75.83	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
17.02.2016	VP/328A	48P/15		12.48	75.84	Gravitational	Lowly dissected	Granite	Moderate					0m	LHP	Damp	Stable	Low or absent
17.02.2016	VP/329A	48P/15		12.47	75.85	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
17.02.2016	VP/330A	48P/15		12.47	75.85	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
17.02.2016	VP/331A	48P/15		12.45	75.86	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
17.02.2016	VP/332A	48P/15		12.45	75.85	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP/Settlement	Damp	Stable	Low or absent
17.02.2016	VP/333A	48P/15		12.43	75.87	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP/Settlement	Damp	Stable	Low or absent
17.02.2016	VP/334A	48P/15		12.45	75.87	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
17.02.2016	VP/335A	48P/15		12.47	75.88	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
17.02.2016	VP/336A	48P/15		12.47	75.88	Gravitational	Lowly dissected							0m	LHP	Damp	Stable	Low or absent
17.02.2016	VP/337A	48P/15		12.47	75.89	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
17.02.2016	VP/338A	48P/15		12.45	75.89	Gravitational	Lowly dissected						Insitu-soil	0-5m	Settlement	Damp	Stable	Low or absent
17.02.2016	VP/339A	48P/15		12.45	75.90	Gravitational	Lowly dissected						Insitu-soil	0-5m	HHP	Damp	Stable	Low or absent
18.02.2016	VP/340A	48P/15		12.40	75.83	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
18.02.2016	VP/341A	48P/15		12.40	75.83	Gravitational	Lowly dissected						Insitu-soil		LHP	Damp	Stable	Low or absent
18.02.2016	VP/342A	48P/15		12.40	75.82	Gravitational	Lowly dissected						Insitu-soil	5-10m	HHP	Damp	Stable	Low or absent
18.02.2016	VP/343A	48P/15		12.42	75.81	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
18.02.2016	VP/344A	48P/15		0.00	0.00	Gravitational	Lowly dissected	Granite	low to fresh	Jointed-low				0m	LHP	Damp	Stable	Low or absent
18.02.2016	VP/345A	48P/15		12.43	75.80	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
18.02.2016	VP/346A	48P/15		12.43	75.89	Gravitational	Lowly dissected	Granite	High	Jointed-moderate				0m	Sparsely vegetated	Damp	Stable	Low or absent
18.02.2016	VP/347A	48P/15		12.43	75.91	Gravitational	Lowly dissected	Granite	Moderate	Jointed-moderate				0m	Sparsely vegetated	Damp	Stable	Low or absent
18.02.2016	VP/348A	48P/15		12.45	75.92	Gravitational	Lowly dissected						Insitu-soil	0-5m	Sparsely vegetated	Damp	Stable	Low or absent
18.02.2016	VP/349A	48P/15		12.45	75.92	Gravitational	Lowly dissected	Granite	Moderate	Jointed-moderate	J1: E-W/70S, J2: N72E/4N			0m	Sparsely vegetated	Damp	Stable	Low or absent
18.02.2016	VP/350A	48P/15		12.47	75.93	Gravitational	Lowly dissected	Mafic dyke	Moderate	Jointed-low			Insitu-soil	0-5m	Sparsely vegetated	Damp	Stable	Low or absent
18.02.2016	VP/351A	48P/15		12.48	75.92	Gravitational	Lowly dissected	Mafic dyke	Moderate	Jointed-moderate				0m	Sparsely vegetated	Damp	Stable	Low or absent
18.02.2016	VP/352A	48P/15		12.48	75.91	Fluvial	Alluvial flood plain						Alluvium	0-5m	Sparsely vegetated	Damp	Stable	Low or absent
18.02.2016	VP/353A	48P/15		12.48	75.93	Gravitational	Lowly dissected	Mafic dyke	Moderate	Jointed-moderate				0m	Sparsely vegetated/Settlement	Damp	Stable	Low or absent
18.02.2016	VP/354A	48P/15		12.48	75.94	Gravitational	Lowly dissected						Insitu-soil	0-5m	Sparsely vegetated	Damp	Stable	Low or absent
18.02.2016	VP/355A	48P/15		12.47	75.95	Gravitational	Lowly dissected	Granite	High	Jointed-low				0m	Settlement	Damp	Stable	Low or absent
18.02.2016	VP/356A	48P/15		12.43	75.97	Gravitational	Lowly dissected						Insitu-soil	0-5m	Sparsely vegetated/Settlement	Damp	Stable	Low or absent
18.02.2016	VP/357A	48P/15		12.43	75.95	Gravitational	Lowly dissected						Insitu-soil	0-5m	Agriculture	Damp	Stable	Low or absent
18.02.2016	VP/358A	48P/15		12.42	75.94	Gravitational	Lowly dissected						Insitu-soil	0-5m		Damp	Stable	Low or absent
18.02.2016	VP/359A	48P/15		12.40	75.94	Gravitational	Piedmont slope						Insitu-soil	0-5m	Agriculture	Damp	Stable	Low or absent
18.02.2016	VP/360A	48P/15		12.40	75.94	Gravitational	Lowly dissected						Insitu-soil	0-5m	Agriculture/Settlement	Damp	Stable	Low or absent
18.02.2016	VP/361A	48P/15		12.40	75.95	Gravitational	Lowly dissected						Insitu-soil	0-5m	Agriculture	Damp	Stable	Low or absent
18.02.2016	VP/362A	48P/15		12.40	75.96	Gravitational	Lowly dissected						Insitu-soil	0-5m	Agriculture/Settlement	Damp	Stable	Low or absent
18.02.2016	VP/363A	48P/15		12.42	75.97	Gravitational	Lowly dissected						Insitu-soil	0-5m	Agriculture/Settlement	Damp	Stable	Low or absent
18.02.2016	VP/364A	48P/15		12.43	75.97	Gravitational	Lowly dissected						Insitu-soil	0-5m	HHP	Damp	Stable	Low or absent
19.02.2016	VP/365A	48P/15		12.32	75.95	Gravitational	Lowly dissected						Insitu-soil	0-5m	HHP	Damp	Stable	Low or absent
19.02.2016	VP/366A	48P/15		12.32	75.94	Gravitational	Lowly dissected						Insitu-soil	0-5m	HHP	Damp	Stable	Low or absent
19.02.2016	VP/367A	48P/15		12.32	75.94	Gravitational	Lowly dissected						Insitu-soil	0-5m	HHP	Damp	Stable	Low or absent
19.02.2016	VP/368A	48P/15		12.32	75.93	Gravitational	Lowly dissected						Insitu-soil	0-5m	HHP	Damp	Stable	Low or absent

