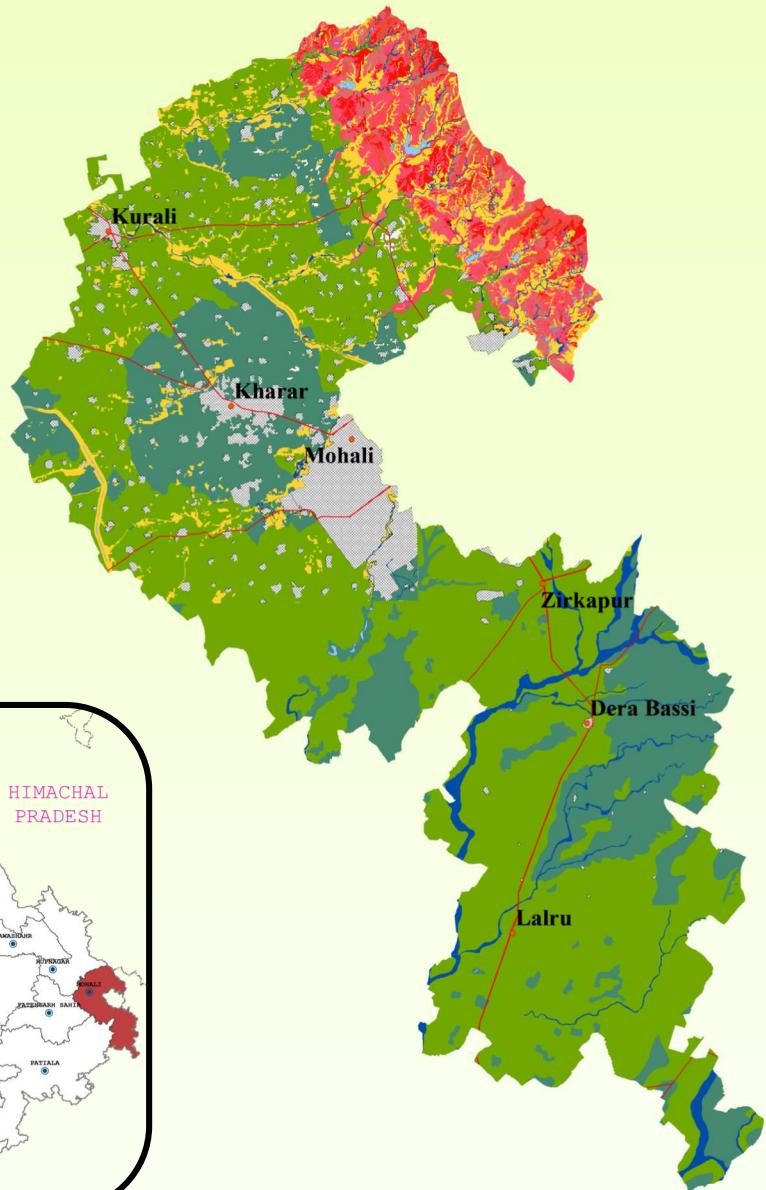


Assessment of Soil Erosion Status In Shivalik Hills of Sahibzada Ajit Singh Nagar, Punjab State



नोएडा केंद्र/Noida Centre



भारतीय मृदा एवं भू-उपयोग सर्वेक्षण Soil and Land Use Survey of India

कृषि, सहकारिता एवं किसान कल्याण विभाग

Department of Agriculture, Cooperation and Farmers Welfare



कृषि एवं किसान कल्याण मंत्रालय

Ministry of Agriculture and Farmers

भारत सरकार

Government of India

PROJECT PERSONNEL

Chief Coordinator	:-	Dr. V. S. Arya <i>Chief Soil Survey Officer</i>
Coordinators	:-	Sh. R. L. Meena <i>Sr. Soil Survey Officer</i> Sh. N. S. Gahlod <i>Asstt. Soil Survey Officer (HQ.)</i>
Co-Coordinators	:-	Dr. Munish Kumar <i>Soil Survey Officer (HQ.)</i> Sh. S. D. Dhargawe <i>Asstt. Soil Survey Officer</i> Sh. Satyendra Kumar <i>Asstt. Field Officer</i> Sh. Ravi Gautam <i>Asstt. Field Officer</i> Dr. Ravi <i>Ex. Field Officer</i>
Team Members	:-	Dr. Sonam Binjola Chamoli <i>Asstt. Field Officer</i> Sh. Manoj Kumar Singh <i>Asstt. Field Officer</i> Sh. Dinesh Kumar Varma <i>Asstt. Field Officer</i> Sh. A. K. Sharma <i>Asstt. Technical officer</i> Sh. Raghvendra Singh <i>Junior Cartographic Asstt.</i> Mrs. Sujata Soren Bhagat <i>Junior Cartographic Asstt.</i>

