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भारतीय भूवैज्ञानिक सर्वेक्षण
GOVERNMENT OF INDIA
GEOLOGICAL SURVEY OF INDIA

कर्नाटक राज्य के उत्तर कन्नड, शिमोगा और चिक्मगलुर जिलो में भूआकृति संख्या 48J/10, 48J/15 और 48O/15 के कुछ हिस्सों में वृहद पैमाने पर (1: 50,000) भूस्खलन संवेदनशीलता मानचित्रण

MACRO-SCALE (1:50,000) LANDSLIDE SUSCEPTIBILITY MAPPING IN PARTS OF TOPOSHEETS NOS. 48J/10, 48J/15 AND 48O/15 UTTAR KANNADA, SHIMOGA AND CHICKMAGALURU DISTRICTS, KARNATAKA

मद सं:: एम4एलएसएसएम/एनसी/एसआर/एसयू-केजी/2018/18733
Item no.: M4LSSM/NC/SR/SU-KG/2018/18733

कार्य सत्र 2018-19 का अंतिम प्रतिवेदन
Final report for field season 2018-19

राहुल कुमार चौरसिया, भूवैज्ञानिक
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मिशन - IV
MISSION-IV

राज्य इकाई: कर्नाटक व गोवा / State Unit: Karnataka & Goa
दक्षिणी क्षेत्र / Southern Region

2019

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(FSP CODE NO: M4LSSM/NC/SR/SU-KG/2018/18733)

Field Season: 2018-19

By

Rahul Kumar Chaurasia, Geologist &
Mohan Raj E, Geologist

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सारांश

भूस्खलन अतिसंवेदनशीलता मानचित्रण 1:50,000 पैमाने पर सीवनहीन भूस्खलन सुग्राहिता मानचित्र व आकाशीय भूस्खलन डाटाबेस (जीआईएस) तैयार करने के उद्देश्य से टोपोशीट सं. 48J/10, 48J/15 व 48O/15 के भागों में पर्याप्त सुदूर संवेदन व क्षेत्र से प्राप्त आदानों की सहायता से आरंभ किया गया। भूमि-उपयोग/भूमि आच्छादन (एलयू/एलसी), भूआकृतिविज्ञान, ढाल को गठन करने वाले पदार्थ (एसएफएम), रिगोलिथ स्थूलता (आरटी), अपवाह तंत्र, ढाल आकारमिति (प्रवणता, अभिमुखता व वक्रता) मानचित्र आईआरएस एलआईएसएस III आँकड़ों, कार्टोड़ेम व बहु-शंख गूगल चित्रों के द्वारा आर्कजीआईएस में तैयार किए गए।

विभिन्न विषयक पूर्व-क्षेत्र व एलएस प्रतिरूपण के भूस्खलन अतिसंवेदनशीलता मानचित्रण कार्य प्रणाली क्षेत्र में किए गए अध्ययन से निर्धारित की गयी । जिसके दौरान 45-भूस्खलन घटनाएँ पहचानी व रिकार्ड़ की गई हैं जिनमें कुछ नए स्खलन शामिल हैं व कुछ पूर्व में रिपोर्ट किए गए स्खलन भी। भूमि उपयोग/भूमि आच्छादन के अनुसार, अध्ययन क्षेत्र में मुख्यतया निम्न ऊँचाई वाले बागान (एलएचपी), उच्च ऊँचाई वाले बागान (एचएचपी), मिश्रित घने से सामान्य रूप से घने वनस्पति रिपोर्ट की गई हैं जहाँ कुछ भाग कृषि भूमि है। क्षेत्र के कुछ भागों में बंजर व परती भूमि भी है।

अधिकतर स्खलन सड़क सेक्शन में परिवर्द्धित ढलान पर अंकित किए गए हैं। इन भूस्खलन आपतनों के कारण्वाचक घटक मुख्यतया मानवजनिक है, यानि पाद के अपनयन के द्वारा ढाल का अस्थायीकरण, पाद भाग व ढलानों में उचित अपवाह-तंत्र का अभाव। यह अभाव संधियों व विभंगों जैसे तरुण तलों के अंदर जल के निस्यंदन का कारण बनता है। अध्ययन क्षेत्र में स्खलन का प्रवर्तक घटक मुख्यतया वर्षा है जो अपक्षयित चट्टान पर छिद्र दाब को बढ़ाने में कार्य करता है, जिसके परिणामस्वरूप अपरूपण प्रबलता व परवर्ती फेलियर होता है।

क्षेत्र में अधिकतर स्खलन स्वस्थान मृदा/लैटराइटी/अपक्षयित चट्टान में उपरिभार के रूप में विशेषकर सिर्सी-अम्हल्लि-कुर्सि, कुर्सि-कसगे-कोदम्बैल, देवन्हल्लि-वज्गदे-मबगि और हेब्बुल-सुंकल सड़क सेक्शन के किनारे टोपोशीट सं. 48J/10 में जबकि टोपोशीट सं. 48J/15 में येल्गार-बनग्गि-बलुर और तत्तिकल-ह्अंतिकुलि-हर्सिकत्ते प्राथमिकतया सड़क के किनारे व्यापक रूप से हो रहे ढलान करतन के कारण हो रहे है। टोपोशीट सं. 48O/15 में, गोदिकल्लु-मल्लेनहल्लि-भक्त्हल्लि और कम्बिहल्लि-होस्पेत-गूंकल्लुर सड़क सेक्शन के किनारे के ढलान करतन व्रिक्षारोपन के कारन सुरक्षित हो गये हैं । चूँकि क्षेत्र में पर्याप्त संख्या में भूस्खलन/ढलान फेलियर की कमी है, क्षेत्र का सुग्राहिता अनुमतांक विश्लेषणात्मक पदानुक्रम प्रक्रिया (एएचपी) पद्धति की सहायता से

किया गया जहाँ हर एक घटक को विशेषज्ञ या ज्ञान पर आधारित तकनीकों की सहायता अनुमतांक व अंतर-प्राग्वक्ता तौल दिए जाते हैं। एएचपी की सहायता से मात्रात्मक मेट्रिस में ऐसे ज्ञान पर आधारित अनुमतांक/तौल को विभिन्न भू-घटक वर्गों के लिए गुणात्मक युगल वार महत्व मैट्रिक्स व अंतर प्राग्वक्ता महत्व के लिए विभिन्न भू-घटकों को तैयार करने/उसके लिए निर्णय पर आने के पश्चात गणितीय तत्व की सहायता से आसानी से निर्धारित किए जा सकते है। यह क्षेत्र में भूस्खलन संबंधी अध्ययन में रत स्थानीय विशेषज्ञों व भूस्खलन वैज्ञानिकों से हुई चर्चा से व प्राप्त टिप्पणियों के द्वारा प्राप्त है।

अंतिम अतिसंवेदनशीलता मानचित्र क्षेत्र के लगभग 68.0182 % भाग को निम्न भूस्खलन सुग्राहिता ज़ोन में, 24.7467 % भाग को सामान्य सुग्राहिता ज़ोन में व 07.2349 % भाग को उच्च भूस्खलन सुग्राहिता ज़ोन में विभाजित करता है। क्षेत्र के दक्षिण-पश्चिमी उपांत, मादापुर, सन्ताहल्ली, कुन्दाहल्ली व सकलेशपुर के पश्चिमी भाग उच्च सुग्राहिता ज़ोन में आता है, यह इस तथ्य को समर्थित करता है कि अनियंत्रित ढाल परिवर्द्धन व अन्य मानवजनिक प्रक्रियाएँ भूस्खलन जैसे हादसों का कारण बन रही हैं। अधिकतर उच्च सुग्राहिता ज़ोन 25°-35° के बीच में आने वाले ग्रेड़िएन्ट वर्ग के अनुसार है। भूमि उपयोग/भूमि आच्छादन के अनुसार परिवर्द्धित ढाल पर स्थित मानवीय बस्ती युक्त क्षेत्र व विस्तृत कर्तित ढलान भूस्खलन के लिए अधिक सुग्राह्य है। भूआकृतिविज्ञान के अनुसार अधिकतर स्खलन निम्न रूप से वियुक्त ढलानों पर होते है जहाँ बड़े पैमाने पर ढाल परिवर्द्धन देखा गया है। देखे गए स्खलन अथाह स्थानांतरीय मलवे स्खलन है; अधिकतर स्खलन पुन: सक्रियात्मक स्खलन हैं जो चौड़े होने वाले व विस्तार पाने वाले प्रकृति की है।

ABSTRACT

Landslide Susceptibility Mapping in parts of Toposheets no. 48J/10, 48J/15 and 48O/15 was carried out to prepare a seamless landslide susceptibility map and spatial (GIS-based) landslide database on 1: 50,000 scale using adequate remote sensing and field inputs. Pre-field maps for Landuse/Landcover (LU/LC), Geomorphology, Slope Forming Material (SFM), Regolith Thickness (RT), Drainage, Slope Morphometry (Slope, Aspect and Curvature) were prepared in ArcGIS through visual interpretation of IRS LISS III data, CartoDEM and multi-temporal Google Imageries.

Landslide susceptible mapping involves preparation of different thematic maps, validating of these pre-field and LS modelling. During the field studies, 45- landslide incident of have been identified and recorded which include some new slides as well as some previously reported slides. In terms of Landuse/Landcover, the study area predominantly comprises of Low Height Plantations (LHPs), High Height Plantations (HHPs), mixed dense to fairly dense vegetation with some part covered by cultivation. Small patches of the area are also covered by barren and fallow land.

Most of the landslides are recorded on modified slope along road sections. The causative factors for these landslide incidences are mainly anthropogenic i.e. destabilisation of slopes by removal of toe, lack of proper drainage at toe part and on the slopes causing seepage of water into the weaker plane like joints and fracture. The triggering factor for landslides in the study area is mainly rainfall which has contributed to increase in the pore pressure of the weathered rock mass resulting in reduction of shear strength and subsequent failure.

Most of the slides of the area are occurring in in-situ soil / lateritic / weathered rock as overburden, on slope especially along Sirsi-Ammenhalli-Kursi, Kursi-Kasage-Kodambail, Devanhalli-Vajgade-Mabagi and Hebbul-Sunksal road sections under toposheet no. 48J/10 whereas under toposheet no 48J/15, there are Yelugar-Banaggi-Balur and Tattikal-Hantikuli-Harsikatte road section primarily caused due to extensive slope cuttings along roads. In the part toposheet no. 48O/15 there are Godikallu-Mallenahalli-Bhaktarhalli and Kambihalli-Hospet-Goonakllur road section, where road cuts slopes are identified and are moderately stabilized due to the growth of vegetation cover. As the area, lacks adequate no. of landslides / slope failures, the susceptibility rating of the area has been done using Analytical Hierarchy Process (AHP) method wherein ratings and inter-predictor weights are given to individual

factors using expert or knowledge driven techniques. This knowledge-driven ratings/ weights in quantitative matrices can easily be determined mathematically using AHP, after preparing/deciding on the qualitative 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.

The final susceptibility map divides about 68.0182 % area falls under low landslide susceptibility zone, 24.7467 % area are in moderate susceptibility zone and 07.2349 % area falls under high landslide susceptibility zone. The area on the south-western fringe, southwest of Ammenhalli, south, southwest and west of Yana, North west of Siddapur, South west of Kansur and north west of Kambihalli-Hospet-Goonakllur falls under high susceptibility zones, this substantiates the fact that uncontrolled slope modification and other anthropogenic activities favors landslide occurrence. Most of the high susceptibility zones correspond to slope gradient class between 25°- 35°. In terms of LULC the area having settlement on modified slopes and Extensive cut slopes has the maximum susceptibility to landslides. In terms of geomorphology most of the slides have been observed to occur in lowly dissected slopes where large scale slope modification was observed. The slides observed are shallow translational debris slide; majority of slides are old reactivated slides of widening and enlarging in nature.

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(FSP CODE NO: M4LSSM/NC/SR/SU-KG/2018/18733)

Field Season: 2018-19

By

Rahul Kumar Chaurasia, Geologist
Mohan Raj E, Geologist

1. INTRODUCTION

1.1 Background Information:

Natural hazards are an integral component of life on Earth. With the ever increasing population and large scale encroachment of hilly and forested areas, landslides have become a topic of serious concern in our society. The pressure for infrastructural development to meet the need of rapid urbanisation and global competition has led to expansion of construction activities even in hilly terrains and has catapulted frequency of landslides to dramatic proportions in recent decades. Kedarnath tragedy in Uttarakhand in 2013, Malin landslide, Maharashtra in 2014, Kodagu landslide in 2018 and Kerala landslide in 2018 are prime examples of the devastation that landslides can cause. Landslides are one of the normal landscape building processes in undulating terrain and are common in Himalayas and Western Ghats regions in our country. Nearly 15% (0.49 million Sq. Km.) area, spread over 1112 Survey of India Topographic map sheets, are landslide-prone in India. Thus a systematic approach is required to map these areas for landslide susceptibility. A thrust in this activity is imminent to match the pace of infrastructural development in these areas. Accordingly, Geological Survey of India (GSI), 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 inventory and geofactor database and GIS based landslide-dependent empirical techniques as well as knowledge based techniques (AHP) for data integration and landslide susceptibility

modelling. The prime objective of this national programme is to prepare a seamless 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.

Uttar Kannada, Shimoga and Chickmagaluru districts in Karnataka state is located in the south-eastern part of Western Ghats with high hills and undulating topography. These districts with their distinctive geomorphological, geological, hydrological and meteorological characteristics have long been known for landslides in selected areas during certain months of a year. The topography of the region is sensitive and any changes in the LULC pattern causes landslides or slope failures affecting the population. Thus, these districts along with their 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 that involve the modification of slopes disturb the equilibrium attained by the nature. Majority of slopes along the high ways pose significant risk mainly from rainfall-induced slope failures (Janardhana et al., 2016). Heavy rain during monsoon season leads to slope saturation by water that decreases the effective cohesion and generates hydrostatic pressures in the soil profile ultimately resulting in slope failures. Infrastructure development in terms of widening of existing road and construction must progress taking into account the scientific methods of slope treatment to restore and minimise the risk to slope instability.

Under the NLSM programme of GSI, the following objectives have been prioritised -

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

(ii) To prepare Toposheet-wise (1: 50,000 scale) spatial database for geo factors of landslides using as input maps, and

(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 1551 Sq. Km. area in parts of Uttar Kannada, Shimoga and Chickmagaluru districts was carried out under the Annual Programme of GSI, Southern Region, vide FSP Code No: M4LSSM/NC/SR/SU-KG/2018/18733 for field season 2018-19.

1.2 Study area:

The study area lies in SOI Toposheet Nos. 48J/10, 48J/15 and 48O/15 in parts of Uttar Kannada, Shimoga and Chickmagaluru Districts, Karnataka and is bounded between latitudes 14°15'00"N-14°30'00"N, longitudes 74°45'00"E-75°00'00"E and 14°30'00"N-14°45'00"N, longitudes 74°30'00"E-74°45'00"E and 13°15'00"N-13°30'00"N, longitudes 75°45'00"E-76°00'00"E, **(***PLATE-1***)** respectively. Uttar Kannada, Shimoga and Chickmagaluru districts falls under the high precipitation zone and receives high amount of rain during the monsoon season. Hassan and Dakshin Kannada districts are lying towards the south and southwest directions respectively from Chickmagaluru district. Chikmagalur district is bordered by Hassan district in the southeast, Tumkuru and Chitradurga district in the east and northeast direction respectively. Udupi district in the west and Shimoga district in the north and northwest direction. Whereas Uttar Kannada and Shimoga districts are lying on a regional trend of NW-SE direction and are adjacent to each other and also these two districts are located towards northwest from Chickmagaluru district. Western boundary of Uttar Kannada is surrounded by Arabian sea, Goa state towards northwest, Belgavi and Dharwar from north and north west respectively. Shimoga district is bounded by Belgavi and Davangere districts from northeast and east side respectively.

The study area is well connected by national highways (NH's), state highways (SH's) and other roads networks of Karnataka state. Uttar Kannada is connected by Bangalore - Haveri - Hubbali National Highway (NH-48), and this NH-48 is connected by SH-28 from Hubbali-Yellapur, Yellapur-Sirsi-Siddapur, Sirsi-Siddapur-Shimoga. This SH-28 is further connected by SH-15 and SH-26 which connects the study area falling under Uttar Kannada and Shimoga district. Fairly good network of roads exists, connecting taluk headquarters with district headquarters. Sirsi town is well connected with all the important places of Karnataka state which is located at about 450Km from Bangalore (State Capital), 45Km towards northwest from Siddapur and 120Km southeast from district headquarter Karwar which is connected by SH-17. Sagar is located towards southeast from Siddapur at about 55 Km located at NH-206 connecting to Shimoga district headquarter further towards southeast. The nearest railway stations are Hubbali and Shimoga. Nearest Airport is located at a distance of about 105Km at Hubbali towards north in Dharwar district.

1.3 Present work:

The present work includes preparation of various thematic layers on 1: 50,000 scale using ArcGIS software and Google Earth imageries. Open Series Maps of the study area were also taken into account while preparing Landuse/Landcover, Road and Location maps. Landslide inventory prepared at headquarters was validated and updated in field. The pre-field maps were validated in field and were updated on ArcGIS platform at headquarters. The final landslide susceptibility map of the study area was prepared using knowledge driven indirect method (Analytical Hierarchy Process) and then classified into low, moderate and high susceptibility zones. The nature and target of work envisaged for FS: 2018-19 and the achievements are given in **Table 1**.

Nature of Work	Target F.S 2018-19 (Sq. Km.)	Achievements in Sq. Km.
1. Pre field map preparation		
a) Slope forming material map	1551	1551
b) Geomorphology and lineament map	1551	1551
c) Slope morphometry (slope, aspect & curvature) map	1551	1551
d) Landuse/Landcover map	1551	1551
e) Drainage map	1551	1551
f) Regolith depth map	1551	1551
ii) Preparation of landslide inventory map	1551	1551
2. Field based studies		
i) Field checking of all thematic maps. Field validation of landslide inventory and collection of recent and historic landslides	1551	1551
ii) collection of landslide inventory and damage data as per 41 point geo – parametric sheet	1551	1551
3. Post Field studies		
i) Updation of thematic and inventory maps in GIS	1551	1551
ii) Preparation of Landslide susceptibility map in GIS	1551	1551
4. Collection of rainfall data	(Collected data for 10 years)	

Table 1, Nature, quantum of work and achievements.

1.4 Physiography and Drainage:

Study area located in and around Western Ghats and represent an orogenic 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 in the eastern part to rugged hilly terrain having

elevations ranging from about 600m to 1682m above MSL in the Western and Southern part. The terrain in this part is very rugged with steeply sloping conical hills and deep valleys. These hills have a general trend of NW-SE. The central, northeastern and eastern parts are showing undulating terrain with isolated hillocks. Major drainage flows towards west and the area shows dendritic to parallel drainage pattern**.**

The Dharma and Varada are two main drainage channels/systems in the study area which flows from NE to SW and drains in to the Jog Falls in southern part. These streams are perennial cum seasonal by nature. Jog falls is 20Km south from southern boundary of 48J/15 toposheet. Several third order streams drain the rest of the area. The study area is covered by some of ancient tributaries of river Cauvery. The average annual rainfall of Uttar Kannada and Shimoga district is about 4000 mm and the area enjoys tropical climate. Whereas, in the study area under Chickmagaluru district rain fall is as similar as in Uttar Kannada district. The climate is dominated by SW monsoon, starting in June, ending in October providing a larger portion of annual precipitation. Rainfall data has been collected from available rain gauge stations for the past ten years.

1.5 General Geology:

In the study area, largest Archaean schist belt of the Dharwar Craton is the Dharwar-Shimoga schist belt, lying in western part of the craton extending from north of Chikmagalur to a few Km south of Belgaum. It is surrounded by Peninsular Gneissic Complex (PGC), generally presumed to be older and have been intruded by several granitic bodies. The oldest supracrustal rocks of the Dharwar Craton have been interpreted to be those of Sargur Group, which occurs within Peninsular Gneiss, generally as narrow belts and scattered isolated enclaves. They have been partially migmatised, assimilated and granitised by younger granitoid intrusions of the PGC. Rocks of Bababudan Group overlie those of Sargur Group and Peninsular Gneisses with a marked angular unconformity. The Chitradurga Group of rocks unconformably overlies the Bababudan Group or rests directly on the PGC basement. A polymictic conglomerate characterized by granite clasts mark the unconformity in both the Chitradurga and Shimoga belts, but locally grades into oligomictic conglomerate and phyllite, greywacke and arkose.

Shimoga Schist Belt is one of the largest Archean Schist Belts in the Dharwar Craton and is known for its manganese and gold mineralization. Most of the manganese quarries and

its old workings are located in Shimoga and Davangere districts. The Shimoga schist belt is a NW-SE trending schist belt which covers an area of 25,000 Sq. Km. area and extends from Tarikere valley to Goa and goes beyond Ratnagiri in Maharashtra.

The manganiferous formation in Uttar Kannada district can be traced impersistently towards north till Belgaum district. This NNW-SSE-trending manganiferous formation also currently occurs near, and runs parallel to, the great escarpment of the Western Ghats. Lateritic weathering of the Late Archaean metasedimentary manganiferous formation of the Shimoga Schist Belt and subsequent epeirogenic uplift and erosion of the Western Ghats terrain gave rise to the uniquely disposed supergene ore accumulations (Sethumadhav et al., 2010).

On the basis of compiled geological mapping on 1: 50,000 scale (*PLATE-12*), rocks of Sargur Group, Peninsular Gneissic Complex (PGC), Chitradurga (Shimoga) Group of Dharwar Supergroup, Mafic-Ultramafic complex of Archean age are exposed and basic intrusive like dolerite dykes of Paleo-Proterozoic age are intruded into all rock types.

Older metamorphics of Sargur Group of Rocks represented by ultramafics are exposed as narrow bands and occurs as enclaves. Peninsular Gneiss represented by grey granite and older granitoids are widely exposed in the eastern part of the area. The granitoids locally called as Karwar Granite is intruded into in the Dharwar Supergroup of rocks. A segment of North Kanara Belt comprising Bababudan Group of rocks represented by Kudremukh Formations consisting of Metabasalt and actinolite-chlorite schist. Chitradurga Group of rocks represented by Joldhal Formation (locally referred as Bisgod Formation) and Ranibennur Formation are exposed in the area. The Joldhal Formation consists of orthoquartzite, limestone, dolomite, phyllite, Mn phyllite and BMQ. The Ranibennur Formation of Chitradurga Group consists of greywacke-argillite suite of rocks. All the rock types in the area has been traversed by the basic intrusive like dolerite dykes.

The regional stratigraphic succession of the area established by the earlier workers as follows.

Supergroup	Group	Formation	Lithology	Age
	Younger Intrusives	Basic Intrusives	Dolerite	Palaeoproterozoic
	Layered Ultramafic Complex	Motimakki Ultramafites	Gabbro	Archaean
			Vanadiferous Titano-Magnetite	
			Talc-Tremolite Schist	
			Peridotite	
			Pyroxenite	
Dharwar	Chitradurga (Shimoga)	Ranibennur	Argillite	
		Joldal	Banded Iron Formation (BIF)	
			Magniferous Phyllite	
			Phyllite	
			Limestone	
	Bababudan (Western Ghat)	Kudremukh	Quartzite	
			Hornblende-actinolite – chlorite schist	
			Actinolite-chlorite schist	
			Pillowed Metabasalt	
Peninsular Gneissic Complex	Peninsular Gneiss-I	Grey Granites (older)	Grey Granite	
		Granitoids	Granitoid (Karwar)	
	Sargur		Ultramafite	

Table 2, Regional Stratigraphy of the area.

Primary Structures like bedding is noticed in Quartzites, banded magnetite quartzite and limestone. In general, the trend of the bedding is NNE-SSW to NNW-SSE with dips ranging from 30° to 80° both in easterly and westerly. Foliation in gneiss and other schistose rocks in the area are parallel to bedding.

In and around Siddapur and northwest of Chandragutti, eastern part a granite body is recorded within intrusive into the biotite gneiss. The granite body is about 15Km in length and 2Km in width trending NW-SE. This rock occurs as massive boulders and consists of quartz, feldspar and biotite. Swarms of dolerite cutting across the general foliation of the gneiss are noticed on the interior of the Sirsi-Kumta road section They are located at about 0.5-2.5Km in length. and consist of plagioclase feldspar, augite and minor biotite. Along Sirsi-Ammenhalli-Yana road section limestone exposure is also encountered and there are

landslide incidences recorded at this litho-unit. These limestones are well exposed in and around Yana locality. Because of these limestone litho-units, there are well developed limestone cave and is famous for tourism. At this tourist spot stalagmite and stalactite are two special characteristic features of the cave.

1.6 Methodology:

The methodology to be followed is primarily landslide dependent following a raster-based ArcGIS modelling approach for integration of all selected and weighted thematic maps to prepare 1:50,000 scale landslide susceptibility map. 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: -

1.6.I. Pre-Field Studies:

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

- **Landslide inventory**: Landslide inventory map is prepared using data from old reports, multi temporal google imagery and LISS III/LISS IV data as source data in ArcGIS software.
- **Slope Morphometry (Slope, Curvature and Aspect) map:** Slope Morphometry (Slope, Curvature and Aspect) pre-field maps are prepared using Carto DEM data

(freely available on BHUVAN portal www.portal.bhuvan.nrsc.gov.in) having 30m * 30m resolution as source data in ArcGIS software.

- **Drainage map:** Drainage pre-field map is prepared using CartoDEM data (freely available on BHUVAN portal www.portal.bhuvan.nrsc.gov.in) having 30m * 30m resolution as source data in ArcGIS software.
- **Landuse/Landcover map (LULC):** Pre-field LULC map has been prepared using multi temporal google imagery and ArcGIS base map as source data in ArcGIS software.
- **Geomorphology map:** Geomorphology pre-field map is prepared using multi temporal google imagery, ArcGIS base map and 1: 50,000 scale NGLM legacy map as source data in ArcGIS software.
- **Slope Forming Material map (SFM):** Slope Forming Material (SFM) pre-field map is prepared using multi temporal google imagery, ArcGIS base map, 1: 50, 000 scale geological legacy map and proxies from LULC and geomorphology maps as source data in ArcGIS 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 ArcGIS software.

1.6. II. Field Based Studies:

During the field validation period, all the pre-field maps are validated in the field by visiting all the assessable locations and noting the modifications. The landslide points from pre-field landslide inventory are also checked and if any new slides are encountered in the field, 42-point proforma are noted for all landslides, the existing landslide inventory is updated based on field data.

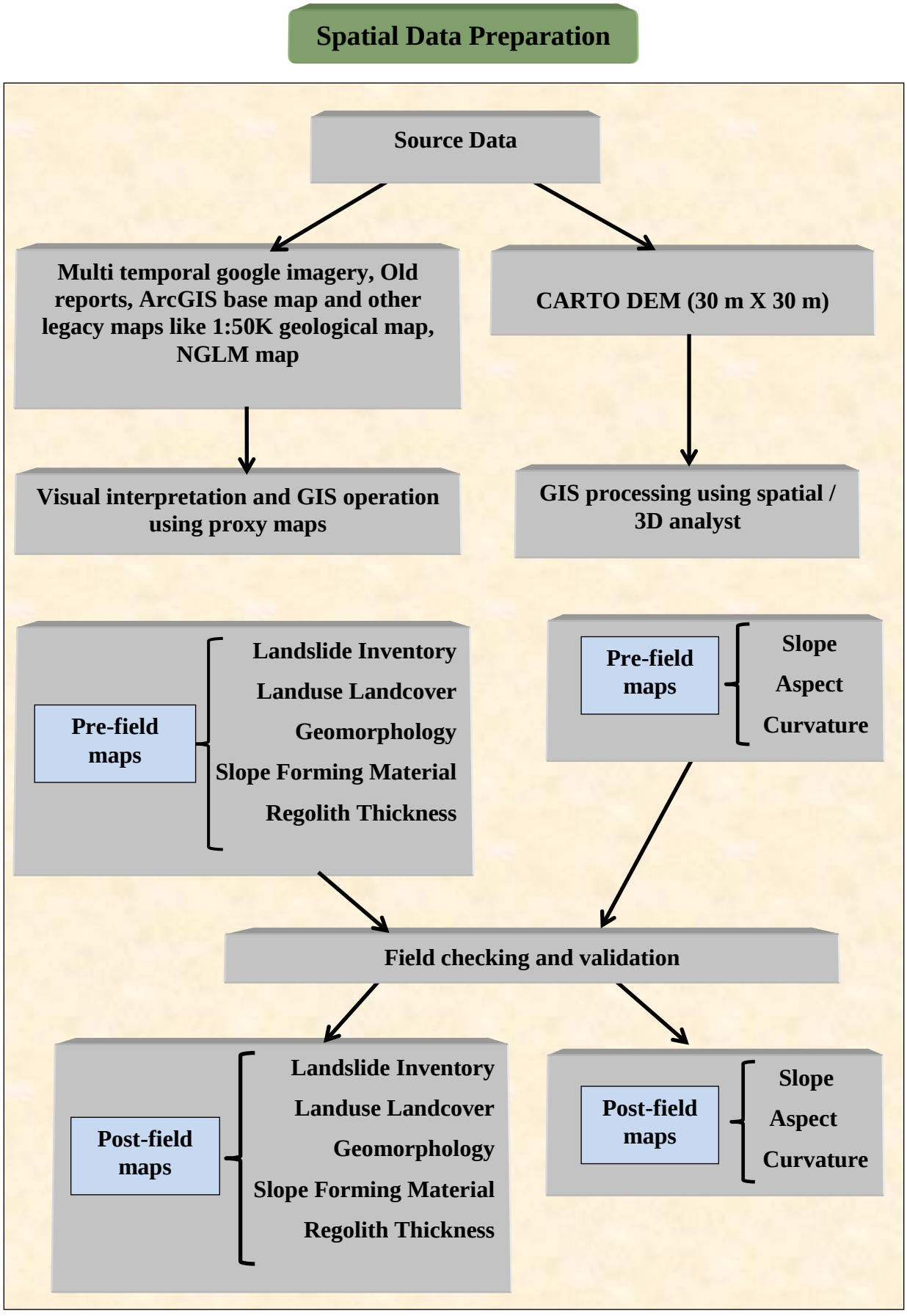
1.6.III. Post-Field Studies:

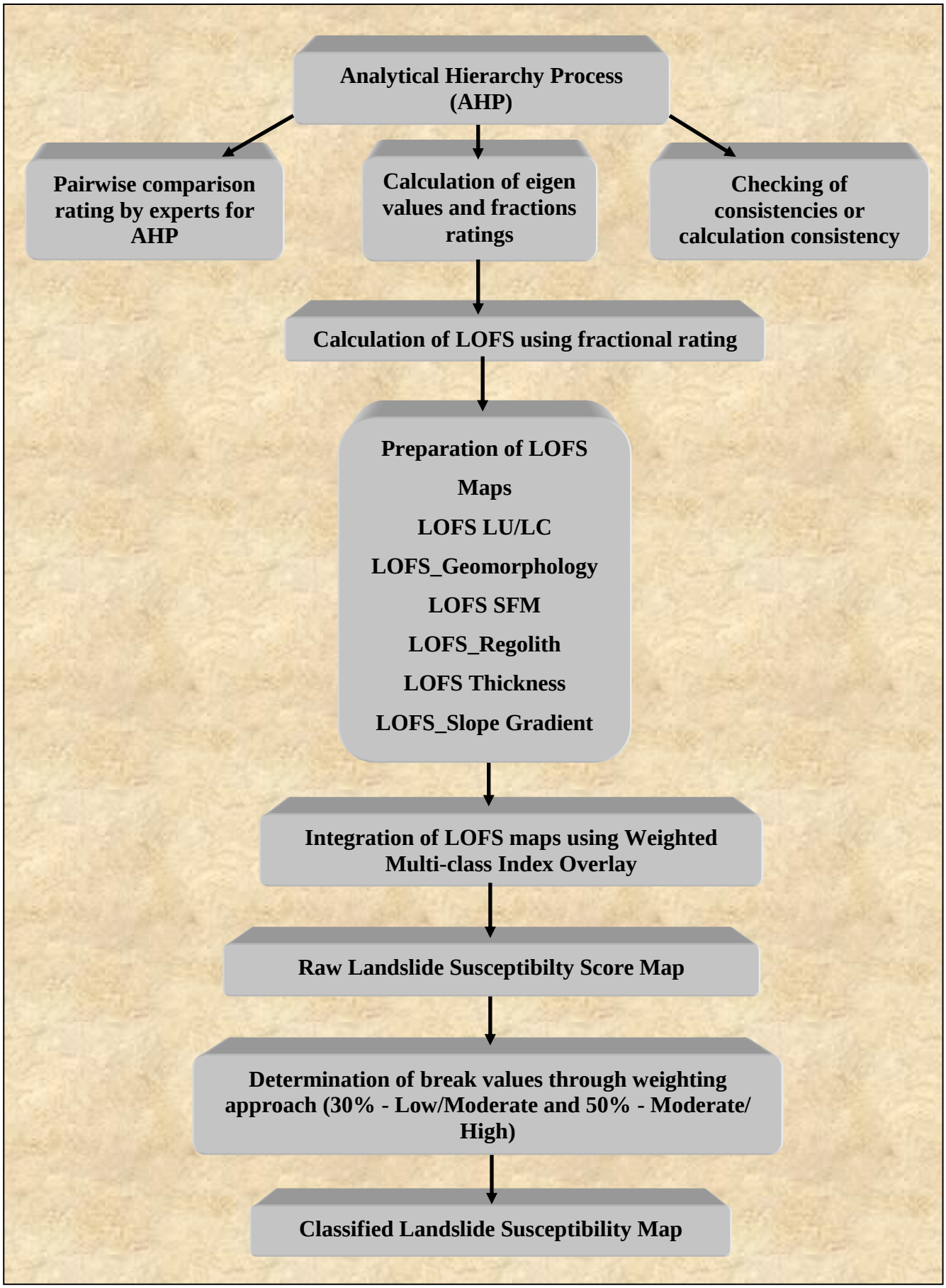
After the field validations are complete, all the thematic maps are updated as per field inputs and finalised. The landslide inventory is also updated as per field inputs. Once all the thematic maps are finalised and landslide inventory is updated, heuristic (knowledge driven) techniques are adopted for modelling and generation of final landslide 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 resolution CARTO DEM). Geomorphology and Landuse/Landcover (prepared using multi-temporal Google Earth imageries and SPOT images as base maps in ESRI ArcGIS), Slope Forming Material and Regolith Thickness (through field-based studies and GSI Geological map) were prepared for susceptibility analysis. Besides these maps, Landslide Inventory map was also prepared using old inventory data from reports/ notes/ archives of GSI and new landslides recorded during the fieldwork.
- 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, Landslide Occurrence Favourability Score (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 ArcGIS software.
- Once all the LOFS maps are prepared, raw landslide susceptibility score map is prepared using weighted multi class index overlay method in ArcGIS 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




Analytical Hierarchy Process (AHP)
Pairwise comparison rating by experts for AHP
Calculation of eigen values and fractions ratings
Checking of consistencies or calculation consistency
Calculation of LOFS using fractional rating
Preparation of LOFS Maps
LOFS LU/LC
LOFS_Geomorphology
LOFS SFM
LOFS_Regolith
LOFS Thickness
LOFS_Slope Gradient
Integration of LOFS maps using Weighted Multi-class Index Overlay
Raw Landslide Susceptibilty Score Map
Determination of break values through weighting approach (30% - Low/Moderate and 50% - Moderate/ High)
Classified Landslide Susceptibility Map

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2. PREVIOUS WORK ON LANDSLIDE STUDIES

Landslides and slope instabilities are major hazards to humans often causing economic losses, property damages and high maintenance costs, as well as injuries or fatalities. They can occur in natural slopes or man-modified slopes, and are triggered by various agents like rainfall, earthquakes, stream undercuts or excavations. Under natural slope conditions, the occurrence of landslides is mainly due to the favourable geo-environmental factors aided by rainfall or earthquakes. On the other hand, in man-made slopes, due to construction for major transportation systems and excavations are triggered by rainfall, earthquake etc. Thus, it becomes more challenging to deal with man modified slopes for landslide susceptibility mapping.

In Karnataka, the landslide studies are mainly focused in the Western Ghats region. The Western Ghats extend from Coorg (now Kodagu) District in the South to Uttar Kannada district in the north in Karnataka state covering an area of about 27855.45 Sq. Km. Out of the approximately 34511 Sq. Km. area of Karnataka and Goa, occupied by the Western Ghats, the hill area having slopes higher than 10 degrees and vulnerable to mass movements constitutes about 8439 Sq. Km. Several Macro-scale landslide susceptibility studies and preparation of landslide inventories have been carried out along NH and SH road corridors in Karnataka and Goa states in the past decade. In Karnataka province, landslides are mainly cut slope failures primarily consisting of debris and sometimes rock and are mostly located along National Highways (NH-13, 17, 48 and 206) and State Highways (SH-1, 27, 48, 50, 64, 66, 69, 88, 89, 90, 93 and 95). In Goa region, landslides are mainly cut slope failures consisting of rock as well as earth/ debris, and are mostly located along National Highways (NH-4A and 17A), State Highways (SH-1, 3 and 4) and Konkan railway corridor.

Landslide studies in the area have been carried out toposheet wise and mainly focused along transportation corridors (NH and SH) in and around Western Ghats. Temporal data for these slides is not available as far as the study area is concerned. Only some newspaper reports about landslides could be obtained. Landslides in the study area generally occur on untreated road cut slopes. These are usually small in size but pose considerable risk to life and property. Several landslides are reported along roads (SHs & NHs) every year during the monsoon time indicating that the triggering factor for these landslides may be rainfall alongwith anthropogenic activities.

Previous works on landslides in the study area include: Micro-scale landslide studies were carried out in and around road corridors for the landslide inventory mapping by K. V. Maruthi and K. V. Chandran., 2013. In the current study area on 27 July 2005, due to incessant rain for 11 days in Siddapur taluk, Shimoga district, 200 m long ground crack was developed along the S10°W facing slope of hill trending ENE-WSW. The landslide complex was mapped between 2006 and 2007 on scale 1:1000, covering 0.10 Sq. Km. with an aim to assess the nature, causes and triggering mechanism of the slide on the slope facing S10ºW in the WNW-SSE trending hill near Yana temple. The recommendations include providing proper drainage to the water accumulated on the slope, construction of retaining wall, providing inclined pile at the toe and vacating the slide zone during monsoon time.