Date	Location	T.S. No.	Locality	Latitude	Longitude	Geomproc	Geomform	Rock	Weathering	RockCharac	Strucdata	Fault/lineament	Overburden type	Overburden depth	Landuse type	Hydrological condition	Susceptibility assessment of slope	Qualitative risk assessment
19.02.2016	VP/369A	48P/15		12.33	75.93	Gravitational	Lowly dissected						Insitu-soil	0-5m	HHP	Damp	Stable	Low or absent
19.02.2016	VP/370A	48P/15		12.32	75.96	Gravitational	Lowly dissected						Insitu-soil	0-5m	Densely vegetated	Damp	Stable	Low or absent
19.02.2016	VP/371A	48P/15		12.30	75.96	Gravitational	Lowly dissected						Insitu-soil	5-10m	LHP	Damp	Stable	Low or absent
19.02.2016	VP/372A	48P/15		12.30	75.96	Gravitational	Lowly dissected						Insitu-soil	0-5m	Densely vegetated	Damp	Stable	Low or absent
19.02.2016	VP/373A	48P/15		12.30	75.95	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
19.02.2016	VP/374A	48P/15		12.28	75.96	Gravitational	Lowly dissected						Insitu-soil	5-10m	LHP	Damp	Stable	Low or absent
19.02.2016	VP/375A	48P/15		12.27	75.95	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
19.02.2016	VP/376A	48P/15		12.25	75.93	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
22.02.2016	VP/377A	48P/16		12.07	75.94	Gravitational	Lowly dissected						Insitu-soil	5-10m	LHP	Damp	Meta stable	Low or absent
22.02.2016	VP/378A	48P/16		12.07	75.93	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
22.02.2016	VP/379A	48P/16		12.05	75.93	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
22.02.2016	VP/380A	48P/16		12.05	75.93	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
22.02.2016	VP/381A	48P/16		12.05	75.93	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
22.02.2016	VP/382A	48P/16		0.00	0.00													
22.02.2016	VP/383A	48P/16		12.05	75.93	Gravitational	Lowly dissected						Insitu-soil	0-5m	HHP	Damp	Stable	Low or absent
22.02.2016	VP/384A	48P/16		12.02	75.97	Gravitational	Lowly dissected						Insitu-soil	0-5m		Damp	Stable	Low or absent
22.02.2016	VP/385A	48P/16		12.02	75.94	Gravitational	Lowly dissected	Granite		Jointed-moderate				0m	LHP	Damp	Stable	Low or absent
22.02.2016	VP/386A	48P/16		12.02	75.90	Gravitational	Lowly dissected						Insitu-soil	5-10m	LHP	Damp	Stable	Low or absent
22.02.2016	VP/387A	48P/16		12.03	75.90	Gravitational	Lowly dissected	Granite	Moderate					0m	LHP	Damp	Stable	Low or absent
22.02.2016	VP/388A	48P/16	Badagarakeri	12.03	75.90	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
22.02.2016	VP/389A	48P/16		12.03	75.90	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
22.02.2016	VP/390A	48P/16		12.05	75.91	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
22.02.2016	VP/391A	48P/16		12.05	75.91	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
22.02.2016	VP/392A	48P/16		12.00	75.87	Gravitational	Lowly dissected						Insitu-soil	0-5m	Sparsely vegetated	Damp	Stable	Low or absent
22.02.2016	VP/393A	48P/16		12.02	75.87	Gravitational	Lowly dissected	Laterite					Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
22.02.2016	VP/394A	48P/16		12.00	75.86	Gravitational	Lowly dissected	Laterite						0m	Sparsely vegetated	Damp	Stable	Low or absent
22.02.2016	VP/395A	48P/16		12.00	75.85	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
22.02.2016	VP/396A	48P/16		12.02	75.89	Gravitational	Lowly dissected	Granite	Moderate				Insitu-soil	0-5m	Settlement	Damp	Stable	Low or absent
22.02.2016	VP/397A	48P/16		12.02	75.89	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
22.02.2016	VP/398A	48P/16		12.02	75.90	Gravitational	Lowly dissected	Granite	Moderate					0m	Sparsely vegetated	Damp	Stable	Low or absent
22.02.2016	VP/399A	48P/16		12.00	75.90	Gravitational	Lowly dissected						Insitu-soil	0-5m		Damp	Stable	Low or absent
22.02.2016	VP/400A	48P/16		12.00	75.90	Gravitational	Lowly dissected	Granite	Massive					0m	Barren rocky slope	Damp	Stable	Low or absent
22.02.2016	VP/401A	48P/16		12.00	75.91	Gravitational	Lowly dissected	Granite	Moderate					0m	LHP	Damp	Stable	Low or absent
22.02.2016	VP/402A	48P/16		12.00	75.92	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
22.02.2016	VP/403A	48P/16		12.02	75.93	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
23.02.2016	VP/404A	48P/16	Virajpet Hill top	12.20	75.81	Gravitational	Lowly dissected	Granite	Moderate	Jointed-moderate				0m	LHP	Damp	Stable	Low or absent
23.02.2016	VP/405A	48P/16		12.20	75.81	Gravitational	Lowly dissected	Granite	Moderate	Jointed-moderate				0m	Sparsely vegetated	Damp	Meta stable	Moderate
23.02.2016	VP/406A	48P/16		12.20	75.81	Gravitational	Lowly dissected	Granite	Moderate	Jointed-low				0m	Settlement with modified slope	Damp	Meta stable	Moderate
23.02.2016	VP/407A	48P/16		12.20	75.81	Gravitational	Lowly dissected	Granite	Moderate	Jointed-moderate				0m	Settlement with modified slope	Damp	Meta stable	Moderate
23.02.2016	VP/408A	48P/16		12.20	75.81	Gravitational	Lowly dissected						Insitu-soil	5-10m	Settlement	Damp	Meta stable	Moderate
23.02.2016	VP/409A	48P/16		12.18	75.82	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
23.02.2016	VP/410A	48P/16		12.18	75.83	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
23.02.2016	VP/411A	48P/16		12.18	75.83	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
23.02.2016	VP/412A	48P/16		12.18	75.84	Gravitational	Lowly dissected	Granite	low to fresh	Massive				0m	LHP	Damp	Stable	Low or absent
23.02.2016	VP/413A	48P/16		12.20	75.84	Gravitational	Lowly dissected						Insitu-soil	0-5m	Settlement	Damp	Stable	Low or absent
23.02.2016	VP/414A	48P/16		12.20	75.83	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
23.02.2016	VP/415A	48P/16		12.20	75.83	Gravitational	Lowly dissected	Laterite		Massive				0m	LHP	Damp	Stable	Low or absent
24.02.2016	VP/416A	48P/16		12.22	75.79	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
24.02.2016	VP/417A	48P/15		12.28	75.76	Gravitational	Hill top	Granite	Moderate	Jointed-low				0m	LHP	Damp	Stable	Low or absent
24.02.2016	VP/418A	48P/15		12.28	75.76	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
24.02.2016	VP/419A	48P/15		12.28	75.77	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
24.02.2016	VP/420A	48P/15		12.28	75.77	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
24.02.2016	VP/421A	48P/15		12.28	75.77	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
24.02.2016	VP/422A	48P/15		12.32	75.76	Gravitational	Lowly dissected	Granite	Moderate					0m	Settlement	Damp	Stable	Low or absent
24.02.2016	VP/423A	48P/15		12.37	75.76	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
24.02.2016	VP/424A	48P/15		12.37	75.76	Gravitational	Lowly dissected	Granite	low to fresh	Massive				0m	LHP	Damp	Stable	Low or absent
24.02.2016	VP/425A	48P/15		12.37	75.77	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
24.02.2016	VP/426A	48P/15		12.38	75.76	Gravitational	Lowly dissected	Granite	low to fresh	Massive				0m	LHP	Damp	Stable	Low or absent
24.02.2016	VP/427A	48P/15		12.38	75.77	Gravitational	Lowly dissected	Granite	Moderate					0m	LHP	Damp	Stable	Low or absent
24.02.2016	VP/428A	48P/15		12.38	75.77	Gravitational	Lowly dissected	Granite	low to fresh	Massive				0m	LHP	Damp	Stable	Low or absent
24.02.2016	VP/429A	48P/15		12.38	75.77	Gravitational	Lowly dissected	Granite	low to fresh	Massive				0m	LHP	Damp	Stable	Low or absent
24.02.2016	VP/430A	48P/15		12.38	75.78	Gravitational	Lowly dissected	Granite	High					0m	LHP	Damp	Stable	Low or absent

Tabular Field Data Collection sheet **Annexure - I**

Date	Location	T.S. No.	Locality	Latitude	Longitude	Geomproc	Geomform	Rock	Weathering	RockCharac	Strucdata	Fault/lineament	Overburden type	Overburden depth	Landuse type	Hydrological condition	Susceptibility assessment of slope	Qualitative risk assessment
24.02.2016	VP/431A	48P/15		12.40	75.77	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
24.02.2016	VP/432A	48P/15		12.40	75.77	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
24.02.2016	VP/433A	48P/15		12.40	75.77	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
24.02.2016	VP/434A	48P/15		12.40	75.78	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
24.02.2016	VP/435A	48P/15		12.42	75.78	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
24.02.2016	VP/436A	48P/15		12.42	75.78	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
24.02.2016	VP/437A	48P/15		12.43	75.85	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
24.02.2016	VP/438A	48P/15		12.42	75.85	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
24.02.2016	VP/439A	48P/15		12.42	75.85	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
24.02.2016	VP/440A	48P/15		12.42	75.85	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
24.02.2016	VP/441A	48P/15		12.42	75.83	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent
24.02.2016	VP/442A	48P/15		12.28	75.88	Gravitational	Lowly dissected						Insitu-soil	0-5m	LHP	Damp	Stable	Low or absent