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GLOSSARY OF ACRONYMS

DEM	Digital Elevation Model
DSS	Detailed Soil Survey
GIS	Geographic Information System
GPS	Global Positioning System
IAM	Image Analysis Map
ISL	Integrated Soils Legend
ISRO	Indian Space Research Organization
LISS-IV	Linear Imaging Self-Scanning System- IV
MIS	Management Information System
MoU	Memorandum of Understanding
NMSA	National Mission for Sustainable Agriculture
NSAL	Nodal Soil Analytical Laboratory
PLPA	Punjab Land Preservation Act
QA/ QC	Quality Assessment/ Quality Check
RDBMS	Relational Data Base Management System
RPI	Runoff Potential Index
RPMU	Runoff Potential Mapping Unit
RPWV	Runoff Potential Weightage Value
RVP	River Valley Project
SHM	Soil Health Management
TSG	Technical Support Group
USLE	Universal Soil Loss Equation

ABSTRACT

- 1. Surveyed Area** : Soil Erosion Mapping in Sub-mountain of Shivalik Hills in Sahibzada Ajit Singh (SAS) Nagar district of Punjab State for identification and mapping of area under different erosion risk categories and prioritization of areas based on Runoff Potential Index.
- 2. Location** : $30^{\circ}23'38''$ to $30^{\circ}45'23''$ North Latitudes
 $76^{\circ}31'20''$ to $76^{\circ}56'23''$ East Longitudes
- 3. Total Area Surveyed** : 1,08,687 ha
- 4. Kind of Survey** : Detailed Soil Survey for Soil Erosion Mapping
- 5. Period of Survey** : April, 2017 to September, 2017
- 6. Agro climatic zone** : 6- Trans Gangetic Plain
- 7. Base Maps** : High Resolution **IKONOS** Satellite data for mapping at 1:5K and SOI Toposheets for 1:50 K scale and Land use /Land Cover data from Forest Dept. Punjab State Cartosat-DEM from BHUVAN portal

8. Soil Erosion Status

S. No.	EROSION CLASS / DESCRIPTION	Area (ha)	Area (%)
1	Slight erosion (Strong sheet erosion)	57278	52.70
2	Slight to Moderate erosion	24422	22.47
3	Moderate erosion (Severe sheet and strong rill erosion)	6483	5.96
4	Moderate to Severe erosion (Severe rill and slight gully erosion)	2758	2.54
5	Severe erosion (Strong Gully erosion)	4078	3.75
6	Severe to Very severe erosion (Severe Gully and Ravine)	1605	1.48
7	Very severe erosion (severe gully to Ravine)	1343	1.24
8	Landslide	21	0.02
9	Miscellaneous Land	10699	9.84
Grand Total		108687	100.00

9. Soil Erosion Risk Categorization

S. No.	Soil Erosion Risk categories / (RPI value)	Area (ha)	Area (%)
1	Very High (above 70)	8270	7.61
2	High (66-70)	1369	1.26
3	Medium (61-65)	5773	5.31
4	Low (56-60)	17743	16.32
5	Very Low (55 & below)	64812	59.63
6	Landslide (LS27)	21	0.02
7	Miscellaneous Area	10699	9.84
GRAND TOTAL		108687	100.00

10. Area of Different Runoff Potential Mapping Units (RPMUs)

S. No.	RPMU	Runoff Potential Mapping unit Weightage	Soil Erosion Risk Category	Area(ha)	Area (%)
1	AC08	67	High	160	0.15%
2	AC02	63	Medium	152	0.14%
3	AC04	63	Medium	232	0.21%
4	AC05	62	Medium	34	0.03%
5	AC01	57	Low	1419	1.31%
6	AC06	57	Low	191	0.18%
7	AC07	57	Low	268	0.25%
8	AC03	55	Very Low	1494	1.37%
9	AL08	59	Low	1525	1.40%
10	AL05	57	Low	907	0.83%
11	AL09	57	Low	1193	1.10%
12	AL06	56	Low	10379	9.55%
13	AL02	55	Very Low	17812	16.39%
14	AL03	54	Very Low	1635	1.50%
15	LS16	94	Very High	192	0.18%
16	LS15	91	Very High	834	0.77%
17	LS24	89	Very High	771	0.71%
18	LS14	88	Very High	802	0.74%
19	LS07	85	Very High	349	0.32%
20	LS25	85	Very High	853	0.78%
21	LS13	82	Very High	1251	1.15%
22	LS05	75	Very High	207	0.19%
23	LS08	74	Very High	630	0.58%
24	LS11	74	Very High	626	0.58%
25	LS02	72	Very High	211	0.19%
26	LS03	72	Very High	324	0.30%
27	LS12	72	Very High	693	0.64%