Landslide susceptibility mapping of the road corridors have been carried out in GSI according to the methodology prescribed by Bureau of India Standards (BIS) 14496 (Part 2): 1998, modified by Geological Survey of India. The recommendations suggested include geometrical modification of the slope by grading benching, bio-technical measures of slope protection and proper drainage. As per the landslide inventory along National Highway and State Highway of Ghat roads in Shimoga, Uttar Kannada, Chickmagaluru, Udupi, Shimoga, Kodagu and Dakshin Kannada districts, Karnataka". Majority of these landslides seem to have occurred due to anthropogenic causes and triggered by heavy rainfall. The recommendations include construction of proper drainage as the drainage is seen blocked or absent in around 60% of the affected areas. The water from uphill slope needs to be diverted in order to minimize sliding by providing contour drainage at the crown part and insertion of horizontal perforated pipes into the slopes which will act as weep-holes in the vertical slopes, thereby reducing the pore water pressure by draining out the excess water. This has to be given at appropriate intervals and lined drainage at the toe part are suggested. Retaining structures like retaining wall, soil nailing and stone pitching is recommended as per the site condition. Bio-geotechnical measures of slope protection like plantation of vetiver grass along the slope will reinforce most of the slides. Some historical landslide (Photo-8) data pertaining to the study area is given in table - 2, 3 and 4.

2.1 Landslide Details Falling in Toposheet No. 48J/10

Under this Toposheet total 43 landslide have been reported by the previous workers. Details of these landslides are enlisted as:

Sl. Nos.	Year	Topo. Nos.	Longitude	Latitude	Dimension of slides (m)		
					Length	Width	Height
1.	2007-08	48J/10	74.4872	14.7164	12	7	2
2.	2007-08	48J/10	74.4869	14.7178	12	7	2
3.	2010-12	48J/10	74.4899	14.5005	18	17	1
4.	2010-12	48J/10	74.5358	14.5224	12	14	1.5
5.	2010-12	48J/10	74.5239	14.5191	13.5	18	1
6.	2010-12	48J/10	74.5230	14.5204	18	19.5	1
7.	2010-12	48J/10	74.5175	14.5224	12	20	1
8.	2010-12	48J/10	74.5176	14.5221	11	20	1
9.	2010-12	48J/10	74.5178	14.5221	9	18	0.5
10.	2010-12	48J/10	74.5491	14.5204	65	28	1
11.	2010-12	48J/10	74.5486	14.5199	18	16.5	1
12.	2010-12	48J/10	74.5465	14.5207	10	18	1
13.	2010-12	48J/10	74.5461	14.5221	26	38	2
14.	2010-12	48J/10	74.5201	14.5213	10	48	0.5
15.	2010-12	48J/10	74.5198	14.5213	5	10	1
16.	2010-12	48J/10	74.5374	14.5215	15	35	1
17.	2010-12	48J/10	74.5489	14.5201	7	35	1
18.	2010-12	48J/10	74.5358	14.5225	4	20	0.5
19.	2010-12	48J/10	74.5383	14.5257	8	20	1
20.	2010-12	48J/10	74.5386	14.5248	10	12	0.5
21.	2010-12	48J/10	74.5383	14.5244	16	17	0.5
22.	2010-12	48J/10	74.5380	14.5244	17	26	1.5
23.	2010-12	48J/10	74.5656	14.5217	29	32	1
24.	2010-12	48J/10	74.5644	14.5203	12	15	1.5
25.	2010-12	48J/10	74.5608	14.5189	17	25	1
26.	2010-12	48J/10	74.5518	14.5221	19	28	1
27.	2010-12	48J/10	74.5962	14.5258	7	5	1
28.	2010-12	48J/10	74.5909	14.5251	5	10	0.5
29.	2010-12	48J/10	74.5953	14.5268	11	10	1
30.	2010-12	48J/10	74.5845	14.5268	11	8	1
31.	2010-12	48J/10	74.6067	14.5269	7	10	2
32.	2010-12	48J/10	74.6017	14.5297	7	25	2
33.	2010-12	48J/10	74.6302	14.5300	10	14	2
34.	2010-12	48J/10	74.6281	14.5299	12	28	3
35.	2010-12	48J/10	74.7131	14.5430	7	12	0.5
36.	2010-12	48J/10	74.6920	14.5472	9	15	0.5
37.	2010-12	48J/10	74.6926	14.5472	24	28	1
38.	2010-12	48J/10	74.6967	14.5467	18	28	1
39.	2010-12	48J/10	74.6979	14.5478	14.5	23	1
40.	2010-12	48J/10	74.6985	14.5485	4.5	9	0.5
41.	2010-12	48J/10	74.6479	14.5284	18	26	1
42.	2010-12	48J/10	74.6016	14.5299	9	16	1
43.	2010-12	48J/10	74.6786	14.5407	10	40	1.5

Table 3, Details of historical landslides in parts of toposheet no. 48J/10

2.2 Landslide Details Falling in Toposheet No. 48J/15

Under this Toposheet total only 13 landslides has been reported by the previous workers. Detail of these landslide is given below.

Sl. Nos.	Year	Topo. Nos.	Longitude	Latitude	Dimension of slides (m)		
					Length	Width	Height
1.	2008-09	48J/15	74.7452	14.2708	19.15	21.3	1
2.	2008-09	48J/15	74.7456	14.2707	12.5	11.5	1
3.	2008-09	48J/15	74.7462	14.2700	15.5	35	2.5
4.	2010-12	48J/15	74.8350	14.4991	8	10	0.5
5.	2010-12	48J/15	74.8343	14.4963	16	28	1
6.	2010-12	48J/15	74.8353	14.4948	17	65	1
7.	2010-12	48J/15	74.8560	14.4812	16	68	1
8.	2010-12	48J/15	74.8043	14.3371	15.8	10.5	1
9.	2010-12	48J/15	74.8126	14.3394	18.2	38	1
10.	2010-12	48J/15	74.7704	14.3596	21	98	1
11.	2010-12	48J/15	74.7752	14.3595	20	75	1
12.	2010-12	48J/15	74.7374	14.3529	46	39	1
13.	2010-12	48J/15	74.7469	14.3557	10	38	0.5

Table 4, Details of historical landslides in parts of toposheet no. 48J/15

2.3 Landslide Details Falling in Toposheet No. 48O/15

Under this Toposheet total 2 landslide have been reported by the previous workers. Details of these landslides are listed below.

Sl. Nos.	Year	Topo. Nos.	Longitude	Latitude	Dimension of slides (m)		
					Length	Width	Height
1.	2010-12	48O/15	75.7494	13.4503	15.6	23	1
2.	2010-12	48O/15	75.7169	13.4662	9.2	17.1	0.5

Table 5, Details of historical landslides in parts of toposheet no. 48O/15

3. LANDSLIDE INVENTORY

Landslide inventory is to prepare a document or channelize or enlist the possible past and present record of any kind of earth mass movement. Landslide inventories form an essential basis for landslide susceptibility, hazard and risk analysis. Landslide inventories that span a substantial period of time are one of the key requirements for landslide studies (Van Westen et al. 2008). 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 study, mapping from remote sensing data and topographic maps, historical archive studies and interviews. Each data source used to construct the new landslide inventory has its own uncertainties and limitations and therefore the details captured for each landslide entry vary in completeness and scientific content. In this study, satellite images and historical records are used as the main source for obtaining a multi-temporal landslide data.

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 42-point attribute data for landslides.

Preparation of the landslide inventory map 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 ArcGIS (up to the resolution of 30m) and high resolution Google Earth data of different time periods (from 2002 to 2018) were used as the main data product for generating the multi-temporal landslide inventory for this area. For landslide inventory mapping in Google Earth platform, it used to have different temporal and spatial inputs remotely with the ground control referring to the fieldwork studies covering on the route and off the route of any road corridor of any possible accessible area.

3.2 Inventory Mapping:

The following steps were used for digitizing a landslide polygon in ArcGIS 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 ArcGIS using "conversion" function. In ArcGIS 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 toposheet in ArcGIS.

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 in the field, the morphological parameters (landslide scar length, width and depth) were noted carefully after measuring them in the field using a meter tape. Additional data such as landslide type, run-out distance, present land use/Landcover class, regolith thickness, structure, probable cause, and damage details were also added to the inventory. Any new landslides identified were plotted in the topographic maps and were digitized as polygons or points and entered in a geo-database of ArcGIS. Though in the present study area, slides reported earlier and marked on ArcGIS using their locational attributes could not be identified due to thick

vegetation cover. No slope failure could be identified using satellite imageries and Google Earth due to their small dimension and thick vegetation cover.

All the slope failures observed in the field are located in the Western and central part of the study area. A total of 45 slope cut failures were observed and recorded in the field (Annexure-II). One 5-year old landslide was observed near Yana temple in the village towards the south which is about 120m in width and 45m in height. This slide is in limestone litho-unit. At the place of this landslide, a retaining walls of 2.5-3m height have been constructed at the base but there are many multiple smaller slope failures observed within the old slide scar that need to be looked into and proper mitigation measures are adopted. Due to the proper remedial measure at this slide, it is stabilized as of now.

One debris slide was observed on Ammenhalli-Devimane-Kodambail road section measuring about 20 m in length, 50 m. This may have been caused due to toe cutting for road construction and triggered by rainfall. The whole section from this slide to Devimane village seems vulnerable to slope failure as loose soil and rock boulders with steep slope are observed in this area. Three debris slides have been observed in the area, near Herur-Golmakki and Herur (Photo-9 and 12). Here along Herur-Golmakki road section it has been observed that this landslide has been caused due to road cut. The landslide near Kansur is a linear cum circular failure that occurred in the cut and fill part of the road. It has more than almost 10m of overburden which is slowly cutting away due to rain fall and also due to presence of small stream on the downslope slide. Ground cracks can be observed on the crown part of the slide rendering it unstable and posing a risk to the road passing near it. Towards the downslope there are HHP which is totally man made and encroaching in to the road cut. Almost all the slides in the study area are debris slide occurring in the overburden part of slopes. The triggering factor may be rainfall and also anthropogenic causes.

The slide reported by previous workers in the study area along the road sections from Sirsi to Kumta via Ammenhalli during the FSP: 2006-07, 2010-2012. Along this road section total 43-landslide were recorded by the previous workers. These slides could not be recorded in the present study due to development of vegetation cover, plantation and road widening in the study area. There is rapid growth of vegetation cover which dominates obliteration of historical landslide incidents and its signature present in the study area.

4. 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 Information:

Landslide susceptibility deals with the likelihood of landslide occurrence in an area on the basis of interplay of various local terrain conditions. Landslide susceptibility is the relative probability 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 analytical hierarchy process (AHP) is a semi-quantitative method in which decisions are taken using weights through pair wise relative comparisons without inconsistencies in the decision process (Saaty, 1980). The AHP consists of the following five steps:

I. Breakdown a decision problem into component factors.

II. Arrangement of these factors in a hierarchic order.

III. Assignment of numerical values (Saaty, 1977) to determine the relative importance of each factor according to their subjective relevance.

IV. Setup of a comparison matrix and

V. Computation of the normalized principal Eigen vector, which gives the weight of each factor (Saaty and Vargas, 2001).

The advantages of using AHP as an expert based method in landslide susceptibility analysis (Long and DeSmedt, 2012) are : (i) all types of information related to landslides can be included in the discussion process; (ii) judgment is structured so that all information is taken into account; (iii) discussion rules are based on expert's knowledge and experience; (iv) when a consensus is reached, weights for each relevant factor are obtained automatically by eigenvector calculation of the comparison matrix; and (v) inconsistencies in the decision process were verified using consistency index values.

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. (in 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 et al, 2010).

For susceptibility analysis six factor maps were prepared that are considered to be the main spatial causative 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 where 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 ArcGIS. As far as 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:

Slope angle is another cause for landslides. Slope angle is formed between any part of the surface of the earth and the horizontal datum. It is a means by which gravity induces stress in the slope rocks, flux of the water or other material: therefore, it is of great significance in hydrology and geomorphology. As the slope angle increases, then the shear stress in the soil or other consolidated material generally increases. Gentle slopes are expected to have a low frequency of landslides because of low shear stresses and associated

low gradients. Slope failures tend to increase with slope angle but when the slope becomes near vertical, land sliding is scarce or absent altogether as there is lack of soil development and debris accumulation in such topographic conditions (Selby and Hodder, 1993; Derruau, 1983).

Slope morphometry is defined by slope gradient, aspect and curvature *(PLATE-2, 3, 4).* The data for these factors was derived from CARTO DEM, downloaded from BHUVAN portal, of having 30m resolution. Slope gradient and slope curvature for the study area was generated in ArcGIS software 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°. A large part of the area (54.27%) falls in low slope range i.e., <15° class. 15°-25° slope gradient class occupies 21.42% of the study area. About 13.17% of the area is occupied by 25° to 35° class, 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-6.

Curvature map is classified into three classes i.e. convex, flat and concave slopes. Slope Curvature in the area ranges from -0.9.5 to +0.9.1. About 9.68% of the area falls in flat slope. The Convex slope (>0.1) class which is given the maximum weightage in the area covers about 43.67% of the study area while 46.64% of the area falls under Concave slope (<0.1). The area coverage in pixels along with LOFS and Rank is given in Table-6. More weightage and ranking is given to convex slope class (>0.1) and slope gradient (25°-35°). The convex slope is more fragile to loss of mass and 25°-35° slope are mostly influenced by anthropogenic activities and habitat in the study area. Four landslides recorded in the area fall in concave class while remaining two fall in convex slope class.

Table 6: LOFS map and area coverage in pixels for Slope gradient of T.S Nos. 48J/10, 48J/15 and 48O/15

CLASS	Rank	LOFS	Area coverage (Pixels.)	Area covered (%)
<15	2	0.1631	911301	54.275

15-25	4	0.4597	359753	21.426
25-35	8	1.0000	221201	13.174
35-45	6	0.2817	111828	6.660
>45	2	0.1631	74959	4.464

Table 7: LOFS map and area coverage in pixels for slope curvature map of T.S Nos 48J/10, 48J/15 and 48O/15

CLASS	Rank	LOFS	Area coverage (Pixels)	Area covered (%)
Concave	4	0.4113	783140	46.642
Flat	2	0.1676	162588	9.683
Convex	6	1.0000	733314	43.674

4.3.2 Geomorphology:

Geomorphology, along with information on soil, water and vegetation has become one of the essential inputs in planning for various developmental activities. The scope of geomorphology has further expanded with the landform maps widely used in various fields of resource surveys, environmental analysis, hydrological studies, engineering applications and geo-technical studies.

Geomorphology map *(PLATE-6)* of the study area was prepared in ArcGIS software through visual interpretation of multi-temporal Google Imageries of the area. NGLM data acquired from SRO, Hyderabad 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. The post field changes in Geomorphology map have been shown in Fig. 3. In terms of geomorphology the area was grouped into the following classes namely ridge top, highly dissected slopes, moderately dissected slopes, low dissected slopes, mounds, hill top, valley fill, pediment-pediplain complex, rolling plains and river. The dissected slopes (high, moderate or low) were mapped based on visual interpretation by taking topographic ruggedness and presence of drainage as criteria. Most of the area (about 66.97%) falls in Low dissected slopes followed by Pediment-Pediplain Complex (30.11%), and moderately dissected slopes (0.98%). Highly dissected slope is given maximum weightage (rating 6) using AHP method followed by lowly dissected slopes (rating 4). The area coverage for each class in pixels, LOFS and rank is given in Table-8. Highly dissected slope is ranked less than the moderately dissected slope based on the ground scenario. It is observed in the study area

that the anthropogenic activities like toe cutting, road cut section and extensive cut are predominantly causative factors apart from natural causes.

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). It also acts as the water divide.

Dissected Structural Hills: Hills, which are originated due to tectonic process and are highly dissected by the drainage lines. This can be further classified as highly, moderately and low dissection (Photo-11) depending on the density of joints and drainage. Mostly this will be interpreted from a planimetric satellite data and the classification is highly subjective. (NGLM Manual, 2010).

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 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 towards northeast, east and southeast of Siddapur.

Valley Fill: The unconsolidated sediment deposited by any agent so as to fill or partly fill a valley (NGLM Manual, 2010).

Rolling Plain: An undulating plain with rugged topography (NGLM Manual, 2010).

Mounds: Isolated hills having low relief and lowly dissected slopes and almost flattish, rounded tops.

Table 8: LOFS, rank and area coverage in pixels for Geomorphology of TS nos. 48J/10, 48J/15 and 48O/15

Class	Rank	LOFS	Area coverage (Sq. Km.)	Area covered (%)
Lowly Dissected Slope	4	0.1947	1038.88	66.97
Moderately Dissected Slope	6	0.4020	15.18	0.98
Highly Dissected Slope	8	0.727	0.44	0.03
Mound	4	0	0.25	0.02
Ridge Top	4	0	6.17	0.4
River	0	0	4.14	0.27
Water body	0	0	4.06	0.26
Rolling Plain	0	0	8.9	0.57
Valley Fill	0	0	1.66	4.11
Escarpment	0	0	4.41	0.28
Pediment Pediplain Complex	0	0	467.03	30.11

4.3.3 Land Use and Land Cover:

Land-use /Land-cover changes, whether of natural origin or man-made, can influence the susceptibility of slopes to landslides (Diaz et al, 2006). The vegetation cover influences directly the susceptibility to landslides through various factors including (i) protection of the surface, (ii) consolidation of the soil and (iii) agriculture resulting in bare soil for long periods (Atkinson, P. M. and Massari, R.). The land-use/land-cover 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. Despite the Western Ghats being a UNESCO world heritage site and one of the eight hottest biodiversity hotspots in the world, it is still being exploited thoroughly, damaging natural slopes, flora and fauna. There have been drastic changes in the landuse/landcover patterns and scarcity of water, low rainfall in recent years in this area, may be a direct result of these anthropogenic activities. Remote sensing in forest management has led to many studies that concluded that forest clearing dramatically accelerates rates of landslides over rates in undisturbed forest (Siddle et al., 1985: Montgomery et al., 2000).

The study area consists of lush green forests, low height and high height plantations consisting of coffee, black pepper, teak etc. The commercial plantations form a major part of landuse in this area, causing large scale exploitation and disturbances in slope stability. Besides these, paddy cultivation is the major landuse pattern in low lying area/valley fill. 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 during monsoon. 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 also led to deforestation.

Construction of roads and railways has opened channels for exploitation and caused rapid changes in LULC of the area. The LULC map *(PLATE-7)* was prepared from the Google Earth data of the year 2012-time frame. Following the normal mapping procedure in Google Earth, first the polylines of different land use/cover classes were drawn and the same were imported in ArcGIS through kml to feature conversion. In ArcGIS 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 landuse/landcover map was checked in the field at all accessible locations. The area in terms of LULC can be classified in to the following classes: Barren, cultivation (Photo-2), settlement, settlement on modified slope, sparse vegetated areas (Photo-5), moderate vegetated areas (Photo-6), thick vegetated areas, river, low height plantation, high height plantation, extensive cut slope (Photo-10), quarry, 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 3.88% is covered with thick vegetation lying in all part of the study area. The next class of highest % is occupied by moderate vegetation covering 25.60% of the area. The south western part of the study area is occupied by moderate and thick vegetation and South eastern part is mostly covered by cultivation. Rest of the area is primarily covered by LHP 3.88% of the study area consists of barren land (Photo-1). Settlements in the area are widely distributed and are a vital cause in disturbing the natural equilibrium of slopes. Slope modification for settlement and commercial plantation is quite rampant in the area. LULC factor class 'extensive slope cut' is observed to be most vulnerable sites for slope failures and

occupies about .00045% of the study area. The maximum weightage is given to extensive slope cut followed by sparse vegetation 9.42% of the area respectively. The area coverage of each factor class in pixels, LOFS and rank is given in Table-9.

Thick Vegetation: The North-Western and Southwestern part of the study area predominates in thick vegetation (Photo-4) which has been fragmented at many places by human activities. Most of the forests are exploited for timber and for cooking purposes. There are several varieties of spices available in these forests.

High Height Plantations: These include commercial plantations like rubber, coconut, arica nut, teak, silver oak etc. They mostly cover the northern and north – western part of the area. Coconut plantations (Photo-3) are found all over the study area.

Low Height Plantations: Uttar Kannada, Chickmagaluru and Shimoga districts are famous for coconut, cashew, cocoa, coffee, and spices. These constitute the low height plantations of the area and occupy central, southern and north eastern part of study area.

Settlements: Due to high degree of commercialization and improvement in communication routes more and more area of the Western Ghats is being encroached upon by human settlements. Labourers from other states are also being brought in to work in plantations and live there. The study area is also a well-known tourist spot, hence to cater to the needs of the tourists, several holiday homes resorts and hotels have come up, thus increasing the urbanization index of the area.

Settlements on Modified Slope: Many slopes in and around Devimane, Murur, Ammenhalli and other important localities such as Gonakal, Kasage, Mabagi and Kodambail south west of Ammenhalli etc. have been modified for human use thus increasing the landslide susceptibility index of the area.

Extensive Slope Cut: Roads and railways are required for improving connectivity and communication in any area. The study area also has good road connectivity though at the cost of extensive damage to slopes (Photo-10). Slopes need to be cut in order to construct roads in the hilly terrains of the Western ghats. This weakens the slopes a great deal. This class has been given high rating for the same.

Table 9: LOFS, rank and area coverage in pixels for Landuse/Landcover of TS Nos. 48J/10, 48J/15 and 45O/15

Class	Rank	LOFS	Area coverage (Sq. Km.)	Area covered (%)
Barren	1	0.0626	43.971	2.834
Cultivation	2	0.0937	144.257	9.299
Extensive Slope Cut	9	1.0000	0.0712	0.004
Fallow Land	1	0.0626	53.082	3.421
Plantation (HHP)	4	0.1988	65.568	4.226
Plantation (LHP)	3	0.1366	60.252	3.884
Quarry	5	0.2912	0.555	0.035
Settlement	1	0.0683	36.662	2.363
Moderate Vegetation	5	0.5631	397.136	25.600
Thick Vegetation	4	0.1988	595.289	38.374
Sparse Vegetation	7	0.5631	146.197	9.424
Water body	0	0.0000	4.062	0.261
River	0	0.0000	4.144	0.267

4.3.4 Slope Forming Material (SFM):

The area under study is observed to have shallow debris slides. These slides occur in the overburden part of slopes where the upper shallow layer slides over the more competent material either bedrock or denser overburden material. These slides are often triggered by high rainfall and anthropogenic activities. Thus careful study of slope forming material is a must for this study area. Slope Forming Material (SFM) (*PLATE-8*) map was prepared in ArcGIS 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 SFM is classified in to the following classes: Rock, transported soil, alluvium and in-situ soil. Though the area comprises of high hill ranges and valleys, transported soil could not be identified due to thick vegetation cover.

On slopes as well as ridge tops, barren rock is present at places where the slope gradient in general is more than 35°, most of the study area (about 84.47%) is covered by in-situ, Laterite is covering 6.304% of the area. The factor class rock includes overburden material of ≤ 0.5m thickness. For this class different rock names are taken from the geological map of the study area by GSI. The class in-situ soil and amphibolites are assigned maximum weightage because minerals present in amphibolites are highly susceptible to weathering and the loose in-situ soil has poor shear strength due to water saturation in Western Ghats climatic conditions. The area covered in pixels, LOFS and rank is given in Table-10.

Table 10: LOFS, rank and area coverage in pixels for Slope forming material of 48J/10, 48J/15 and 45O/15

CLASS	Rank	LOFS	Area Coverage (Sq. Km.)	Area Coverage (%)
In-situ soil	4	0.240	1310.35	84.476
Laterite	1	0.068	97.790	6.304
Transported Soil	1	0.068	0.507	0.032
Amphibolite	1	0.068	1.885	0.121
Argillite	1	0.068	2.122	0.136
Banded iron formation	1	0.068	1.550	0.099
Banded magnetite quartzite	1	0.068	1.139	0.073
Carbonaceous phyllite	1	0.068	1.285	0.082
Chlorite schist	2	0.240	0.500	0.032
Diorite porphyry	3	0.150	0.0170	0.001

Dolerite	0	0.000	0.081	0.005
Ferruginous phyllite	0	0.000	12.636	0.814
Gabbro	0	0.000	11.763	0.758
Granite gneiss	4	0.240	3.062	0.197
Granitoid	4	0.240	33.272	2.145
Grey granite	1	0.068	2.511	0.161
Hornblende-actinolite-chlorite schist	3	0.240	37.909	2.443
Limestone	1	0.068	0.110	0.007
Manganiferous phyllite	4	0.240	11.450	0.738
Meta-basalt	1	0.068	6.910	0.445
Meta-pyroxenite	1	0.068	0.357	0.023
Meta-rhyolite	1	0.068	5.171	0.333
Quartzite	1	0.068	0.535	0.0345
River	0	0	4.144	0.267
Water body	0	0	4.062	0.261

4.3.5 Regolith Thickness:

One of the most sensitive parameters is soil thickness (Van Westen et. al, 2008 and Page et al., 1994) correlate sediment thickness with landslide events. Landslide is triggered due to the decrease in shear strength of the soil as a result of increase in pore water pressure on the failure surface. An increase in pore water pressure can be caused directly by percolating rainfall or indirectly by an accumulation of water at a certain depth due to changes in permeability within the soil cover (perched water tables) or by an accumulation of water at the soil – bedrock contact (Terlien, 1998). In soils, pore water pressure may be due to: (i) hydrostatic head, (ii) pressure exerted by water flowing through a soil mass whose volume remains constant, and (iii) pressures associate with stress changes in the soil, which initiates changes in volume of the soil mass (consolidation or swelling) (Parcher, JV and Means, RE, 1968).

Thickness of overburden (Photo-7, 13 and 14) is directly controlled by SFM, geomorphology, LULC and slope gradient. Overloading of slopes with sediments, debris, quarry dump may result in slope failures often triggered by heavy rainfall. During the fieldwork, regolith/overburden thickness is estimated by observing road cuts, forest trenches and nala sections wherever available. An attempt has been made to record 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 to 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. In the study area, it can be classified in to four classes less than 0.5 m, 0.5m to 5 m, 5m to 10m and more than 10m (*PLATE-9).* At the same time, it is remarkable point that along the road section we have best exposure or overburden and also to estimate its thickness too. Along the moderate and steep slopes depth of overburden, in general, is less while along major weathered profiles, regolith thickness is more, and these areas are more prone to landslides. Regolith depth of <0.5m depth is observed on rocky, steep slopes and is included into rock class. Areas in the western part of TS No. 48J/15 have rock as slope forming material, regolith thickness for which is taken as less than 0.5m. Major part of the study area (about 84.497%) has a regolith depth of 5m to 10m. Some places (about 14.96%) have regolith depths of more than <0.5 m like Siddapur, Sirsi, Devimane, Ammenhalli, Kasage, Mabagi and Kodambail while 0.0044% of the area is occupied by regolith depths of more than >10m (1, 2, 6) are in south of Chandragutti and Murur area. 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 -11.

Table 11: LOFS, rank and area coverage in pixels for Regolith Thickness of T.S. Nos. 48J/10, 48J/15 and 45O/15

CLASS	Rank	LOFS	Area coverage (Sq. Km.)	Area covered (%)
< 0.5 m	0	0	232.175	14.968
0.5 - 5 m	7	1	0.069	0.004
5 - 10 m	4	0.322	1310.680	84.497
>10m	2	0.136	0.014	0.0009
River	0	0	4.144	0.267
Water body	0	0	4.062	0.261

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 of slide is 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: Finalization of ratings and weights in a smaller neighboring 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 utilized for the entire study area where landslide data is not available. Since NLSM aims to develop and utilize terrain-specific ratings and weights, this seems to be the best approximation of terrain-specific importance of geofactors.

Alternative 2: Finalization 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 utilizing 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., 2010), 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 landsliding 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 (1980) 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 and 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

$maks.eigenvalue=\sum_{\iota} wi.ci$ 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 ≥ 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 (SPS) used is given in Table-12.

Table 12: Class value and their ratings

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 SPS 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-13.

Table 13: Generic Table showing mutual comparison rank of LULC factor classes

CLASS	Rank	LOFS
Barren	1	0.0626
Cultivation	2	0.0937
Extensive Slope Cut	9	1.0000
Fallow Land	1	0.0626
Moderate Vegetation	5	0.2912
Plantation (HHP)	4	0.1988
Plantation (LHP)	3	0.1366
Quarry	5	0.2912
Settlement	1	0.0683
Settlement on modified slope	7	0.5631
Swamp	0	0.0000
Thick Vegetation	4	0.1988

Sparse Vegetation	7	0.5631
Water body	0	0.0000
River	0	0.0000

Table 14: Table showing matrix of mutual comparison ranks of LULC classes given rank >0

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

Table 15: Table Showing Fraction rate and LOFS values

LULC	B	CL	ESC	FL	MV	HHP	LHP	QR	S	SM	TV	SV	Sum rows	Frac rate	LOFS
B	0.02041	0.01299	0.03702	0.02041	0.01551	0.01158	0.01013	0.01292	0.02041	0.02052	0.01158	0.02052	0.21283	0.01774	0.0626
CL	0.04082	0.02597	0.04165	0.04082	0.01647	0.01544	0.01695	0.01615	0.04082	0.02394	0.01544	0.02394	0.3184	0.02653	0.0937
ESC	0.18367	0.20779	0.3332	0.18367	0.32931	0.27799	0.23729	0.32293	0.18367	0.43092	0.27799	0.43092	3.39936	0.28328	1.0000
FL	0.02041	0.01299	0.03702	0.02041	0.01551	0.01158	0.01013	0.01292	0.02041	0.02052	0.01158	0.02052	0.21283	0.01774	0.0626
MV	0.10204	0.10039	0.06664	0.10204	0.06586	0.09266	0.10169	0.06459	0.10204	0.04788	0.09266	0.04788	0.98989	0.08249	0.2912
HHP	0.08163	0.07792	0.05553	0.08163	0.03293	0.04633	0.06078	0.03229	0.08163	0.03591	0.04633	0.03591	0.67586	0.05632	0.1988
LHP	0.06122	0.05195	0.04076	0.06122	0.02195	0.02317	0.03039	0.02153	0.06122	0.02873	0.02317	0.02873	0.46439	0.03867	0.1366
QR	0.10204	0.10039	0.06664	0.10204	0.06586	0.09266	0.10169	0.06459	0.10204	0.04788	0.09266	0.04788	0.98989	0.08249	0.2912
S	0.02041	0.01299	0.03702	0.02041	0.01551	0.01158	0.01013	0.03229	0.02041	0.02052	0.01158	0.02052	0.23222	0.01935	0.0683
SM	0.14286	0.15584	0.11107	0.14286	0.19759	0.18533	0.16949	0.19376	0.14286	0.14364	0.18533	0.14364	1.91425	0.15952	0.5631
TV	0.08163	0.07792	0.05553	0.08163	0.03293	0.04633	0.06078	0.03229	0.08163	0.03591	0.04633	0.03591	0.67586	0.05632	0.1988
SV	0.14286	0.15584	0.11107	0.14286	0.19759	0.18533	0.16949	0.19376	0.14286	0.14364	0.18533	0.14364	1.91425	0.15952	0.5631

Table 16: Table showing estimation of consistency vector (CV)

LULC	B	CL	ESC	FL	MV	HHP	LHP	QR	S	SM	TV	SV	Sum rows	CV
B	0.01774	0.01327	0.03148	0.01774	0.0165	0.01408	0.0129	0.0165	0.01935	0.02279	0.01408	0.02279	0.2192	12.3591
CL	0.03547	0.02653	0.03541	0.03547	0.02062	0.01877	0.01935	0.02062	0.0387	0.02659	0.01877	0.02659	0.3229	12.1696
ESC	0.15962	0.21227	0.28328	0.15962	0.41245	0.33793	0.27089	0.41245	0.17415	0.47856	0.33793	0.47856	3.71773	13.1239
FL	0.01774	0.01327	0.03148	0.01774	0.0165	0.01408	0.0129	0.0165	0.01935	0.02279	0.01408	0.02279	0.2192	12.3591
MV	0.08868	0.10613	0.05666	0.08868	0.08249	0.11264	0.1161	0.08249	0.09675	0.05317	0.11264	0.05317	1.04961	12.724
HHP	0.07094	0.0796	0.04721	0.07094	0.04125	0.05632	0.0774	0.04125	0.0774	0.03988	0.05632	0.03988	0.69839	12.4001
LHP	0.05321	0.05307	0.04047	0.05321	0.0275	0.02816	0.0387	0.0275	0.05805	0.0319	0.02816	0.0319	0.47182	12.1921
QR	0.08868	0.10613	0.05666	0.08868	0.08249	0.11264	0.1161	0.08249	0.09675	0.05317	0.11264	0.05317	1.04961	12.724
S	0.01774	0.01327	0.03148	0.01774	0.0165	0.01408	0.0129	0.04125	0.01935	0.02279	0.01408	0.02279	0.24395	12.6068
SM	0.12415	0.1592	0.09443	0.12415	0.24747	0.22529	0.1935	0.24747	0.13545	0.15952	0.22529	0.15952	2.09543	13.1358
TV	0.07094	0.0796	0.04721	0.07094	0.04125	0.05632	0.0774	0.04125	0.0774	0.03988	0.05632	0.03988	0.69839	12.4001
SV	0.12415	0.1592	0.09443	0.12415	0.24747	0.22529	0.1935	0.24747	0.13545	0.15952	0.22529	0.15952	2.09543	13.1358
													Sum CV	151.33

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	**12.6109**	
Consistency Index (CI) =		**(Mean CV-number of themes)/(No of themes -1)**
CI	**0.05553**	
Consistency Ratio (CR) =		**CI/RI**
CR	0.00463	
CR should never be more than 0.1		

In the same manner LOFS and consistency ratio (CR) were calculated for all the six factor maps. All the tables of the six factor maps for LOFS and consistency ratio calculations have been attached in Annexure – I. Here table 15 is showing calculation of consistency index (CI) and consistency ratio (CR) and table 16 is showing mutual comparison of individual factor maps and weights.

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

Factor	Slope	Curvat	SFM	LUL	Geo	RT
Slope	1.00	8.00	4.00	2.00	4.00	6.00
Curva	0.13	1.00	0.20	0.14	0.20	0.33
SFM	0.25	5.00	1.00	0.33	1.00	3.00
LULC	0.50	7.00	3.00	1.00	3.00	5.00
Geom	0.25	5.00	1.00	0.33	1.00	3.00
RT	0.17	3.00	0.33	0.20	0.33	1.00
Sum Clmn	2.29	29.00	9.53	4.01	9.53	18.33

Factor	Slope	Curvature	SFM	LULC	Geom	RT	Sum rows	Frac rate	Weight	Weight W N
Slope	**0.43636**	**0.27586**	**0.41958**	**0.49881**	**0.41958**	**0.32727**	**2.37747**	**0.39625**	**12.8653**	**13**
Curvature	**0.05455**	**0.03448**	**0.02098**	**0.03563**	**0.02098**	**0.01818**	**0.18480**	**0.0308**	**1**	**1**
SFM	**0.10909**	**0.17241**	**0.10490**	**0.08314**	**0.10490**	**0.16364**	**0.73807**	**0.12301**	**3.99392**	**4**
LULC	**0.21818**	**0.24138**	**0.31469**	**0.24941**	**0.31469**	**0.27273**	**1.61107**	**0.26851**	**8.718**	**9**
Geom	**0.10909**	**0.17241**	**0.10490**	**0.08314**	**0.10490**	**0.16364**	**0.73807**	**0.12301**	**3.99392**	**4**
RT	**0.07273**	**0.10345**	**0.03497**	**0.04988**	**0.03497**	**0.05455**	**0.35053**	**0.05842**	**1.89685**	**2**

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 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 done 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 are 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*".

5. LANDSLIDE SUSCEPTIBILITY MAP

Landslide susceptibility maps are key tools for landuse planning, management and risk mitigation. Landslide susceptibility mapping aims to differentiate a land surface into homogeneous areas according to their probability of failure caused by mass-movement at specific locations (Varnes, 1978). It relies on understanding complex mass movement processes and their controlling factors. An accurate and reliable landslide susceptibility map requires high quality data to arrive at useful decisions, and an appropriate methodology for analysis and modelling.

A Landslide susceptibility score map is thus obtained after generating LOFS maps for all the factor classes and using Weighted Multiclass Index Overlay method to generate 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 likelihood of an area for initiation of landslide or slope failure in a pixel (the mapping unit) under the given geo-environmental conditions. According to the final susceptibility map obtained after AHP modelling. The final susceptibility map divides about 68.0182 % area falls under low landslide susceptibility zone, 24.7467 % area are in moderate susceptibility zone and 07.2349 % area falls under high landslide susceptibility zone. The area on the south-western fringe, west of Devimane, Murur, Yana and west of Siddapur, South of Siddapur (Near Jog Fall), these area falls under high susceptibility zones, this corroborates the fact that uncontrolled slope modification and other anthropogenic activities contribute in landslide occurrence. Most of the high susceptibility zones correspond to slope gradient class between 25° - 35°. It has been observed that most of the slides occur in this slope gradient class 15° - 25° (16-slides) and 25° - 35° (29-slides) *(PLATE-10).* In terms of landuse/landcover the area having settlement on modified slopes and extensive cut slopes (ECS) has the maximum susceptibility to landslides. In terms of geomorphology, most of the slides are observed to occur in lowly dissected slopes (45-slides). It has to be noted here that most of the slides occurring in low dissected slopes are located along cut slopes where modification slope and slope disturbances are maximum.

Most of the area in toposheet no. 48J/10 falls under moderate to high susceptibility which can be attributed to two facts (i) most parts in this sheet have steep slope gradients as compared to northern part of the area, and (ii) natural slopes have been excavated and modified for construction of highways, settlements and commercial plantations rendering the

slopes unstable and prone to failures. Whereas, almost most of 78% of the area in toposheet no. 48J/15 falls low to moderate susceptibility zone and rest of 22% area falls under high susceptibility zone. Several incidences of road cut failure varying from 15m to 75m in size have been recorded along the Sirsi-Kumta road section. On the other hand, along Sirsi-Siddapur road section occurrences of slope cut failures and road subsidence are present which are almost stabilized due to the vegetation growth and lined drainage maintenance by PWD and other stake holders. Uncontrolled slope modification, removal of vegetation and overloading of slopes are few measures for slope failure in this area.

All the places where extensive slope cuts are demarcated are falling in high susceptibility zone. These places are vulnerable to slope failures due to removal of toe material and construction work being carried out without any remedial measures make these slopes unstable.