LOCATION MAP

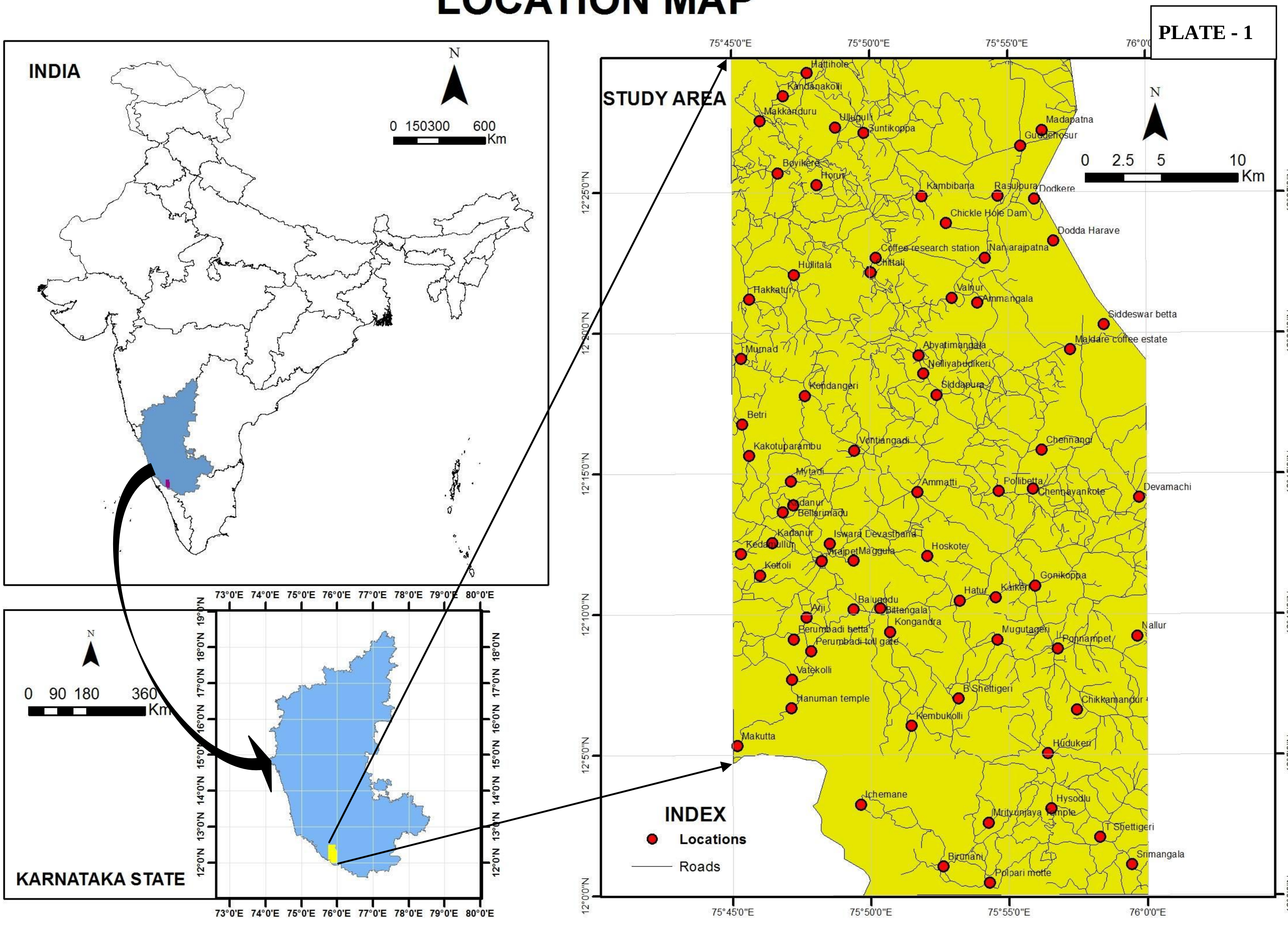


PLATE -2

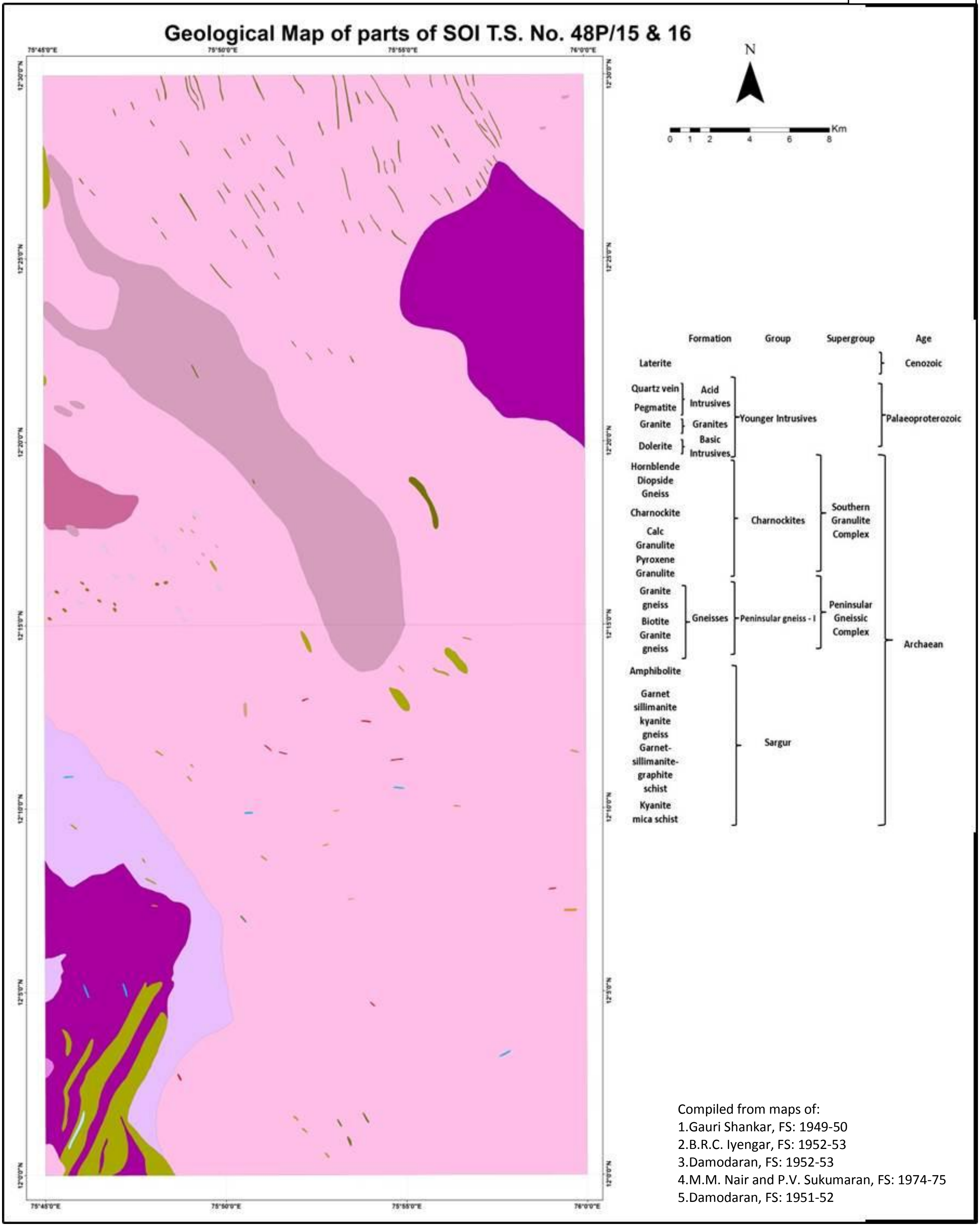
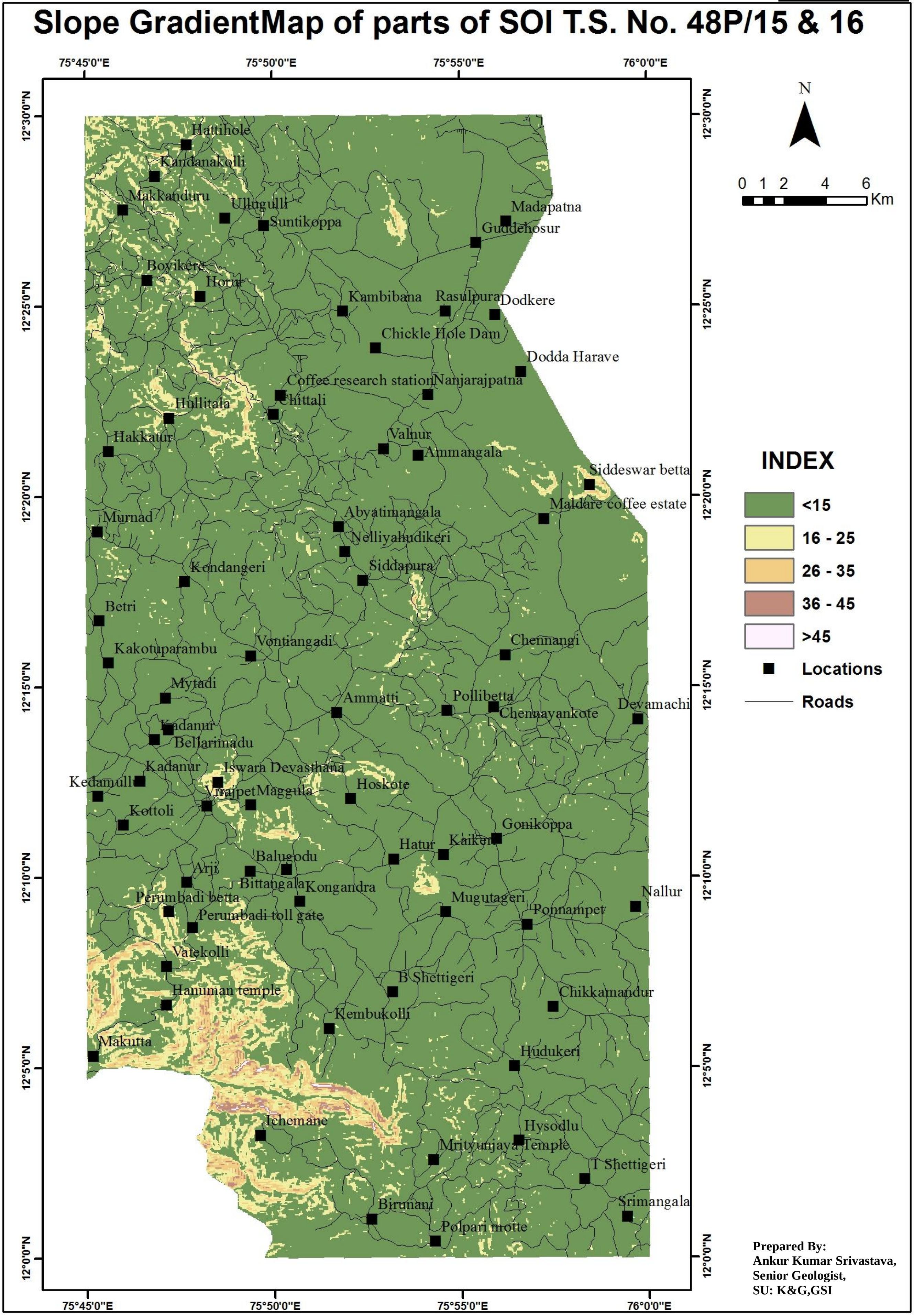

Geological Map of parts of SOI T.S. No. 48P/15 & 16
N
0 1 2 4 6 8 Km
Formation
Group
Supergroup
Age
Laterite
Cenozoic
Quartz vein
Pegmatite
Acid Intrusives
Granite
Granites
Dolerite
Basic Intrusives
Younger Intrusives
Palaeoproterozoic
Hornblende Diopside Gneiss
Charnockite
Calc Granulite
Pyroxene Granulite
Charnockites
Southern Granulite Complex
Granite gneiss
Biotite Granite gneiss
Gneisses
Peninsular gneiss - I
Peninsular Gneissic Complex
Archaean
Amphibolite
Garnet sillimanite kyanite gneiss
Garnet-sillimanite-graphite schist
Kyanite mica schist
Sargur
Compiled from maps of:
1.Gauri Shankar, FS: 1949-50
2.B.R.C. Iyengar, FS: 1952-53
3.Damodaran, FS: 1952-53
4.M.M. Nair and P.V. Sukumaran, FS: 1974-75
5.Damodaran, FS: 1951-52