S. No.	RPMU	Runoff Potential Mapping unit Weightage	Soil Erosion Risk Category	Area(ha)	Area (%)
28	LS29	72	Very High	11	0.01%
29	LS10	71	Very High	516	0.47%
30	LS06	70	High	466	0.43%
31	LS26	70	High	28	0.03%
32	LS09	68	High	242	0.22%
33	LS23	66	High	473	0.44%
34	LS22	63	Medium	196	0.18%
35	LS04	62	Medium	423	0.39%
36	LS19	62	Medium	691	0.64%
37	LS28	62	Medium	70	0.06%
38	LS21	61	Medium	146	0.13%
39	LS01	58	Low	2	0.00%
40	LS18	56	Low	585	0.54%
41	LS20	56	Low	115	0.11%
42	H	65	Medium	3829	3.52%
43	S	60	Low	1159	1.07%
44	U	55	Very Low	1862	1.71%
45	J	55	Very Low	13	0.01%
46	Q	45	Very Low	5029	4.63%
47	T	40	Very Low	567	0.52%
48	M	40	Very Low	529	0.49%
49	R	40	Very Low	28039	25.80%
50	P	30	Very Low	7151	6.58%
51	R2	35	Very Low	371	0.34%
52	W	20	Very Low	310	0.29%
53	Brick Kiln			190	0.17%
54	Dam			3	0.00%
55	HB			7556	6.95%
56	Landslide (LS27)			21	0.02%
57	River			2654	2.44%
58	Rock Quarry			1	0.00%
59	Water bodies			295	0.27%
Grand Total				108687	100.00

Salient Features

- Soil erosion mapping of Shivalik hills of SAS Nagar is carried out using high resolution satellite data using onscreen satellite data interpretation technique and for remaining area of SAS Nagar, the details are included from SLUSI's report no. AGRI 1079.
- Out of total 1,08,687 ha area in the district surveyed, 8270 ha area and 1369 ha area falls under very high and high soil erosion risk category, respectively.
- The area under very high and high category is unstable and requires immediate attention for proper soil and water conservation.
- About 2758 ha (2.54 %) of surveyed area is prone for moderate to severe erosion hazards whereas 7026 ha (6.47 %) prone for severe, severe to very severe & very severe erosion hazards and requires immediate conservation measures.

SLUSI

HOW TO USE SOIL SURVEY REPORT

This report embodies the findings of Detailed Soil erosion mapping in the area of SAS Nagar district, Punjab covering an area of 1,08,687 ha. The study includes critical examination of various physical features of soil such as depth, texture, structure, colour, organic matter and geomorphic features such as physiography, slope, lithology, floral composition and erosion etc. for identification and mapping of area under different erosion classes, assessment of risk areas prone to erosion and priority categorization of micro-watersheds falling on district. The study has been carried out at 1:5 K scale for 55028 ha area, soils are suffering from moderate, severe and very severe erosion and presented in 1x1 minutes interval grid (19599 ha) and in 3x3 minute grid (89088 ha). Whereas, remaining part of district (53659 ha) mapped on 1:50K scale and reported in 3x3 minutes. The total geographic area of district is 1,08,687 ha, out of which 19599 ha area reported in 1x1 min grid, whereas 89088 ha spread in 3x3 min grids for presentation of data on soil erosion status, soil risk categories and micro-watershed wise area under RPMU map. The soil erosion risk categories were fixed on the basis of Runoff Potential weightage value (RPWV). Higher the values of Runoff Potential weightage suggest higher the erosion risk and vice versa. It also furnishes information on general characteristics of the area such as, location and extent, physiography, relief, drainage, geology, climate, present land use, natural vegetation, water supply and soils of the area.