In the western part of the study area there are moderately dissected slopes having slope gradient of 25° to 45° which has been given the maximum weightage for landslide susceptibility. Deforestation and slope disturbance have been observed in this part of study due to human interference as the place is a significant tourist destination. Due to these factors the western part of the area having steep hills, thick forest and plantations has been classified in to moderate to high susceptible zone.

Most of the northern, central and eastern part of study area is categorised into low to moderate susceptibility zone in all three toposheet of the study area. This may be attributed to presence of low lying planes which are 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 thick vegetation on the slope forming material, the site is penetrated by roots of these plants. This also provides stability to area as far as slope failure is concerned.

6. CONCLUSIONS AND RECOMMENDATIONS

The hazards that landslides pose to society tend to be less appreciated as compared to other hazards. This is because landslides seldom occur at the same places. As compared to other hazards (viz. floods) where some sort of early warning systems has been developed, landslide warning in terms of time and location of occurrence can rarely be predicted with accuracy. Nevertheless, until some reliable system is developed for prediction of landslide occurrence, mitigation of damage caused by slope failures and creating better awareness among common man are the only tools against this natural hazard. The area under study mostly has slides of small dimension. Small landslides make up the vast majority of landslide incidents that effect communities and individuals globally. These costs are mostly associated with human habitation and transport linkages. The decision whether to actively manage small landslides either by slope stabilisation methods or mitigation of their impacts is function of the cost-benefit analysis that are undertaken explicitly or implicitly (Elisabeth et al., 2015). About 07.2349 % (17 Sq. Km.) of area is grouped under high susceptibility zone covering all three toposheet no.'s 48J/10, 48J/15 and 48O/15. 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:

Some areas southwest of Sirsi near to Ammenhalli, Devimane, Kasage have extensive slope cuts. This part of the slope 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. There have been previous instances of slope failures near Kasage, Mabagi, Kodambail road section causing damage to road transportation. 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. Moreover, the local authorities should also consider shifting of residential areas to other stable areas to minimise damage in the current calamities.

Similarly, road sections on the Sunkal which falls on a very small stretch of NH-63 have been observed to have steep slope gradients and some incidences of slope failures have been reported earlier. This area also has high to moderate 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, slope contouring and conservation of forests need to be taken up so that the roads and associated populace is kept safe from any damage.

Similarly, the ghat road between Herur, Golmakki, Hemadbail and Bilgi have some post historic instances of small slope failures which are due to deforestation and slope modification. In these areas slopes have to be stabilised to prevent slope failures in the future. Since there is continuous increase in anthropogenic activities in the area and also increase in its inhabitants, this area has socio economic impact also.

There is extensive slope cut near Gadilkallu-Mallenahalli-Kambihalli road section in Chickmagaluru district. This area also has high to moderate possibility of slope failures as indicated by susceptibility map. Heavy rainfall and deforestation may lead to loosening of the overburden which may slide. Here in the study area deforestation is on modified slope for coffee plantation. In this areas, these slopes have to be stabilised to prevent slope failures in the future but are still under moderate zone due to high land.

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; few vulnerable sites may be explored or investigated through

sub-surface exploration 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 may 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 may 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.

Despite 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 and also suggested to investigate thoroughly through geotechnical investigation with engineering geologists.

Landslide susceptibility mapping is useful in identifying potential landslide hazard zones but remedial measure 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

Sl. Nos.	Latitude (N)	Longitude (E)	Locality Name
1.	14.40	74.93	Aigod
2.	14.45	74.76	Ainbail
3.	14.31	74.89	Akkunji
4.	14.31	74.76	Alavalli
5.	14.30	74.82	Algod
6.	13.35	75.76	Allampura
7.	14.55	74.74	Ammenhalli
8.	14.48	74.78	Analebail
9.	14.48	74.77	Analebail
10.	13.36	75.75	Aralaguppe
11.	13.39	75.78	Arasinaguppe
12.	13.39	75.77	Arshinaguppae
13.	13.50	75.79	Athigiri
14.	14.62	74.68	Attadmane
15.	14.49	74.78	Attimurd
16.	14.36	74.88	Avarguppa
17.	14.52	74.67	Badagi
18.	14.30	74.77	Bailalli
19.	14.52	74.70	Balavalli
20.	14.49	74.85	Balekai
21.	14.53	74.60	Balekoppa
22.	14.43	74.77	Balekoppa
23.	14.47	74.80	Balesar
24.	14.36	74.86	Balguli
25.	14.37	74.91	Ballatte
26.	14.48	74.78	Balur
27.	14.48	74.77	Banaggi
28.	14.53	74.66	Bandal
29.	14.49	74.81	Bannige
30.	14.33	74.84	Bedkani
31.	13.36	75.79	Beekanagallik
32.	13.34	75.80	Beekanahalli Rural
33.	14.53	74.51	Bellangi
34.	14.59	74.60	Benagaon
35.	13.44	75.80	Bhaktarhalli
36.	14.43	74.84	Bhandarkeri
37.	14.35	74.84	Bhankuli
38.	14.38	74.84	Bidarkan
39.	14.48	74.76	Bidarmane
40.	14.36	74.79	Bilgi
41.	13.49	75.84	Bilichenahalli
42.	14.29	74.80	Chandraghatgi
43.	14.38	74.77	Chapparmane
44.	13.32	75.78	Chickmagaluru
45.	13.41	75.86	Chindenahalli

46.	13.33	75.79	Dantaramakki
47.	13.38	75.75	Dasarahalli
48.	13.35	75.82	Dasarahalli
49.	13.48	75.75	Dattathreyapeeta
50.	14.62	74.66	Devanhalli
51.	14.65	74.66	Devanhalli
52.	14.62	74.59	Devanmane
53.	14.51	74.58	Devimane
54.	13.49	75.87	Doddayyana Mane
55.	14.70	74.53	Dongri
56.	13.44	75.79	Galipooje
57.	13.39	75.77	Godikallu
58.	14.36	74.82	Golikai
59.	14.45	74.77	Golmakki
60.	13.45	75.80	Gonakal
61.	14.71	74.65	Gonsar
62.	13.48	75.77	Goonakllur
63.	13.42	75.87	Gunagarahalli
64.	14.72	74.70	Guruvalli
65.	14.60	74.70	Hakkigadde
66.	14.39	74.89	Halagadikoppa
67.	13.43	75.81	Halasabalu
68.	13.48	75.85	Halasinamaradahalli
69.	13.50	75.86	Hale Siddarahally
70.	14.48	74.82	Halkani
71.	14.75	74.59	Halvalli
72.	13.34	75.79	Hampapura
73.	13.40	75.86	Hanchihalli
74.	14.49	74.85	Hangarkhanda
75.	14.46	74.76	Hantikuli
76.	14.42	74.75	Harihar
77.	14.43	74.82	Harsikatta
78.	14.40	74.79	Harsikatte
79.	14.50	74.79	Hasaragod
80.	14.41	74.78	Havinbil
81.	13.40	75.80	Hebballi
82.	14.71	74.51	Hebbul
83.	14.51	74.60	Hebre
84.	14.61	74.72	Hegdekatte
85.	14.45	74.78	Hegnur
86.	14.26	74.76	Hejnai
87.	14.48	74.78	Herur
88.	14.46	74.88	Hirekai
89.	14.49	74.83	Hosakoppa
90.	14.34	74.80	Hosamanju
91.	13.48	75.80	Hospet
92.	14.57	74.72	Hostota
93.	14.51	74.63	Hosur

94.	14.28	74.74	Hukali
95.	13.36	75.77	Huliyarahalli
96.	14.35	74.77	Huvinmane
97.	13.35	75.77	Inddavara
98.	14.33	74.76	Itagi
99.	13.35	75.78	Iyanhalli
100.	14.66	74.69	Jaddigadde
101.	14.63	74.73	Jagalemane
102.	14.54	74.73	Janmane
103.	14.64	74.72	Kadabala
104.	14.46	74.89	Kalen Halli
105.	14.49	74.88	Kalgadde
106.	14.50	74.84	Kalkatte Hunasekoppa
107.	14.59	74.63	Kallalli
108.	13.48	75.84	Kalluhole
109.	14.25	74.88	Kallur
110.	14.59	74.67	Kalugar
111.	13.32	75.80	Kalyananagara
112.	14.59	74.70	Kambigar
113.	13.49	75.81	Kambihalli
114.	13.46	75.85	Kamenahallikaval
115.	13.44	75.84	Kamenhalli
116.	14.70	74.59	Kammani
117.	14.59	74.74	Kanalli
118.	14.74	74.66	Kanamuski
119.	14.54	74.83	Kansur
120.	13.36	75.77	Karadihallikaval
121.	14.48	74.81	Karjagi
122.	13.35	75.77	Karkipete
123.	14.44	74.79	Karkisaval
124.	13.34	75.80	Karnataka Housing Layout
125.	14.55	74.68	Kasage
126.	14.39	74.90	Kastur
127.	14.27	74.90	Kavanchur
128.	14.68	74.62	Kelginkeri
129.	14.30	74.74	Keremane
130.	14.55	74.68	Khurse
131.	14.46	74.78	Kibballi
132.	14.26	74.82	Kilar
133.	14.51	74.52	Kodambail
134.	14.52	74.54	Kodambale
135.	14.45	74.90	Kodambi
136.	14.57	74.74	Kodgibail
137.	14.36	74.83	Kodgibail
138.	14.25	74.80	Kodkani
139.	14.45	74.84	Kodsar
140.	14.49	74.82	Kodsar Halkkani
141.	14.39	74.87	Kolsirsi

142.	14.35	74.90	Kondli
143.	14.28	74.77	Kudagund
144.	14.68	74.66	Kudragoa
145.	14.53	74.73	Kukri
146.	14.39	74.88	Kunaji
147.	14.66	74.54	Kuntagani
148.	13.33	75.79	Kuppenalli
149.	14.57	74.76	Kursi
150.	14.31	74.74	Lambapura
151.	14.54	74.52	Mabagi
152.	13.42	75.80	Mallenahalli
153.	14.48	74.84	Malubalgar
154.	14.68	74.69	Manadur
155.	14.40	74.88	Mandikoppa
156.	14.64	74.56	Manigadde
157.	14.57	74.67	Manjaguni
158.	14.46	74.86	Matti Halli
159.	14.30	74.87	Mattigar
160.	14.45	74.92	Mavinaballikoppa
161.	14.66	74.74	Melin Onikeri
162.	14.46	74.76	Melina Hirekai
163.	14.28	74.82	Mensi
164.	14.61	74.69	Mudgar
165.	14.47	74.91	Mudhalli
166.	14.66	74.60	Mundganmane
167.	14.70	74.70	Muregar
168.	14.47	74.76	Murur
169.	13.45	75.77	Muthinapura
170.	14.34	74.82	Muttige
171.	14.41	74.83	Muttige
172.	14.30	74.86	Nagarbhavi
173.	13.43	75.78	Nagenahalli
174.	14.64	74.68	Naigar
175.	14.48	74.87	Nanikatta
176.	14.46	74.93	Narchi
177.	14.57	74.70	Navilgar
178.	14.67	74.67	Neelkani
179.	14.70	74.74	Nekshe
180.	14.42	74.89	Nidgod
181.	14.61	74.68	Onigadde
182.	13.45	75.86	Padamane
183.	14.32	74.87	Padavanbail
184.	13.34	75.77	Rathnagiri Bore
185.	13.48	75.86	Sagani Basavanahalli
186.	14.43	74.86	Sampagod
187.	14.55	74.71	Sampakhada
188.	14.54	74.54	Sandolli Muttolli
189.	14.62	74.63	Sarguppa

190.	14.45	74.81	Shamemane
191.	13.48	75.90	Shankunipura
192.	14.72	74.62	Shirgani
193.	14.62	74.72	Shivalli
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195.	14.62	74.85	Sirsi
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197.	13.34	75.80	Sumuka Nagar
198.	14.73	74.51	Sunkasal
199.	14.73	74.52	Sunksal
200.	14.47	74.90	Surgikoppa
201.	13.43	75.79	Suruguppe
202.	14.32	74.79	Taragod
203.	14.37	74.79	Tarakhanda
204.	14.50	74.76	Tattikal
205.	14.67	74.73	Tattisara
206.	14.56	74.65	Teppar
207.	13.48	75.81	Thogarihankal
208.	14.68	74.72	Tolagaragadde
209.	14.43	74.88	Tumbargod
210.	14.49	74.75	Umbalmane
211.	13.33	75.76	Uppalli
212.	14.44	74.85	Vaajagadde
213.	13.48	75.86	Vaddarahatti
214.	14.65	74.58	Vajgade
215.	14.73	74.70	Vanalli
216.	13.33	75.77	Vijayapura
217.	14.59	74.57	Yana
218.	14.50	74.78	Yelugar

SYNOPSIS OF WORK DONE

1.	**Title of the report**	MACRO-SCALE (1:50,000) LANDSLIDE SUSCEPTIBILITY MAPPING IN PARTS OF TOPOSHEETS NOS. 48J/10, 48J/15 AND 48O/15 UTTAR KANNADA, SHIMOGA AND CHICKMAGALURU DISTRICTS, KARNATAKA
2.	**FSP Code No**	M4LSSM/NC/SR/SU-KG/2018/18733
3.	**Field Season**	2018 – 19
4.	**Date of Commencement**	26th September – 2018
5.	**Date of Completion**	31st March – 2019
6.	**Officers associated with the investigation and no. of days spent in the field**	1. Rahul Kumar Chaurasia, Geologist – 124 Days 2. Mohan Raj E, Geologist – 119 Days
7.	**Quantum of work done**	

1. Pre-field preparation	
(i) Slope Forming Material map	1551 Sq. Km
(ii) Geomorphology & Lineament map	1551 Sq. Km
(iii) Slope Morphometry (slope, aspect & curvature) map	1551 Sq. Km
(iv) Landuse / Landcover map	1551 Sq. Km
(v) Drainage map	1551 Sq. Km
(vi) Regolith thickness map	1551 Sq. Km
(vii) Preparation of Landslide Inventory Map	1551 Sq. Km
2. Field-based studies	
(i) Field-checking of all thematic maps	1551 Sq. Km
(ii) Field validation of landslide inventory and collection of recent and historic landslides (using archives, old reports, road register etc.)	1551 Sq. Km
(iii) Collection of landslide inventory and damage data as per 42 point geo parametric data sheet	45 Nos.
(iv) Validation of landslide susceptibility map at important locations	1551 Sq. Km
3. Post-field studies & modelling	
(i) Updation of thematic and inventory maps in GIS	1551 Sq. Km
(ii) Preparation of Landslide Susceptibility Map in GIS	1551 Sq. Km
4. Collection of rainfall data from available rain stations	1551 Sq. Km

8. Expenditure

Expenditure Details	Amount (Rs.)
Wages	89018/-
OC	52307/-
POL	15055/-
Total	156380/-

FIVE POINT PROFORMA

Title of the report: "Macro-scale (1:50,000) landslide susceptibility mapping in parts of toposheets nos. 48J/10, 48J/15 and 48O/15 Uttar Kannada, Shimoga and Chickmagaluru districts, Karnataka".	
1. Background of the investigation at whose instance or with what particular objective in view the investigation was undertaken	The item was taken up as per the annual programme of GSI vide FSP Code No: M4LSSM/NC/SR/SU-KG/2018/18733 with an objective to prepare seamless Landslide Susceptibility Map of India.
2. Whether the item of investigation was included in the approved programme for the year concerned. If so, particulars, such as item No. page reference etc. may be given.	Yes FSP Code No: M4LSSM/NC/SR/SU-KG/2018/18733
3. Date of commencement of the investigation with month and year, and exact number of days spent by the officer(s) in the field in connection with the investigation.	26th September 2018 1. Rahul Kumar Chaurasia 124 days 2. Mohan Raj E, Geologist 119 days Total 243 days
4. Brief comments by Director / Supervisory officer on the conclusion and recommendation by the author(s) with suggestion for implementing the same.	I fully agree with the conclusions drawn and recommendations made by the authors.
5. Please state specifically how the results of the investigation were achieved compared with the objective for which it was undertaken.	The objective of the investigation is fully achieved.
Date: Place: Bengaluru	Shri. K. V. Maruthi Director

GEOLOGICAL SURVEY OF INDIA

Certificate of Quality of the report

Project/ Division: NLSM/EG Division **FSP No.: M4LSSM/NC/SR/SU-KG/2018/18733**
Mission: IV

Title of the report: Macro-scale (1:50,000) landslide susceptibility mapping in parts of toposheets Nos. 48J/10, 48J/15 and 48U/15 Uttar Kannada, Shimoga and Chickmagaluru districts, 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. Rahul Kumar Chaurasia, Geologist	124 days	
2. Mohan Raj E, Geologist, Geologist	119 days	

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
Shri. K. V. Maruthi	02	04	

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

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

PLATES

PLATE 1

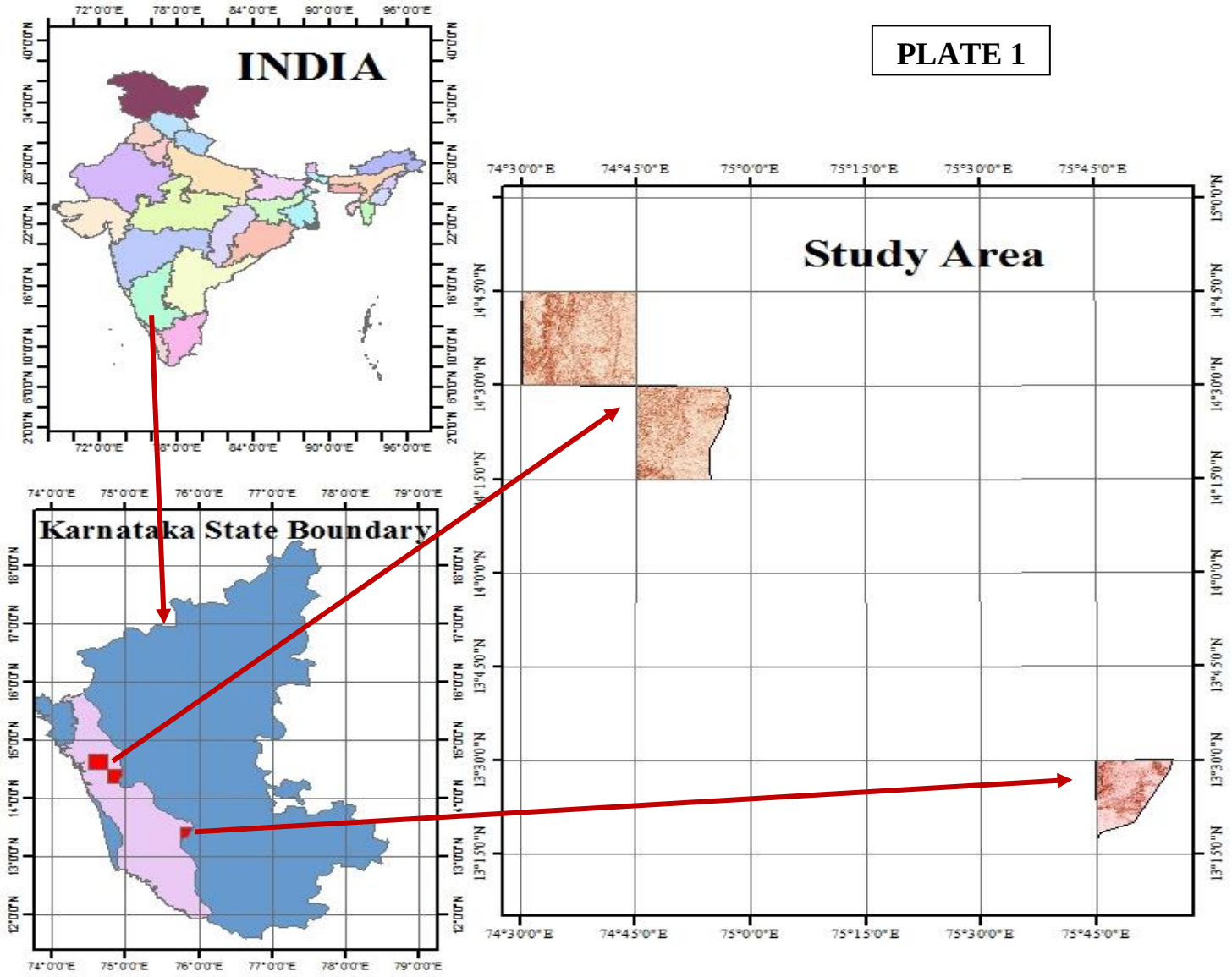


PLATE 2

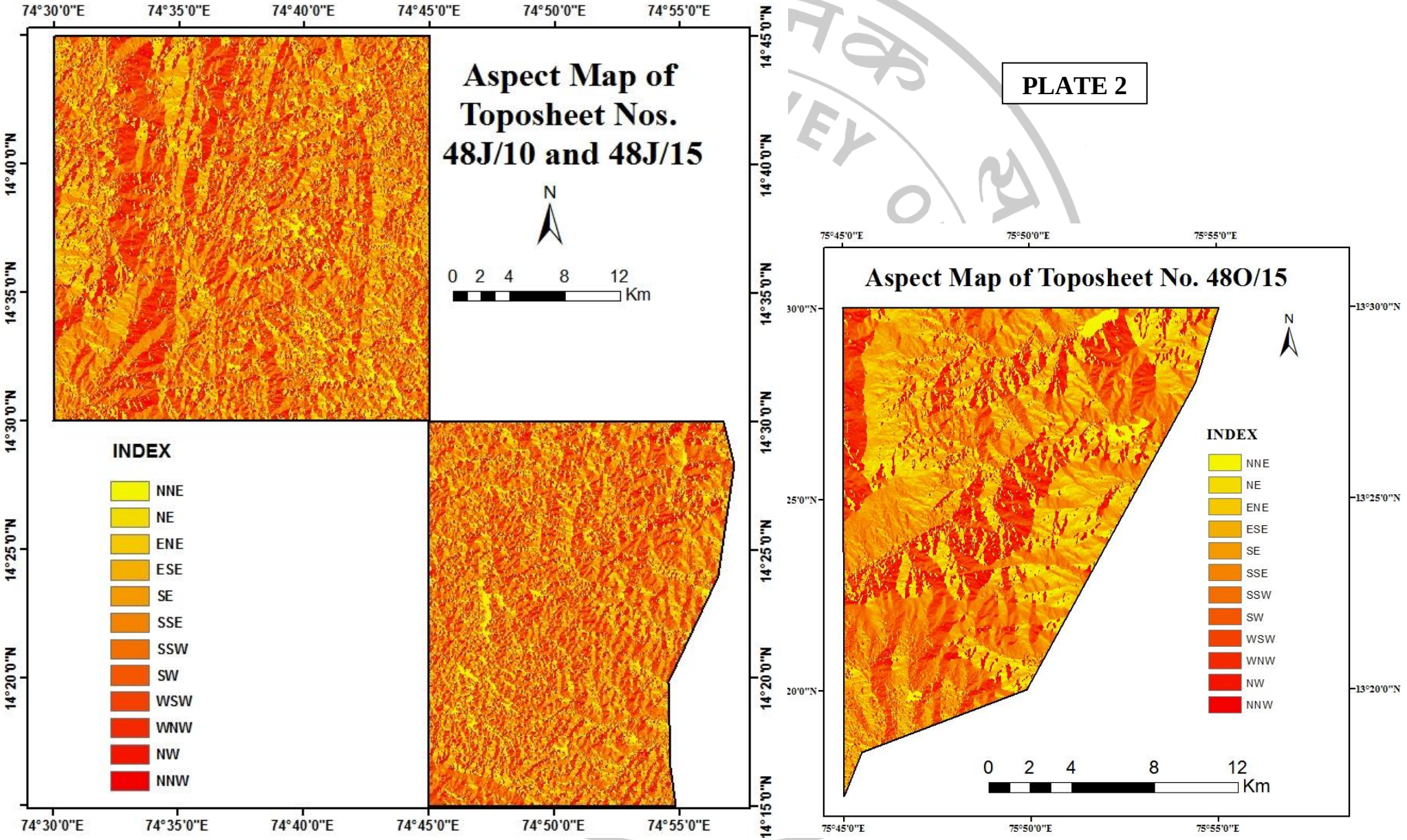
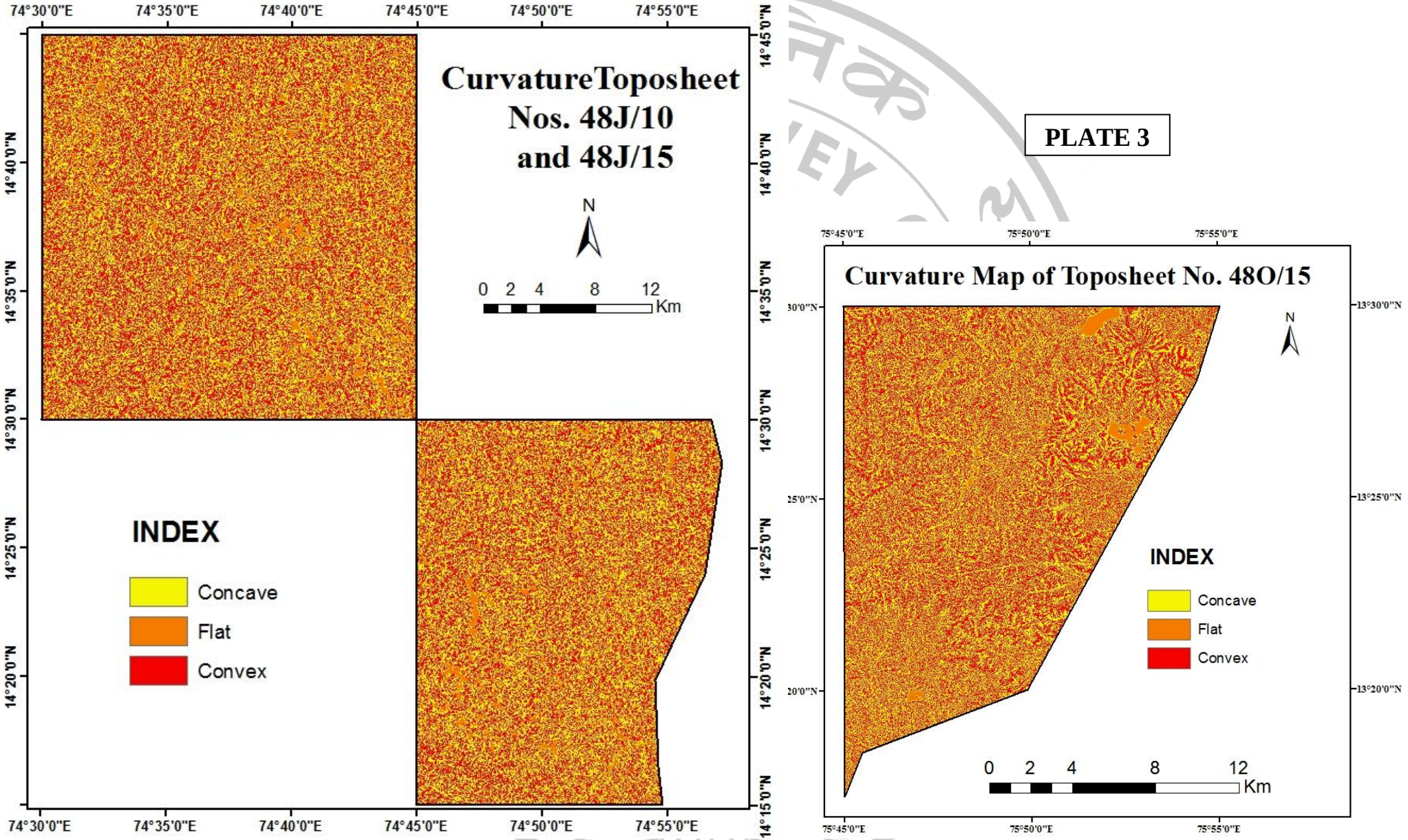
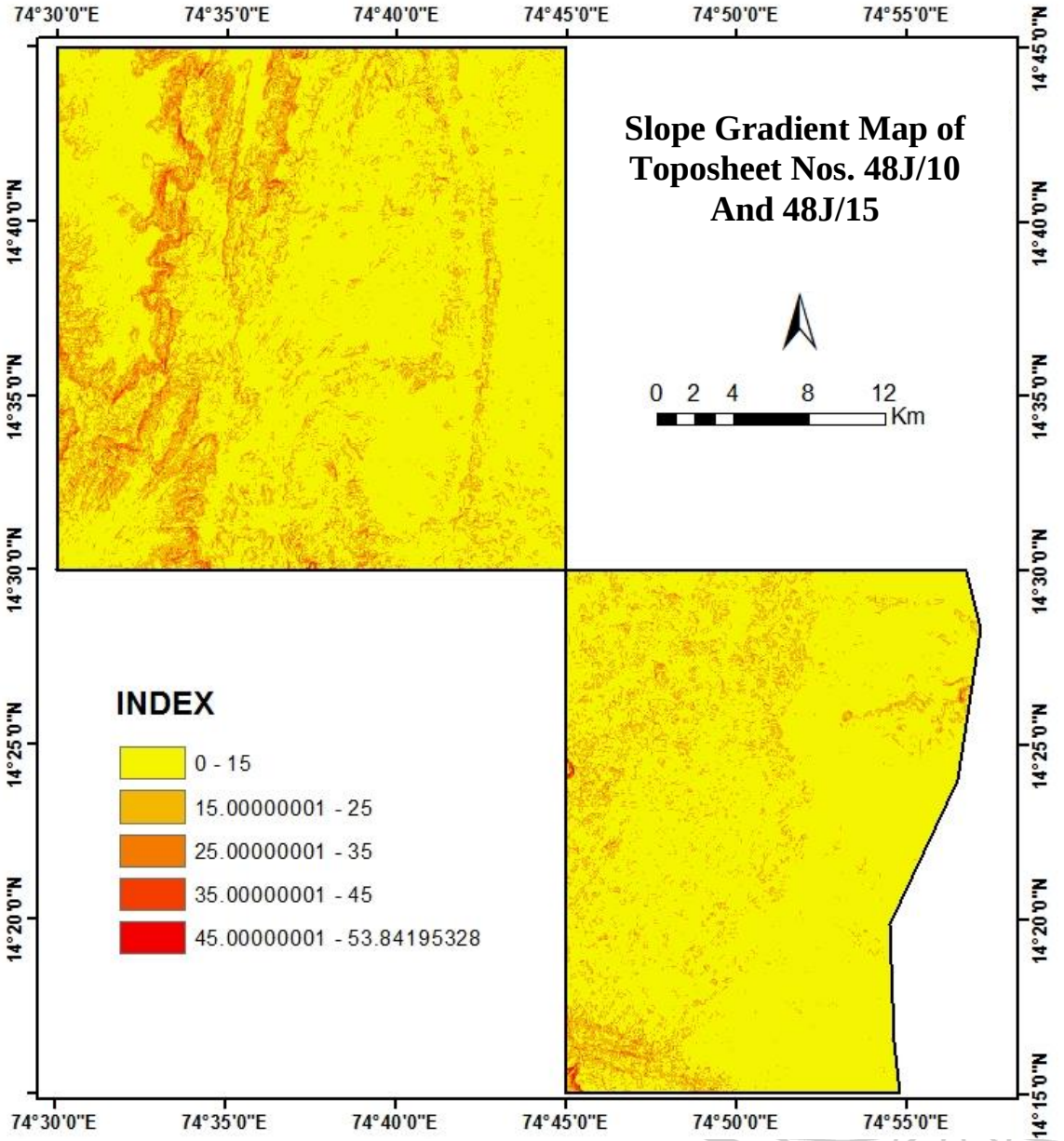

Aspect Map of Toposheet Nos. 48J/10 and 48J/15
N
0 2 4 8 12
Km
INDEX
NNE
NE
ENE
ESE
SE
SSE
SSW
SW
WSW
WNW
NW
NNW
74°30'0"E
74°35'0"E
74°40'0"E
74°45'0"E
74°50'0"E
74°55'0"E
14°45'0"N
14°40'0"N
14°35'0"N
14°30'0"N
14°25'0"N
14°20'0"N
14°15'0"N
Aspect Map of Toposheet No. 48O/15
N
0 2 4 8 12
Km
INDEX
NNE
NE
ENE
ESE
SE
SSE
SSW
SW
WSW
WNW
NW
NNW
75°45'0"E
75°50'0"E
75°55'0"E
30'0"N
25'0"N
20'0"N
13°30'0"N
13°25'0"N
13°20'0"N

PLATE 3


CurvatureToposheet
Nos. 48J/10
and 48J/15
N
0 2 4 8 12
Km
INDEX
Concave
Flat
Convex
74°30'0"E
74°35'0"E
74°40'0"E
74°45'0"E
74°50'0"E
74°55'0"E
14°40'0"N
14°35'0"N
14°30'0"N
14°25'0"N
14°20'0"N
14°15'0"N

Curvature Map of Toposheet No. 48O/15
N
INDEX
Concave
Flat
Convex
0 2 4 8 12
Km
75°45'0"E
75°50'0"E
75°55'0"E
30'0"N
25'0"N
20'0"N
13°30'0"N
13°25'0"N
13°20'0"N

PLATE 4


Slope Gradient Map of Toposheet Nos. 48J/10 And 48J/15
74°30'0"E
74°35'0"E
74°40'0"E
74°45'0"E
74°50'0"E
74°55'0"E
14°45'0"N
14°40'0"N
14°35'0"N
14°30'0"N
14°25'0"N
14°20'0"N
14°15'0"N
0 2 4 8 12
Km
INDEX
0 - 15
15.00000001 - 25
25.00000001 - 35
35.00000001 - 45
45.00000001 - 53.84195328

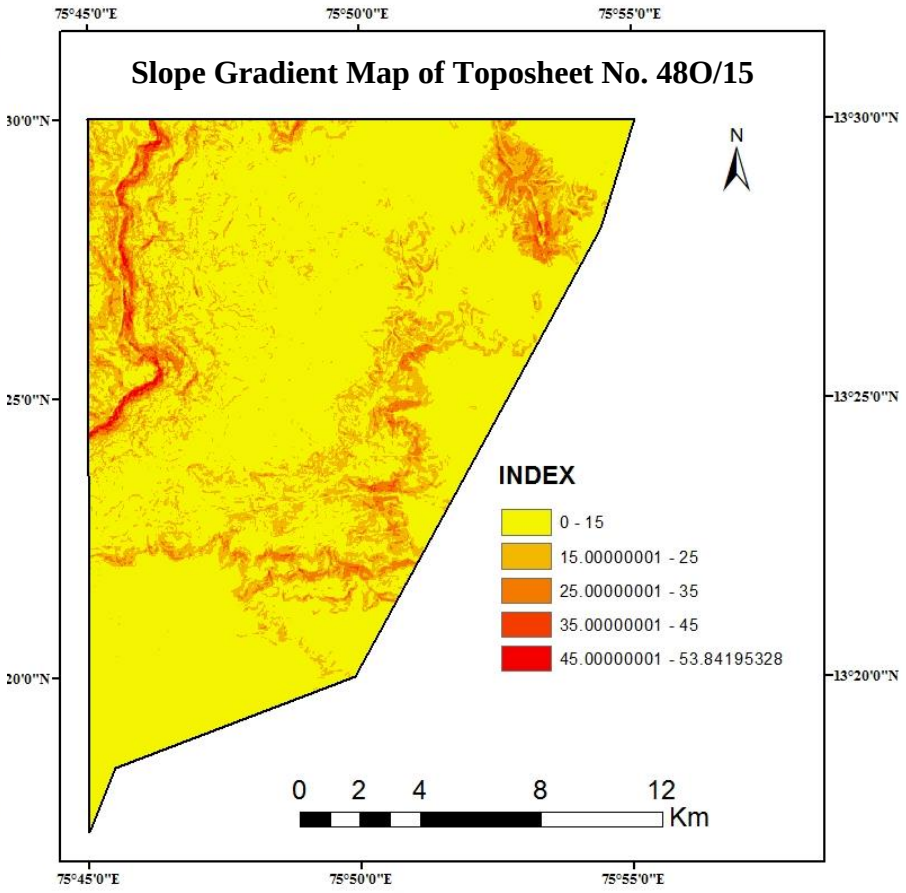
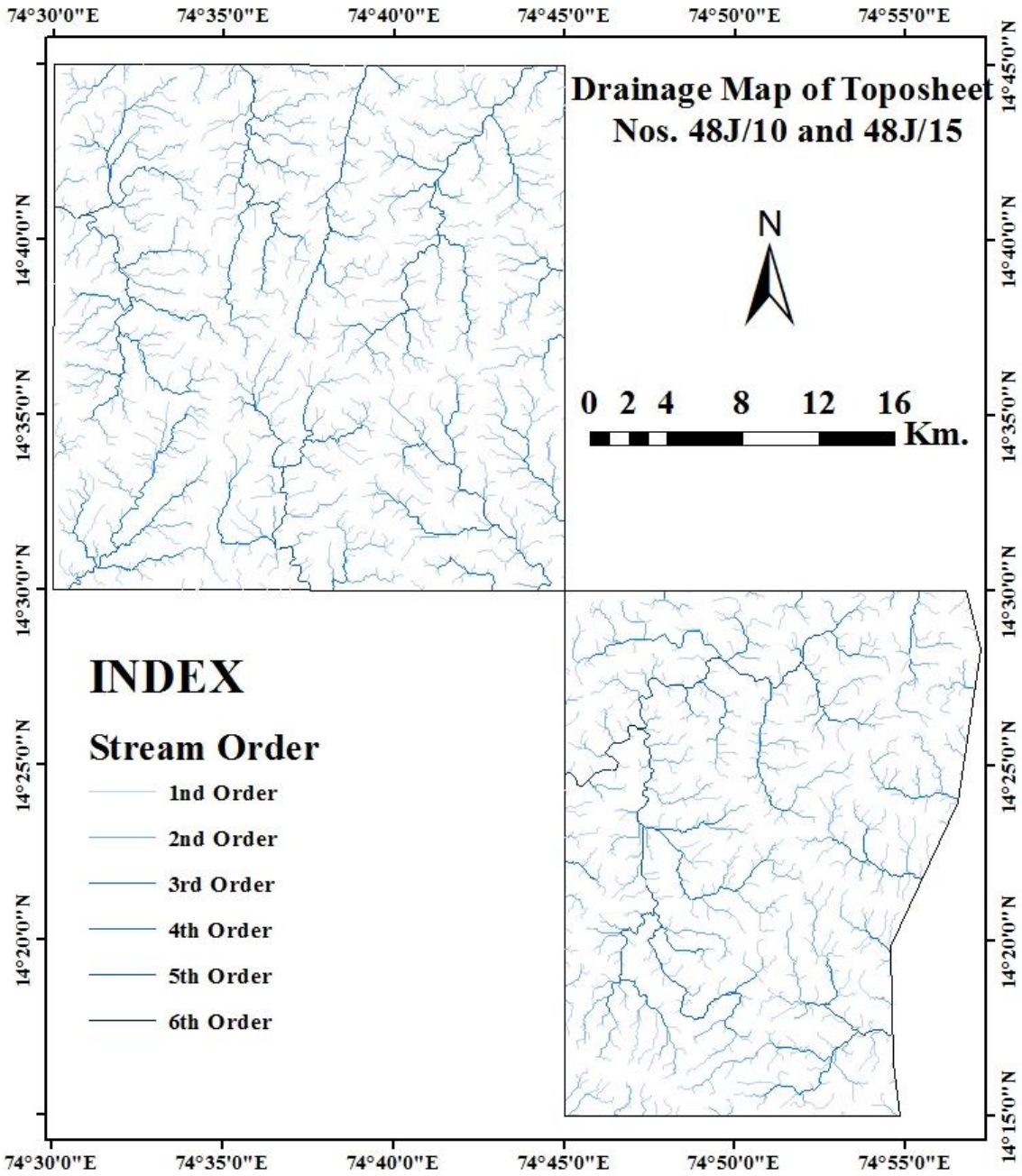
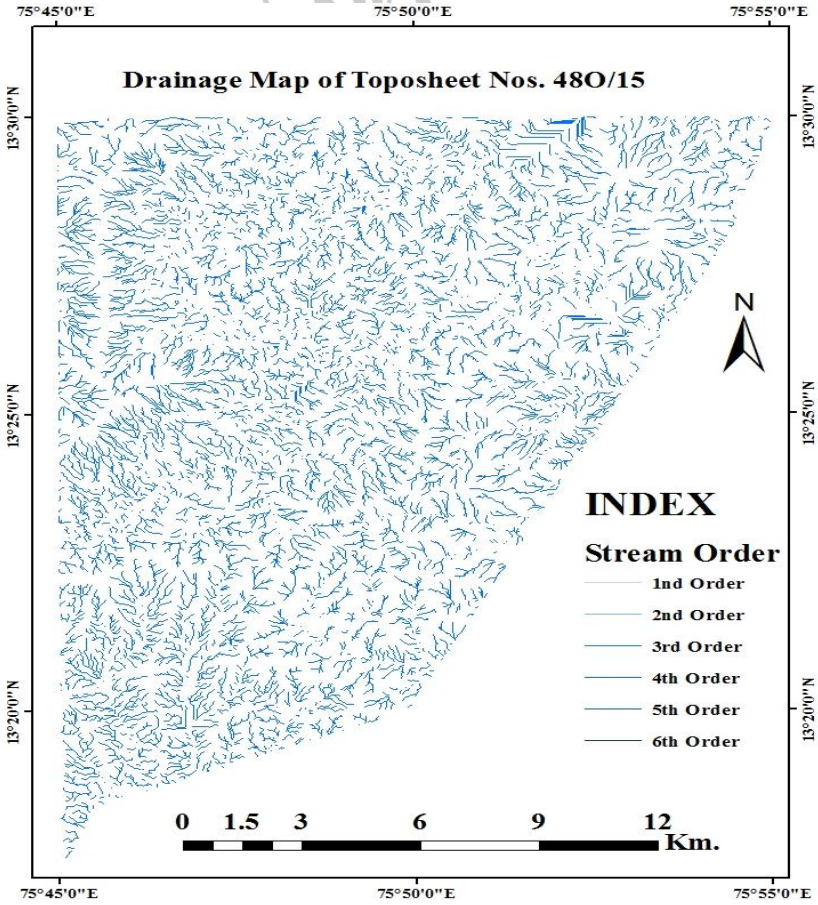