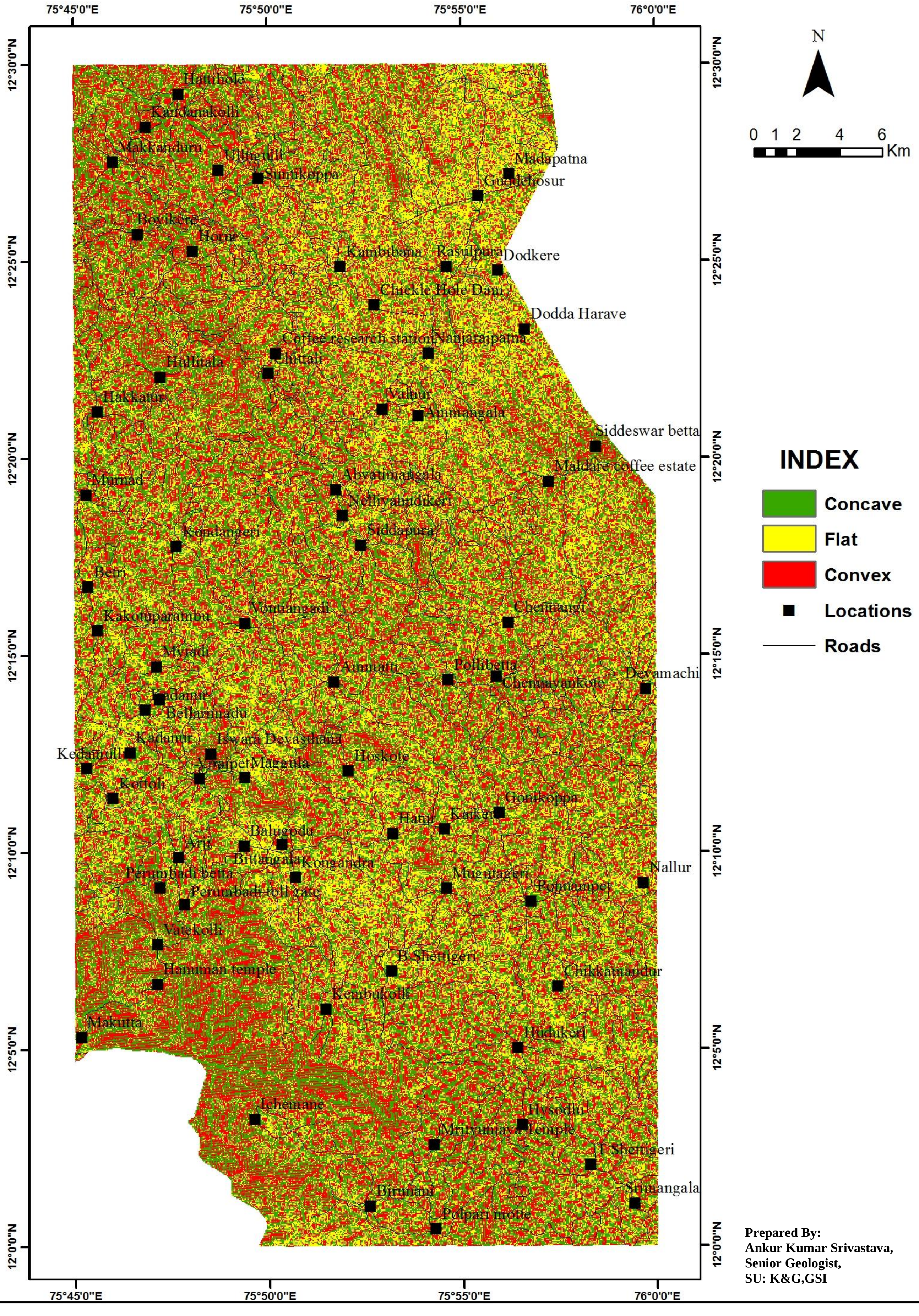
PLATE -3



Prepared By:
Ankur Kumar Srivastava,
Senior Geologist,
SU: K&G,GSI

PLATE - 4

Slope Curvature Map of parts of SOI T.S. No. 48P/15 & 16



Prepared By:
Ankur Kumar Srivastava,
Senior Geologist,
SU: K&G,GSI

PLATE - 5

Geomorphology map of parts of SOI T.S. No. 48P/15 & 16

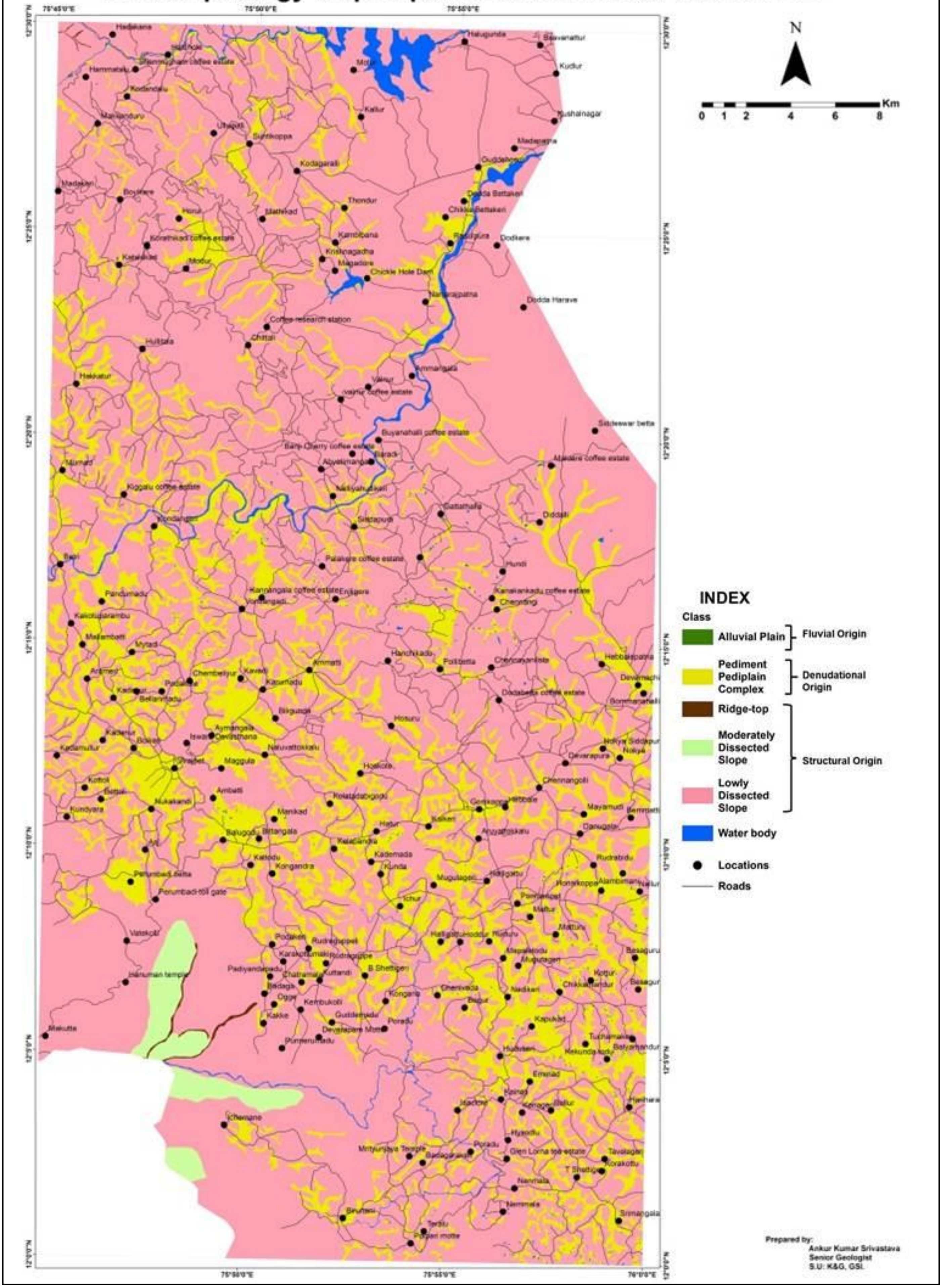
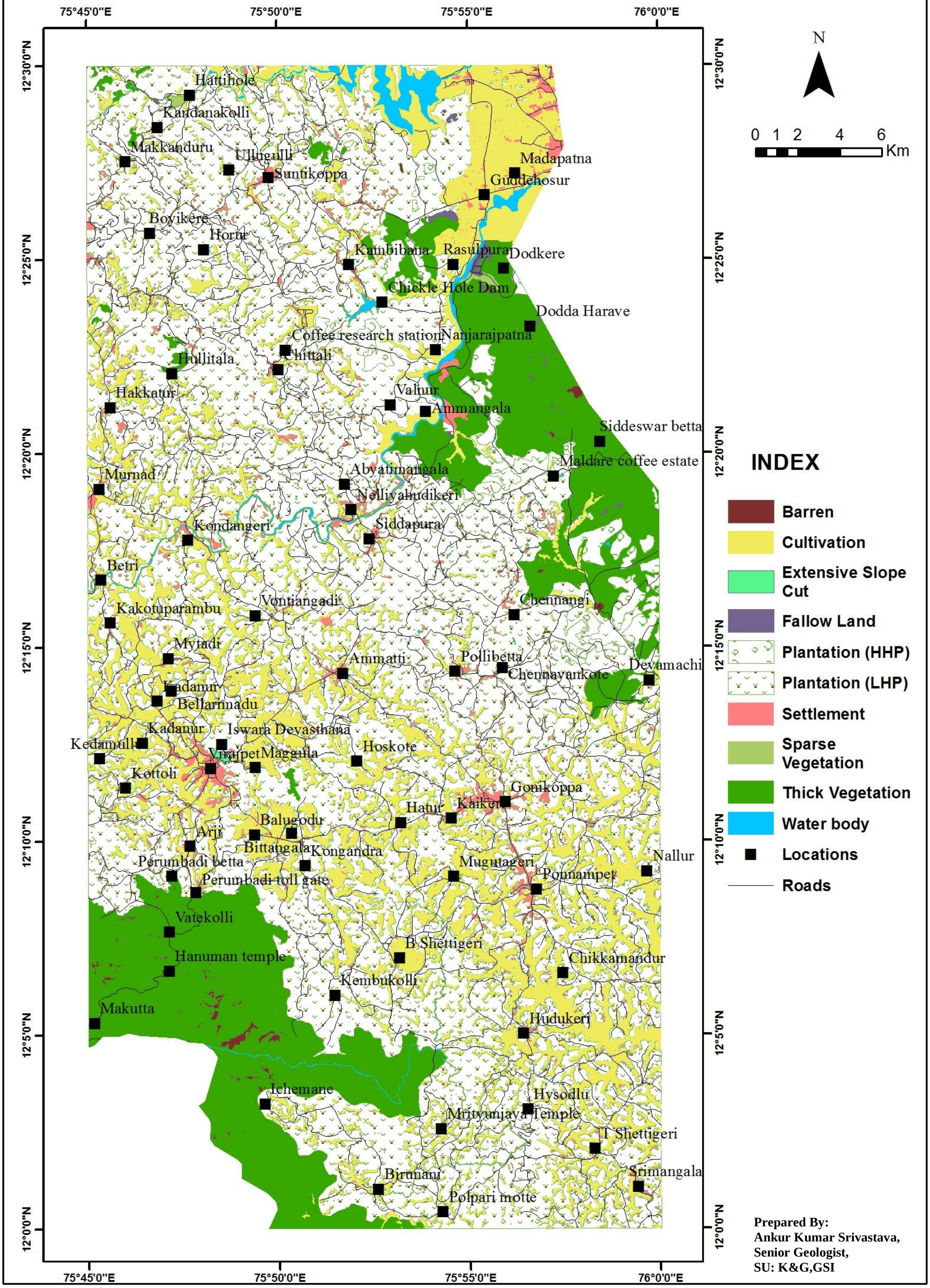