In the map, the Runoff Potential Mapping Units (RPMUs) are demarcated according and symbolized by capital English alphabets, based on geological origin of the land ‘AL’ stands for Alluvium and their further subdivisions are made on the basis of land and soil characteristics. Each unit connotes a set of physiography, slope, land-use, soil characteristics such as soil depth, colour, texture, severity of erosion and management practices. The runoff potential weightage assigned to Runoff Potential Mapping Units (RPMU) with their respective area has been used for determination Runoff Potential index (RPI) for categorization of micro-watersheds in to different priority category.

The RPMU legends furnished in the **Table-1** and areal extent of each RPMU units represented in **Table-2**. The details of computation made for determining grid wise runoff potential index of SAS Nagar district of Punjab State are furnished in **Annexure-I** and the information of relative priority of grid wise in descending order of grading are furnished in **Table-7**.

Grid wise categorized under very high, high and medium soil erosion risk categories have to be selected for treatment of degraded lands for risk areas identified in the district. Both treatable and non-treatable lands are occupied by each soil erosion risk categories (very high, high and medium category) in the district. The ratio of treatable and non-treatable lands in soil erosion risk categories in the district varies with the kind, degree and extent of the degraded lands.

SUMMARY

Land degradation, is a dynamic process which is the result of both natural and biotic forces operating on earth. The problem is alarming in the South Asian countries, especially in India threatening food security due to spontaneous degradation of soil, water and forest resources, the three most precious natural resources for life supporting system on earth. Soil is subject to a series of degradation processes. Soil erosion is the most serious form of degradation and as per the latest statistical reports it affects 175 million ha land in the country. The increasing biotic pressure on land and over-exploitation of these vital natural resources for agricultural and non-agricultural needs led to accelerated soil erosion causing large scale degradation of natural resources and the eco-system as well.

The importance of scientific data base for natural resources management is an established fact. The advent of remote sensing technology has revolutionized the acquisition of real time earth information by virtue of its capabilities with respect to synoptic view, multi-spectral, multi-temporal and multi-sensor imaging, repetitive coverage and computer compatibility. This technology in conjunction with Geographic Information System (GIS) facilitated the generation, management and use of spatial data base for natural resource management.

India is one of the ten most forest-rich countries of the world. The Shivalik landscape, in North India, forms the part of the Sub-Himalayas, is the youngest mountain range in the country which run more or less parallel to the lesser Himalayas. The hills of Shivalik ranges were developed as depositional landscape owing to the transport of sediments from middle and upper Himalayan. The sediments deposited are mostly loose, unconsolidated and are prone to water erosion due to which the area under these landscapes in Punjab state were brought under Punjab Land Prevention Act (PLPA) as the landforms on these hill ranges are problematic and yielding higher runoff and sediment load.

‘Watershed’ has been considered as a basic unit of planning and management of natural resources. Soil and Land Use Survey of India (SLUSI) developed a unique system of delineation and codification of hydrologic units based on the stream hierarchy and has published the same as the Watershed Atlas of India (Anon, 1990). The watersheds are then successively subdivided to microwatersheds in order to provide viable size of hydrologic unit for implementation of soil conservation programme. The soil and land data base of micro-watersheds have been generated through Detailed Priority Delineation Mapping Survey using Remote Sensing and GIS techniques. The objective of the priority delineation survey and mapping is to identify the priority micro-watersheds on the basis of Run-off Potential Index (RPI) and Silt Yield Index (SYI) which, in turn, reflects the resultant effect of physiography, slope, land use/ land cover, soil depth, soil texture, surface roughness, erosion hazards and existing management practices in producing sediment yield/run-off from a particular hydrologic unit. Higher value of SYI /RPI suggests higher priority and vice-versa.

SLUSI, has completed the priority categorization of micro watersheds/states of India in total area of about 240.59 Million ha (as on March, 2017), which constitutes 73.25 % of total

geographic area of the country, out of this 26.62 Million ha categorized under very high priority category and 32.69 Million ha were placed under high priority category.

A Memorandum of Understanding (MoU) was signed between SLUSI and Department of Forests and Wild Life, to take up the task of identification of soil erosion status, mapping of area under different erosion risk categories based on the values of Runoff Potential Weightage (RPW) and also to carry prioritization of micro watersheds of SAS Nagar District. The development of soil database and preparation of the report of the study area has been assigned to Noida Centre, Soil & Land Use Survey of India, Department of Agriculture, Cooperation and Farmer's Welfare, Government of India.

SAS Nagar District having geographical area of 108687 ha was studied for identification and mapping of soil erosion status, manifested on ground in three forms namely sheet, rill and gully erosion. The severity of each type has been described under four classes namely, i.e. slight, moderate, severe and very severe erosion as recognized in the study area.