Slope Gradient Map of Toposheet No. 48O/15
75°45'0"E
75°50'0"E
75°55'0"E
30'0"N
25'0"N
20'0"N
13°30'0"N
13°25'0"N
13°20'0"N
N
INDEX
0 - 15
15.00000001 - 25
25.00000001 - 35
35.00000001 - 45
45.00000001 - 53.84195328
0 2 4 8 12
Km

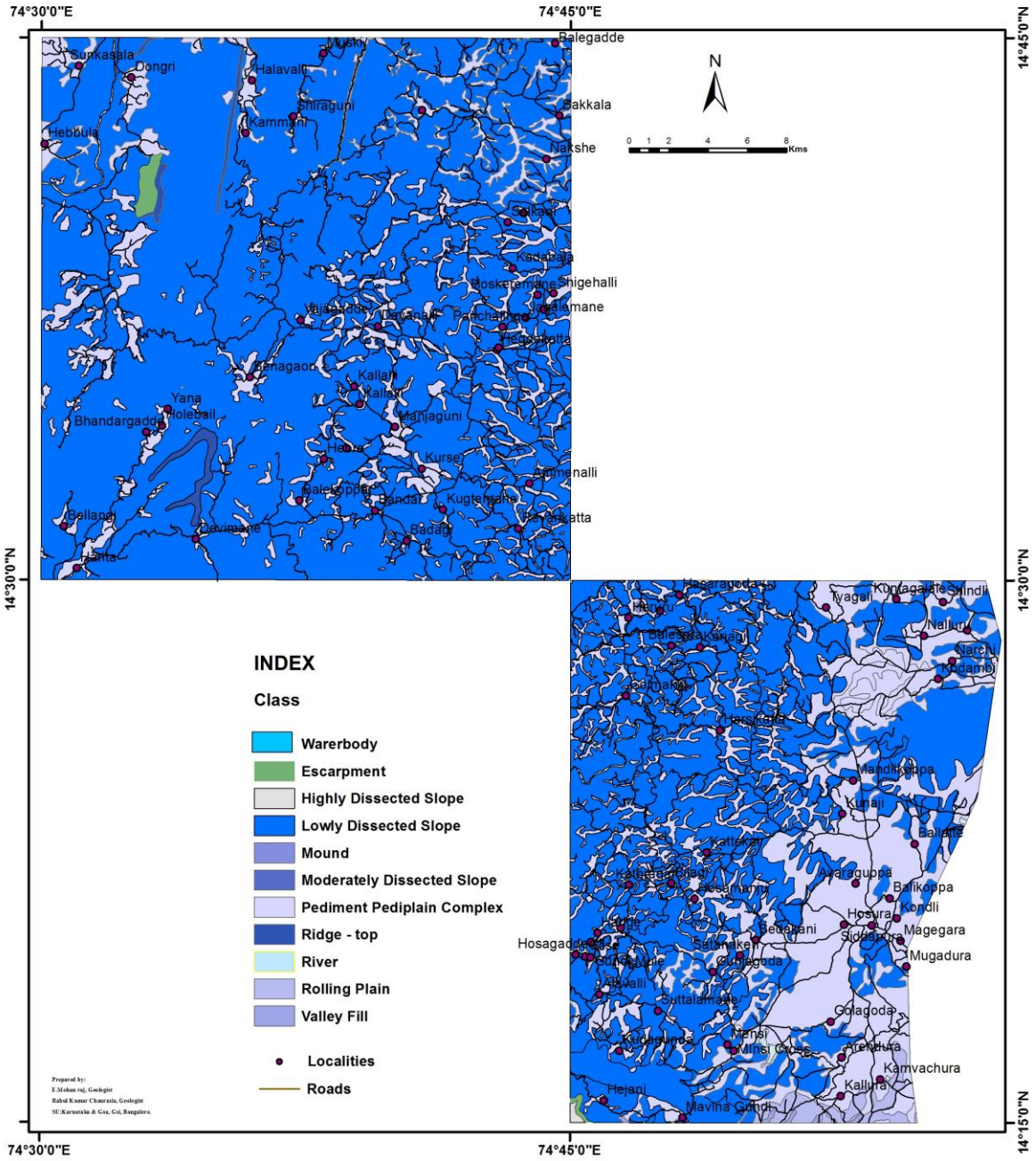
PLATE 5


Drainage Map of Toposheet Nos. 48J/10 and 48J/15
74°30'0"E
74°35'0"E
74°40'0"E
74°45'0"E
74°50'0"E
74°55'0"E
14°45'0"N
14°40'0"N
14°35'0"N
14°30'0"N
14°25'0"N
14°20'0"N
14°15'0"N
N
0 2 4 8 12 16
Km.
INDEX
Stream Order
1nd Order
2nd Order
3rd Order
4th Order
5th Order
6th Order

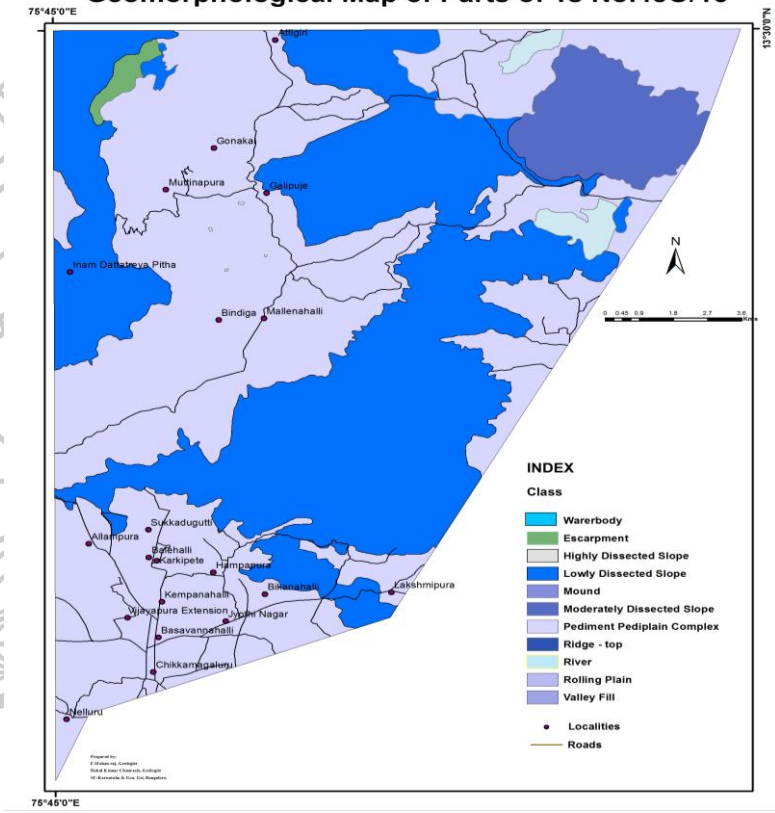

Drainage Map of Toposheet Nos. 48O/15
75°45'0"E
75°50'0"E
75°55'0"E
13°30'0"N
13°25'0"N
13°20'0"N
N
INDEX
Stream Order
1nd Order
2nd Order
3rd Order
4th Order
5th Order
6th Order
0 1.5 3 6 9 12
Km.

Geomorphological Map of Parts of Ts No.48J/10 & J/15

PLATE 6



Geomorphological Map of Parts of Ts No.48O/15



Landuse/Landcover Map of Parts of Ts No.48J/10 & J/15

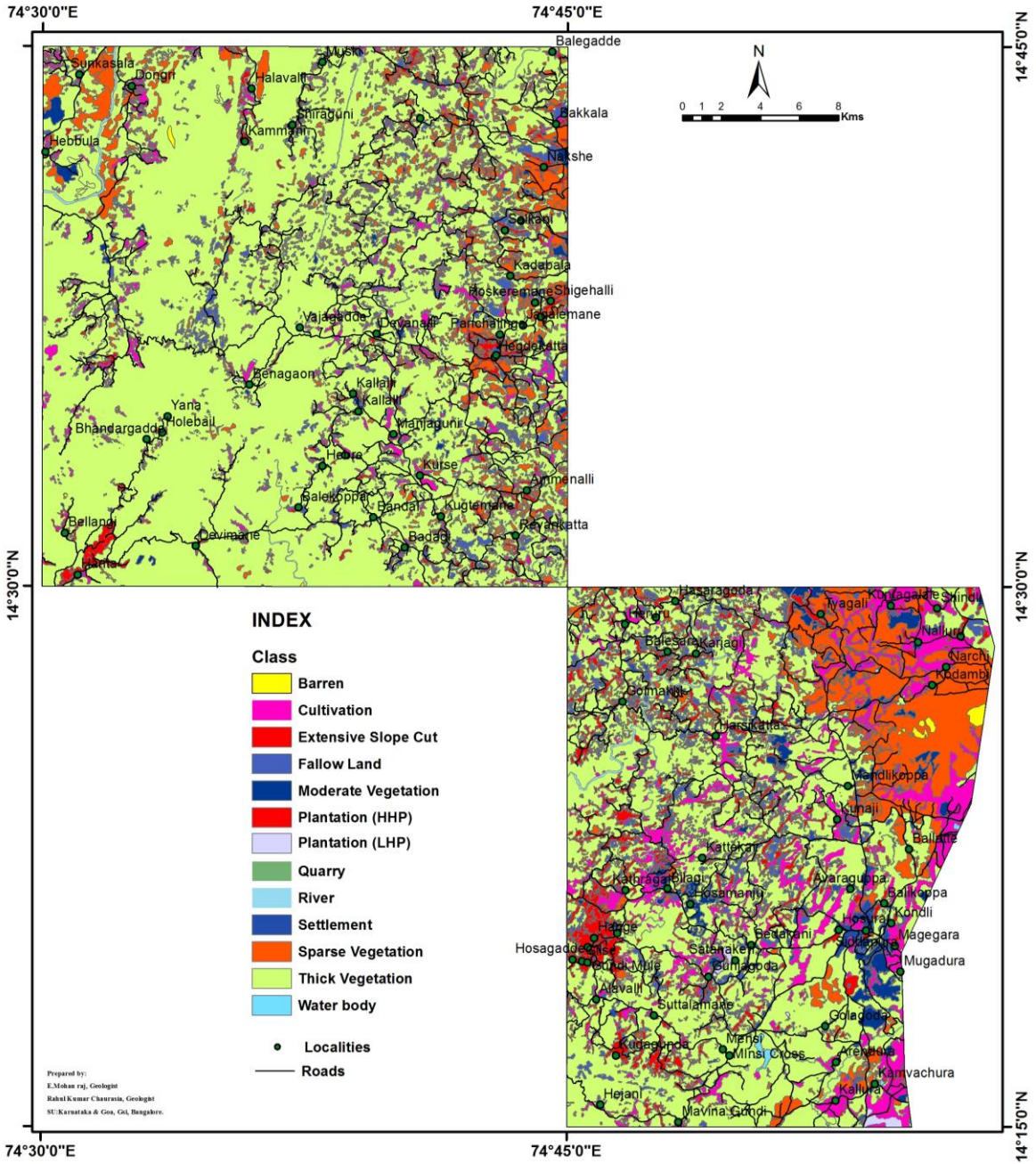
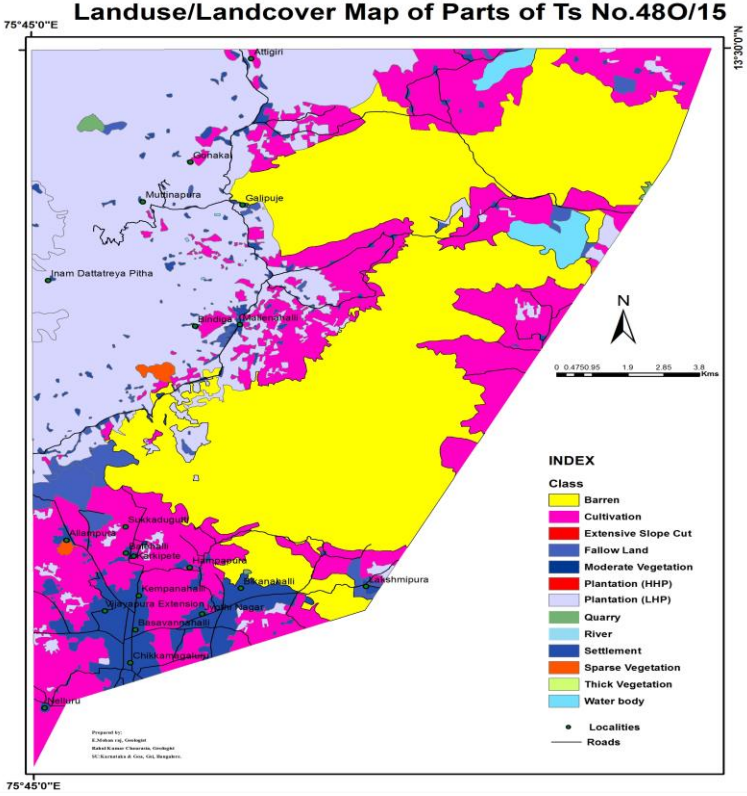


PLATE 7

Landuse/Landcover Map of Parts of Ts No.48O/15



Slope Forming Material Map of Parts of Ts No.48J/10 and J/15

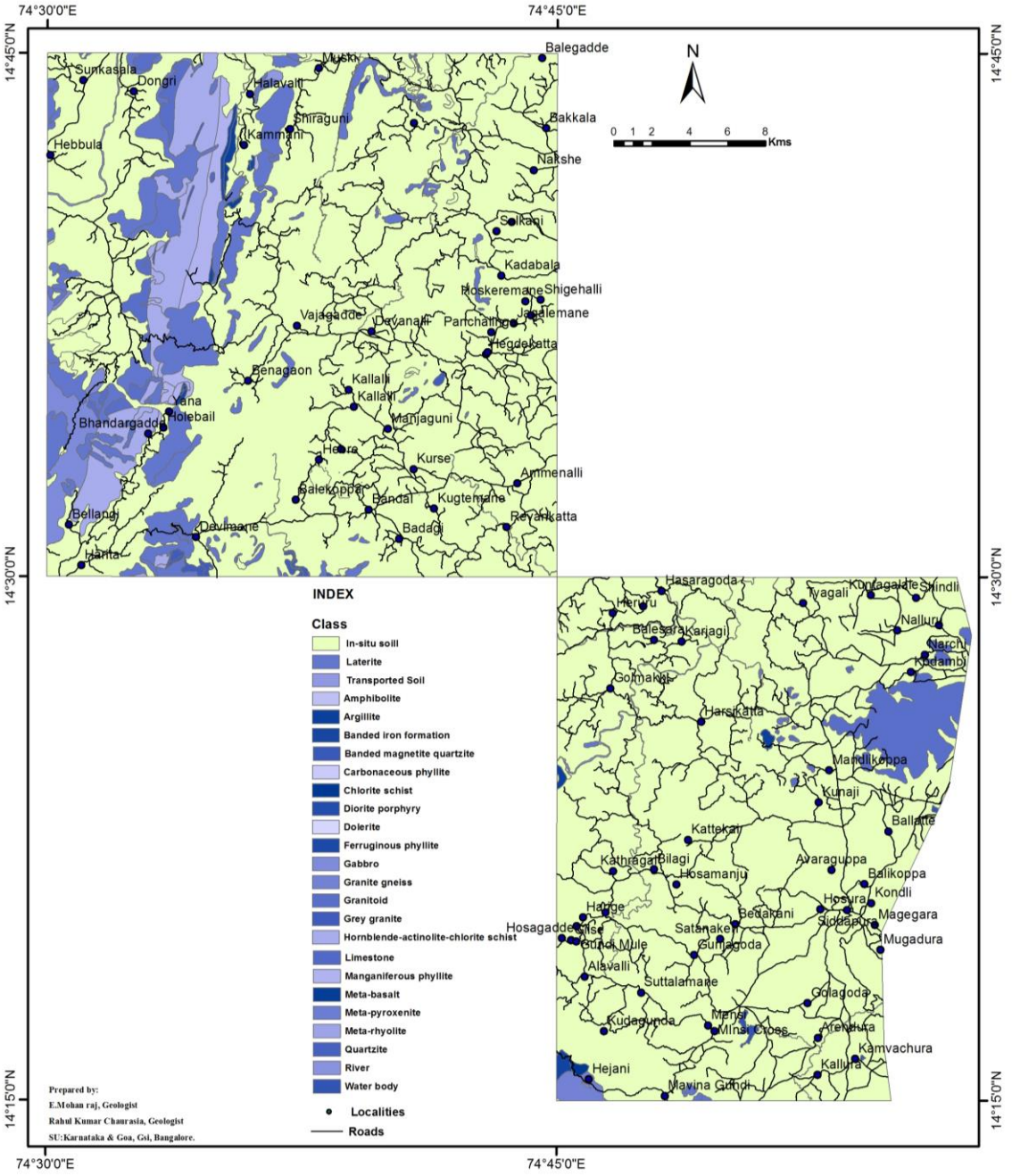
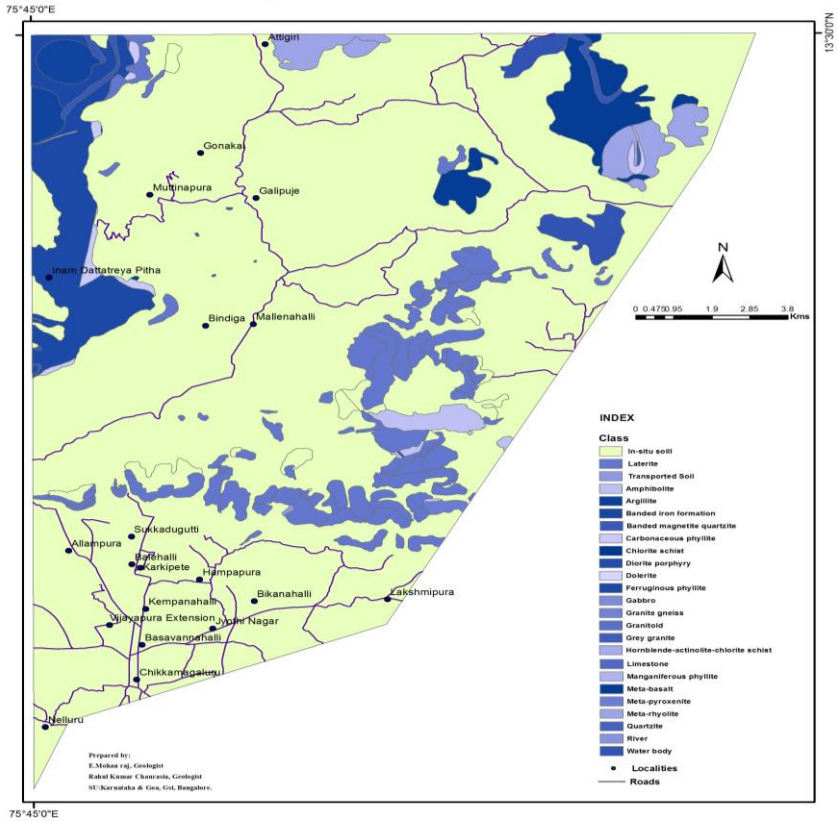


PLATE 8

Slope Forming Material Map of Parts of TsNo.48O/15



Regolith Thickness Map of Parts of Ts No. 48J/10 & J/15

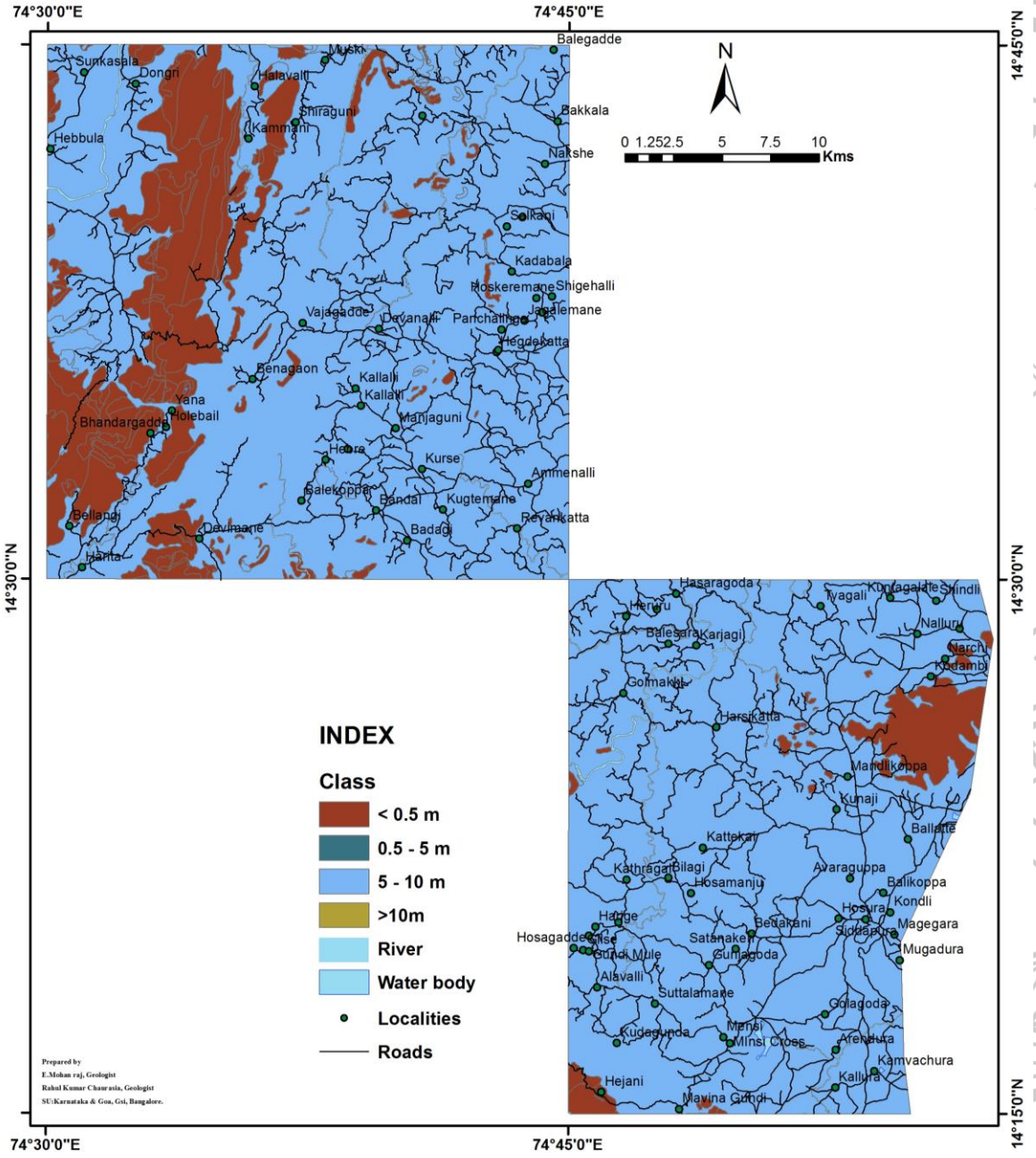
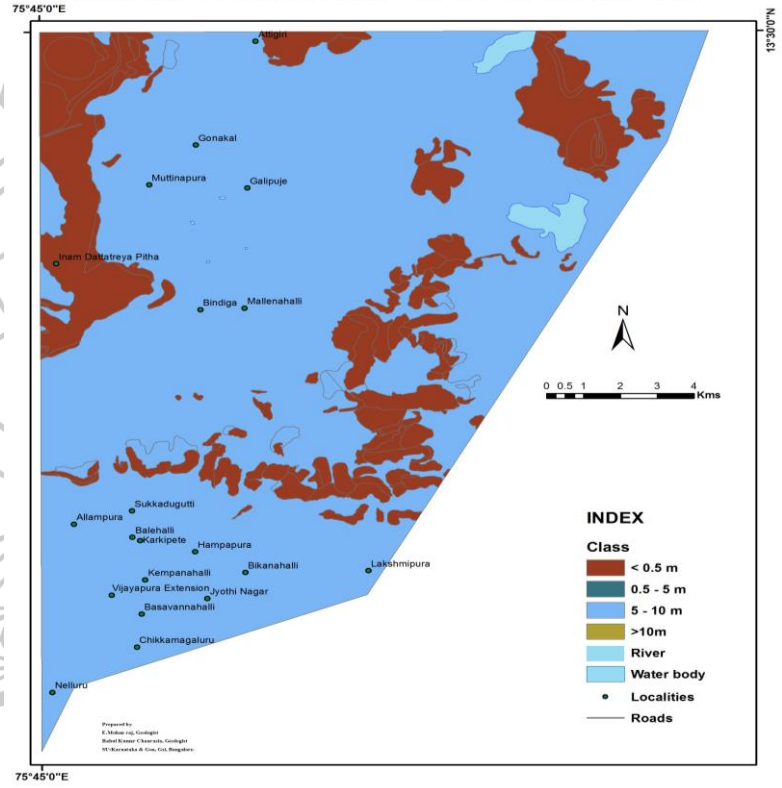


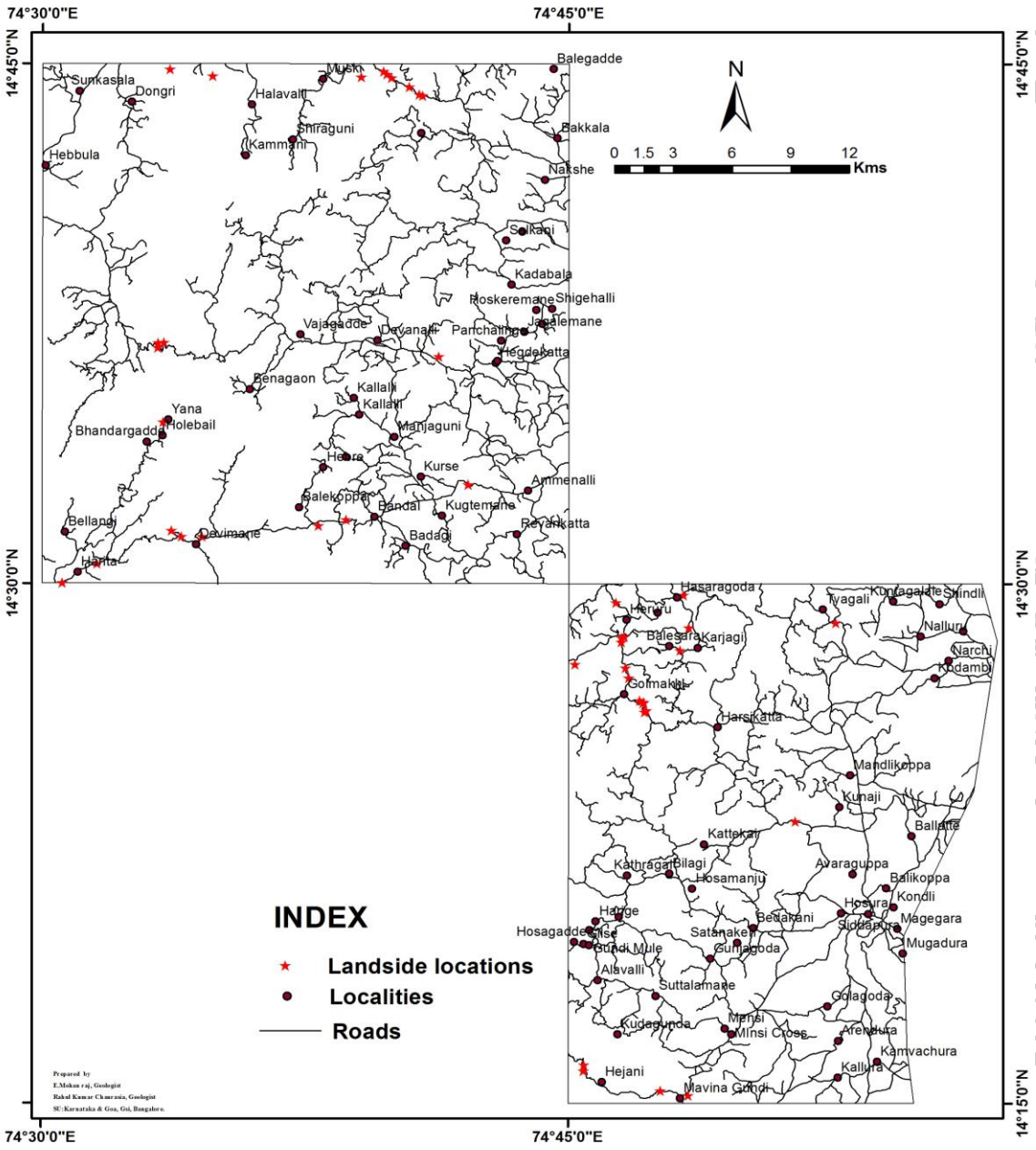
PLATE 9

Regolith Thickness Map of Parts of Ts No.48O/15



Landslide Inventory Map of Parts of Ts No.48J/10 & J/15

PLATE 10



Landslide Inventory Map of Parts of Ts No.48O/15

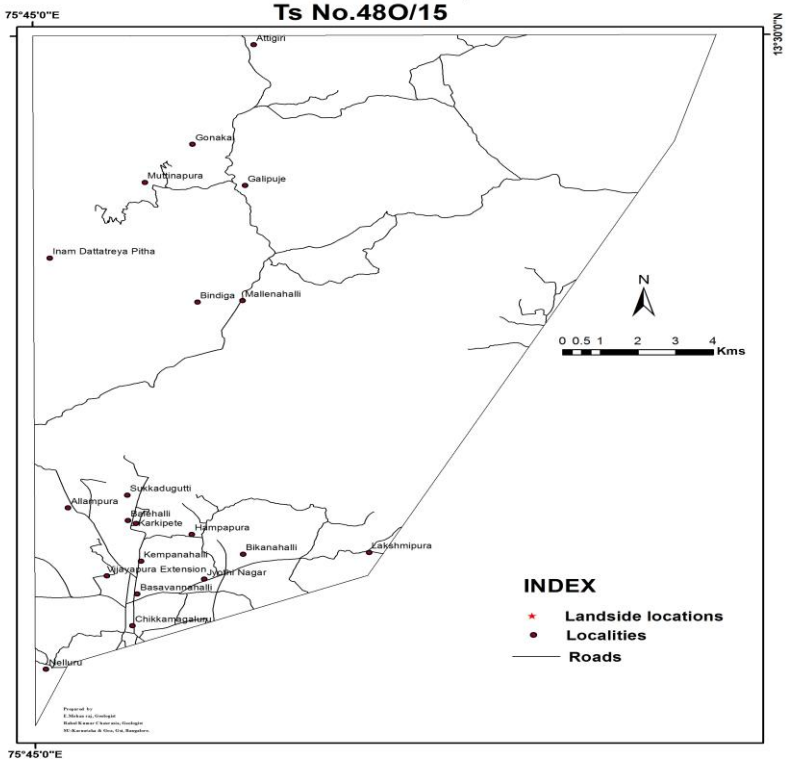
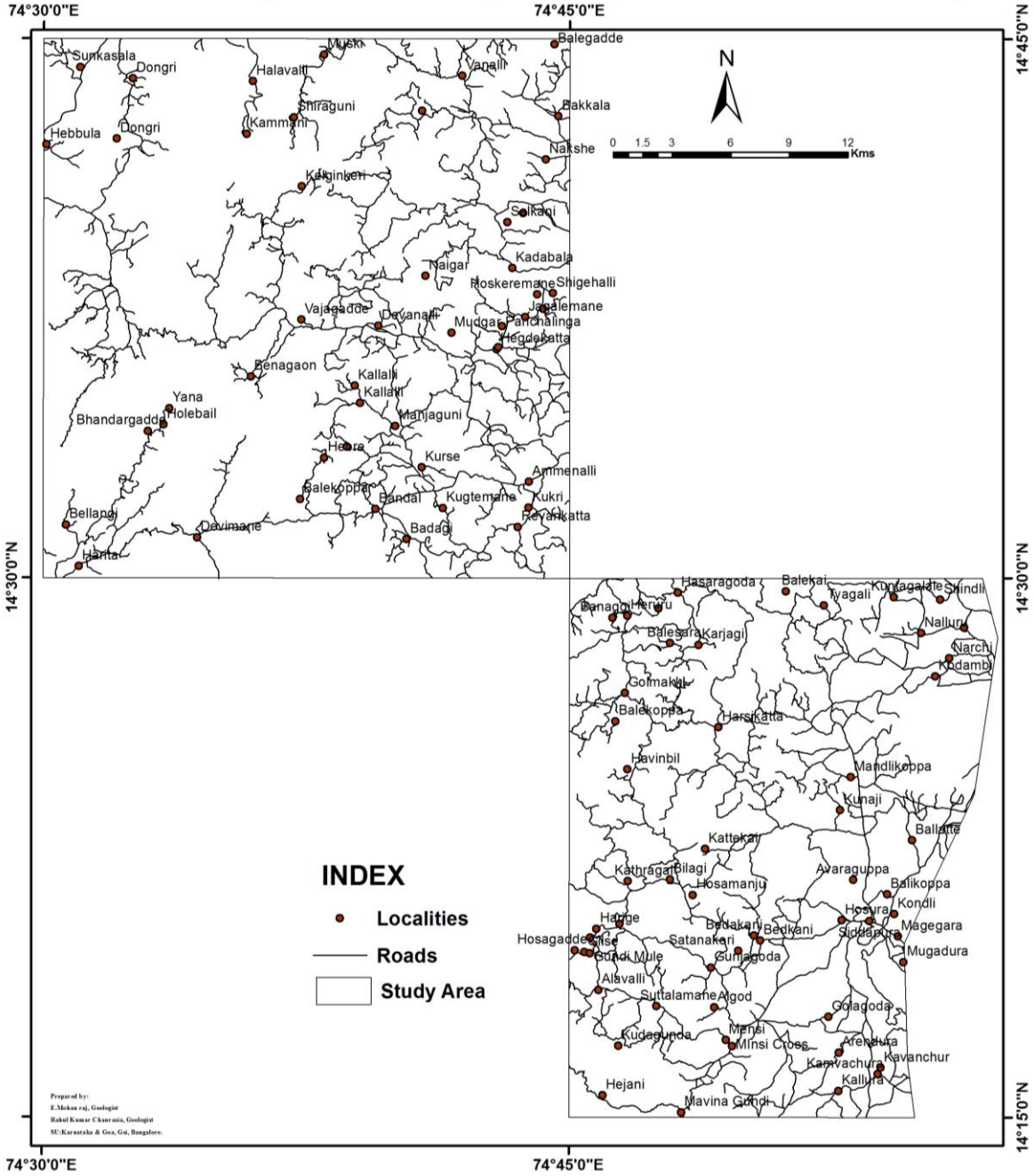


PLATE 11

Location Map of the Study Area (Ts No.48J/10 & J/15)



Location Map of the Study Area (TS No.48 O/15)