PLATE -6

LULC Map of parts of SOI T.S. No. 48P/15 & 16



Prepared By:
Ankur Kumar Srivastava,
Senior Geologist,
SU: K&G,GSI

PLATE -7

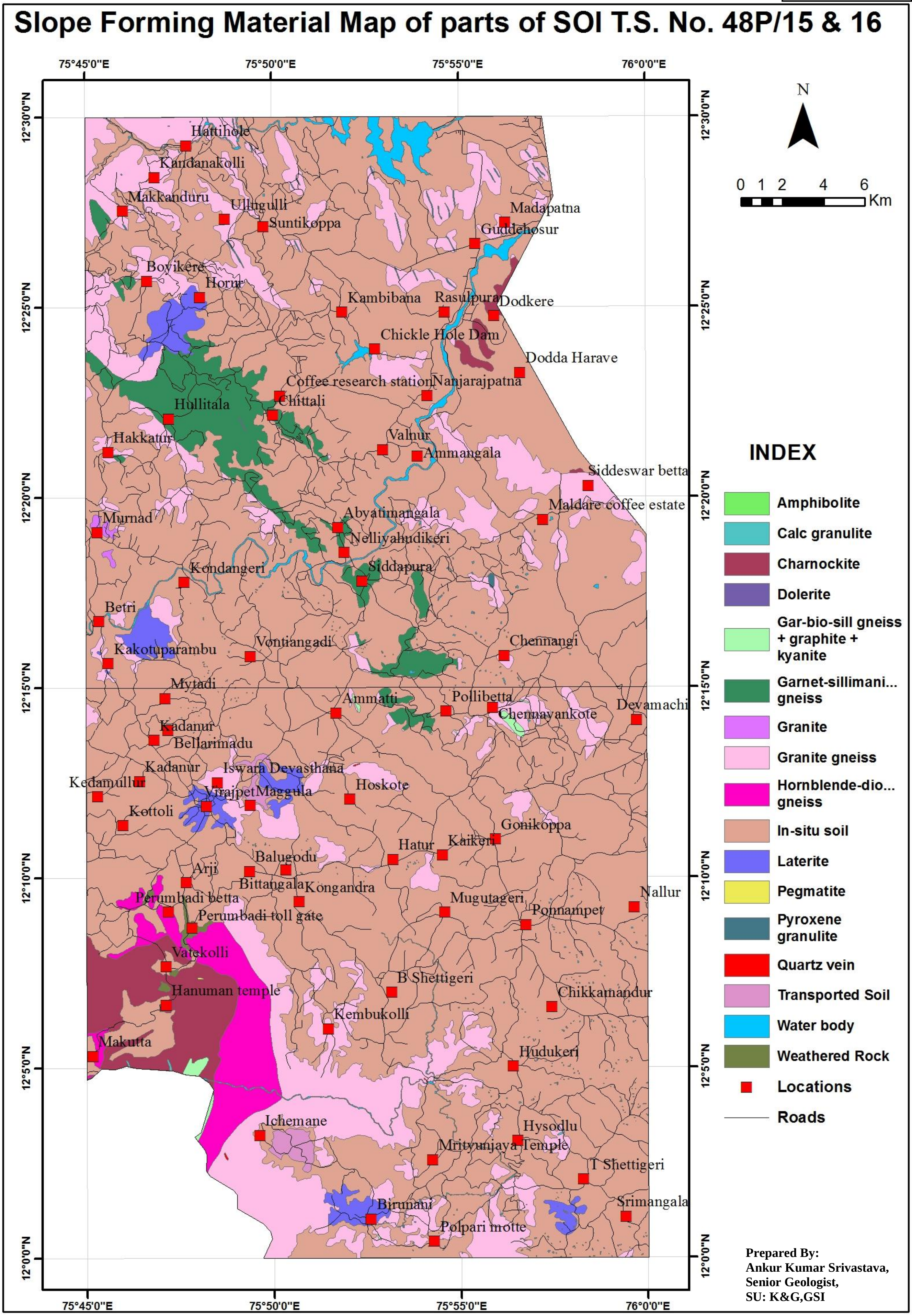
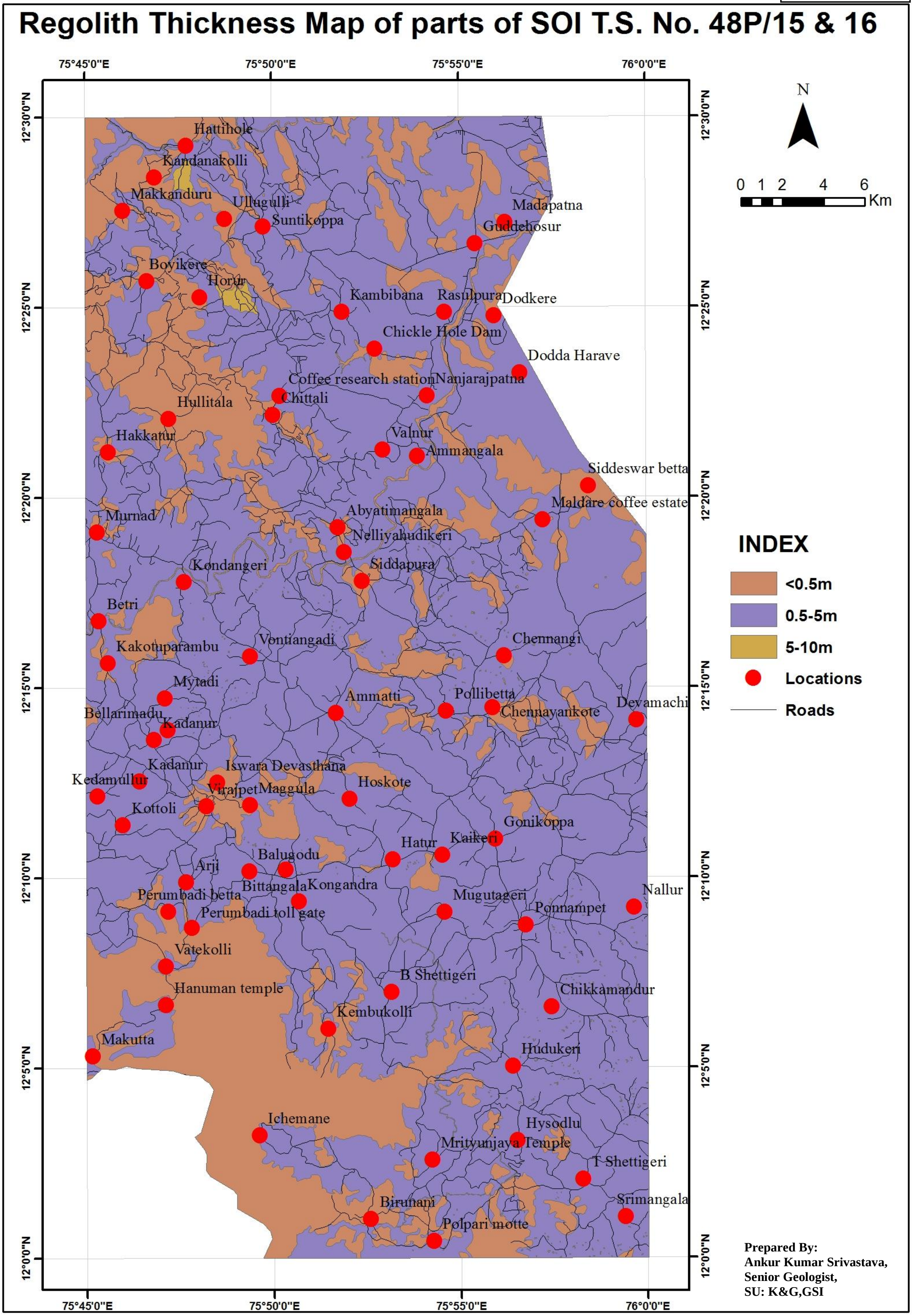