The soil erosion status and other soil and land attributes were studied for 55,028 ha on 1:5K scale in the forest areas prone to severe to very severe soil erosion and high soil erosion risk, which includes the area covered under PLPA and the areas adjoining to severe to very severely eroded lands (area described in total 82 grids for 1x1 minute and 22 numbers of grids of 3x3 minute interval), whereas the remaining area of the district less prone to soil erosion was studied on 1:50 K scale for 53659 ha area (described in total 31 number of grids of 3x3 minutes intervals).

The results of the area studied SAS Nagar that out of 1,08,687 ha about 88,183 ha is under sheet and rill erosion mapped as slight to moderate erosion & moderate erosion; about 9,784 ha area under moderate to severe erosion, severe erosion, severe to very severe erosion, gullies and ravines mapped under severe to very severe; 21 ha area under landslide and 10,699 ha has been mapped as miscellaneous category includes the habitation, water bodies, choe, quarry and other uses.

With regard to soil erosion risk category for the area studied in 1x1 min grid, about 2484 ha has been identified as the area prone to moderate, 9639 ha has been category under high and very high risk of soil erosion, whereas 6042 ha area under low to very low category. Similarly, in the area studied in 3x3 min grids shows that all i.e. 76513 ha has been categorized under low to very low category and 3289 ha has been categorized under medium.

The Priority categorization of microwatershed in SAS Nagar district based on the runoff potential Index (RPI) confirms, that in the area studied in 1x1 min grid interval, about 15636 ha categorized as medium to high and very high priority (RPI value >60) requires to be protected whereas 3963 ha area found under low.

The report consists of various chapters from chapter-1 to 8 describing introduction, general description of the area, methodology, legend description, assessment and reporting of the surveyed area, risk and priority categorization. This report provides the findings of the project and translates them into conclusions and recommendations.

ABOUT SLUSI

The Soil and Land Use Survey of India (SLUSI), New Delhi, a premiere organization of Department of Agriculture, Cooperation and Farmers Welfare under Ministry of Agriculture and farmer welfare, Government of India, was established in 1958, mandated to conduct soil and land use surveys at different scales. Soil survey provides information on soil and land resources of the state government user agencies. The principal activity is the characterization of soils, soil properties such as depth, soil erosion, texture etc., and prediction of soil suitability for agriculture, forestry, pasture development and presenting the information of location with spatial extent by mapping on suitable base map within suitable framework i.e. watershed of designated area/tehsil or district. The information is instrumental in outlining potential agriculture areas, the development, planning and management of degraded lands areas through soil and water conservation measures. The program also provides technical advice to the national level organization and other state user department viz. agriculture, forest, irrigation, rural development on the adaptability of soils for various soil and water conservation and for other purposes. The interpretation of survey data land capability, soil and land irrigability classes and hydrological soil grouping for sustainable natural resource management using remote sensing and geographic information system.

The soils and land use mapping services section of Soil and Land Use Survey of India currently have two levels of soils and land use data- each level represents a different intensity of data collection. As such, the soil survey program has been prepared to fulfill the needs and priorities of the land under agricultural, forest and other user's development.

The soil and land use database developed on two levels are:

Reconnaissance Soil Survey (1:50,000 scale)

- i) Priority delineation survey
- ii) Land degradation survey
- iii) Soil resource mapping

Detailed Soil Survey (from 1:5000 to 1:15,000 scale using cadastral, aerial photo and high resolution satellite data)

Each type of soil survey involves scientific study of soils, identification and demarcation of the area under very high and high priority based on the assessment of soil erosion and on computation of Silt Yield Index and Run off potential Index using remote sensing, GIS and RDBMS technique. The prioritization model helps for sustainable development of area in selective mode and in phased manner. The SLUSI has also mandated to carry out field surveys to identify & map soils of the country and develop land use plan.

The SLUSI is implementing its mandate through seven regional centres at Bangalore, Noida, Kolkata, Nagpur, Ahmadabad, Ranchi and Hyderabad are involved in soil resource mapping, soil correlation, classification for development of land based action plan. The organization is also imparting training to officers of the user agencies in the area of soil survey, soil survey interpretations for land use planning using modern techniques of remote sensing and GIS. The SLUSI working in collaboration with SAC, NRSC, State Agriculture, forest department and state land use board to develop scientific soil database for sustainable development planning.