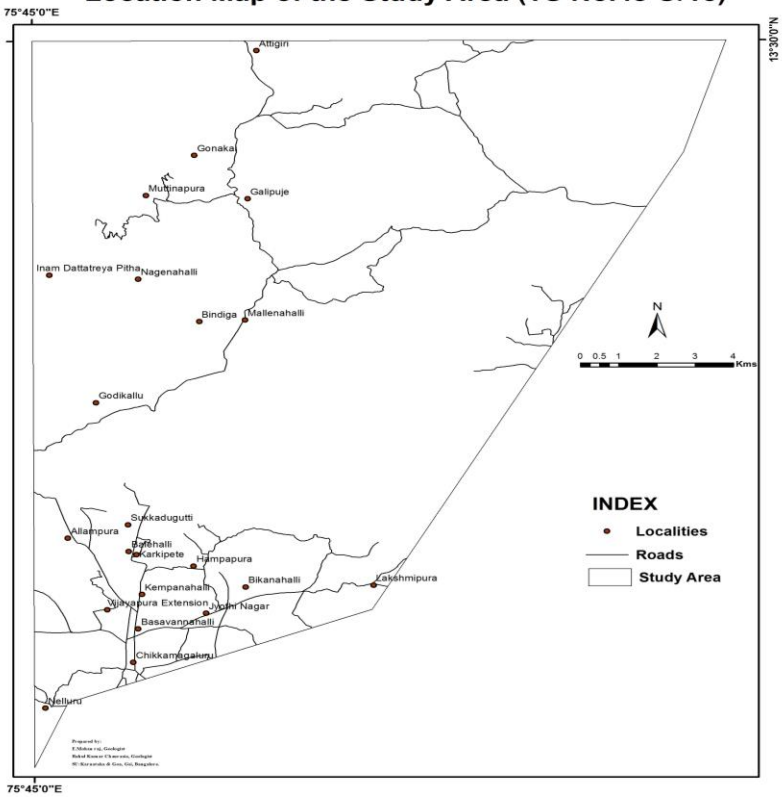
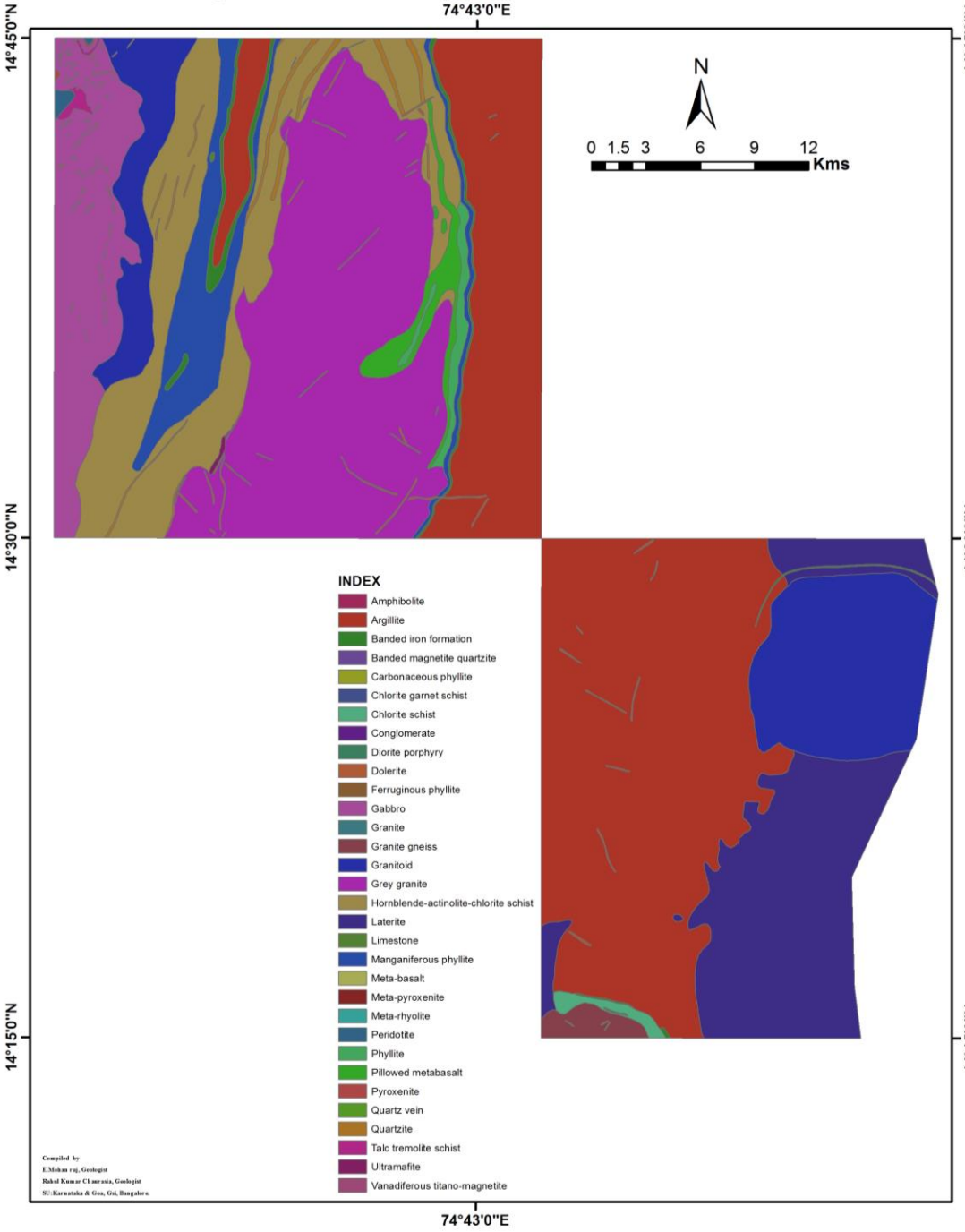


PLATE 12

Geological Map of Parts of TS No.48J/10 & J/15



Geological Map of Parts of TS No.48O/15

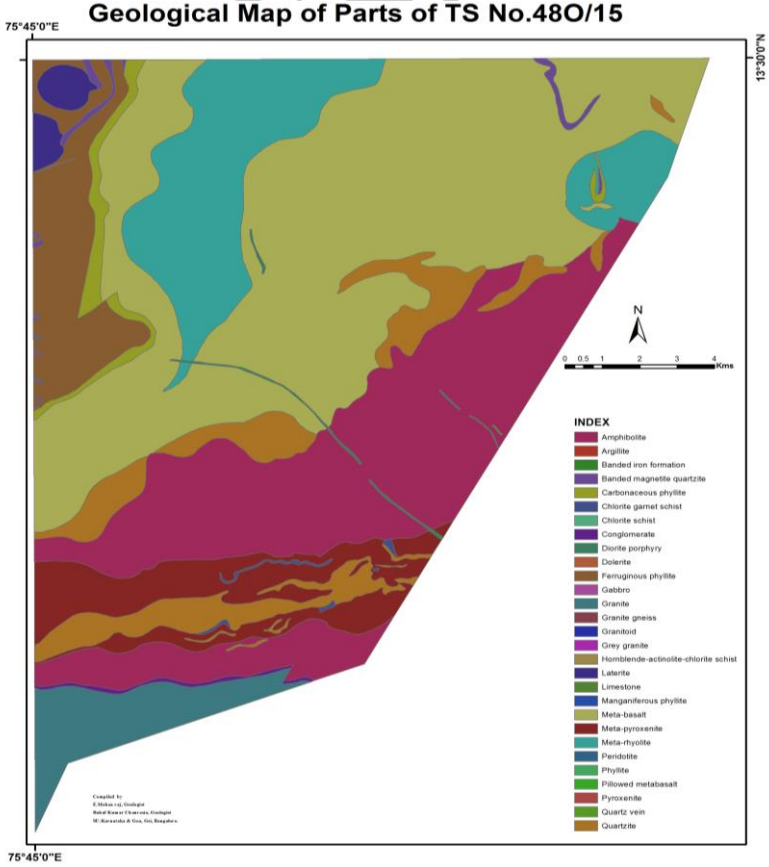
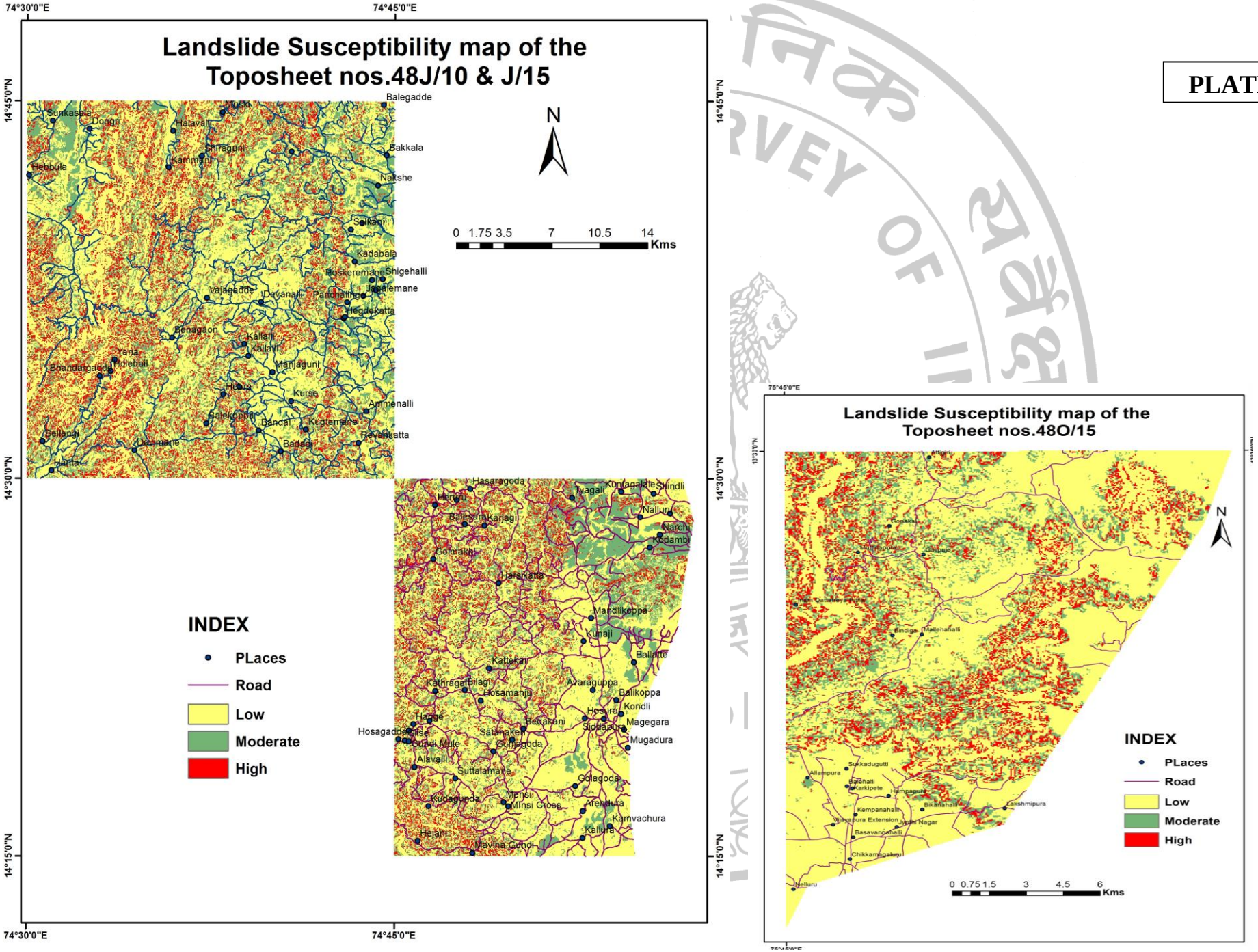


PLATE 13


Landslide Susceptibility map of the Toposheet nos.48J/10 & J/15
74°30'0"E
74°45'0"E
14°45'0"N
14°30'0"N
14°15'0"N
N
0 1.75 3.5 7 10.5 14
Kms
INDEX
PLaces
Road
Low
Moderate
High
Landslide Susceptibility map of the Toposheet nos.48O/15
75°45'0"E
13°30'0"N
0 0.75 1.5 3 4.5 6
Kms

PHOTOGRAPHS

Photo 1: Barren land in and around Chandragutti area.

Photo 2: Cultivated land near Marur area.

Photo 3: High height plantation (HHP) near Hospet.

Photo 4: Thick vegetation (TV) near Ammenhalli.

Photo 5: Sparse vegetation (SV) near Siddapur.

Photo 6: Moderate vegetation (MV) near Chandragutti.

Photo 7: In-situ soil near Devimane.

Photo 8: Old landslide scar along Sirsi-Siddapur road section.

Photo 9: Road cut failure along Herur-Golmakki road section.

Photo 10: Extensive slope cut along Ammenhalli-Marur road section.

Photo 11: Lowly Dissected Slope (LDS) west of Kansur.

Photo 12: Landslide along the road section near Herur.

Photo 13: Over burden thickness along the road section near Golmakki.

Photo 14: In-situ over burden near Golmakki.

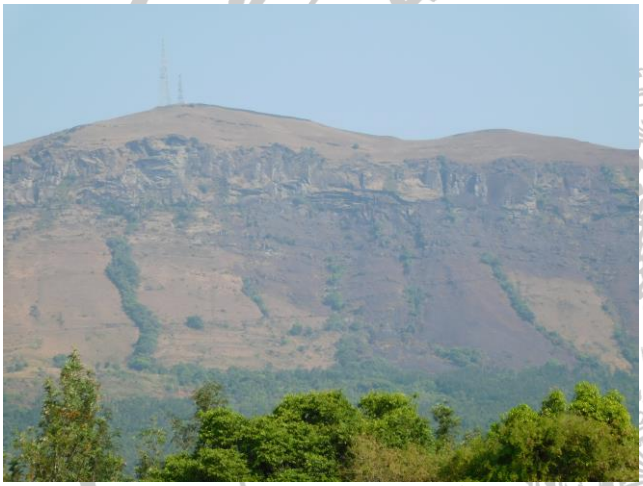


Photo 15: Escarpment near Hospet in PGC.

Photo 16: Road cut failure near Kursi.

Photo 17: Extensive cut failure near Kansur.

Photo 18: PGC litho-unit in Ammenhalli.

Annexure – I: LOFS Calculations
Geofactor: Land Use Land Cover (LULC)
Rank of LULC Classes

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

Geofactor: Land Use Land Cover (LULC)
Matrix of Pairwise Ratings of LULC Class

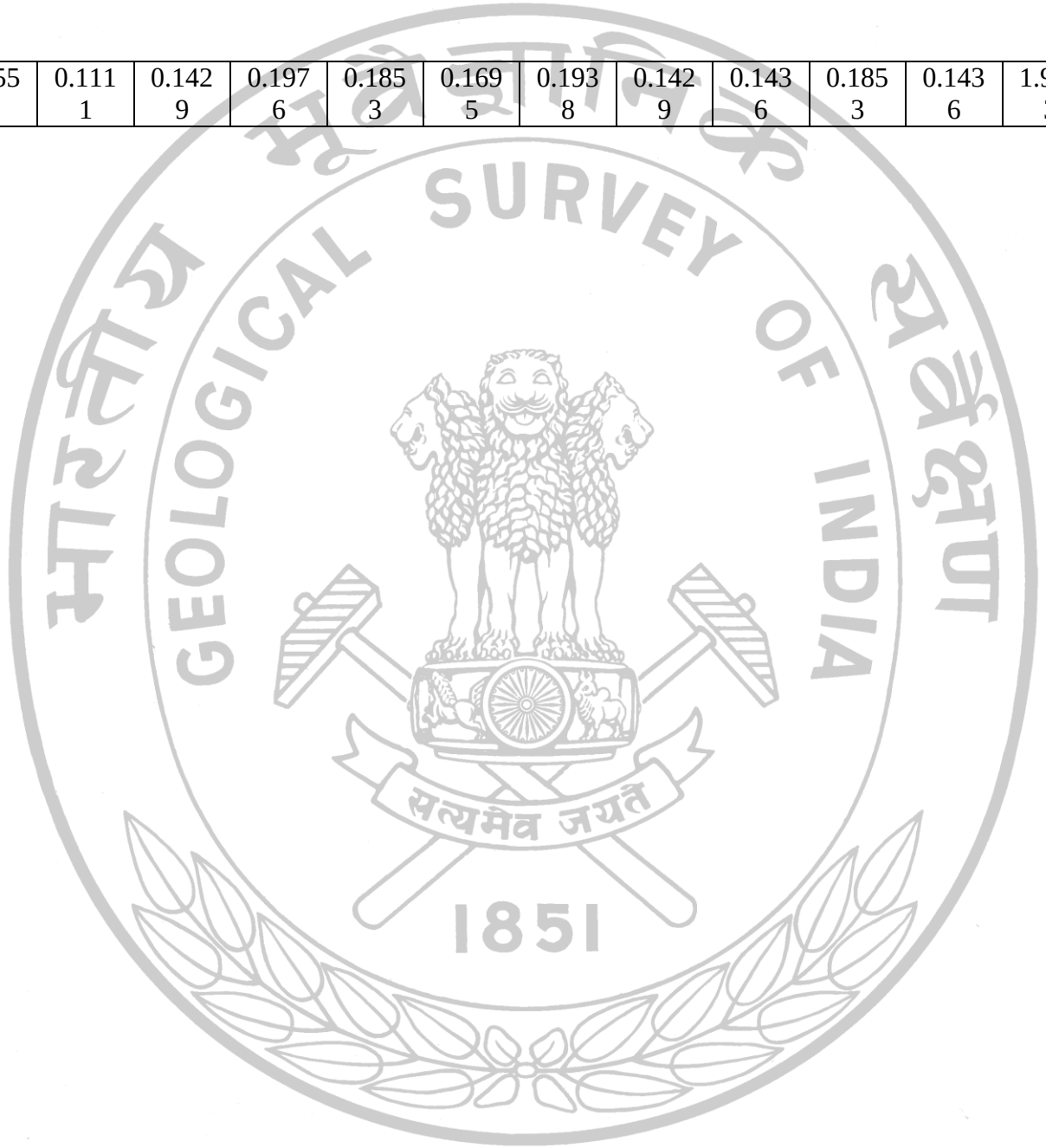
LULC	B	CL	ESC	FL	MV	HHP	LHP	QR	S	SM	TV	SV
B	1.00	0.50	0.11	1.00	0.20	0.25	0.33	0.20	1.00	0.14	0.25	0.14
CL	2.00	1.00	0.13	2.00	0.25	0.33	0.50	0.25	2.00	0.17	0.33	0.17
ESC	9.00	8.00	1.00	9.00	5.00	6.00	7.00	5.00	9.00	3.00	6.00	3.00
FL	1.00	0.50	0.11	1.00	0.20	0.25	0.33	0.20	1.00	0.14	0.25	0.14
MV	5.00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

Geofactor: Land Use Land Cover (LULC)

Estimated Eigen values, fraction rate and LOFS for LULC classes

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

SV	0.1429	0.1558	0.1111	0.1429	0.1976	0.1853	0.1695	0.1938	0.1429	0.1436	0.1853	0.1436	1.9143	0.1595	0.5631



Geofactor: Land Use Land Cover (LULC)

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

LULC	B	CL	ESC	FL	MV	HHP	LHP	QR	S	SM	TV	SV	Sum Rows	CV
B	0.0177	0.0133	0.0315	0.0177	0.0165	0.0141	0.0129	0.0165	0.0194	0.0228	0.0141	0.0228	0.2192	12.3591
CL	0.0355	0.0265	0.0354	0.0355	0.0206	0.0188	0.0193	0.0206	0.0387	0.0266	0.0188	0.0266	0.3229	12.1696
ESC	0.1596	0.2123	0.2833	0.1596	0.4125	0.3379	0.2709	0.4125	0.1742	0.4786	0.3379	0.4786	3.7177	13.1239
FL	0.0177	0.0133	0.0315	0.0177	0.0165	0.0141	0.0129	0.0165	0.0194	0.0228	0.0141	0.0228	0.2192	12.3591
MV	0.0887	0.1061	0.0567	0.0887	0.0825	0.1126	0.1161	0.0825	0.0968	0.0532	0.1126	0.0532	1.0496	12.7240
HHP	0.0709	0.0796	0.0472	0.0709	0.0412	0.0563	0.0774	0.0412	0.0774	0.0399	0.0563	0.0399	0.6984	12.4001
LHP	0.0532	0.0531	0.0405	0.0532	0.0275	0.0282	0.0387	0.0275	0.0581	0.0319	0.0282	0.0319	0.4718	12.1921
QR	0.0887	0.1061	0.0567	0.0887	0.0825	0.1126	0.1161	0.0825	0.0968	0.0532	0.1126	0.0532	1.0496	12.7240
S	0.0177	0.0133	0.0315	0.0177	0.0165	0.0141	0.0129	0.0412	0.0194	0.0228	0.0141	0.0228	0.2439	12.6068
SM	0.1241	0.1592	0.0944	0.1241	0.2475	0.2253	0.1935	0.2475	0.1355	0.1595	0.2253	0.1595	2.0954	13.1358
TV	0.0709	0.0796	0.0472	0.0709	0.0412	0.0563	0.0774	0.0412	0.0774	0.0399	0.0563	0.0399	0.6984	12.4001
SV	0.1241	0.1592	0.0944	0.1241	0.2475	0.2253	0.1935	0.2475	0.1355	0.1595	0.2253	0.1595	2.0954	13.1358
													Sum CV	151.33
													Mean Consistency Vector (Mean CV) = Total CV/ Nos. Of factor class (151.33/12) =	12.6109
													Consistency Index (CI) = (Mean CV - No. Of criteria/ factor class) / (No. Of factor class - 1) =	0.0555
													Consistency Ratio (CR) = CI/ RI = 0.0555 / 1.49 =	0.0373

Geofactor: Geomorphology
Rank of Geomorphology Classes

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

Geofactor: Geomorphology
Matrix of Pairwise Ratings of Geomorphology Class

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

Estimated Eigen values, fraction rate and LOFS for Geomorphology classes

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

Geofactor: Geomorphology

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

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

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

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

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

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

Estimated Eigen values, fraction rate and LOFS for SFM classes

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

WR	0.2017	0.2209	0.2194	0.1290	0.1667	0.1818	0.2209	0.2017	0.1657	1.7077	0.1897	0.5437

Geofactor: Slope Forming Material (SFM)

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

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

Geofactor: Regolith Thickness
Rank of Regolith Thickness Classes

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

Matrix of Pairwise Ratings of Regolith Thickness Class

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

Geofactor: Regolith Thickness

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

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

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

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

Geofactor: Slope Angle
Rank of Slope Angle Classes

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

Matrix of Pairwise Ratings of Slope Angle Class

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

Geofactor: Slope Angle

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

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

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

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

Geofactor: Slope Curvature

Rank of Slope Curvature Classes

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

Matrix of Pairwise Ratings of Slope Curvature Class

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

Geofactor: Slope Curvature

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

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

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

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

Geofactor Maps
Weightage of Geofactor Maps

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

Matrix of Pairwise Ratings of Factor Map

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

Factor Map

Estimated Eigen values, fraction rate and Weight for Factor Map

Factor Class	SLP	CUR	SFM	LULC	GEOM	RT	Sum Rows	Frac Weight	Weight

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

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

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

Annexure – II: 41 Point Geo-Parametric Data Format for Landslides

1.	Name	KAR/UK/28J10/2018-19/L1
2.	Latitude (N) (DMS)	14°32′50.80″
3.	Longitude (E) (DMS)	74°42′09.02″
4.	Toposheet No.	48J10
5.	Village Name	Chakdi
6.	Road	
7.	Geomorphic Process	Gravitational
8.	Geomorphic Form	Moderately Dissected Slope
9.	Rock	Laterite
10.	Weathering	Moderate
11.	Rock Character	Massive
12.	Dip Foliation	Not available
13.	Dip Direction Foliation	Not available
14.	Dip J1	Not available
15.	Dip Direction J1	Not available
16.	Overburden Type	Soil
17.	Thickness	.5 m
18.	Landuse	Extensive Slope Cut
19.	Hydrology	Damp
20.	Erosion	Toe Erosion
21.	Susceptibility	High
22.	Risk	Moderate
23.	Landslide Length	10 m
24.	Landslide Width	80 m
25.	Landslide Height	06 m
26.	Landslide Run Out	03 m
27.	Landslide Material	Soil
28.	Movement Type	Subsidence
29.	Failure Depth	Shallow (< = 5m)
30.	Landslide Activity	Suspended
31.	Landslide Distribution	Widening and Enlarging
32.	Landslide Style	Successive
33.	Landslide Mechanism	Shallow Translational Failure
34.	Landslide Initiation	Not available
35.	Upslope	20°
36.	Downslope	60°
37.	Triggering Factor	Rain
38.	Casualties	Not available
39.	Geo Scientific Cause	Road widening
40.	Remedial Measures	Soil nailing and proper drainage
41.	Remarks	

1.	Name	KAR/UK/28J10/2018-19/L2
2.	Latitude (N) (DMS)	14°32′50.80″
3.	Longitude (E) (DMS)	74°42′09″
4.	Toposheet No.	48J10
5.	Village Name	Chakdi
6.	Road	
7.	Geomorphic Process	Gravitational
8.	Geomorphic Form	Moderately Dissected Slope
9.	Rock	Laterite
10.	Weathering	Moderate
11.	Rock Character	Massive
12.	Dip Foliation	Not available
13.	Dip Direction Foliation	Not available
14.	Dip J1	Not available
15.	Dip Direction J1	Not available
16.	Overburden Type	Soil
17.	Thickness	0.5 m
18.	Landuse	Extensive Slope Cut
19.	Hydrology	Damp
20.	Erosion	Toe Erosion
21.	Susceptibility	High
22.	Risk	Moderate
23.	Landslide Length	08 m
24.	Landslide Width	60 m
25.	Landslide Height	06 m
26.	Landslide Run Out	03 m
27.	Landslide Material	Soil
28.	Movement Type	Subsidence
29.	Failure Depth	Shallow (< = 5m)
30.	Landslide Activity	Suspended
31.	Landslide Distribution	Widening and Enlarging
32.	Landslide Style	Successive
33.	Landslide Mechanism	Shallow Translational Failure
34.	Landslide Initiation	Not available
35.	Upslope	30°
36.	Downslope	60°
37.	Triggering Factor	Rain
38.	Casualties	Not available
39.	Geo Scientific Cause	Road widening
40.	Remedial Measures	Soil nailing and proper drainage
41.	Remarks	

1.	Name	KAR/UK/28J10/2018-19/L3
2.	Latitude (N) (DMS)	14°31′50.19″
3.	Longitude (E) (DMS)	74°38′40.37″
4.	Toposheet No.	48J10
5.	Village Name	Kasage
6.	Road	
7.	Geomorphic Process	Gravitational
8.	Geomorphic Form	Moderately Dissected Slope
9.	Rock	PGC
10.	Weathering	Moderate
11.	Rock Character	Massive
12.	Dip Foliation	Not available
13.	Dip Direction Foliation	Not available
14.	Dip J1	Not available
15.	Dip Direction J1	Not available
16.	Overburden Type	Soil
17.	Thickness	0.5 m
18.	Landuse	Extensive Slope Cut
19.	Hydrology	Damp
20.	Erosion	Toe Erosion
21.	Susceptibility	High
22.	Risk	Moderate
23.	Landslide Length	15 m
24.	Landslide Width	50 m
25.	Landslide Height	10 m
26.	Landslide Run Out	03 m
27.	Landslide Material	Soil
28.	Movement Type	Subsidence
29.	Failure Depth	Shallow (< = 5m)
30.	Landslide Activity	Active
31.	Landslide Distribution	Widening
32.	Landslide Style	Successive
33.	Landslide Mechanism	Shallow Translational Failure
34.	Landslide Initiation	Not available
35.	Upslope	25°
36.	Downslope	50°
37.	Triggering Factor	Rain
38.	Casualties	Not available
39.	Geo Scientific Cause	Road widening
40.	Remedial Measures	Proper drainage
41.	Remarks	

1.	Name	KAR/UK/28J10/2018-19/L4
2.	Latitude (N) (DMS)	14°31′40.01″
3.	Longitude (E) (DMS)	74°37′53″
4.	Toposheet No.	48J10
5.	Village Name	Arge
6.	Road	
7.	Geomorphic Process	Gravitational
8.	Geomorphic Form	Moderately Dissected Slope
9.	Rock	PGC
10.	Weathering	Moderate
11.	Rock Character	Massive
12.	Dip Foliation	Not available
13.	Dip Direction Foliation	Not available
14.	Dip J1	Not available
15.	Dip Direction J1	Not available
16.	Overburden Type	Soil
17.	Thickness	0.5 m
18.	Landuse	Extensive Slope Cut
19.	Hydrology	Damp
20.	Erosion	Toe Erosion
21.	Susceptibility	High
22.	Risk	Moderate
23.	Landslide Length	15 m
24.	Landslide Width	80 m
25.	Landslide Height	10 m
26.	Landslide Run Out	03 m
27.	Landslide Material	Soil
28.	Movement Type	Subsidence
29.	Failure Depth	Shallow (< = 5m)
30.	Landslide Activity	Active
31.	Landslide Distribution	Widening and Enlarging
32.	Landslide Style	Successive
33.	Landslide Mechanism	Shallow Translational Failure
34.	Landslide Initiation	Not available
35.	Upslope	20°
36.	Downslope	40°
37.	Triggering Factor	Rain
38.	Casualties	Not available
39.	Geo Scientific Cause	Road widening
40.	Remedial Measures	Soil nailing and proper drainage
41.	Remarks	

1.	Name	KAR/UK/28J10/2018-19/L5
2.	Latitude (N) (DMS)	14°31′20.97″
3.	Longitude (E) (DMS)	74°34′33.97″
4.	Toposheet No.	48J10
5.	Village Name	Devimane
6.	Road	
7.	Geomorphic Process	Gravitational
8.	Geomorphic Form	Moderately Dissected Slope
9.	Rock	PGC
10.	Weathering	Moderate
11.	Rock Character	Massive
12.	Dip Foliation	Not available
13.	Dip Direction Foliation	Not available
14.	Dip J1	Not available
15.	Dip Direction J1	Not available
16.	Overburden Type	Soil
17.	Thickness	0.5 to 5.0 m
18.	Landuse	Extensive Slope Cut
19.	Hydrology	Damp
20.	Erosion	Toe Erosion
21.	Susceptibility	High
22.	Risk	Moderate
23.	Landslide Length	60 m
24.	Landslide Width	120 m
25.	Landslide Height	15 m
26.	Landslide Run Out	05 m
27.	Landslide Material	Debries
28.	Movement Type	Slide
29.	Failure Depth	Deep Seated (> 5m)
30.	Landslide Activity	Active
31.	Landslide Distribution	Widening and Enlarging
32.	Landslide Style	Multiple
33.	Landslide Mechanism	Deep seated translational
34.	Landslide Initiation	Not available
35.	Upslope	35°
36.	Downslope	60°
37.	Triggering Factor	Rain
38.	Casualties	Not available
39.	Geo Scientific Cause	Road widening
40.	Remedial Measures	Soil nailing and proper drainage
41.	Remarks	

1.	Name	KAR/UK/28J10/2018-19/L6
2.	Latitude (N) (DMS)	14°30′01.20″
3.	Longitude (E) (DMS)	74°30′35.35″
4.	Toposheet No.	48J10
5.	Village Name	South west of Hanta
6.	Road	
7.	Geomorphic Process	Gravitational
8.	Geomorphic Form	Moderately Dissected Slope
9.	Rock	Laterite
10.	Weathering	Moderate
11.	Rock Character	Massive
12.	Dip Foliation	Not available
13.	Dip Direction Foliation	Not available
14.	Dip J1	Not available
15.	Dip Direction J1	Not available
16.	Overburden Type	Soil
17.	Thickness	0.5 m
18.	Landuse	Extensive Slope Cut
19.	Hydrology	Damp
20.	Erosion	Toe Erosion
21.	Susceptibility	High
22.	Risk	Moderate
23.	Landslide Length	35 m
24.	Landslide Width	70 m
25.	Landslide Height	15 m
26.	Landslide Run Out	05 m
27.	Landslide Material	Soil
28.	Movement Type	Subsidence
29.	Failure Depth	Shallow (<= 5m)
30.	Landslide Activity	Inactive
31.	Landslide Distribution	Widening and Enlarging
32.	Landslide Style	Successive
33.	Landslide Mechanism	Shallow Translational Failure
34.	Landslide Initiation	Not available
35.	Upslope	25°
36.	Downslope	50°
37.	Triggering Factor	Rain
38.	Casualties	Not available
39.	Geo Scientific Cause	Road widening
40.	Remedial Measures	Soil nailing and proper drainage
41.	Remarks	

1.	Name	KAR/UK/28J10/2018-19/L7
2.	Latitude (N) (DMS)	14°30´33.86″
3.	Longitude (E) (DMS)	74°31´34.80″
4.	Toposheet No.	48J10
5.	Village Name	Hanta
6.	Road	
7.	Geomorphic Process	Gravitational
8.	Geomorphic Form	Moderately Dissected Slope
9.	Rock	Laterite
10.	Weathering	Moderate
11.	Rock Character	Massive
12.	Dip Foliation	Not available
13.	Dip Direction Foliation	Not available
14.	Dip J1	Not available
15.	Dip Direction J1	Not available
16.	Overburden Type	Soil
17.	Thickness	0.5 m
18.	Landuse	Extensive Slope Cut
19.	Hydrology	Damp
20.	Erosion	Toe Erosion
21.	Susceptibility	High
22.	Risk	Moderate
23.	Landslide Length	10 m
24.	Landslide Width	80 m
25.	Landslide Height	05 m
26.	Landslide Run Out	02 m
27.	Landslide Material	Soil
28.	Movement Type	Lateral Spread
29.	Failure Depth	Shallow (<= 5m)
30.	Landslide Activity	Suspended
31.	Landslide Distribution	Widening and Enlarging
32.	Landslide Style	Multiple
33.	Landslide Mechanism	Shallow Translational Failure
34.	Landslide Initiation	Not available
35.	Upslope	20°
36.	Downslope	30°
37.	Triggering Factor	Rain
38.	Casualties	Not available
39.	Geo Scientific Cause	Road widening
40.	Remedial Measures	Soil nailing and proper drainage
41.	Remarks	

1.	Name	KAR/UK/28J10/2018-19/L8
2.	Latitude (N) (DMS)	14°36′32.88″
3.	Longitude (E) (DMS)	74°41′18.02″
4.	Toposheet No.	48J10
5.	Village Name	Hakkigadde
6.	Road	
7.	Geomorphic Process	Gravitational
8.	Geomorphic Form	Moderately Dissected Slope
9.	Rock	PGC
10.	Weathering	Moderate
11.	Rock Character	Massive
12.	Dip Foliation	Not available
13.	Dip Direction Foliation	Not available
14.	Dip J1	Not available
15.	Dip Direction J1	Not available
16.	Overburden Type	Soil
17.	Thickness	0.5 m
18.	Landuse	Extensive Slope Cut
19.	Hydrology	Damp
20.	Erosion	Toe Erosion
21.	Susceptibility	High
22.	Risk	Moderate
23.	Landslide Length	08 m
24.	Landslide Width	12 m
25.	Landslide Height	06 m
26.	Landslide Run Out	02 m
27.	Landslide Material	Soil
28.	Movement Type	Subsidence
29.	Failure Depth	Shallow (<= 5m)
30.	Landslide Activity	Suspended
31.	Landslide Distribution	Widening
32.	Landslide Style	Single
33.	Landslide Mechanism	Shallow Translational Failure
34.	Landslide Initiation	Not available
35.	Upslope	45°
36.	Downslope	50°
37.	Triggering Factor	Rain
38.	Casualties	Not available
39.	Geo Scientific Cause	Road widening
40.	Remedial Measures	Soil nailing and proper drainage
41.	Remarks	

1.	Name	KAR/UK/28J10/2018-19/L9
2.	Latitude (N) (DMS)	14°31′20.77″
3.	Longitude (E) (DMS)	74°33′58.40″
4.	Toposheet No.	48J10
5.	Village Name	West of Devimane
6.	Road	
7.	Geomorphic Process	Gravitational
8.	Geomorphic Form	Moderately Dissected Slope
9.	Rock	PGC
10.	Weathering	Moderate
11.	Rock Character	Massive
12.	Dip Foliation	Not available
13.	Dip Direction Foliation	Not available
14.	Dip J1	Not available
15.	Dip Direction J1	Not available
16.	Overburden Type	Soil
17.	Thickness	0.5 m
18.	Landuse	Extensive Slope Cut
19.	Hydrology	Damp
20.	Erosion	Toe Erosion
21.	Susceptibility	High
22.	Risk	Moderate
23.	Landslide Length	05 m
24.	Landslide Width	15 m
25.	Landslide Height	13 m
26.	Landslide Run Out	02 m
27.	Landslide Material	Soil
28.	Movement Type	Subsidence
29.	Failure Depth	Shallow (<= 5m)
30.	Landslide Activity	Suspended
31.	Landslide Distribution	Widening and Enlarging
32.	Landslide Style	Multiple
33.	Landslide Mechanism	Shallow Translational Failure
34.	Landslide Initiation	Not available
35.	Upslope	30°
36.	Downslope	40°
37.	Triggering Factor	Rain
38.	Casualties	Not available
39.	Geo Scientific Cause	Road widening
40.	Remedial Measures	Soil nailing and proper drainage
41.	Remarks	

1.	Name	KAR/UK/28J10/2018-19/L10
2.	Latitude (N) (DMS)	14°31′31.26″
3.	Longitude (E) (DMS)	74°33′41.67″
4.	Toposheet No.	48J10
5.	Village Name	West of Devimane
6.	Road	
7.	Geomorphic Process	Gravitational
8.	Geomorphic Form	Moderately Dissected Slope
9.	Rock	PGC
10.	Weathering	Moderate
11.	Rock Character	Massive
12.	Dip Foliation	Not available
13.	Dip Direction Foliation	Not available
14.	Dip J1	Not available
15.	Dip Direction J1	Not available
16.	Overburden Type	Soil
17.	Thickness	0.5 m
18.	Landuse	Extensive Slope Cut
19.	Hydrology	Damp
20.	Erosion	Toe Erosion
21.	Susceptibility	High
22.	Risk	Moderate
23.	Landslide Length	12 m
24.	Landslide Width	52 m
25.	Landslide Height	08 m
26.	Landslide Run Out	03 m
27.	Landslide Material	Soil
28.	Movement Type	Subsidence
29.	Failure Depth	Shallow (<= 5m)
30.	Landslide Activity	Suspended
31.	Landslide Distribution	Widening and Enlarging
32.	Landslide Style	Successive
33.	Landslide Mechanism	Shallow Translational Failure
34.	Landslide Initiation	Not available
35.	Upslope	30°
36.	Downslope	50°
37.	Triggering Factor	Rain
38.	Casualties	Not available
39.	Geo Scientific Cause	Road widening
40.	Remedial Measures	Slope modification with benching.
41.	Remarks	