Slope Forming Material Map of parts of SOI T.S. No. 48P/15 & 16
75°45'0"E
75°50'0"E
75°55'0"E
76°0'0"E
12°30'0"N
12°25'0"N
12°20'0"N
12°15'0"N
12°10'0"N
12°5'0"N
12°0'0"N
N
0 1 2 4 6 Km
Hattihole
Kandanakolli
Makkanduru
Ullugulli
Suntikoppa
Madapatna
Guddehosur
Boyikere
Horur
Kambibana
Rasulpura
Dodkere
Chickle Hole Dam
Dodda Harave
Coffee research station
Nanjarajpatna
Chittali
Hullitala
Hakkatur
Valnur
Ammangala
Siddeswar betta
Maldare coffee estate
Murnad
Abyatimangala
Nelliyahudikeri
Kondangeri
Siddapura
Betri
Kakotuparambu
Vontiangadi
Chennangi
Mytadi
Ammatti
Pollibetta
Chennayankote
Devamachi
Kadanur
Bellarimadu
Kadanur
Iswara Devasthana
Kedamullur
Virajpet
Maggula
Hoskote
Kottoli
Gonikoppa
Hatur
Kaikeri
Balugodu
Arji
Bittangala
Kongandra
Perumbadi betta
Mugutageri
Nallur
Ponnampet
Perumbadi toll gate
Vatekolli
B Shettigeri
Hanuman temple
Chikkamandur
Kembukolli
Makutta
Hudukeri
Ichemane
Hysodlu
Mrityunjaya Temple
T Shettigeri
Birunani
Srimangala
Polpari motte
INDEX
Amphibolite
Calc granulite
Charnockite
Dolerite
Gar-bio-sill gneiss + graphite + kyanite
Garnet-sillimani... gneiss
Granite
Granite gneiss
Hornblende-dio... gneiss
In-situ soil
Laterite
Pegmatite
Pyroxene granulite
Quartz vein
Transported Soil
Water body
Weathered Rock
Locations
Roads
Prepared By:
Ankur Kumar Srivastava,
Senior Geologist,
SU: K&G,GSI

PLATE -8



Prepared By:
Ankur Kumar Srivastava,
Senior Geologist,
SU: K&G,GSI

PLATE -9

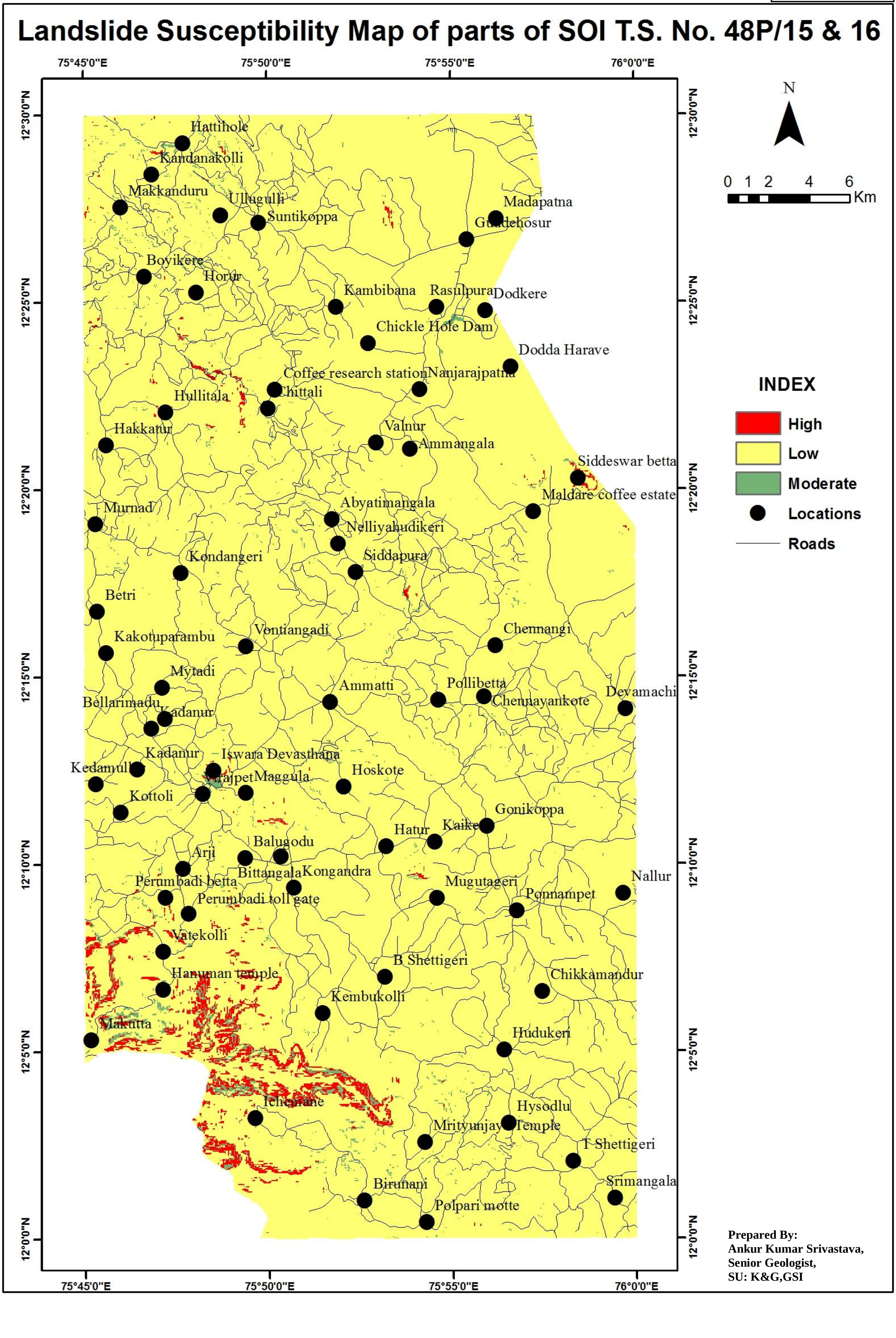
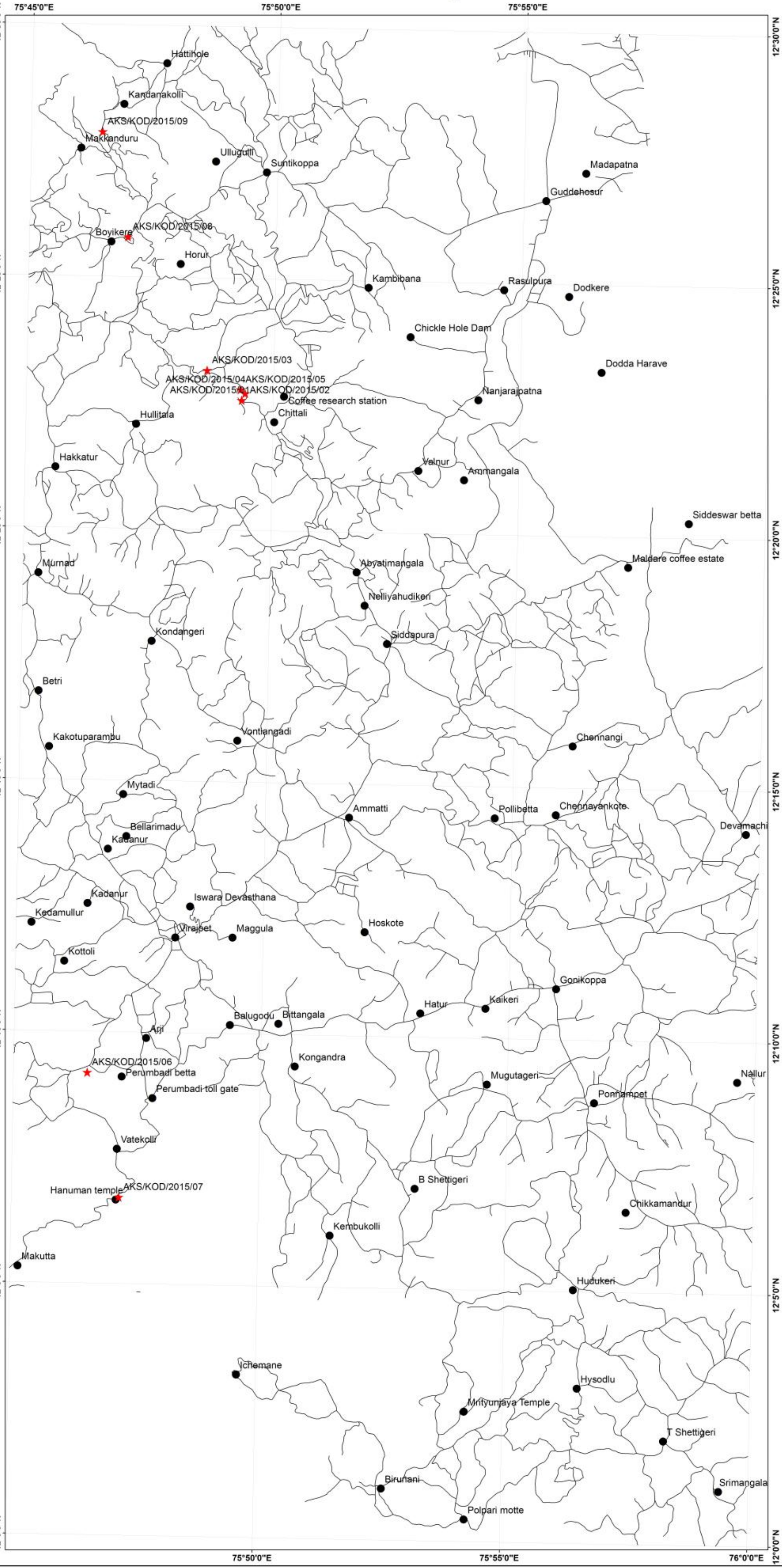