1.	Name	KAR/UK/28J10/2018-19/L11
2.	Latitude (N) (DMS)	14°34´39.23″
3.	Longitude (E) (DMS)	74°33´27.06″
4.	Toposheet No.	48J10
5.	Village Name	Nagagadde
6.	Road	
7.	Geomorphic Process	Gravitational
8.	Geomorphic Form	Moderately Dissected Slope
9.	Rock	Dolomite
10.	Weathering	Moderate
11.	Rock Character	Massive
12.	Dip Foliation	Not available
13.	Dip Direction Foliation	Not available
14.	Dip J1	Not available
15.	Dip Direction J1	Not available
16.	Overburden Type	Soil
17.	Thickness	0.5 m
18.	Landuse	Extensive Slope Cut
19.	Hydrology	Damp
20.	Erosion	Toe Erosion
21.	Susceptibility	High
22.	Risk	Moderate
23.	Landslide Length	10 m
24.	Landslide Width	95 m
25.	Landslide Height	12 m
26.	Landslide Run Out	08 m
27.	Landslide Material	Soil
28.	Movement Type	Subsidence
29.	Failure Depth	Shallow (<= 5m)
30.	Landslide Activity	Suspended
31.	Landslide Distribution	Widening and Enlarging
32.	Landslide Style	Successive
33.	Landslide Mechanism	Shallow Translational Failure
34.	Landslide Initiation	Not available
35.	Upslope	65°
36.	Downslope	30°
37.	Triggering Factor	Rain
38.	Casualties	Not available
39.	Geo Scientific Cause	Road widening
40.	Remedial Measures	Slope modification with benching.
41.	Remarks	Retaining wall and proper drainage

1.	Name	KAR/UK/28J10/2018-19/L12
2.	Latitude (N) (DMS)	14°36′56.74″
3.	Longitude (E) (DMS)	74°33′28.27″
4.	Toposheet No.	48J10
5.	Village Name	Vaddi
6.	Road	
7.	Geomorphic Process	Gravitational
8.	Geomorphic Form	Moderately Dissected Slope
9.	Rock	Laterite
10.	Weathering	Moderate
11.	Rock Character	Massive
12.	Dip Foliation	Not available
13.	Dip Direction Foliation	Not available
14.	Dip J1	Not available
15.	Dip Direction J1	Not available
16.	Overburden Type	Soil
17.	Thickness	0.5 m
18.	Landuse	Extensive Slope Cut
19.	Hydrology	Damp
20.	Erosion	Toe Erosion
21.	Susceptibility	High
22.	Risk	Moderate
23.	Landslide Length	25 m
24.	Landslide Width	20 m
25.	Landslide Height	20 m
26.	Landslide Run Out	05 m
27.	Landslide Material	Soil
28.	Movement Type	Subsidence
29.	Failure Depth	Shallow (<= 5m)
30.	Landslide Activity	Suspended
31.	Landslide Distribution	Enlarging
32.	Landslide Style	Successive
33.	Landslide Mechanism	Shallow Translational Failure
34.	Landslide Initiation	Not available
35.	Upslope	60°
36.	Downslope	45°
37.	Triggering Factor	Rain
38.	Casualties	Not available
39.	Geo Scientific Cause	Road widening
40.	Remedial Measures	Soil nailing and proper drainage
41.	Remarks	

1.	Name	KAR/UK/28J10/2018-19/L13
2.	Latitude (N) (DMS)	14°36′47.87″
3.	Longitude (E) (DMS)	74°33′17.68″
4.	Toposheet No.	48J10
5.	Village Name	West of Vaddi
6.	Road	
7.	Geomorphic Process	Gravitational
8.	Geomorphic Form	Moderately Dissected Slope
9.	Rock	PGC
10.	Weathering	Moderate
11.	Rock Character	Massive
12.	Dip Foliation	Not available
13.	Dip Direction Foliation	Not available
14.	Dip J1	Not available
15.	Dip Direction J1	Not available
16.	Overburden Type	Soil
17.	Thickness	0.5 m
18.	Landuse	Extensive Slope Cut
19.	Hydrology	Damp
20.	Erosion	Toe Erosion
21.	Susceptibility	High
22.	Risk	Moderate
23.	Landslide Length	20 m
24.	Landslide Width	120 m
25.	Landslide Height	15 m
26.	Landslide Run Out	05 m
27.	Landslide Material	Debries
28.	Movement Type	Subsidence
29.	Failure Depth	Shallow (<= 5m)
30.	Landslide Activity	Suspended
31.	Landslide Distribution	Widening and Enlarging
32.	Landslide Style	Successive
33.	Landslide Mechanism	Shallow Translational Failure
34.	Landslide Initiation	Not available
35.	Upslope	35°
36.	Downslope	60°
37.	Triggering Factor	Rain
38.	Casualties	Not available
39.	Geo Scientific Cause	Road widening
40.	Remedial Measures	Retaining wall and proper drainage
41.	Remarks	

1.	Name	KAR/UK/28J10/2018-19/L14
2.	Latitude (N) (DMS)	14°36′56.41″
3.	Longitude (E) (DMS)	74°33′18.24″
4.	Toposheet No.	48J10
5.	Village Name	West of Vaddi
6.	Road	
7.	Geomorphic Process	Gravitational
8.	Geomorphic Form	Moderately Dissected Slope
9.	Rock	Laterite
10.	Weathering	Moderate
11.	Rock Character	Massive
12.	Dip Foliation	Not available
13.	Dip Direction Foliation	Not available
14.	Dip J1	Not available
15.	Dip Direction J1	Not available
16.	Overburden Type	Soil
17.	Thickness	0.5 to 5.0m
18.	Landuse	Extensive Slope Cut
19.	Hydrology	Damp
20.	Erosion	Toe Erosion
21.	Susceptibility	High
22.	Risk	Moderate
23.	Landslide Length	70 m
24.	Landslide Width	50 m
25.	Landslide Height	40 m
26.	Landslide Run Out	15 m
27.	Landslide Material	Debries
28.	Movement Type	Subsidence
29.	Failure Depth	Deep seated (> 5m)
30.	Landslide Activity	Suspended
31.	Landslide Distribution	Widening and Enlarging
32.	Landslide Style	Successive
33.	Landslide Mechanism	Deep seated Translational Failure
34.	Landslide Initiation	Not available
35.	Upslope	60°
36.	Downslope	40°
37.	Triggering Factor	Rain
38.	Casualties	Not available
39.	Geo Scientific Cause	Road widening
40.	Remedial Measures	Retaining wall
41.	Remarks	

1.	Name	KAR/UK/28J10/2018-19/L15
2.	Latitude (N) (DMS)	14°44′50.20″
3.	Longitude (E) (DMS)	74°33′38″
4.	Toposheet No.	48J10
5.	Village Name	West of Kanmuski
6.	Road	
7.	Geomorphic Process	Gravitational
8.	Geomorphic Form	Moderately Dissected Slope
9.	Rock	Laterite
10.	Weathering	Moderate
11.	Rock Character	Massive
12.	Dip Foliation	Not available
13.	Dip Direction Foliation	Not available
14.	Dip J1	Not available
15.	Dip Direction J1	Not available
16.	Overburden Type	Soil
17.	Thickness	0.5 m
18.	Landuse	Extensive Slope Cut
19.	Hydrology	Damp
20.	Erosion	Toe Erosion
21.	Susceptibility	High
22.	Risk	Moderate
23.	Landslide Length	20 m
24.	Landslide Width	80 m
25.	Landslide Height	08 m
26.	Landslide Run Out	05 m
27.	Landslide Material	Debries
28.	Movement Type	Creep
29.	Failure Depth	Shallow (<= 5m)
30.	Landslide Activity	Suspended
31.	Landslide Distribution	Enlarging
32.	Landslide Style	Successive
33.	Landslide Mechanism	Deep seated Translational Failure
34.	Landslide Initiation	Not available
35.	Upslope	35°
36.	Downslope	45°
37.	Triggering Factor	Rain
38.	Casualties	Not available
39.	Geo Scientific Cause	Road widening
40.	Remedial Measures	Soil nailing and proper drainage
41.	Remarks	

1.	Name	KAR/UK/28J10/2018-19/L16
2.	Latitude (N) (DMS)	14°44′46.82″
3.	Longitude (E) (DMS)	74°39′43.21″
4.	Toposheet No.	48J10
5.	Village Name	West of Kanmuski
6.	Road	
7.	Geomorphic Process	Gravitational
8.	Geomorphic Form	Moderately Dissected Slope
9.	Rock	Laterite
10.	Weathering	Moderate
11.	Rock Character	Massive
12.	Dip Foliation	Not available
13.	Dip Direction Foliation	Not available
14.	Dip J1	Not available
15.	Dip Direction J1	Not available
16.	Overburden Type	Soil
17.	Thickness	0.5 m
18.	Landuse	Extensive Slope Cut
19.	Hydrology	Damp
20.	Erosion	Toe Erosion
21.	Susceptibility	High
22.	Risk	Moderate
23.	Landslide Length	25 m
24.	Landslide Width	240 m
25.	Landslide Height	20 m
26.	Landslide Run Out	15 m
27.	Landslide Material	Debries
28.	Movement Type	Creep
29.	Failure Depth	Shallow (<= 5m)
30.	Landslide Activity	Suspended
31.	Landslide Distribution	Widening and Enlarging
32.	Landslide Style	Multiple
33.	Landslide Mechanism	Deep seated Translational Failure
34.	Landslide Initiation	Not available
35.	Upslope	30°
36.	Downslope	60°
37.	Triggering Factor	Rain
38.	Casualties	Not available
39.	Geo Scientific Cause	Road widening
40.	Remedial Measures	Soil nailing and proper drainage
41.	Remarks	

1.	Name	KAR/UK/28J10/2018-19/L17
2.	Latitude (N) (DMS)	14°44′41.90″
3.	Longitude (E) (DMS)	74°39′49″
4.	Toposheet No.	48J10
5.	Village Name	West of Kanmuski
6.	Road	
7.	Geomorphic Process	Gravitational
8.	Geomorphic Form	Moderately Dissected Slope
9.	Rock	Phyllitic Granite Gneiss
10.	Weathering	Moderate
11.	Rock Character	Massive
12.	Dip Foliation	Not available
13.	Dip Direction Foliation	Not available
14.	Dip J1	Not available
15.	Dip Direction J1	Not available
16.	Overburden Type	Soil
17.	Thickness	0.5 m
18.	Landuse	Extensive Slope Cut
19.	Hydrology	Damp
20.	Erosion	Toe Erosion
21.	Susceptibility	High
22.	Risk	Moderate
23.	Landslide Length	50 m
24.	Landslide Width	135 m
25.	Landslide Height	30 m
26.	Landslide Run Out	15 m
27.	Landslide Material	Debries
28.	Movement Type	Creep
29.	Failure Depth	Shallow (<= 5m)
30.	Landslide Activity	Suspended
31.	Landslide Distribution	Widening and Enlarging
32.	Landslide Style	Multiple
33.	Landslide Mechanism	Shallow Translational
34.	Landslide Initiation	Not available
35.	Upslope	30°
36.	Downslope	45°
37.	Triggering Factor	Rain
38.	Casualties	Not available
39.	Geo Scientific Cause	Road widening
40.	Remedial Measures	Soil nailing and proper drainage
41.	Remarks	

1.	Name	KAR/UK/28J10/2018-19/L18
2.	Latitude (N) (DMS)	14°44′39″
3.	Longitude (E) (DMS)	74°34′51″
4.	Toposheet No.	48J10
5.	Village Name	West of Kanmuski
6.	Road	
7.	Geomorphic Process	Gravitational
8.	Geomorphic Form	Moderately Dissected Slope
9.	Rock	Laterite
10.	Weathering	Moderate
11.	Rock Character	Massive
12.	Dip Foliation	Not available
13.	Dip Direction Foliation	Not available
14.	Dip J1	Not available
15.	Dip Direction J1	Not available
16.	Overburden Type	Soil
17.	Thickness	0.5 m
18.	Landuse	Extensive Slope Cut
19.	Hydrology	Damp
20.	Erosion	Toe Erosion
21.	Susceptibility	High
22.	Risk	Moderate
23.	Landslide Length	15 m
24.	Landslide Width	70 m
25.	Landslide Height	12 m
26.	Landslide Run Out	05 m
27.	Landslide Material	Debries
28.	Movement Type	Creep
29.	Failure Depth	Shallow (<= 5m)
30.	Landslide Activity	Suspended
31.	Landslide Distribution	Widening and Enlarging
32.	Landslide Style	Successive
33.	Landslide Mechanism	Shallow Translational
34.	Landslide Initiation	Not available
35.	Upslope	40°
36.	Downslope	60°
37.	Triggering Factor	Rain
38.	Casualties	Not available
39.	Geo Scientific Cause	Road widening
40.	Remedial Measures	Soil nailing
41.	Remarks	

1.	Name	KAR/UK/28J10/2018-19/L19
2.	Latitude (N) (DMS)	14°44′37″
3.	Longitude (E) (DMS)	74°39′05.30″
4.	Toposheet No.	48J10
5.	Village Name	West of Kanmuski
6.	Road	
7.	Geomorphic Process	Gravitational
8.	Geomorphic Form	Moderately Dissected Slope
9.	Rock	Lateritic Phyllite
10.	Weathering	Moderate
11.	Rock Character	Massive
12.	Dip Foliation	Not available
13.	Dip Direction Foliation	Not available
14.	Dip J1	Not available
15.	Dip Direction J1	Not available
16.	Overburden Type	Soil
17.	Thickness	0.5 m
18.	Landuse	Extensive Slope Cut
19.	Hydrology	Damp
20.	Erosion	Toe Erosion
21.	Susceptibility	High
22.	Risk	Moderate
23.	Landslide Length	20 m
24.	Landslide Width	60 m
25.	Landslide Height	12 m
26.	Landslide Run Out	05 m
27.	Landslide Material	Debries
28.	Movement Type	Subsidence and Lateral Spread
29.	Failure Depth	Shallow (<= 5m)
30.	Landslide Activity	Suspended
31.	Landslide Distribution	Widening and Enlarging
32.	Landslide Style	Multiple
33.	Landslide Mechanism	Shallow Translational
34.	Landslide Initiation	Not available
35.	Upslope	30°
36.	Downslope	60°
37.	Triggering Factor	Rain
38.	Casualties	Not available
39.	Geo Scientific Cause	Road widening
40.	Remedial Measures	Soil nailing and proper drainage
41.	Remarks	

1.	Name	KAR/UK/28J10/2018-19/L20
2.	Latitude (N) (DMS)	14°44′36″
3.	Longitude (E) (DMS)	74°39′57″
4.	Toposheet No.	48J10
5.	Village Name	West of Kanmuski
6.	Road	
7.	Geomorphic Process	Gravitational
8.	Geomorphic Form	Moderately Dissected Slope
9.	Rock	Laterite
10.	Weathering	Moderate
11.	Rock Character	Massive
12.	Dip Foliation	Not available
13.	Dip Direction Foliation	Not available
14.	Dip J1	Not available
15.	Dip Direction J1	Not available
16.	Overburden Type	Soil
17.	Thickness	0.5 m
18.	Landuse	Extensive Slope Cut
19.	Hydrology	Damp
20.	Erosion	Toe Erosion
21.	Susceptibility	High
22.	Risk	Moderate
23.	Landslide Length	40 m
24.	Landslide Width	110 m
25.	Landslide Height	25 m
26.	Landslide Run Out	10 m
27.	Landslide Material	Debries
28.	Movement Type	Creep
29.	Failure Depth	Shallow (<= 5m)
30.	Landslide Activity	Suspended
31.	Landslide Distribution	Widening and Enlarging
32.	Landslide Style	Multiple
33.	Landslide Mechanism	Shallow Translational
34.	Landslide Initiation	Not available
35.	Upslope	35°
36.	Downslope	60°
37.	Triggering Factor	Rain
38.	Casualties	Not available
39.	Geo Scientific Cause	Road widening
40.	Remedial Measures	Soil nailing and proper drainage
41.	Remarks	

1.	Name	KAR/UK/28J10/2018-19/L21
2.	Latitude (N) (DMS)	14°44′20″
3.	Longitude (E) (DMS)	74°40′27.33″
4.	Toposheet No.	48J10
5.	Village Name	Kanmuski
6.	Road	
7.	Geomorphic Process	Gravitational
8.	Geomorphic Form	Moderately Dissected Slope
9.	Rock	Laterite
10.	Weathering	Moderate
11.	Rock Character	Massive
12.	Dip Foliation	Not available
13.	Dip Direction Foliation	Not available
14.	Dip J1	Not available
15.	Dip Direction J1	Not available
16.	Overburden Type	Soil
17.	Thickness	0.5 m
18.	Landuse	Extensive Slope Cut
19.	Hydrology	Damp
20.	Erosion	Toe Erosion
21.	Susceptibility	High
22.	Risk	Moderate
23.	Landslide Length	08 m
24.	Landslide Width	70 m
25.	Landslide Height	06 m
26.	Landslide Run Out	04 m
27.	Landslide Material	Soil
28.	Movement Type	Creep
29.	Failure Depth	Shallow (<= 5m)
30.	Landslide Activity	Suspended
31.	Landslide Distribution	Widening
32.	Landslide Style	Successive
33.	Landslide Mechanism	Shallow Translational
34.	Landslide Initiation	Not available
35.	Upslope	25°
36.	Downslope	65°
37.	Triggering Factor	Rain
38.	Casualties	Not available
39.	Geo Scientific Cause	Road widening
40.	Remedial Measures	Soil nailing
41.	Remarks	

1.	Name	KAR/UK/28J10/2018-19/L22
2.	Latitude (N) (DMS)	14°44′6.9″
3.	Longitude (E) (DMS)	74°40′44″
4.	Toposheet No.	48J10
5.	Village Name	Kanmuski
6.	Road	
7.	Geomorphic Process	Gravitational
8.	Geomorphic Form	Moderately Dissected Slope
9.	Rock	Laterite
10.	Weathering	Moderate
11.	Rock Character	Massive
12.	Dip Foliation	Not available
13.	Dip Direction Foliation	Not available
14.	Dip J1	Not available
15.	Dip Direction J1	Not available
16.	Overburden Type	Soil
17.	Thickness	0.5 m
18.	Landuse	Extensive Slope Cut
19.	Hydrology	Damp
20.	Erosion	Toe Erosion
21.	Susceptibility	High
22.	Risk	Moderate
23.	Landslide Length	15 m
24.	Landslide Width	90 m
25.	Landslide Height	08 m
26.	Landslide Run Out	08 m
27.	Landslide Material	Soil
28.	Movement Type	Creep
29.	Failure Depth	Shallow (<= 5m)
30.	Landslide Activity	Suspended
31.	Landslide Distribution	Widening and Enlarging
32.	Landslide Style	Successive
33.	Landslide Mechanism	Shallow Translational
34.	Landslide Initiation	Not available
35.	Upslope	20°
36.	Downslope	45°
37.	Triggering Factor	Rain
38.	Casualties	Not available
39.	Geo Scientific Cause	Road widening
40.	Remedial Measures	Soil nailing and proper drainage
41.	Remarks	

1.	Name	KAR/UK/28J10/2018-19/L23
2.	Latitude (N) (DMS)	14°44′05″
3.	Longitude (E) (DMS)	74°40′50″
4.	Toposheet No.	48J10
5.	Village Name	East of Kanmuski
6.	Road	
7.	Geomorphic Process	Gravitational
8.	Geomorphic Form	Moderately Dissected Slope
9.	Rock	Laterite
10.	Weathering	Moderate
11.	Rock Character	Massive
12.	Dip Foliation	Not available
13.	Dip Direction Foliation	Not available
14.	Dip J1	Not available
15.	Dip Direction J1	Not available
16.	Overburden Type	Soil
17.	Thickness	0.5 m
18.	Landuse	Extensive Slope Cut
19.	Hydrology	Damp
20.	Erosion	Toe Erosion
21.	Susceptibility	High
22.	Risk	Moderate
23.	Landslide Length	15 m
24.	Landslide Width	60 m
25.	Landslide Height	07 m
26.	Landslide Run Out	05 m
27.	Landslide Material	Soil
28.	Movement Type	Subsidence
29.	Failure Depth	Shallow (<= 5m)
30.	Landslide Activity	Suspended
31.	Landslide Distribution	Widening and Enlarging
32.	Landslide Style	Multiple
33.	Landslide Mechanism	Shallow Translational
34.	Landslide Initiation	Not available
35.	Upslope	25°
36.	Downslope	60°
37.	Triggering Factor	Rain
38.	Casualties	Not available
39.	Geo Scientific Cause	Road widening
40.	Remedial Measures	Soil nailing and proper drainage
41.	Remarks	

1.	Name	KAR/UK/28J15/2018-19/L24
2.	Latitude (N) (DMS)	14°28′51.60″
3.	Longitude (E) (DMS)	74°52′37.40″
4.	Toposheet No.	48J15
5.	Village Name	Nanikatta
6.	Road	
7.	Geomorphic Process	Gravitational
8.	Geomorphic Form	Moderately Dissected Slope
9.	Rock	Laterite
10.	Weathering	Moderate
11.	Rock Character	Massive
12.	Dip Foliation	Not available
13.	Dip Direction Foliation	Not available
14.	Dip J1	Not available
15.	Dip Direction J1	Not available
16.	Overburden Type	Soil
17.	Thickness	0.5 m
18.	Landuse	Extensive Slope Cut
19.	Hydrology	Damp
20.	Erosion	Toe Erosion
21.	Susceptibility	High
22.	Risk	Moderate
23.	Landslide Length	16 m
24.	Landslide Width	90 m
25.	Landslide Height	12 m
26.	Landslide Run Out	05 m
27.	Landslide Material	Debries
28.	Movement Type	Creep
29.	Failure Depth	Shallow (<= 5m)
30.	Landslide Activity	Suspended
31.	Landslide Distribution	Widening and Enlarging
32.	Landslide Style	Successive
33.	Landslide Mechanism	Shallow Translational
34.	Landslide Initiation	Not available
35.	Upslope	20°
36.	Downslope	45°
37.	Triggering Factor	Rain
38.	Casualties	Not available
39.	Geo Scientific Cause	Road widening
40.	Remedial Measures	Soil nailing and proper drainage
41.	Remarks	

1.	Name	KAR/UK/28J15/2018-19/L25
2.	Latitude (N) (DMS)	14°29′40.20″
3.	Longitude (E) (DMS)	74°48′17.10″
4.	Toposheet No.	48J15
5.	Village Name	Yelugar
6.	Road	
7.	Geomorphic Process	Gravitational
8.	Geomorphic Form	Moderately Dissected Slope
9.	Rock	Laterite
10.	Weathering	Moderate
11.	Rock Character	Massive
12.	Dip Foliation	Not available
13.	Dip Direction Foliation	Not available
14.	Dip J1	Not available
15.	Dip Direction J1	Not available
16.	Overburden Type	Soil
17.	Thickness	0.5 m
18.	Landuse	Extensive Slope Cut
19.	Hydrology	Damp
20.	Erosion	Toe Erosion
21.	Susceptibility	High
22.	Risk	Moderate
23.	Landslide Length	20 m
24.	Landslide Width	180 m
25.	Landslide Height	15 m
26.	Landslide Run Out	08 m
27.	Landslide Material	Debries
28.	Movement Type	Creep
29.	Failure Depth	Shallow (<= 5m)
30.	Landslide Activity	Suspended
31.	Landslide Distribution	Widening and Enlarging
32.	Landslide Style	Successive
33.	Landslide Mechanism	Shallow Translational
34.	Landslide Initiation	Not available
35.	Upslope	35°
36.	Downslope	60°
37.	Triggering Factor	Rain
38.	Casualties	Not available
39.	Geo Scientific Cause	Road widening
40.	Remedial Measures	Soil nailing and proper drainage
41.	Remarks	

1.	Name	KAR/UK/28J15/2018-19/L26
2.	Latitude (N) (DMS)	14°28′43.50″
3.	Longitude (E) (DMS)	74°48′26.30″
4.	Toposheet No.	48J15
5.	Village Name	South of Balur
6.	Road	
7.	Geomorphic Process	Gravitational
8.	Geomorphic Form	Moderately Dissected Slope
9.	Rock	Laterite
10.	Weathering	Moderate
11.	Rock Character	Massive
12.	Dip Foliation	Not available
13.	Dip Direction Foliation	Not available
14.	Dip J1	Not available
15.	Dip Direction J1	Not available
16.	Overburden Type	Soil
17.	Thickness	0.5 m
18.	Landuse	Extensive Slope Cut
19.	Hydrology	Damp
20.	Erosion	Toe Erosion
21.	Susceptibility	High
22.	Risk	Moderate
23.	Landslide Length	12 m
24.	Landslide Width	120 m
25.	Landslide Height	08 m
26.	Landslide Run Out	04 m
27.	Landslide Material	Soil
28.	Movement Type	Creep
29.	Failure Depth	Shallow (<= 5m)
30.	Landslide Activity	Suspended
31.	Landslide Distribution	Enlarging
32.	Landslide Style	Single
33.	Landslide Mechanism	Shallow Translational
34.	Landslide Initiation	Not available
35.	Upslope	20°
36.	Downslope	60°
37.	Triggering Factor	Rain
38.	Casualties	Not available
39.	Geo Scientific Cause	Road widening
40.	Remedial Measures	Proper drainage
41.	Remarks	

1.	Name	KAR/UK/28J15/2018-19/L27
2.	Latitude (N) (DMS)	14°28′04.30″
3.	Longitude (E) (DMS)	74°48′11.10″
4.	Toposheet No.	48J15
5.	Village Name	Balesar
6.	Road	
7.	Geomorphic Process	Gravitational
8.	Geomorphic Form	Moderately Dissected Slope
9.	Rock	Laterite
10.	Weathering	Moderate
11.	Rock Character	Massive
12.	Dip Foliation	Not available
13.	Dip Direction Foliation	Not available
14.	Dip J1	Not available
15.	Dip Direction J1	Not available
16.	Overburden Type	Soil
17.	Thickness	0.5 m
18.	Landuse	Extensive Slope Cut
19.	Hydrology	Damp
20.	Erosion	Toe Erosion
21.	Susceptibility	High
22.	Risk	Moderate
23.	Landslide Length	15 m
24.	Landslide Width	180 m
25.	Landslide Height	08 m
26.	Landslide Run Out	05 m
27.	Landslide Material	Debries
28.	Movement Type	Creep
29.	Failure Depth	Shallow (<= 5m)
30.	Landslide Activity	Suspended
31.	Landslide Distribution	Widening and Enlarging
32.	Landslide Style	Successive
33.	Landslide Mechanism	Shallow Translational
34.	Landslide Initiation	Not available
35.	Upslope	25°
36.	Downslope	60°
37.	Triggering Factor	Rain
38.	Casualties	Not available
39.	Geo Scientific Cause	Road widening
40.	Remedial Measures	Proper drainage
41.	Remarks	

1.	Name	KAR/UK/28J15/2018-19/L28
2.	Latitude (N) (DMS)	14°28′27.70″
3.	Longitude (E) (DMS)	74°46′35.80″
4.	Toposheet No.	48J15
5.	Village Name	Nelemav
6.	Road	
7.	Geomorphic Process	Gravitational
8.	Geomorphic Form	Moderately Dissected Slope
9.	Rock	Laterite
10.	Weathering	Moderate
11.	Rock Character	Massive
12.	Dip Foliation	Not available
13.	Dip Direction Foliation	Not available
14.	Dip J1	Not available
15.	Dip Direction J1	Not available
16.	Overburden Type	Soil
17.	Thickness	0.5 m
18.	Landuse	Extensive Slope Cut
19.	Hydrology	Damp
20.	Erosion	Toe Erosion
21.	Susceptibility	High
22.	Risk	Moderate
23.	Landslide Length	12 m
24.	Landslide Width	70 m
25.	Landslide Height	08 m
26.	Landslide Run Out	03 m
27.	Landslide Material	Debries
28.	Movement Type	Creep
29.	Failure Depth	Shallow (<= 5m)
30.	Landslide Activity	Suspended
31.	Landslide Distribution	Widening and Enlarging
32.	Landslide Style	Single
33.	Landslide Mechanism	Shallow Translational
34.	Landslide Initiation	Not available
35.	Upslope	30°
36.	Downslope	45°
37.	Triggering Factor	Rain
38.	Casualties	Not available
39.	Geo Scientific Cause	Road widening
40.	Remedial Measures	Soil nailing and proper drainage
41.	Remarks	

1.	Name	KAR/UK/28J15/2018-19/L29
2.	Latitude (N) (DMS)	14°28′26.40″
3.	Longitude (E) (DMS)	74°46′30.60″
4.	Toposheet No.	48J15
5.	Village Name	Nelemav
6.	Road	
7.	Geomorphic Process	Gravitational
8.	Geomorphic Form	Moderately Dissected Slope
9.	Rock	Laterite
10.	Weathering	Moderate
11.	Rock Character	Massive
12.	Dip Foliation	Not available
13.	Dip Direction Foliation	Not available
14.	Dip J1	Not available
15.	Dip Direction J1	Not available
16.	Overburden Type	Soil
17.	Thickness	0.5 m
18.	Landuse	Extensive Slope Cut
19.	Hydrology	Damp
20.	Erosion	Toe Erosion
21.	Susceptibility	High
22.	Risk	Moderate
23.	Landslide Length	60 m
24.	Landslide Width	90 m
25.	Landslide Height	40 m
26.	Landslide Run Out	15 m
27.	Landslide Material	Debries
28.	Movement Type	Creep
29.	Failure Depth	Shallow (<= 5m)
30.	Landslide Activity	Suspended
31.	Landslide Distribution	Widening and Enlarging
32.	Landslide Style	Successive
33.	Landslide Mechanism	Shallow Translational
34.	Landslide Initiation	Not available
35.	Upslope	30°
36.	Downslope	60°
37.	Triggering Factor	Rain
38.	Casualties	Not available
39.	Geo Scientific Cause	Road widening
40.	Remedial Measures	Soil nailing and proper drainage
41.	Remarks	

1.	Name	KAR/UK/28J15/2018-19/L30
2.	Latitude (N) (DMS)	14°28′18.70″
3.	Longitude (E) (DMS)	74°46′30.90″
4.	Toposheet No.	48J15
5.	Village Name	Kamkar
6.	Road	
7.	Geomorphic Process	Gravitational
8.	Geomorphic Form	Moderately Dissected Slope
9.	Rock	Laterite
10.	Weathering	Moderate
11.	Rock Character	Massive
12.	Dip Foliation	Not available
13.	Dip Direction Foliation	Not available
14.	Dip J1	Not available
15.	Dip Direction J1	Not available
16.	Overburden Type	Soil
17.	Thickness	0.5 m
18.	Landuse	Extensive Slope Cut
19.	Hydrology	Damp
20.	Erosion	Toe Erosion
21.	Susceptibility	High
22.	Risk	Moderate
23.	Landslide Length	15 m
24.	Landslide Width	140 m
25.	Landslide Height	08 m
26.	Landslide Run Out	04 m
27.	Landslide Material	Debries
28.	Movement Type	Creep
29.	Failure Depth	Shallow (<= 5m)
30.	Landslide Activity	Suspended
31.	Landslide Distribution	Widening and Enlarging
32.	Landslide Style	Successive
33.	Landslide Mechanism	Shallow Translational
34.	Landslide Initiation	Not available
35.	Upslope	25°
36.	Downslope	60°
37.	Triggering Factor	Rain
38.	Casualties	Not available
39.	Geo Scientific Cause	Road widening
40.	Remedial Measures	Proper drainage
41.	Remarks	

1.	Name	KAR/UK/28J15/2018-19/L31
2.	Latitude (N) (DMS)	14°27′16.30″
3.	Longitude (E) (DMS)	74°46′43.80″
4.	Toposheet No.	48J15
5.	Village Name	Hantikuli
6.	Road	
7.	Geomorphic Process	Gravitational
8.	Geomorphic Form	Moderately Dissected Slope
9.	Rock	Laterite
10.	Weathering	Moderate
11.	Rock Character	Massive
12.	Dip Foliation	Not available
13.	Dip Direction Foliation	Not available
14.	Dip J1	Not available
15.	Dip Direction J1	Not available
16.	Overburden Type	Soil
17.	Thickness	0.5 m
18.	Landuse	Extensive Slope Cut
19.	Hydrology	Damp
20.	Erosion	Toe Erosion
21.	Susceptibility	High
22.	Risk	Moderate
23.	Landslide Length	45 m
24.	Landslide Width	90 m
25.	Landslide Height	30 m
26.	Landslide Run Out	15 m
27.	Landslide Material	Soil
28.	Movement Type	Subsidence
29.	Failure Depth	Shallow (<= 5m)
30.	Landslide Activity	Suspended
31.	Landslide Distribution	Widening
32.	Landslide Style	Successive
33.	Landslide Mechanism	Shallow Translational
34.	Landslide Initiation	Not available
35.	Upslope	30°
36.	Downslope	40°
37.	Triggering Factor	Rain
38.	Casualties	Not available
39.	Geo Scientific Cause	Road widening
40.	Remedial Measures	Proper drainage
41.	Remarks	

1.	Name	KAR/UK/28J15/2018-19/L32
2.	Latitude (N) (DMS)	14°26′36.90″
3.	Longitude (E) (DMS)	74°47′01.90″
4.	Toposheet No.	48J15
5.	Village Name	Balahalli
6.	Road	
7.	Geomorphic Process	Gravitational
8.	Geomorphic Form	Moderately Dissected Slope
9.	Rock	Laterite
10.	Weathering	Moderate
11.	Rock Character	Massive
12.	Dip Foliation	Not available
13.	Dip Direction Foliation	Not available
14.	Dip J1	Not available
15.	Dip Direction J1	Not available
16.	Overburden Type	Soil
17.	Thickness	0.5 m
18.	Landuse	Extensive Slope Cut
19.	Hydrology	Damp
20.	Erosion	Toe Erosion
21.	Susceptibility	High
22.	Risk	Moderate
23.	Landslide Length	50 m
24.	Landslide Width	180 m
25.	Landslide Height	40 m
26.	Landslide Run Out	15 m
27.	Landslide Material	Debries
28.	Movement Type	Creep
29.	Failure Depth	Shallow (<= 5m)
30.	Landslide Activity	Suspended
31.	Landslide Distribution	Enlarging
32.	Landslide Style	Successive
33.	Landslide Mechanism	Shallow Translational
34.	Landslide Initiation	Not available
35.	Upslope	35°
36.	Downslope	60°
37.	Triggering Factor	Rain
38.	Casualties	Not available
39.	Geo Scientific Cause	Road widening
40.	Remedial Measures	Soil nailing and proper drainage
41.	Remarks	

1.	Name	KAR/UK/28J15/2018-19/L33
2.	Latitude (N) (DMS)	14°26′32.60″
3.	Longitude (E) (DMS)	74°47′07.50″
4.	Toposheet No.	48J15
5.	Village Name	Balahalli
6.	Road	
7.	Geomorphic Process	Gravitational
8.	Geomorphic Form	Moderately Dissected Slope
9.	Rock	Laterite
10.	Weathering	Moderate
11.	Rock Character	Massive
12.	Dip Foliation	Not available
13.	Dip Direction Foliation	Not available
14.	Dip J1	Not available
15.	Dip Direction J1	Not available
16.	Overburden Type	Soil
17.	Thickness	0.5 m
18.	Landuse	Extensive Slope Cut
19.	Hydrology	Damp
20.	Erosion	Toe Erosion
21.	Susceptibility	High
22.	Risk	Moderate
23.	Landslide Length	45 m
24.	Landslide Width	120 m
25.	Landslide Height	30 m
26.	Landslide Run Out	10m
27.	Landslide Material	Debries
28.	Movement Type	Creep
29.	Failure Depth	Shallow (<= 5m)
30.	Landslide Activity	Suspended
31.	Landslide Distribution	Enlarging
32.	Landslide Style	Successive
33.	Landslide Mechanism	Shallow Translational
34.	Landslide Initiation	Not available
35.	Upslope	30°
36.	Downslope	50°
37.	Triggering Factor	Rain
38.	Casualties	Not available
39.	Geo Scientific Cause	Road widening
40.	Remedial Measures	Soil nailing and proper drainage
41.	Remarks	

1.	Name	KAR/UK/28J15/2018-19/L34
2.	Latitude (N) (DMS)	14°26′34.30″
3.	Longitude (E) (DMS)	74°47′09.20″
4.	Toposheet No.	48J15
5.	Village Name	Balahalli
6.	Road	
7.	Geomorphic Process	Gravitational
8.	Geomorphic Form	Moderately Dissected Slope
9.	Rock	Laterite
10.	Weathering	Moderate
11.	Rock Character	Massive
12.	Dip Foliation	Not available
13.	Dip Direction Foliation	Not available
14.	Dip J1	Not available
15.	Dip Direction J1	Not available
16.	Overburden Type	Soil
17.	Thickness	0.5 m
18.	Landuse	Extensive Slope Cut
19.	Hydrology	Damp
20.	Erosion	Toe Erosion
21.	Susceptibility	High
22.	Risk	Moderate
23.	Landslide Length	45 m
24.	Landslide Width	110 m
25.	Landslide Height	35 m
26.	Landslide Run Out	10m
27.	Landslide Material	Debries
28.	Movement Type	Creep
29.	Failure Depth	Shallow (<= 5m)
30.	Landslide Activity	Suspended
31.	Landslide Distribution	Enlarging
32.	Landslide Style	Successive
33.	Landslide Mechanism	Shallow Translational
34.	Landslide Initiation	Not available
35.	Upslope	30°
36.	Downslope	35°
37.	Triggering Factor	Rain
38.	Casualties	Not available
39.	Geo Scientific Cause	Road widening
40.	Remedial Measures	Soil nailing and proper drainage
41.	Remarks	