Landslide Susceptibility Map of parts of SOI T.S. No. 48P/15 & 16
75°45'0"E
75°50'0"E
75°55'0"E
76°0'0"E
12°30'0"N
12°25'0"N
12°20'0"N
12°15'0"N
12°10'0"N
12°5'0"N
12°0'0"N
N
0 1 2 4 6
Km
INDEX
High
Low
Moderate
Locations
Roads
Hattihole
Kandanakolli
Makkanduru
Ullugulli
Suntikoppa
Madapatna
Guddehosur
Boyikere
Horur
Kambibana
Rasulpura
Dodkere
Chickle Hole Dam
Dodda Harave
Coffee research station
Nanjarajpatna
Chittali
Hullitala
Hakkatur
Valnur
Ammangala
Siddeswar betta
Maldare coffee estate
Murnad
Abyatimangala
Nelliyahudikeri
Kondangeri
Siddapura
Betri
Kakotuparambu
Vontiangadi
Chennangi
Mytadi
Ammatti
Pollibetta
Chennayankote
Devamachi
Bellarimadu
Kadanur
Kedamullu
Iswara Devasthana
Virajpet
Maggula
Hoskote
Kottoli
Gonikoppa
Hatur
Kaikeri
Balugodu
Arji
Bittangala
Kongandra
Perumbadi betta
Perumbadi toll gate
Mugutageri
Ponnampet
Nallur
Vatekolli
B Shettigeri
Hanuman temple
Chikkamandur
Kembukolli
Makutta
Hudukeri
Ichchinane
Hysodlu
Mrityunjaya Temple
T Shettigeri
Birunani
Srimangala
Polpari motte
Prepared By:
Ankur Kumar Srivastava,
Senior Geologist,
SU: K&G,GSI

PLATE -10

Landslide locations in parts of SOI T.S. No. 48P/15 & 16



INDEX

- Landslide locations
- Locations
- Roads

Prepared By:
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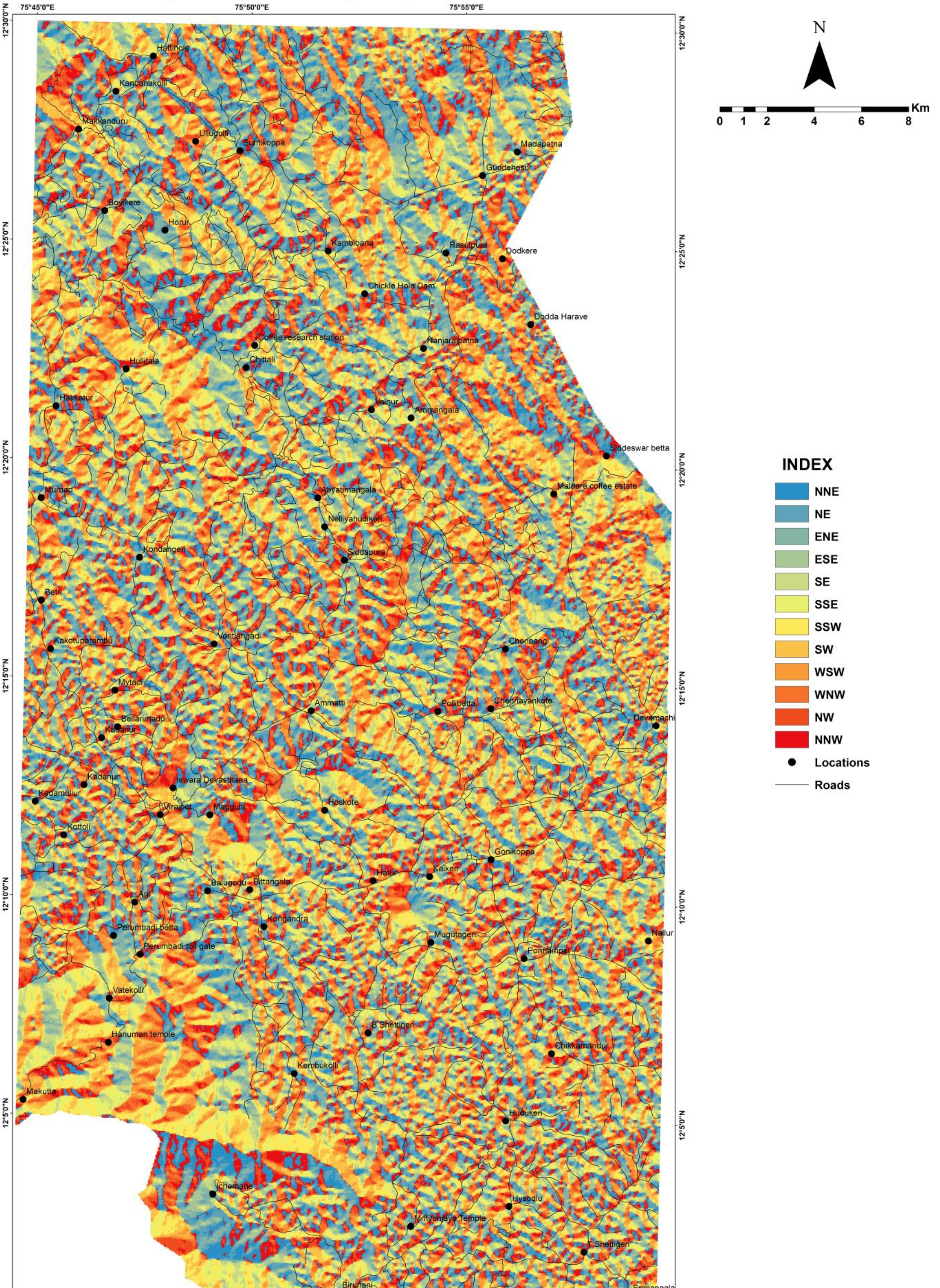
SU: K&G,GSI

PLATE -11

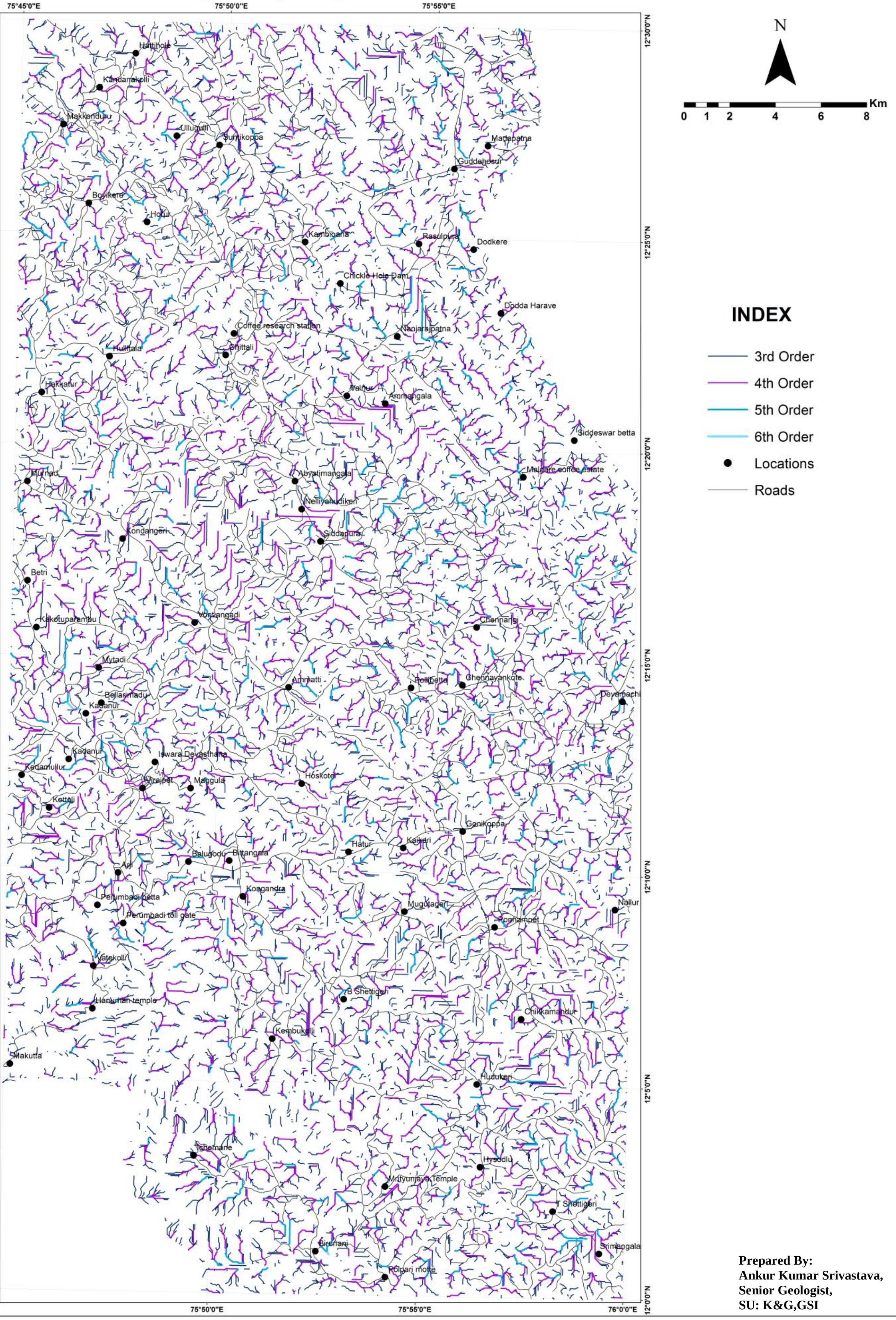
Slope Aspect Map of parts SOI T.S. No. 48P/15 & 16