1.	Name	KAR/UK/28J15/2018-19/L35
2.	Latitude (N) (DMS)	14°26′17.50″
3.	Longitude (E) (DMS)	74°47′10.20″
4.	Toposheet No.	48J15
5.	Village Name	West of Matalmane
6.	Road	
7.	Geomorphic Process	Gravitational
8.	Geomorphic Form	Moderately Dissected Slope
9.	Rock	Laterite
10.	Weathering	Moderate
11.	Rock Character	Massive
12.	Dip Foliation	Not available
13.	Dip Direction Foliation	Not available
14.	Dip J1	Not available
15.	Dip Direction J1	Not available
16.	Overburden Type	Soil
17.	Thickness	0.5 m
18.	Landuse	Extensive Slope Cut
19.	Hydrology	Damp
20.	Erosion	Toe Erosion
21.	Susceptibility	High
22.	Risk	Moderate
23.	Landslide Length	45 m
24.	Landslide Width	180 m
25.	Landslide Height	30 m
26.	Landslide Run Out	10m
27.	Landslide Material	Debries
28.	Movement Type	Subsidence
29.	Failure Depth	Shallow (<= 5m)
30.	Landslide Activity	Suspended
31.	Landslide Distribution	Widening and Enlarging
32.	Landslide Style	Multiple
33.	Landslide Mechanism	Shallow Translational
34.	Landslide Initiation	Not available
35.	Upslope	30°
36.	Downslope	60°
37.	Triggering Factor	Rain
38.	Casualties	Not available
39.	Geo Scientific Cause	Road widening
40.	Remedial Measures	Soil nailing and proper drainage
41.	Remarks	

1.	Name	KAR/UK/28J15/2018-19/L36
2.	Latitude (N) (DMS)	14°26′20.30″
3.	Longitude (E) (DMS)	74°47′13.30″
4.	Toposheet No.	48J15
5.	Village Name	West of Matalmane
6.	Road	
7.	Geomorphic Process	Gravitational
8.	Geomorphic Form	Moderately Dissected Slope
9.	Rock	Laterite
10.	Weathering	Moderate
11.	Rock Character	Massive
12.	Dip Foliation	Not available
13.	Dip Direction Foliation	Not available
14.	Dip J1	Not available
15.	Dip Direction J1	Not available
16.	Overburden Type	Soil
17.	Thickness	0.5 m
18.	Landuse	Extensive Slope Cut
19.	Hydrology	Damp
20.	Erosion	Toe Erosion
21.	Susceptibility	High
22.	Risk	Moderate
23.	Landslide Length	40 m
24.	Landslide Width	90 m
25.	Landslide Height	35 m
26.	Landslide Run Out	10m
27.	Landslide Material	Debries
28.	Movement Type	Lateral spread
29.	Failure Depth	Shallow (<= 5m)
30.	Landslide Activity	Suspended
31.	Landslide Distribution	Widening and Enlarging
32.	Landslide Style	Successive
33.	Landslide Mechanism	Shallow Translational
34.	Landslide Initiation	Not available
35.	Upslope	35°
36.	Downslope	45°
37.	Triggering Factor	Rain
38.	Casualties	Not available
39.	Geo Scientific Cause	Road widening
40.	Remedial Measures	Soil nailing and proper drainage
41.	Remarks	

1.	Name	KAR/UK/28J15/2018-19/L37
2.	Latitude (N) (DMS)	14°29′26.70″
3.	Longitude (E) (DMS)	74°46′21.50″
4.	Toposheet No.	48J15
5.	Village Name	North of Herur
6.	Road	
7.	Geomorphic Process	Gravitational
8.	Geomorphic Form	Moderately Dissected Slope
9.	Rock	Laterite
10.	Weathering	Moderate
11.	Rock Character	Massive
12.	Dip Foliation	Not available
13.	Dip Direction Foliation	Not available
14.	Dip J1	Not available
15.	Dip Direction J1	Not available
16.	Overburden Type	Soil
17.	Thickness	0.5 m
18.	Landuse	Extensive Slope Cut
19.	Hydrology	Damp
20.	Erosion	Toe Erosion
21.	Susceptibility	High
22.	Risk	Moderate
23.	Landslide Length	08 m
24.	Landslide Width	90 m
25.	Landslide Height	06 m
26.	Landslide Run Out	03m
27.	Landslide Material	Soil
28.	Movement Type	Creep
29.	Failure Depth	Shallow (<= 5m)
30.	Landslide Activity	Suspended
31.	Landslide Distribution	Widening and Enlarging
32.	Landslide Style	Successive
33.	Landslide Mechanism	Shallow Translational
34.	Landslide Initiation	Not available
35.	Upslope	20°
36.	Downslope	35°
37.	Triggering Factor	Rain
38.	Casualties	Not available
39.	Geo Scientific Cause	Road widening
40.	Remedial Measures	Soil nailing and proper drainage
41.	Remarks	

1.	Name	KAR/UK/28J15/2018-19/L38
2.	Latitude (N) (DMS)	14°27′39.80″
3.	Longitude (E) (DMS)	74°45′11.60″
4.	Toposheet No.	48J15
5.	Village Name	Heggarbail
6.	Road	
7.	Geomorphic Process	Gravitational
8.	Geomorphic Form	Moderately Dissected Slope
9.	Rock	Laterite
10.	Weathering	Moderate
11.	Rock Character	Massive
12.	Dip Foliation	Not available
13.	Dip Direction Foliation	Not available
14.	Dip J1	Not available
15.	Dip Direction J1	Not available
16.	Overburden Type	Soil
17.	Thickness	0.5 m
18.	Landuse	Extensive Slope Cut
19.	Hydrology	Damp
20.	Erosion	Toe Erosion
21.	Susceptibility	High
22.	Risk	Moderate
23.	Landslide Length	08 m
24.	Landslide Width	90 m
25.	Landslide Height	06 m
26.	Landslide Run Out	04 m
27.	Landslide Material	Debries
28.	Movement Type	Subsidence and Creep
29.	Failure Depth	Shallow (<= 5m)
30.	Landslide Activity	Suspended
31.	Landslide Distribution	Widening and Enlarging
32.	Landslide Style	Successive
33.	Landslide Mechanism	Shallow Translational
34.	Landslide Initiation	Not available
35.	Upslope	20°
36.	Downslope	60°
37.	Triggering Factor	Rain
38.	Casualties	Not available
39.	Geo Scientific Cause	Road widening
40.	Remedial Measures	Soil nailing and proper drainage
41.	Remarks	

1.	Name	KAR/UK/28J15/2018-19/L39
2.	Latitude (N) (DMS)	14°15′13.30″
3.	Longitude (E) (DMS)	74°48′25.40″
4.	Toposheet No.	48J15
5.	Village Name	Mavingundi
6.	Road	
7.	Geomorphic Process	Gravitational
8.	Geomorphic Form	Moderately Dissected Slope
9.	Rock	Laterite
10.	Weathering	Moderate
11.	Rock Character	Massive
12.	Dip Foliation	Not available
13.	Dip Direction Foliation	Not available
14.	Dip J1	Not available
15.	Dip Direction J1	Not available
16.	Overburden Type	Soil
17.	Thickness	0.5 m
18.	Landuse	Extensive Slope Cut
19.	Hydrology	Damp
20.	Erosion	Toe Erosion
21.	Susceptibility	High
22.	Risk	Moderate
23.	Landslide Length	25 m
24.	Landslide Width	120 m
25.	Landslide Height	15 m
26.	Landslide Run Out	06 m
27.	Landslide Material	Soil
28.	Movement Type	Lateral Spread
29.	Failure Depth	Shallow (<= 5m)
30.	Landslide Activity	Suspended
31.	Landslide Distribution	Widening and Enlarging
32.	Landslide Style	Multiple
33.	Landslide Mechanism	Shallow Translational
34.	Landslide Initiation	Not available
35.	Upslope	30°
36.	Downslope	45°
37.	Triggering Factor	Rain
38.	Casualties	Not available
39.	Geo Scientific Cause	Road widening
40.	Remedial Measures	Soil nailing and proper drainage
41.	Remarks	

1.	Name	KAR/UK/28J15/2018-19/L40
2.	Latitude (N) (DMS)	14°15′21.50″
3.	Longitude (E) (DMS)	74°47′38.30″
4.	Toposheet No.	48J15
5.	Village Name	Tummaragadde
6.	Road	
7.	Geomorphic Process	Gravitational
8.	Geomorphic Form	Moderately Dissected Slope
9.	Rock	Laterite
10.	Weathering	Moderate
11.	Rock Character	Massive
12.	Dip Foliation	Not available
13.	Dip Direction Foliation	Not available
14.	Dip J1	Not available
15.	Dip Direction J1	Not available
16.	Overburden Type	Soil
17.	Thickness	0.5 m
18.	Landuse	Extensive Slope Cut
19.	Hydrology	Damp
20.	Erosion	Toe Erosion
21.	Susceptibility	High
22.	Risk	Moderate
23.	Landslide Length	20 m
24.	Landslide Width	45 m
25.	Landslide Height	12 m
26.	Landslide Run Out	06 m
27.	Landslide Material	Debries
28.	Movement Type	Lateral Spread
29.	Failure Depth	Shallow (<= 5m)
30.	Landslide Activity	Suspended
31.	Landslide Distribution	Widening and Enlarging
32.	Landslide Style	Multiple
33.	Landslide Mechanism	Shallow Translational
34.	Landslide Initiation	Not available
35.	Upslope	30°
36.	Downslope	45°
37.	Triggering Factor	Rain
38.	Casualties	Not available
39.	Geo Scientific Cause	Road widening
40.	Remedial Measures	Soil nailing and proper drainage
41.	Remarks	

1.	Name	KAR/UK/28J15/2018-19/L41
2.	Latitude (N) (DMS)	14°16′5.60″
3.	Longitude (E) (DMS)	74°45′27.00″
4.	Toposheet No.	48J15
5.	Village Name	Bare Gudda
6.	Road	
7.	Geomorphic Process	Gravitational
8.	Geomorphic Form	Moderately Dissected Slope
9.	Rock	Laterite
10.	Weathering	Moderate
11.	Rock Character	Massive
12.	Dip Foliation	Not available
13.	Dip Direction Foliation	Not available
14.	Dip J1	Not available
15.	Dip Direction J1	Not available
16.	Overburden Type	Soil
17.	Thickness	0.5 m
18.	Landuse	Extensive Slope Cut
19.	Hydrology	Damp
20.	Erosion	Toe Erosion
21.	Susceptibility	High
22.	Risk	Moderate
23.	Landslide Length	35 m
24.	Landslide Width	40 m
25.	Landslide Height	20 m
26.	Landslide Run Out	10 m
27.	Landslide Material	Soil
28.	Movement Type	Lateral Spread
29.	Failure Depth	Shallow (<= 5m)
30.	Landslide Activity	Suspended
31.	Landslide Distribution	Widening
32.	Landslide Style	Multiple
33.	Landslide Mechanism	Shallow Translational
34.	Landslide Initiation	Not available
35.	Upslope	40°
36.	Downslope	60°
37.	Triggering Factor	Rain
38.	Casualties	Not available
39.	Geo Scientific Cause	Road widening
40.	Remedial Measures	Soil nailing and proper drainage
41.	Remarks	

1.	Name	KAR/UK/28J15/2018-19/L42
2.	Latitude (N) (DMS)	14°15′55.90″
3.	Longitude (E) (DMS)	74°45′26.80″
4.	Toposheet No.	48J15
5.	Village Name	Bare Gudda
6.	Road	
7.	Geomorphic Process	Gravitational
8.	Geomorphic Form	Moderately Dissected Slope
9.	Rock	Laterite
10.	Weathering	Moderate
11.	Rock Character	Massive
12.	Dip Foliation	Not available
13.	Dip Direction Foliation	Not available
14.	Dip J1	Not available
15.	Dip Direction J1	Not available
16.	Overburden Type	Soil
17.	Thickness	0.5 m
18.	Landuse	Extensive Slope Cut
19.	Hydrology	Damp
20.	Erosion	Toe Erosion
21.	Susceptibility	High
22.	Risk	Moderate
23.	Landslide Length	35 m
24.	Landslide Width	110 m
25.	Landslide Height	25 m
26.	Landslide Run Out	05 m
27.	Landslide Material	Debries
28.	Movement Type	Lateral Spread
29.	Failure Depth	Shallow (<= 5m)
30.	Landslide Activity	Suspended
31.	Landslide Distribution	Widening and Enlarging
32.	Landslide Style	Multiple and successive
33.	Landslide Mechanism	Shallow Translational
34.	Landslide Initiation	Not available
35.	Upslope	40°
36.	Downslope	50°
37.	Triggering Factor	Rain
38.	Casualties	Not available
39.	Geo Scientific Cause	Road widening
40.	Remedial Measures	Soil nailing and proper drainage
41.	Remarks	

1.	Name	KAR/UK/28J15/2018-19/L43
2.	Latitude (N) (DMS)	14°27′34.00″
3.	Longitude (E) (DMS)	74°46′37.70″
4.	Toposheet No.	48J15
5.	Village Name	Hendur
6.	Road	
7.	Geomorphic Process	Gravitational
8.	Geomorphic Form	Moderately Dissected Slope
9.	Rock	Laterite
10.	Weathering	Moderate
11.	Rock Character	Massive
12.	Dip Foliation	Not available
13.	Dip Direction Foliation	Not available
14.	Dip J1	Not available
15.	Dip Direction J1	Not available
16.	Overburden Type	Soil
17.	Thickness	0.5 m
18.	Landuse	Extensive Slope Cut
19.	Hydrology	Damp
20.	Erosion	Toe Erosion
21.	Susceptibility	High
22.	Risk	Moderate
23.	Landslide Length	30 m
24.	Landslide Width	60 m
25.	Landslide Height	20 m
26.	Landslide Run Out	04 m
27.	Landslide Material	Soil
28.	Movement Type	Flow
29.	Failure Depth	Shallow (<= 5m)
30.	Landslide Activity	Suspended
31.	Landslide Distribution	Widening and Enlarging
32.	Landslide Style	Successive
33.	Landslide Mechanism	Shallow Translational
34.	Landslide Initiation	Not available
35.	Upslope	30°
36.	Downslope	40°
37.	Triggering Factor	Rain
38.	Casualties	Not available
39.	Geo Scientific Cause	Road widening
40.	Remedial Measures	Soil nailing and proper drainage
41.	Remarks	

1.	Name	KAR/UK/28J15/2018-19/L44
2.	Latitude (N) (DMS)	14°23′8.0″
3.	Longitude (E) (DMS)	74°51′28.30″
4.	Toposheet No.	48J15
5.	Village Name	Bidrakan
6.	Road	
7.	Geomorphic Process	Gravitational
8.	Geomorphic Form	Moderately Dissected Slope
9.	Rock	Lateritic clay
10.	Weathering	Moderate
11.	Rock Character	Massive
12.	Dip Foliation	Not available
13.	Dip Direction Foliation	Not available
14.	Dip J1	Not available
15.	Dip Direction J1	Not available
16.	Overburden Type	Soil
17.	Thickness	0.5 m
18.	Landuse	Extensive Slope Cut
19.	Hydrology	Damp
20.	Erosion	Toe Erosion
21.	Susceptibility	High
22.	Risk	Moderate
23.	Landslide Length	45 m
24.	Landslide Width	80 m
25.	Landslide Height	35 m
26.	Landslide Run Out	03 m
27.	Landslide Material	Soil
28.	Movement Type	Subsidence
29.	Failure Depth	Shallow (<= 5m)
30.	Landslide Activity	Suspended
31.	Landslide Distribution	Widening and Enlarging
32.	Landslide Style	Successive
33.	Landslide Mechanism	Shallow Translational
34.	Landslide Initiation	Not available
35.	Upslope	40°
36.	Downslope	60°
37.	Triggering Factor	Rain
38.	Casualties	Not available
39.	Geo Scientific Cause	Road widening
40.	Remedial Measures	Retaining wall
41.	Remarks	

1.	Name	KAR/UK/28J15/2018-19/L45
2.	Latitude (N) (DMS)	14°33′8.0″
3.	Longitude (E) (DMS)	74°46′07.00″
4.	Toposheet No.	48J15
5.	Village Name	Hendur
6.	Road	
7.	Geomorphic Process	Gravitational
8.	Geomorphic Form	Moderately Dissected Slope
9.	Rock	Laterite
10.	Weathering	Moderate
11.	Rock Character	Massive
12.	Dip Foliation	Not available
13.	Dip Direction Foliation	Not available
14.	Dip J1	Not available
15.	Dip Direction J1	Not available
16.	Overburden Type	Soil
17.	Thickness	0.5 m
18.	Landuse	Extensive Slope Cut
19.	Hydrology	Damp
20.	Erosion	Toe Erosion
21.	Susceptibility	High
22.	Risk	Moderate
23.	Landslide Length	25 m
24.	Landslide Width	70 m
25.	Landslide Height	18 m
26.	Landslide Run Out	04 m
27.	Landslide Material	Soil
28.	Movement Type	Flow
29.	Failure Depth	Shallow (<= 5m)
30.	Landslide Activity	Abandoned
31.	Landslide Distribution	Widening and Enlarging
32.	Landslide Style	Successive
33.	Landslide Mechanism	Shallow Translational
34.	Landslide Initiation	Not available
35.	Upslope	30°
36.	Downslope	45°
37.	Triggering Factor	Rain
38.	Casualties	Not available
39.	Geo Scientific Cause	Road widening
40.	Remedial Measures	Soil nailing and proper drainage
41.	Remarks	

Annexure – III: Rain Fall Data

1. Chickmangaluru District

Year – 2009

Sl. No.	Taluk Name	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC	Annual (mm)
1.	CHIKKAMAGALURU	0	0	66	50	134	129	647	151	275	138	92	59	1741
2.	KADUR	0	0	43	52	112	108	91	135	222	69	58	47	937
3.	KOPPA	0	0	142	21	64	259	1478	466	412	225	117	71	3256
4.	MUDIGERE	0	0	98	52	121	264	1929	293	390	240	139	69	3595
5.	NARASIMHARAJAPURA	0	0	149	30	108	115	952	214	312	121	85	37	2121
6.	SRINGERI	0	0	156	23	78	333	1785	622	564	348	118	47	4073
7.	TARIKERE	0	0	65	38	95	95	289	182	202	86	60	104	1216
	DISTRICT AVERAGE	0	0	87	46	116	170	850	247	316	156	94	69	2152

Year - 2010

Sl. No.	Taluk Name	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC	Annual (mm)
1.	CHIKKAMAGALURU	17	0	16	73	119	130	268	279	197	199	207	6	1510
2.	KADUR	2	0	7	65	105	53	102	165	144	141	164	0	948
3.	KOPPA	19	0	18	94	74	380	823	636	376	188	212	2	2821
4.	MUDIGERE	7	0	2	93	97	385	636	528	369	222	246	3	2588
5.	NARASIMHARAJAPURA	9	0	17	84	101	189	462	319	277	217	168	8	1851
6.	SRINGERI	26	0	5	85	74	534	1149	774	510	265	261	6	3687
7.	TARIKERE	8	0	13	76	96	84	192	225	184	109	199	0	1185
	DISTRICT AVERAGE	11	0	12	83	107	202	406	364	262	188	215	3	1852

Year - 2011

Sl. No.	Taluk Name	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC	Annual (mm)
1.	CHIKKAMAGALURU	2	9	10	124	104	204	197	212	132	154	53	1	1201
2.	KADUR	0	1	3	39	46	59	53	50	33	164	29	1	479
3.	KOPPA	0	1	0	56	34	649	846	681	384	145	31	0	2826
4.	MUDIGERE	1	31	11	156	89	658	646	586	436	214	77	0	2905
5.	NARASIMHARAJAPURA	0	39	6	108	113	279	391	366	187	210	44	0	1742
6.	SRINGERI	0	0	5	98	43	977	1328	1035	625	199	35	0	4345
7.	TARIKERE	0	3	1	61	60	125	165	106	66	185	26	0	800
	DISTRICT AVERAGE	1	10	6	95	76	331	381	329	209	187	45	0	1669

Year - 2012

Sl. No.	Taluk Name	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC	Annual (mm)
1.	CHIKKAMAGALURU	1	0	0	115	36	96	124	351	100	56	100	4	982
2.	KADUR	0	0	0	118	29	44	30	129	35	44	62	1	492
3.	KOPPA	0	0	0	121	30	303	469	903	288	35	145	0	2295
4.	MUDIGERE	2	2	1	146	47	315	374	660	283	98	80	1	2008
5.	NARASIMHARAJAPURA	0	0	1	128	54	167	281	543	167	36	95	0	1470
6.	SRINGERI	0	0	0	95	15	541	683	1119	314	41	99	0	2906
7.	TARIKERE	0	0	0	139	25	29	57	158	64	30	70	1	573
	DISTRICT AVERAGE	0	0	0	132	35	162	212	441	147	54	92	2	1279

Year - 2013

Sl. No.	Taluk Name	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC	Annual (mm)
1.	CHIKKAMAGALURU	3	27	43	31	141	226	601	200	212	68	25	9	1586
2.	KADUR	0	16	11	12	109	51	122	36	171	41	7	3	579
3.	KOPPA	1	24	16	16	104	695	1717	634	284	68	24	1	3584
4.	MUDIGERE	8	23	34	37	97	706	1306	546	351	184	40	16	3347
5.	NARASIMHARAJAPURA	1	17	19	22	121	384	963	348	213	42	13	2	2146
6.	SRINGERI	2	7	11	16	141	886	1908	808	263	162	16	1	4222
7.	TARIKERE	0	10	18	2	131	157	355	125	141	37	4	0	980
	DISTRICT AVERAGE	2	20	26	21	128	354	792	300	233	82	19	6	1982

Year - 2014

Sl. No.	Taluk Name	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC	Annual (mm)
1.	CHIKKAMAGALURU	0.9	0.7	8.5	93.0	210.7	84.2	414.5	338.4	163.3	119.3	12.1	12.9	1458.4
2.	KADUR	0.0	0.1	6.9	45.5	145.9	29.2	70.5	186.1	126.6	174.1	25.1	5.5	815.4
3.	KOPPA	0.9	8.2	15.8	96.6	137.5	293.4	1204.8	989.0	341.0	121.5	16.0	12.5	3237.3
4.	MUDIGERE	2.3	0.3	18.7	91.3	233.2	385.0	1280.2	699.2	436.6	157.8	26.5	33.4	3364.4
5.	NARASIMHARAJAPURA	0.1	1.8	14.6	106.1	145.2	143.3	779.6	606.1	225.2	106.4	13.2	19.2	2160.7
6.	SRINGERI	0.0	15.4	3.8	114.3	131.0	495.0	1743.5	1054.4	455.9	153.3	18.5	28.8	4213.8
7.	TARIKERE	0.1	0.2	2.6	62.8	152.9	54.7	239.0	248.6	127.1	156.1	23.5	13.8	1081.4
	DISTRICT AVERAGE	0.7	2.1	9.9	83.5	184.4	166.2	636.7	483.5	239.0	154.9	21.3	16.6	1998.8

Year - 2015

Sl. No.	Taluk Name	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC	Annual (mm)
1.	CHIKKAMAGALURU	0	0	47	122	97	284	141	181	142	131	140	8	1293
2.	KADUR	0	0	33	82	82	111	42	74	189	133	163	6	915
3.	KOPPA	1	0	63	79	166	678	628	397	148	153	123	13	2450
4.	MUDIGERE	1	1	36	116	170	908	400	318	192	139	151	11	2442
5.	NARASIMHARAJAPURA	0	0	43	94	128	383	293	237	135	124	80	5	1521
6.	SRINGERI	0	0	13	75	176	894	1097	700	177	197	161	19	3510
7.	TARIKERE	0	0	15	59	150	173	122	137	141	126	113	3	1040
	DISTRICT AVERAGE	0	0	38	98	134	416	277	235	173	146	147	8	1673

Year - 2016

Sl. No	Taluk Name	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC	Annual (mm)
1.	CHIKKAMAGALURU TALUK	1.4	2.9	3.9	30.3	132.7	229.6	242.0	139.9	85.8	21.3	17.0	38.3	945.1
2.	KADUR TALUK	1.1	0.1	0.2	11.1	84.8	103.0	70.5	12.0	30.3	17.5	5.3	40.7	376.7
3.	KOPPA TALUK	1.6	0.0	11.1	20.1	93.5	514.9	688.7	522.1	186.4	31.0	13.8	7.4	2090.5
4.	MUDIGERE TALUK	2.8	1.3	5.4	29.2	149.3	518.2	647.6	329.9	147.5	50.9	35.8	18.2	1936.1
5.	NARASIMHARAJAPUR TALUK	1.6	0.0	6.0	14.3	77.3	293.6	365.9	279.3	112.0	29.1	15.0	6.5	1200.7
6.	SRINGERI TALUK	1.5	0.4	4.3	19.3	94.6	860.5	1016.2	821.3	282.2	65.5	19.5	5.8	3190.9
7.	TARIKERE TALUK	1.9	0.4	0.4	6.6	65.1	179.5	165.0	78.4	82.4	19.3	5.9	27.0	631.8
8	DISTRICT AVERAGE	1.7	1.0	1.7	19.1	102.9	310.6	356.5	222.1	107.0	29.3	15.5	25.7	1192.9

Year - 2017

Sl. No.	Taluk Name	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC	Annual (mm)
1.	CHIKKAMAGALURU TALUK	1.1	0.4	10.1	36.5	115.3	260.1	316.8	343.8	205.8	124	18	2	1434
2.	KADUR TALUK	1.5	0.1	11.9	63.7	136.4	133.7	225.7	270.3	220.9	110	24	3	1201
3.	KOPPA TALUK	0.9	0.0	3.3	34.3	82.0	35.2	37.2	67.2	197.2	112	15	1	586
4.	MUDIGERE TALUK	0.9	0.5	4.9	23.8	135.4	484.5	618.1	601.7	224.1	118	18	2	2232
5.	NARASIMHARAJAPUR TALUK	2.8	1.8	32.5	42.2	155.5	622.6	551.6	574.6	246.1	170	15	2	2417
6.	SRINGERI TALUK	0.2	0.1	5.9	23.3	106.8	223.3	361.5	350.9	168.1	91	19	2	1352
7.	TARIKERE TALUK	0.5	0.2	1.7	18.3	164.9	811.2	992.6	1121.3	276.0	197	28	6	3617
8.	DISTRICT AVERAGE	0.3	0.0	2.6	19.4	67.1	65.5	125.7	137.7	148.8	111	13	1	692

Year – 2018

Sl. No.	Taluk Name	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC	Annual (mm)
1.	CHIKKAMAGALURU TALUK	0.2	3.7	35	61	229	320	438	543	111	116	27	10	2278
2.	KADUR TALUK	0.2	5.6	47	64	199	82	78	400	134	97	24	6	1766
3.	KOPPA TALUK	0.1	10.4	19	32	332	977	1362	55	111	116	30	10	742
4.	MUDIGERE TALUK	0.4	0.7	64	88	285	1040	1057	1121	105	116	24	16	4207
5.	NARASIMHARAJAPUR TALUK	0.4	0.4	51	77	288	562	742	896	115	150	21	9	3701
6.	SRINGERI TALUK	0.2	0.6	36	84	249	1219	1975	593	101	85	17	7	2516
7.	TARIKERE TALUK	0.0	0.7	31	76	229	147	229	1871	118	165	26	25	5756
8.	DISTRICT AVERAGE	0.0	0.8	11	40	229	318	412	183	85	108	25	7	1065

2. Shimoga District

Year - 2009

Sl. Nos.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual (mm)
1.	0.0	0.0	0.0	0.0	0.0	1.0	4.0	9.6	7.5	18.5	0.0	0.0	
2.	0.0	0.0	0.0	2.0	0.0	2.0	34.0	1.6	15.5	9.0	0.0	0.0	
3.	0.0	0.0	0.0	0.0	0.0	0.5	114.5	2.0	14.5	89.0	0.0	0.0	
4.	0.0	0.0	0.0	0.0	0.0	0.0	77.0	0.0	44.5	21.5	0.0	0.4	
5.	0.0	0.0	0.0	0.0	0.0	10.0	30.1	8.0	76.0	3.5	0.0	0.5	
6.	0.0	0.0	0.0	0.0	0.0	23.0	97.0	0.0	53.0	0.0	0.5	0.0	
7.	0.0	0.0	0.0	0.0	0.0	86.0	76.5	1.0	13.3	1.5	0.0	0.0	
8.	0.0	0.0	0.0	0.0	1.0	3.5	43.5	3.5	10.0	0.0	0.5	0.0	
9.	0.0	0.0	0.0	0.0	0.0	1.0	64.0	1.5	0.5	0.5	4.0	0.0	
10.	0.0	0.0	0.0	0.0	0.0	0.5	96.0	0.0	0.5	0.0	17.5	0.0	
11.	0.0	0.0	0.0	0.0	0.0	0.0	54.5	1.5	0.0	0.0	15.0	0.0	
12.	0.0	0.0	0.2	0.0	0.0	0.0	26.5	2.0	0.5	0.0	10.5	0.0	
13.	0.0	0.0	5.5	0.0	0.0	0.0	23.5	0.0	0.3	28.0	0.0	0.0	
14.	0.0	0.0	0.0	0.0	0.0	0.0	32.0	0.0	0.0	9.5	0.0	0.0	
15.	0.0	0.0	0.0	0.0	0.0	0.0	59.5	0.0	0.0	0.0	0.0	0.0	
16.	0.0	0.0	0.0	0.0	0.0	0.0	127.0	3.0	0.0	0.0	26.0	0.0	
17.	0.0	0.0	0.5	0.0	0.0	7.5	62.0	24.0	0.0	0.0	5.5	0.0	
18.	0.0	0.0	0.0	0.0	43.0	0.5	87.5	11.0	0.0	0.0	0.0	0.0	
19.	0.0	0.0	0.0	0.0	0.5	0.0	47.5	20.4	9.0	0.0	0.0	0.0	
20.	0.0	0.0	0.0	0.0	4.0	4.5	56.0	21.0	0.0	0.0	31.5	0.0	
21.	0.0	0.0	0.0	0.0	0.0	5.5	4.5	1.0	0.5	0.0	0.0	0.0	
22.	0.0	0.0	0.0	0.0	0.0	0.5	3.5	10.6	2.5	0.0	0.5	0.0	
23.	0.0	0.0	0.0	0.0	0.0	7.5	8.0	1.0	0.0	0.0	0.0	0.0	
24.	0.0	0.0	0.0	0.0	0.0	9.0	14.5	4.0	0.0	0.0	0.0	0.5	

25.	0.0	0.0	11.5	0.0	0.0	3.0	2.5	17.2	25.5	0.0	0.0	0.0	
26.	0.0	0.0	0.0	0.0	3.0	13.0	0.0	6.8	0.0	0.0	0.0	0.0	
27.	0.0	0.0	0.0	0.0	0.0	4.5	11.0	6.2	4.5	0.0	0.0	0.0	
28.	0.0	0.0	0.0	23.0	0.0	8.5	18.5	2.0	2.0	0.0	0.0	0.0	
29.	0.0		0.0	10.5	36.0	1.5	53.5	1.0	0.5	0.0	0.0	0.0	
30.	0.0		16.5	0.0	15.5	1.0	59.5	0.5	41.0	9.5	0.0	0.0	
31.	0.5		0.0		0.0		16.5	1.5		0.0		0.0	
Total	0.5	0.0	34.2	35.5	103.0	194.0	1404.6	161.9	321.6	190.5	111.5	1.4	2558.7

Year - 2010

Sl. Nos.	Talluk Name	Annual Rain Fall (mm)
1.	Tirthahalli	1338.2
2.	Agrahara	837.0
3.	Agumbe	897.8
4.	Mandagadde	895.2
5.	Malur	757.9

Year - 2011

Sl. Nos.	Talluk Name	Annual Rain Fall (mm)
1.	TIRTHAHALLI	3461.3
2.	AGRAHARA	2847.1
3.	AGUMBE	5425.0
4.	MANDAGADDE	1769.1
5.	MALUR	2506.4

Year - 2012

Sl. Nos.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual (mm)
1.	0.00	0.00	0.00	0.00	0.00	0.00	22.10	7.80	47.30	13.00	8.10	0.00	
2.	0.00	0.00	0.00	2.10	0.30	0.10	46.20	8.40	1.20	6.40	67.50	0.00	
3.	0.00	0.00	0.00	2.10	0.00	0.10	8.50	34.70	38.90	13.30	6.60	0.00	
4.	0.00	0.00	0.00	0.00	0.00	0.30	1.50	58.40	1.90	6.80	3.80	0.00	
5.	0.00	0.00	0.00	0.50	0.00	17.10	8.50	35.40	4.80	4.20	0.00	0.00	
6.	0.00	0.30	0.00	0.00	0.00	6.80	1.50	97.90	9.30	0.30	0.20	0.00	
7.	0.00	0.00	0.00	0.00	0.00	8.20	6.30	92.70	8.80	0.00	0.00	0.00	
8.	0.00	0.00	0.00	0.00	0.00	3.00	21.90	40.90	11.30	0.00	0.00	0.00	
9.	0.30	0.00	0.00	1.30	0.00	2.90	10.60	21.30	3.00	0.00	0.30	0.00	
10.	0.00	0.00	0.00	0.00	0.00	16.70	14.10	13.10	12.80	0.00	2.00	0.00	
11.	0.00	0.00	0.00	0.00	4.70	0.90	10.80	40.90	35.30	0.00	0.00	0.00	
12.	0.00	0.00	0.00	0.50	0.00	9.90	11.90	59.70	22.70	0.00	2.40	0.00	
13.	0.00	0.00	0.00	0.00	0.00	14.00	7.20	50.30	16.20	0.00	0.00	0.00	
14.	0.00	0.00	0.00	2.10	0.00	1.70	0.60	7.50	2.80	0.00	0.00	0.30	
15.	0.00	0.00	0.00	0.10	0.20	2.10	7.70	23.90	7.60	0.00	0.00	0.00	
16.	0.00	0.00	0.00	19.90	0.00	0.10	12.60	2.40	7.60	0.00	0.00	0.00	
17.	0.00	0.00	0.00	0.10	0.00	9.00	6.50	4.70	5.60	0.00	0.00	0.00	
18.	0.00	0.00	0.00	6.70	0.00	62.10	11.70	1.50	3.10	0.00	0.00	0.00	
19.	0.00	0.00	0.00	3.40	0.00	32.00	14.70	3.40	0.50	0.00	0.00	0.00	
20.	0.00	0.00	0.00	0.00	0.00	42.10	15.10	0.70	0.00	0.00	0.00	0.00	
21.	0.00	0.00	0.00	0.60	0.00	3.70	55.30	0.70	0.10	8.30	0.00	0.00	
22.	0.00	0.00	0.00	0.00	0.00	17.70	82.00	0.30	0.00	0.10	0.00	0.00	
23.	0.00	0.00	0.00	0.10	0.00	6.30	24.10	0.80	0.00	0.00	0.00	0.00	
24.	0.00	0.00	0.00	0.00	0.00	23.50	38.00	0.00	0.00	0.00	0.00	0.00	
25.	0.00	0.00	0.00	12.60	0.00	28.70	7.10	0.00	0.20	0.00	0.00	0.00	
26.	0.00	0.00	0.00	26.30	0.00	4.90	47.10	15.00	0.00	0.30	0.00	0.00	

27.	0.00	0.00	0.00	4.10	0.00	22.90	104.50	12.20	0.00	0.00	0.00	0.00	
28.	0.00	0.00	0.00	8.70	0.00	11.00	32.00	3.50	0.00	0.00	0.00	0.00	
29.	0.00		0.00	0.70	0.00	12.30	19.50	65.90	0.90	0.10	0.00	0.00	
30.	0.30		0.00	0.00	0.10	32.37	8.90	21.70	3.40	0.00	0.00	0.00	
31.	0.00		0.00		0.00		4.60	36.00		0.00		0.10	
Total	0.60	0.30	0.00	91.90	5.30	392.47	663.10	761.70	245.30	52.80	90.90	0.40	2304.77

Year - 2013

Sl. Nos.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual (mm)
1.	1.83	0	0	0	0	14.4	12.15	67.12	0	0.37	0	0	
2.	0	0	0	0	0	3.36	42.6	87.15	0.06	0.24	0	0	
3.	0	0	0	0	0.85	0.9	227.45	17.56	0.33	0	2.59	3.73	
4.	0.28	0	0	0	0	1.01	118.59	29.49	3.87	0.28	0.28	0.01	
5.	0.01	0	0	0	0	0	33.92	10.55	3.42	2.73	0.28	0	
6.	0	0	0	0	0.06	0.27	68.52	11.53	5.48	31.18	0	0	
7.	0	0	0	0	0	0.72	34.42	16.16	1.65	0.14	0	0	
8.	0	0	0	0.01	0	16.97	14.65	18.91	6.82	0.06	0	0	
9.	0.01	0	0	0	4.4	15.03	6.6	7.62	1.26	0.01	0	0	
10.	0	1.63	0	0	0	17.4	22.15	5.14	2.87	0.01	0	0	
11.	0	0	0	0	0	35.9	38.85	20.93	3.6	0.34	0	0	
12.	0	0	0	0	0	8.11	57.95	4.92	1.21	0.01	0	0	
13.	0	0	0	0	0	7.71	14.31	9.91	0.63	6.55	0	0	
14.	0	0	0	0	0	63.78	7.92	29.52	2.86	4.8	0.01	0	
15.	0	3.27	0	0	0	15.88	14.82	9.75	2.46	0.04	0	0	
16.	0	0.12	0	0	0	28.5	26.1	20.65	0	0	0	0	
17.	0	18.46	0.01	0	0	27.3	39.06	54.89	6.74	15.05	0	0	

18.	0	0.58	0	0	0	31.68	76.28	34.14	107.25	1.51	0	0	
19.	0	0	0	0	0.84	13.07	67.59	8.6	6.95	12.15	0	0	
20.	0	0	0.03	0	0	17.74	106.14	24.68	42.67	0.08	0	0	
21.	0	0	0	0	4.84	5.17	36.27	24.33	25.24	0	0	0	
22.	0	0	0	0	0	28.63	37.95	15.84	13.1	0	0	0	
23.	0	0	0	0	0	9.68	69.35	45.97	0.85	1.14	0	0	
24.	0	0	0	0	0	59.83	49.13	5.79	9.76	32.58	0	0	
25.	0	0.01	0	0.82	0.01	57.16	59.61	10.9	3.88	0.5	0.28	0	
26.	0	0	0	2.1	0	53.57	64.96	2.81	0.18	3.36	0.03	0	
27.	0	0	0	0	0	26.03	25.69	0.59	0.02	0.31	0.48	0	
28.	0.01	0.01	0	0	7.62	18.85	46.43	1.69	0.03	0.02	0.01	0	
29.	0		0	7.38	14.88	7.95	46.79	3.72	0.02	0.04	0	0	
30.	0		0	0.48	0	2.37	12.79	0.34	4.77	0.32	0	0	
31.	0		0		3.15		32.98	3.45		0		0	
Total	2.14	24.08	0.04	10.79	36.65	588.97	1512.02	604.65	257.98	113.82	3.96	3.74	3158.84

Year - 2014

Sl. Nos.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual (mm)
1.	0	0	0	0	0.35	0	0	129.32	22.85	22.74	0	0	
2.	0	0	0	0.09	6.81	0.02	9.53	62.09	17.79	9.6	0	0	
3.	0	0	0	0	0	4.43	0.89	20.74	20.15	0.02	0	0	
4.	0	0	0	0.02	0.2	0.53	4.1	37.7	13.64	0.01	0	0	
5.	0	0	0	0	0	0	0.58	82.49	16.08	0	0.01	0	
6.	0.01	0	0	0	2.61	0	0.5	111.26	18.08	5.42	0	0	
7.	0	0	0	0	3.97	0	1.53	57.04	46.79	1.78	0.01	0	
8.	0	0	0	0.06	23.14	0	15.11	44.58	9.44	0.02	0	0	
9.	0	0	0	0	33.05	0.35	6.59	11.74	7.02	0.21	0	0	

10.	0	0	0.06	0	0.02	2.16	18.94	16.52	2.2	2.45	0	0.93	
11.	0	0	0.02	0	0	2.85	9.41	9.32	4.13	5.53	0	0.59	
12.	0	0	0.35	0	0	13.69	18.11	17.87	3.27	21.37	0	1.17	
13.	0	0	0	0	0.01	11.91	56.09	15.12	0.67	0.01	0	24.41	
14.	0	0	0	0	0	2.93	133.9	4.78	2.11	0.01	0.22	9.02	
15.	0	0	0	0	0.02	27.3	42.85	6.78	0.01	0	14.09	0.35	
16.	0	0	0	0.12	0	0.93	80.12	4.14	0.76	0	0.01	0	
17.	0	0	0	0	0	36.45	22.18	16.98	2.17	0	0	0	
18.	0	0	0	0	0	10.61	25.29	1.56	0	0	0	0	
19.	0	0	0	1.43	0	41.52	62.41	0.37	0.58	0	0	0	
20.	0	0	0.01	0.53	0.66	44.98	20.14	1.76	1.9	0.17	0	0	
21.	0	0	0	0	0	54.15	46.43	3.4	2.33	0.07	0	0	
22.	0	0	0	0	0.1	69.65	94.09	4.95	0.64	0	0	0	
23.	0	0	0	0	0	28.26	77.77	42.41	0.25	0	0	0	
24.	0	0	0	0	0	7.98	55.72	0.36	0.12	0.12	0	0.01	
25.	0	0	0.01	0.36	0.05	0.64	45.13	4.29	1.81	19.93	0	0	
26.	0	0.68	0	0.35	0	0	56.3	16.2	30.87	16.61	0	0.01	
27.	0	0.01	0	7.15	0.06	0	16.84	20.19	7.43	1.67	0.01	0	
28.	0	0	0	0.65	0.13	0	36.81	15.28	0	2.85	0	0	
29.	0		0	0	0.18	0	17.95	30.24	15.34	0.01	0	0	
30.	0		0	29.9	15.4	0	29.83	16.01	36.44	0	0	0	
31.	0		0		0.01		89.32	43.34		0.01		0	
Total	0.01	0.69	0.45	40.66	86.77	361.34	1094.46	848.83	284.87	110.61	14.35	36.49	2879.53

Year - 2015

Sl. Nos.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual (mm)
1.	0	0	0	0.66	0.0	0.1	2.8	13.7	0.3	10.6	2.5	0.0	
2.	0	0.01	0.57	6.54	0.0	0.0	7.2	11.1	0.0	8.0	0.4	0.0	
3.	0	0	0.28	0.13	0.0	0.1	8.1	10.9	0.5	0.1	24.8	0.0	
4.	0.58	0	0	0.04	0.0	0.0	9.4	8.6	1.1	0.1	0.3	0.0	
5.	0.28	0	0	0.01	1.7	0.4	1.4	33.9	0.6	6.2	7.6	0.0	
6.	0	0	0	0	9.8	0.4	0.2	51.4	0.1	15.1	0.2	0.0	
7.	0	0	0	0	0.0	0.0	0.7	55.1	2.8	15.0	0.1	0.0	
8.	0	0	0.17	0	6.6	4.3	13.1	14.7	2.3	2.5	0.0	0.0	
9.	0	0	7.44	0	0.0	9.9	16.9	8.4	2.0	0.0	0.0	0.0	
10.	0.28	0	20.5	0.04	6.4	8.3	45.0	12.2	2.7	0.1	0.0	0.0	
11.	0	0	0.01	0	0.0	0.0	14.9	17.8	8.7	0.0	0.0	0.0	
12.	0	0	0	0.04	3.4	3.1	24.7	24.9	0.2	1.1	0.0	0.0	
13.	0	0	0	0.5	13.9	0.2	3.1	22.0	3.6	0.0	0.0	0.0	
14.	0	0	0	0.82	13.3	18.1	4.0	15.0	18.0	0.8	0.0	0.0	
15.	0	0	1.69	0	0.0	16.7	1.8	13.1	31.5	0.0	0.0	0.0	
16.	0	0.08	0	0.07	13.5	1.3	10.6	8.0	32.0	0.0	0.0	0.0	
17.	0	0.17	0	0	31.5	6.2	24.1	4.0	4.0	0.0	0.0	0.0	
18.	0	0	0	0.03	0.3	18.5	30.4	1.4	21.8	0.0	0.0	0.0	
19.	0	0	0	0	0.0	19.7	21.6	0.4	7.4	0.0	0.0	0.0	
20.	0	0	0	0.03	0.0	50.3	68.9	5.4	3.9	0.0	0.0	0.1	
21.	0	0	0	0	0.0	66.4	11.1	0.0	2.4	0.1	1.0	0.1	
22.	0	0	0	0	0.0	94.4	22.4	6.7	0.0	0.0	0.0	0.0	
23.	0	0	0	0	0.0	66.7	12.6	9.5	0.4	0.1	0.0	0.0	
24.	0.01	0	0	14.75	0.0	87.3	7.4	2.8	0.0	0.0	0.0	0.0	
25.	0.01	0	0	0.03	0.0	56.1	3.1	4.4	0.0	0.0	0.0	0.1	
26.	0.01	0	2.32	0	0.0	50.8	11.5	4.1	0.2	0.0	0.0	0.0	

27.	0.01	0	0.53	1.11	0.0	8.5	11.1	21.0	0.0	0.0	0.0	0.0	
28.	0.01	0	0	0.32	0.0	12.3	5.8	8.1	1.0	0.0	0.0	0.0	
29.	0		0	3.72	0.0	4.7	3.7	2.2	1.3	0.0	0.0	0.0	
30.	0		0	0	25.1	1.7	2.9	8.3	2.9	0.2	0.0	0.0	
31.	0		13.69		0.0		14.3	0.3		1.0		0.0	
Total	1.19	0.26	47.2	28.84	125.5	606.5	414.6	399.3	151.4	61.0	36.9	0.3	1872.95

Year - 2016

Sl. Nos.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual (mm
1.	0.0	0.0	0.0	0.0	0.0	0.0	49.9	9.5	10.1	0.5	0.0	0.0	
2.	0.0	0.0	0.0	0.0	0.0	1.6	23.5	4.6	5.3	0.4	0.1	0.0	
3.	0.0	0.0	0.0	0.0	0.0	9.0	36.1	17.5	3.1	0.0	6.1	0.0	
4.	0.0	0.0	0.0	0.0	0.0	5.6	56.8	30.4	7.9	0.0	0.0	0.1	
5.	0.0	0.0	0.0	0.0	0.0	0.0	63.0	40.9	1.8	0.1	0.0	0.0	
6.	0.0	0.0	0.0	0.0	0.0	0.1	18.1	17.6	3.0	0.1	0.0	0.0	
7.	0.0	0.0	0.0	0.5	0.0	0.2	8.7	21.7	2.8	0.1	0.0	0.0	
8.	0.0	0.0	0.0	0.0	0.0	0.6	4.2	23.9	2.0	0.1	0.0	0.0	
9.	0.0	0.0	0.0	0.0	0.0	33.0	6.3	20.2	0.2	4.4	0.0	0.0	
10.	0.0	0.0	0.0	0.0	0.0	8.2	5.1	10.6	0.0	6.3	0.0	0.0	
11.	0.0	0.0	0.0	0.0	0.0	12.1	20.9	5.1	0.0	13.6	0.0	0.0	
12.	0.0	0.0	0.0	0.0	1.4	9.8	12.6	17.5	0.2	3.4	0.0	0.0	
13.	0.0	0.0	0.0	0.0	18.4	18.3	9.2	11.3	0.0	0.1	0.0	0.0	
14.	0.0	0.0	0.0	0.0	0.0	7.9	8.9	10.3	3.1	9.7	0.0	0.4	
15.	0.0	0.0	0.0	0.0	4.1	1.3	4.8	8.4	4.2	0.2	20.0	1.6	
16.	0.0	0.0	0.0	0.3	0.0	2.4	3.8	12.7	2.8	0.0	28.9	0.0	
17.	0.0	0.0	0.0	0.0	7.6	0.4	4.1	8.2	6.0	0.1	0.0	0.0	
18.	0.0	0.0	0.0	0.0	28.2	0.1	2.2	11.7	5.2	0.0	0.0	0.0	

19.	0.2	0.0	0.0	0.0	0.4	0.1	3.6	10.3	5.1	0.0	0.0	0.0	
20.	2.3	0.0	0.0	0.0	0.7	0.4	6.3	2.9	3.5	0.0	0.0	0.0	
21.	0.0	0.0	0.0	0.0	0.0	32.8	22.5	1.0	5.8	0.1	0.0	0.0	
22.	0.0	0.0	0.0	0.0	0.0	20.7	13.4	15.9	1.1	0.1	0.0	0.0	
23.	0.0	0.0	0.0	0.0	0.0	12.2	20.6	7.7	2.2	0.3	0.1	0.0	
24.	0.0	0.0	0.0	0.0	0.0	8.4	6.7	12.2	9.8	0.0	0.0	0.0	
25.	0.0	0.0	0.0	0.0	0.0	10.2	8.7	13.8	8.9	0.0	0.1	0.0	
26.	0.0	0.0	0.0	0.0	0.0	14.8	2.3	1.6	23.2	0.0	0.0	0.0	
27.	0.0	0.0	0.0	0.0	0.0	55.0	0.2	17.3	3.3	0.0	0.0	0.0	
28.	0.0	0.0	0.0	0.0	0.0	51.9	7.8	4.7	0.0	0.0	0.0	0.0	
29.	0.0	0.0	0.0	0.0	0.0	109.3	1.9	6.9	0.5	0.0	0.1	0.0	
30.	0.0		0.0	0.0	0.0	63.0	7.0	1.3	0.0	0.2	0.1	0.0	
31.	0.0		0.0		0.0		10.2	1.7		0.0		0.0	
Total	2.5	0.0	0.0	0.9	60.7	489.2	449.4	379.0	120.9	39.7	55.3	2.2	1599.8

Year - 2017

Sl. Nos.	Village Name	Annual Rain Fall (mm)
1.	BHADRAVATHI HOBLI	794.76
2.	BHADRAVATHI (2) HOBLI	840.55
3.	HOLEHONNURU (1) HOBLI	703.9
4.	HOLEHONNURU (2) HOBLI	775.9
5.	HOLEHONNURU (3) HOBLI	651.84
6.	KUDALIGERE HOBLI	690.86
7.	HOSANAGAR HOBLI	2034.97
8.	HUNCHA HOBLI	1906.26
9.	KEREHALLI HOBLI	1262.49
10.	NAGAR HOBLI	3739.24
11.	SAGAR HOBLI	1308.75

12.	ANANDAPURAM HOBLI	1127.7
13.	BARAGADDE HOBLI	3449.46
14.	ANAHALLI HOBLI	1456.17
15.	KARAURU HOBLI	3400.49
16.	TALGUPPA HOBLI	1786.29
17.	SHIKARIPUR HOBLI	810.17
18.	ANJANAPURA HOBLI	779.88
19.	HUSURU HOBLI	696.67
20.	UDAGANI HOBLI	892.95
21.	TALAGUNDA HOBLI	909.04
22.	SHIMOGA (1) HOBLI	700.99
23.	SHIMOGA (2) HOBLI	885.61
24.	HARANAHALLI HOBLI	899.22
25.	HOLALUR (1) HOBLI	725.05
26.	HOLALUR (2) HOBLI	724.88
27.	KUMSI HOBLI	851.82
28.	NIDIGE HOBLI	880.38
29.	NIDIGE (2) HOBLI	906.61
30.	SORAB HOBLI	1097.95
31.	ANAVATTI HOBLI	764.7
32.	CHANDRAGUTTI HOBLI	1473.96
33.	JADE HOBLI	774.04
34.	KUPPAGADDE HOBLI	897.61
35.	ULVI HOBLI	1116.89
36.	TIRTHAHALLI HOBLI	2754.55
37.	AGRAHARA HOBLI	2188.17
38.	AGUMBE HOBLI	3805.57
39.	MANDAGADDE HOBLI	1389.22
40.	MALUR HOBLI	1854.59
	Total (average annual rain fall)	1367.753

3. Uttar Kannada District

Year - 2009

Sl. Nos.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual (mm)
1.	0	0	0	0	0	0	5	0	0	20	0	0	
2.	0	0	0	0	0	0	10	3	2.5	12	0	0	
3.	0	0	0	5	0	0	14.5	2	2.5	45.5	0	0	
4.	0	0	0	0	0	0	32	0.5	22.5	3	0	0	
5.	0	0	0	0	0	0	34	0	20.5	0.5	0	0	
6.	0	0	0	0	0	0	7.5	0.5	42.5	0	0	0	
7.	0	0	0	0	0	0	7	0	0.5	0	0	0	
8.	0	0	0	52.5	0	0	16.5	0	4	0	0	0	
9.	0	0	0	28	0	0	35.5	0	0	0	0.5	0	
10.	0	0	0	0	0	0	30	1	17	0	2.5	0	
11.	0	0	0	0	0	2.5	3.5	0.5	0	0	18.5	0	
12.	0	0	0	0	0	2.5	11.5	9	7.5	4.5	34	0	
13.	0	0	1	0	0	114	4.5	1.5	0	9	0	0	
14.	0	0	1	5.5	0	114	15	0	0	12.5	0	0	
15.	0	0	0	0	0	4.5	71.5	8.5	11.5	0	0	0	
16.	0	0	0.5	0	0	4.5	27.5	3.5	0.5	0	7	0	
17.	0	0	2.5	0	0.5	0	11	7.5	30	0	1.5	0	
18.	0	0	0	0	6	0	5	8.5	0	0	0	0	
19.	0	0	7	0	0	0	7.5	2	0	0	0	0	
20.	0	0	18	0	0.5	0	8	0	0.5	0	4	0	
21.	0	0	0	0	4	0		4.5	13.5	0	0.5	0	
22.	0	0	0	0	28.5	0		13	1	0	0	0	
23.	0	0	0	0	0	0		5	0	0	0	0	
24.	0	0	0	0	0	0		2.5	0	0	0	0	
25.	0	0	1	0	0	0			7.5	0	0		

26.	0	0	0	0	0	0			0	0	0		
27.	0	0	0	0	0	0			0	0	0		
28.	0	0	0	2.5	0	0			2.5	0	0		
29.	0		0	6.5	8	1			33	0	0		
30.	0		1	2.5	0	1			14.5	0	0		
31.	0		0		0	0				0			
Total	0	0	32	102.5	47.5	244	357	73	234	107	68.5	0	1265.5

Year - 2010

Sl. Nos.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual (mm)
1.	0	0	0	0	0	0	2.5	6	5.5	7	0	0	
2.	0	0	0	0	0	0	31.5	5.5	4.5	0	0	0	
3.	0	0	0	0	6	0	5.5	5.5	3	48.5	7.5	0	
4.	0	0	0	0	0	0	14.5	27	14	26	2	0	
5.	0	0	0	0	0	0	4	0	8	27	27.5	0	
6.	0	0	0	0	0	0	13	0.5	17	1.5	0.5	0	
7.	0	0	0	0	0	0	2.865	0	3.5	12.5	1.5	0	
8.	0	0	0	0	9	8.488	0	2.5	10	0	12.5	0	
9.	10.64	0	0	8.998	2.845	0.5	11	6.694	5.059	3.5	21.5	0	
10.	0	0	0	26.13	0	22	3.5	0	2	3	0	0	
11.	0	0	0	0	0	2.5	23.5	5.5	6	0	0	2.5	
12.	0	0.5	0	0	0	0	22.5	0.5	0.5	0	0.5	0.5	
13.	0	0	0	0	0	6.5	12	0	0	0	1.5	0	
14.	0	0	0	0	0	47.5	35	10.5	0.5	0	0	0	
15.	0	0	0	0	0	14.5	8	5	0	0	0	0	
16.	0	0	0	0	0	20.5	39.5	12	11.76	7	0	0	
17.	0	0	0	13	0	36	40.5	0.5	1	4.5	0	0	
18.	0	0	0	0	0	17	19.5	11.5	4.5	4	0	0	

19.	0	0	0	0	0	5	24	2.5	7	0.5	0	0	
20.	0	0	0	0	0.5	0.5	20	0	2.058	0.5	0	0	
21.	0	0	0	0	4	0	10.5	0.5	0	0	0	0	
22.	0	0	0	0	28.5	0		6	20	0	0	0	
23.	0	0	0	14	0	0.5		0	0	0	0	0	
24.	0	0	0	0	0	11.5		4	33.5	16	2.5	0	
25.	0	0	0	0.5	0	10		0.5	0	0	0	0	
26.	0	0	0	0	0	2		16	0.5	0.5	0	0	
27.	0	0	0	0	0	0.5		1	3.5	0	0	0	
28.	0	0	0	0.5	0	2.5		3	6	0	0	0	
29.	0		0	34.5	8	0.5		2	1	0	0	0	
30.	0		0	11	0	1		8.5	0	0	0	0	
31.	0	0	0		0	0		18.5		0		0	
Total	10.64	0.5	0	108.628	58.845	209.488	343.365	161.694	170.377	162	77.5	3	1306.04

Year - 2011

Sl. Nos.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual (mm)
1.	0	0	0	0	0	0	3.5	5	27.5	2	0	0	
2.	0	0	0	0	0	0.5	34	4.5	45	0	0	0	
3.	0	0	0	0	0	19	7.5	17	38	1	0	0	
4.	0	0	0	0	0	24	6	27.5	8.5	0	0	0	
5.	0	0	0	0	0	16.5	8	13.5	2	0	0	0	
6.	0	0	0	0	0	3.5	0	6	3.5	0	0	0	
7.	0	0	0	0	0	14.5	3.5	10	4.5	0	0	0	
8.	0	0	0	0	0	1.5	21	9	7	9.5	0	0	
9.	0	0	0	0	0	3.5	4.8	7	9	0	0	0	
10.	0	0	0	50	0	32.5	0.5	2.5	0	2	0	0	
11.	0	0	0	0	0	31.5	5	2.5	0	10	0	0	

12.	0	0	0	0	0	0.5	0.5	2	4.5	0	0	0	
13.	0	0	0	1	0	1	12.5	8.5	0	25.5	0	0	
14.	0	0	0	0	0	4	2.5	0	17	7	0	0	
15.	0	0	0	4.5	0	13.5	6	3	8.5	3	0	0	
16.	0	0	0	22	0	16	21.5	14.5	7.3	0	0	0	
17.	0	0	0	0	0	22.5	68	2	1	25.5	0	0	
18.	0	0	0	25.5	3.5	66	36	0.5	2.5	0	0	0	
19.	0	0	0	0	0	0	32.5	28	6.5	0	0	0	
20.	0	0	0	0	0	1	5.5	3.5	0.5	4	0	0	
21.	0	0	0	0	0	1.5	6	20	1	0	0	0	
22.	0	0	0	0	0	14.5	0.5	0	0	0	0	0	
23.	0	0	0	0	0	55	7.5	0	0	0	0	0	
24.	0	49.5	0	0	0	16.5	15	9.2	0	0	0	0	
25.	0	0	0	0	0	5.5	2	5.1	0	0	0	0	
26.	0	0	0	0	0	10	0	2.4	0	2.5	0	0	
27.	0	0	0	0	65	9	6.5	4	0	0	0	0	
28.	0	0	0	0	0	6.5	3	4	0	3	0	0	
29.	0		0	0	0	2	6.5	25	0	0	31	0	
30.	0		0	0	13	0	5.5	30	0	1.5	47.5	0	
31.	0		0		0.5	0	14	6.5		0		0	
Total	0	49.5	0	103	82	392	345.3	272.7	193.8	96.5	78.5	0	1613.3

Year - 2012

Sl. Nos.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual (mm)
1.	0	0	0	0	0	0	3	1.5	7.5	22.5	0	0	
2.	0	0	0	9	0	0	4	0	3	0	30	0	
3.	0	0	0	0	0	0	36	19.5	4	10	14.5	0	
4.	0	0	0	0	0	0	8.5	45.5	24.5	4	1	0	

5.	0	0	0	2	0	1	2	27	1.5	0.5	0	0	
6.	0	0	0	0	0	3.5	2.5	14	0.5	3.5	0	0	
7.	0	0	0	0	0	22	9.5	22	11	0.5	0	0	
8.	0	0	0	0	0	0	5	6	7	0	0	0	
9.	0	0	0	0	0.5	4.5	0	6.5	2	0	0	0	
10.	0	0	0	0	0	0	1.5	10	0	0	1	0	
11.	0	0	0	1.5	0	0	0	22.5	4	0	0	0	
12.	0	0	0	0	11	0.5	2.5	15	0.5	0	0	0	
13.	0	0	0	0	0	4	0.5	14.5	2	0	0	0	
14.	0	0	0	0	0.5	0	0	3	0	0	0	0	
15.	0	0	0	0	0	8.5	0.5	1	0.5	0	0	0	
16.	0	0	0	0	0	3	0.5	1	0	0	0	0	
17.	0	0	0	8	0	3	0	1	1	0	0	0	
18.	0	0	0	0	0	26	37.5	1	12.5	0	0	0	
19.	0	0	0	26.5	0	9	6	1	0	0	0	0	
20.	0	0	0	0	0	0	1	2	0	0	0	0	
21.	0	0	0	0	0	0	14	11.5	0	0	0	0	
22.	0	0	0	0	0	3	4	2	0	0	0	0	
23.	0	0	0	0	0	0	4	13	0	0	0	0	
24.	0.5	0	0	0	0	12.5	2.5	2	0	0	0	0	
25.	0	0	0	0	0	16.5	2	0	0	0	0	0	
26.	0	0	0	0	0	1	9	15.5	0	0	0	0	
27.	0	0	0	0	0	11.5	101	0.5	0	0	0	0	
28.	0	0	0	0	0	5	1	4	14.5	0	0	0	
29.	0	0	0	0	0	2.5	0.5	13	0.5	0	0	0	
30.	0		0	0	0	29.5	1.5	4	17.5	0	0	0	
31.	0		0		0	0	0.5	2.5		0		3	
Total	0.5	0	0	47	12	166.5	260.5	282	114	41	46.5	3	973

Year - 2013

Sl. Nos.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual (mm)
1.	1.5	0	0	0	2	6	9.5	54.5	0	1.5	0	0	
2.	13.5	0	0	0	0	0	5	21	0	0	0	0	
3.	0	0	0	0	2	0.5	81	10	0	0	0	0	
4.	0	0	0	0	0	0	0.5	3.5	0	1	0	0	
5.	0	0	0	0	0	0	10	2.5	0	2.5	0	0	
6.	0	0	0	0	0	20	9.5	1	0	29.5	0	0	
7.	0	0	0	0	0	0	4	0	11.5	0	0	0	
8.	0	0	0	0	0	6.5	3	1	1	0	0	0	
9.	0	0	0	0	0	5.5	1.5	1	5	0	0	0	
10.	0	0	0	0	0	4	2	1	2.5	0	0	0	
11.	0	0	0	0	0	4.5	11.5	4.8	3.5	0	0	0	
12.	0	0	0	0	0	3	30.5	1.5	1	0	0	0	
13.	0	0	0	0	0	1.5	14.5	3	6.5	0	0	0	
14.	0	0	0	0	0	6	8	3.5	0	0	0	0	
15.	0	0	0	0	0	7.5	2	2	0	0	0	0	
16.	0	0.5	9.5	0	0	3.5	3	1	1.5	0	0	0	
17.	0	5	0	0	0	2.5	5	10.5	25.5	0	0	0	
18.	0	0	0	0	0	13	17	9	4.5	0	0	0	
19.	0	0	0	0	0	10.5	9.5	4.5	0.5	19.5	0	0	
20.	0	0	0	0	0	1.5	48	7.5	33.5	0	0	0	
21.	0	0	0	0	4.5	11	45.5	1.5	0	0	0	0	
22.	0	0	0	0	0	0.5	24	1	0	0	0	0	
23.	0	0	0	0	0	1.5	42	11	22	7.5	0	0	
24.	0	0	0	0	0	7.5	38.5	8	7.5	25	0	0	
25.	0	0	0	0	0	3	57	2	5.5	0	1.5	0	
26.	0	0	0	2	0	16.5	20.5	1	8	40.5	0	0	

27.	0	0	0	0	0	19.5	26	3	0.5	0	0	0	
28.	0	0	0	0	39.5	4	31.5	0.5	1.5	0	0	0	
29.	0	0	0	0	9.5	0.8	7	1.5	1.5	0	0	0	
30.	0		0	0	26	3.5	9.5	0	3	0	0	0	
31.	0		0		0	0	8	0		0		0	
Total	15	5.5	9.5	2	83.5	163.8	584.5	172.3	146	127	1.5	0	1310.6

Year - 2014

Sl. Nos.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual (mm)
1.	0	0	0	0	6.5	0	0	26	1.5	8.5	0	0	
2.	0	0	0	0	17	0.5	0	21	1	0	0	0	
3.	0	0	0	0	39	8.5	0	3	2	0	0	0	
4.	0	0	0	0	0	0	0	8.5	5	0	0	0	
5.	0	0	0	0	0	0	1	30.5	3	0	0	0	
6.	0	0	0	0	0	0	0	13.5	2	1.5	0	0	
7.	0	0	0	0	0	1.5	0.5	30.5	4.5	2.5	0	0	
8.	0	0	0	0	6	0	18	21	0	0	0	0	
9.	0	0	0	0.5	30.5	1	1	7	3.5	0	0	0	
10.	0	0	0	1	0.5	2	3.5	11	2	0	0	0	
11.	0	0	0	0	0	3	2.5	1.5	0.5	22	0	0	
12.	0	0	1	0	0	5.5	2.5	1	0	6.5	0.5	0	
13.	0	0	0	0	0	0	1.5	2.5	0	0	0	35	
14.	0	0	0	0	0	0.5	4	0.5	0.5	0	11	0	
15.	0	0	0	0	0	35.5	2	0	0	0	51	0	
16.	0	0	0	0	0	1.5	15	1.5	0	0	0	0	
17.	0	0	0	0	0	17.5	3	12	0	0	0	0	
18.	0	0	0	0	2.5	1.5	7.5	0.5	0	0	0	0	
19.	0	0	0	2	8.5	10	10	1	9	0	0	0	

20.	0	0	0	0.5	18.5	15.5	6	0	1	0	0	0	
21.	0	0	0	0	0	7	10	0.5	0	0	0	0	
22.	0	0	0	0	40	0	23.5	2.5	0	0	0	0	
23.	0	0	0	0	0	0.5	31	29	0	0	0	0	
24.	0	0	0	0	0	0	48.5	0.5	0	0	0	0	
25.	0	0	0	5.5	0	0	5	3.5	3	7	0	0	
26.	0	0	0	0.5	0	0	17.5	32.5	0	53.5	0	0	
27.	0	0	0	3.5	0	0	0.5	5.5	16	4	0	0	
28.	0	0	0	0.5	0	0	1.5	10.5	2.5	2	0	0	
29.	0	0	0	0.5	2	0	12	13.5	0	0	0	0	
30.	0		0	1	0	0	11.5	4	5	0	0	0	
31.	0		0	0	0	0	59	3.5		0		0	
Total	0	0	1	15.5	171	111.5	298	298	62	107.5	62.5	35	1162

Year - 2015

Sl. Nos.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual (mm)
1.	0	0	7.5	15	0	2	6.6	26	0	0	14.2	0	
2.	0	0	2	0	0	0	1.3	21	0	9.5	0	0	
3.	0	0	0	0	0	0	0	3	16	1.5	0	0	
4.	0	0	0	0	0	0	0	8.5	0	15.5	2.5	0	
5.	0	0	0	0	5.5	0	0	30.5	0	15.5	0.2	0	
6.	0	0	0	0	36.5	0	0.5	13.5	0	13	0	0	
7.	0	0	0	0	0	0	0	30.5	0	26.5	0	0	
8.	0	0	0	0	1	0	2.5	21	3.5	12	0	0	
9.	0	0	8.5	0	21.5	0	2.5	7	13	0	0	0	
10.	0	0	11.5	0	2	8.1	3	11	0.5	0	0	0	
11.	0	0	0	0	1.5	0	5.5	1.5	1.5	0	0	0	
12.	0	0	0	0	0	0	2.5	1	0.5	0	0	0	

13.	0	0	0	0	47	0	0.5	2.5	5	0	0	0	
14.	0	0	0	0	1	9.4	0	0.5	16	1	0	0	
15.	0	0	0	0	0	23.4	0	0	6.5	0	0	0	
16.	0	0	0	0	6.5	0	0	1.5	2.5	0	0	0	
17.	0	0	0	0	0	0.5	5	12	3	0.2	0	0	
18.	0	0	0	0	4	0	0.5	0.5	1.5	2	0	0	
19.	0	0	0	0	0	14	5	1	0.2	0	0	0	
20.	0	0	0	0	0	10	15.5	0	0	0	0	0	
21.	0	0	0	0	0	12.9	3.5	0.5	0	0	0	0	
22.	0	0	0	0	0	16.5	3	2.5	0	0	0.2	0	
23.	0	0	0	0	0	3	3	29	0	0	0	0	
24.	0	0	7.5	4	0	12.9	4	0.5	0	0	0	0	
25.	0	0	0	0	0	8.4	6.5	3.5	0	0	0	0	
26.	0	0	0	0	0	0.8	1.5	32.5	0	0	0	0	
27.	0	0	0	0	0	2	4	5.5	0	0	0	0	
28.	0	0	0	32	0	0.5	4	10.5	3.8	0	0	0	
29.	0	0	0	0.5	0	0	0.5	13.5	1	0	0	0	
30.	0		0	0	1	0	3	4	0	0	0	0	
31.	0		0		0	0	2.5	3.5		11.2		0	
Total	0	0	37	51.5	127.5	124.4	86.4	298	74.5	107.9	17.1	0	924.3

Year - 2016

Sl. Nos.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual (mm)
1.	0	0	0	0	1.5	0	8.5	3	0.5	0	0	0	
2.	0	0	0	0	0	14	12.5	3	0.5	0	0	0	
3.	0	0	0	0	0	0	4	2.5	7	0	0	0	
4.	0	0	0	0	0	16.5	5.5	16.5	0	0.5	0	0	
5.	0	0	0	0	0	0	32	16.5	0	0	0	0	

6.	0	0	0	0.5	0	0	2	7.5	0	0	0	0	
7.	0	0	0	2.5	0	29	1	8	0.5	0	0	0	
8.	0	0	0	0	0	0	0.5	1.5	0	0	0	0	
9.	0	0	0	0.5	0	27	10	5	0	1.5	0	0	
10.	0	0	0	0	0	4.5	7.5	0.5	0	1.5	0	0	
11.	0	0	0	0	0	0	4	2.5	0	9.5	0	0	
12.	0	0	0	0	7.5	6.5	5	4.5	0	0	0	0	
13.	0	0	0	0	0	0	7	8	0	0	0	0	
14.	0	0	0	0	5	5	1.5	5	0	0	0	0	
15.	0	0	0	0	30	5.5	0.5	3.5	0	0	5.5	0	
16.	0	0	0	0	3.5	0	0	6	2	0	1	0	
17.	0	0	0	0	0	0	0	1	3	0	0	0	
18.	0	0	0	0	0	0	5	1	1	0	0	0	
19.	0	0	0	0	16	0	16.5	1	4.5	0	0	0	
20.	0.5	0	0	0	0	0	1	1.5	9	0	0	0	
21.	0	0	0	0	0	4	7	0.5	0	0	0	0	
22.	0	0	0	0	0	4	7.5	7	3	0	0	0	
23.	0	0	0	0	0	0	5.5	3.5	0.5	0	0	0	
24.	0	0	0	0	0	4.5	6.5	17	1	0	0	0	
25.	0	0	0	0	0	6	8	1.5	13	0	0	0	
26.	0	0	0	0	0	1.5	3	0.5	0	0	0	0	
27.	0	0	0	0	0	4	1	0	0	0	0	0	
28.	0	0	0	0	0	14	1	0	1.5	0	0	0	
29.	0	0	0	0	0	33.5	0.5	8	2	0	0	0	
30.	0		0	0	0	25.5	2.5	0.5	0	0	0	0	
31.	0		0		0	0	2	0		0		0	
Total	0.5	0	0	3.5	63.5	205	168.5	136.5	49	13	6.5	0	646

Year - 2017

Sl. Nos.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual (mm)
1.	0	0	0	0	0	11	2.5	0	19	46.5	0	0	
2.	0	0	0	15	0	0	3	0	0	34.5	0	0	
3.	0	0	0	0	1	5.5	2	2	0	0	0	0	
4.	0	0	0	0	0	0.5	2	7.4	0	4.5	0	0	
5.	0	0	0	0	6.5	0	2	4.8	0	29.5	0	0	
6.	0	0	0	0	1.5	0	1	0.2	0	0	0	1.5	
7.	0	0	0	0	0.5	0	2.5	0.5	0	0.5	0	0	
8.	0	0	0	0	1	1	1.5	0	3.5	0	0	0	
9.	0	0	0	0.5	0.5	0	0	0	0	0	0	0	
10.	0	0	0	0	0.5	2	3.5	0	0	0	0	0	
11.	0	0	0	2.5	0.5	0.5	1.5	0.5	8.5	0.5	0	0	
12.	0	0	0	0	0	19	2.5	0	0	0	0	0	
13.	0	0	0	0	0.5	13.5	1.5	0.5	24	1	0	0	
14.	0	0	0	0	0	1	17.3	0	0.5	14	0	0	
15.	0	0	0	0	56.9	2	1.5	0	3.5	6.5	0	0	
16.	0	0	0	0	0.2	7	10.9	1.5	0	2	0	0	
17.	0	0	0.5	0	0	2	0.8	0	18.5	37	0	0	
18.	0	0	0	0	0	1.5	9.6	10	19	0	0	0	
19.	0	0	0	0	0	0.5	35.8	7	4	0	0	0	
20.	0	0	0	0	0	0	59	3	3.5	0	1	0	
21.	0	0	0	0	0	1.5	6.5	11	7	0	0	0	
22.	0	0	0	0	0.5	1	0	7.5	0.5	0	0	0	
23.	0	0	0	0	0	0.5	0	0	0	0	1.5	0	
24.	0	0	0	0	4.5	3	1	6	0	1.5	0	0	
25.	0	0	0	0	2	3	0	2	3	0	0	0	
26.	0	0	0	0	0	11	0	4	5	0.5	0	0	

27.	0	0	0	0	0	15.5	0	11.5	8	0	0	0	
28.	0	0	0	0	0	2	14.2	4.5	6	0	0	0	
29.	0	0	0	0	0	4	4.8	9.5	16	0	0	0	
30.	0		0	1	0	3	0	14.5	0.5	0	0	0	
31.	0		0		22	0	0.8	3		0		0	
Total	0	0	0.5	19	98.6	111.5	187.7	110.9	150	178.5	2.5	1.5	860.7

Year - 2018

Sl. Nos.	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual (mm)**
1.	0	0	0	0	0	0	0	1	0.5	0.5	0	0	
2.	0	0	0	0	0	7	0.8	5	0	3.5	0	0	
3.	0	0	0	0	0	6	0.8	3	0.5	0	0	0	
4.	0	0	0	0	0	1	0.5	4.5	1	2.5	0	0	
5.	0	0	0	0.5	6.5	0.5	3.8	2	0	0	0	0	
6.	0	0	0	0	0	0	21.5	11.5	0.5	4.5	0	0	
7.	0	0	0	0	0	1	4	5.5	1.5	0	0	0	
8.	0	0	0	0	12.5	5	8.5	5.5	0.5	0	0	0	
9.	0	0	0	0	0	8.5	9.5	7	0	0	0	0	
10.	0	0	0	0	3.5	48	14.5	6.5	0	0	0	0	
11.	0	0	0	2	13	56.5	17	14	0	0	0	0	
12.	0	0	0	0	0	2	14	22	0	0	0	0	
13.	0	0	0	3.5	0	1	35	30.5	0	0	0	0	
14.	0	0	0	30	0.5	1	11.5	11.5	0	0	0	0	
15.	0	0	1	0	1.5	0	11.5	16.5	0	0	0	0	
16.	0	0	1	0.5	0	0	24	13	0	0	0	0	
17.	0	0	0	0	13	1	23	24.5	0	8.5	0	0	
18.	0	0	3	14.5	34.5	2	5	2	1.5	37.5	0	0	

19.	0	0	9	0	0	13	6	8	0	0.5	4	0	
20.	0	0	2.5	0	0	7	5.5	9	0	7.5	0	0	
21.	0	0	0	0	0	2.5	7	13	0	0	0	0	
22.	0	0	0	0	0	0	13.5	15.5	0	0	0	0	
23.	0	0	0	0	0	0	16.5	3.5	0	0	0	0	
24.	0	0	0	0	31	0	12	4	0	0	0	0	
25.	0	0	0	0	0.5	0	4.5	0.5	0	15	0	0	
26.	0	0	0	0	0	1.5	2.5	0.5	1.5	0	0	0	
27.	0	0	0	0	22.5	0.8	7.5	8.5	12	0	0	0	
28.	0	0	0	0	21.5	0	0.5	19.5	19	0	0	0	
29.	0	0	0	0	0	0.8	1.5	2	19.5	0	0	0	
30.	0		0	0	4.5	1	0	6.5	2.5	0	0	0	
31.	0		0	0	0	0	2	2.5		0		0	
Total	0	0	16.5	51	165	167.1	283.9	278.5	60.5	80	4	0	1106.5

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