Prepared By:
Ankur Kumar Srivastava,
Senior Geologist,
SU: K&G,GSI

PLATE -12

Drainage map of parts of SOI T.S. No. 48P/15 & 16



Prepared By:
Ankur Kumar Srivastava,
Senior Geologist,
SU: K&G,GSI

PHOTOGRAPHS

Photo:1 Slope failure (Chittalli-Madikere road)

Photo:2 Old slide scar (Perumbadi-makutta road)

Photo: 3 Precariously placed house due to Extensive road cut (Virajpet hill)

Photo: 4 Slope failure (Chittalli-Madikere road)

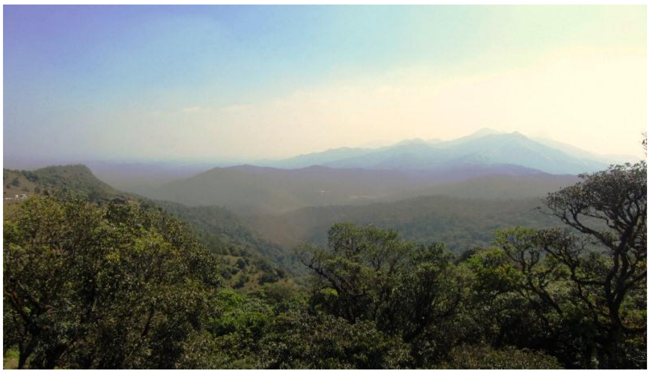


Photo: 5 Low dissected slope –North of Chittalli

Photo: 6 Pediment – pediplain Complex (west of Guddehosur)

Photo: 7 Moderately dissected slope –West of Birunani

Photo: 8 Ridge top –East of Madikeri

Photo:9 Cultivated land – South of Ponnampet

Photo:10 Extensive road cut – North of Murnad

Photo: 11 Low height plantation – SW of T. Shettigere

Photo:12 High height plantation – Gonnikoppal

Photo:13 Thick vegetation – Chittali

Photo:14 Settlement – Virajpet

Photo:15 Laterite development- west of Virajpet

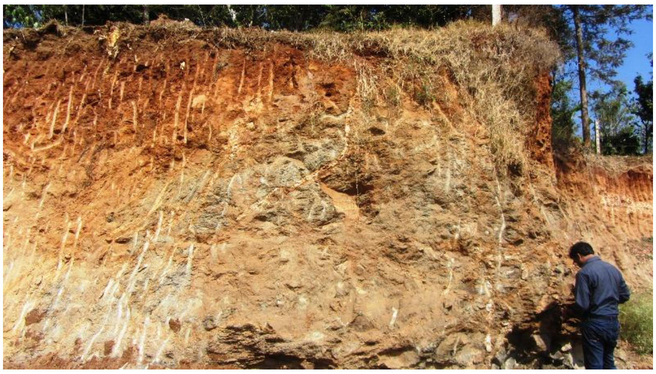


Photo:16 Weathered rock - South of Makkanduru

Photo:17 Barren Rock – NW of Hullitalla

Photo:18 Granitic (In situ soil) East of Birunani

Photo:19 Regolith thickness 0 to 0.5m North of Guddehosur

Photo:20 Regolith thickness 0.5m to 5m – west of Devamachi

Photo:21 Regolith thickness > 5metres – west of Hudikere.

GEOLOGICAL SURVEY OF INDIA

Certificate of Quality of the report

Project/ Division: NLSM/EG Division **FSP No.:** LSM/SR/KG/2015/099 **Mission:**IV

Title of the report: Macro-Scale (1:50,000) Landslide Susceptibility Mapping In Parts Of Toposheet No. 48P/15 & 16, Coorg District, Karnataka.

Part -A: This is to certify that the following Officer(s) have carried out the above mentioned FSP and are responsible for collection of field data, carrying out required laboratory analysis, compilation and synthesis of field data, collation of the data and writing of the report as per the approved guidelines. The duration of field stay of each Officer is as against his/ her name.

Name and designation of the Officer	Total field stay during the FSP (No. of days)	Signature with date
1. Ankur Kumar Srivastava, Sr.Geologist	85 days	Srivastava 30/6/16
2. Harsha Sundar E., Sr.Geologist	38 days	[illegible]

Part-B: This is to certify that drilling has been carried out and completed as per the table given below: Not Applicable

Drilling Unit No	Date of commencement of drilling	Date of completion of drilling	Name and signature of the Director Drilling
1.			
2.			

Part-C: This is to certify that geophysical component of the item has been carried out as per the table given below: ---- Not Applicable ------

Name(s) Designation of the geophysicist	Date of commencement of work	Date of completion of work	Signature of the Geophysicist with date
1.			
2.			
Name of the Director (Geophysics)			
Signature with date			

Part-D: This is to certify that the chemical analysis of the geological samples has been carried out as per the table given below - Not applicable.

Name of the Director in charge of the Laboratory	Date of receipt of samples from the Field Officer/ party	Date of providing complete analytical results to the Field Officer/ party	Signature with date

Part –E: This is to certify that the Supervisory Officer(s) mentioned below have supervised the above item and have provided guidance to the Field Officer(s). The number of inspection visits and total duration of field visits is as per the table below. It is also certified that the work carried out under the project is of high standards, the norms of field work, lab work etc. have been followed. It is also certified that thorough scrutiny of the report for maintaining the scientific contents and its quality has been overseen

Name(s) and designation of the Supervisory Officers	No. of inspection visits	Total No. of days spent on inspection visit	Signature with date
1. Shri. J. Srihari, Director	03	06	J.S. Srihari 26-9-16

Part-F: This is to certify that the report has been thoroughly scrutinized at the Regional Mission Head level. The scientific contents and the quality of the report are certified. The report has been peer reviewed and the needful corrections have been attended to.

Name and designation of the Regional Mission Head	Signature with date
R.K. AGARWAL DEPUTY DIRECTOR GENERAL	30/09/16

Part-G: This is to certify that the report has been scrutinized at various levels and has also been peer reviewed. On being satisfied regarding the scientific content and quality of the report, the undersigned has accorded approval for its circulation.

Name and designation of the Regional HOD	Signature with date

GEOLOGICAL SURVEY OF INDIA

DATA SHEET ON REPORT MOVEMENT IN CONNECTION WITH ITS SCRUTINY

<table>
<tr><td>Project / Division: NLSM-VI</td><td>FSP No: LSM/SR/K&G/2015/099</td><td>Mission:IV A</td></tr>
<tr><td colspan="3">Title of the report: MACRO-SCALE (1:50,000) LANDSLIDE SUSCEPTIBILITY MAPPING IN PARTS OF TOPOSHEET NO. 48P/15 & 16, COORG DISTRICT, KARNATAKA</td></tr>
<tr><td rowspan="2">Names of author(s)
1.Ankur Kumar Srivastava,
Sr. Geologist
2. Harsha Sunder E.
Sr. Geologist</td><td>Date of submission to the Supervisory Officer:</td><td>30/06/2016</td></tr>
<tr><td>Signature of the senior most author:</td><td>[illegible]</td></tr>
<tr><td rowspan="4">Name of the Supervisory Officer:
Shri J.Srihari,
Director</td><td>Date of receipt of the report:</td><td>30.6.16</td></tr>
<tr><td>Date of completion of scrutiny:</td><td>9.7.16</td></tr>
<tr><td>Date of handing over the report to the author(s) after scrutiny:</td><td>10.7.16</td></tr>
<tr><td>Signature:</td><td>J.S.Srihari</td></tr>
<tr><td rowspan="3">Name of the author to whom the report has been handed over by the Supervisory Officer:
Ankur Kumar Srivastava,
Sr. Geologist</td><td>Date of receipt after scrutiny:</td><td>10/07/2016</td></tr>
<tr><td>Date of resubmission:</td><td>15/07/2016</td></tr>
<tr><td>Signature:</td><td>[illegible]</td></tr>
<tr><td rowspan="3">Supervisory Officer
Shri J.Srihari,
Director</td><td>Date of receipt after modification:</td><td>15-7.16</td></tr>
<tr><td>Date of handing over the report to the Regional Mission Head:</td><td>28.7.16</td></tr>
<tr><td>Signature:</td><td>J.S.Srihari</td></tr>
<tr><td rowspan="3">Name of Regional Mission Head</td><td>Date of receipt of the report:</td><td>05-08-2016</td></tr>
<tr><td>Date of handing over the report to the Supervisory Officer :</td><td>25-08-2016</td></tr>
<tr><td>Signature:</td><td></td></tr>
</table>

Name of Supervisory Officer Shri J.Srihari, Director	Date of receipt from the Regional Mission Head after peer review:	20/09/2016
	Date of handing over to author(s):	20/09/2016
	Signature:	J. Srihari
Name of author(s) 1.Ankur Kumar Srivastava, Sr. Geologist 2. Harsha Sunder E. Sr, Geologist	Date of receipt of report from Supervisory Officer:	20/09/2016
	Date of handing over report after modification to Supervisory Officer:	26/09/2016
	Signature:	Srivastava
Name of Supervisory Officer Shri J.Srihari, Director	Date of receipt of report after modification from the author(s):	26.9.16
	Date of handing over report to Regional Mission Head:	26.9.16
	Signature:	J. Srihari
Name of Regional Mission Head R.K. AGARWAL DEPUTY DIRECTOR GENERAL	Date of receipt of the report from the Project Director after modification:	30-09-16
	Date of handing over the report to the HOD of the region for approval:	30-09-16
	Signature:	Agarwal
Name of the HOD of the Region B.D. Thappa	Date of receipt of report for approval:	30-9-16
	Date of approval:	30-9-16
	Date of sending back to Project Director:	
	Signature of the HOD:	
Name of the Project Director Shri J.Srihari, Director	Date of receipt of report after approval of HOD:	30-09-16
	Date of circulation of report:	30/09/16
	Signature:	J. Srihari