The publication on “***Assessment of Soil Erosion Status in Shivalik Hills of Sahibzada Ajit Singh Nagar – Punjab State***” is the outcome of the database developed by the SLUSI by conducting Intensive **Priority Delineation Survey and Mapping** of SAS Nagar district of Punjab state. Soil and Land database information generated in field surveys used to determine the relative priority of smaller hydrologic units within the SAS Nagar district based on the estimated values of Run Off Potential Index (RPI). The database generation work has carried out following steps given below:

- Delineation and codification of micro watersheds in the district with unique codes
- Prioritization of watersheds through rapid detailed inventory of soil erosion of the district
- Identification of risk areas for soil erosion for micro level planning

The objectives of the aforesaid study are proposing planning to arrest soil loss through identifying risk areas prone to soil erosion for sustainable management of soil and land resources without disturbing the natural system.

1. INTRODUCTION

1.1 Review of the Survey Area

The Shivalik landscape ($29^{\circ}57'$ to $31^{\circ}20'$ N Lat. and $77^{\circ}35'$ to $79^{\circ}20'$ E), which is also called the Sub-Himalaya, is the youngest of all mountains in India. It extends from the Indus basin to the Brahmaputra with one gap of over 300 km from the Saptakosi to the Manas River.

In North India the Shivalik Region is a belt align more or less parallel to lesser Himalaya; with an average width of about 52 km and length of about 650 km administratively spans across of Punjab, Haryana, Uttarakhand, Himachal Pradesh, Jammu and Kashmir and Uttar Pradesh.

Shivalik Hills are one of the youngest mountain ranges running parallel to the Himalayan ranges. These are spelled differently as choes, Sivalik, Sewalik, Shivalik and Shivalik but term Shivalik has been preferred owing to its derivation from the tresses of lord Shiva (*Mittal et al. 2000*). Term Shivalik has also been used synonymously to outer or lower Himalayas, though others consider it as part of outer or lower Himalayas. Shivalik region is commonly referred askandi region has bouldery soil frequently dissected by overland flow from hills through networks of small streams, choe, gullies etc. North-Western Shivalik Region (Lower Himalayas) is generally up to 1000 m elevation.

The Shivalik landscape classified under Indo-Gangetic plains and has special significance in India's biogeography. This area is marked by fragile land formation, subtropical climate and varied complex topography requires special attention for conservation as because this ecosystem has been referred as 8th most degraded agro-ecosystem in the country (*Agrawal et al., 2002; Rawat and Mukherjee, 2005*). The entire belt all along covers an area of 40,000 sq. km out of which only <3000 sq. km area falls under wild life protected area and the wild life Protected Areas (PAs) formed in the region, not only serve as repository of unique biological diversity but also supports basic life support system i.e. soil, air and water. The landscapes in is typically low rolling hills bisected by innumerable gullies, seasonal streams (locally known as choes) which drain this region (*Rawat and Mukherjee, 2005; Jerath et al., 2006*).

1.1.1 Soil Erosion in Shivalik Hills:

The Shivalik Hills are formed of easily erodible and unconsolidated sand stones and inter-bedded calcareous clay and silt strata. Even with good vegetative cover, the heavy storms of the monsoon season cause significant erosion in unconsolidated sand particle and exposing the less erodible part in the form of eroded spikes/ pillars commonly noticed in the surveyed area (*Jerath and Puja, 2006*).

Soil erosion begins with the removal of the vegetative cover. There are two types of soil erosion, both of which are in evidence in the surveyed area but according to the nature of the soil, one or the other is generally predominant. 'Gully' erosion originates, as its name implies, from the formation of small rills by water action; the gullies deepen and cut back into the hill-side producing the well-known 'ravine' lands which are as common in bare undulating country

as in more mountainous regions. 'Gully' erosion is most active in heavy, coherent soils, such as clay, less so on sandy and friable soils, and least of all on stony ground derived from conglomerates.

The second type of erosion, 'sheet' erosion, implies the removal of soil particles by the flow of water over open surfaces rather than in channels. This form of erosion acts on all surfaces which are not protected by close-growing vegetation or a humus layer. Loose and friable soils, such as sandy soils and sand-rock, are the most liable to 'sheet' erosion. These coarse-textured soils maintain a smooth or rounded configuration under the action of water.

When slopes are steep and the soil and underlying rock of a friable nature, when the forest covering is scanty or absent and rainfall heavy, erosion and the degradation of the hills is accelerated by the occurrence of landslips.

1.1.2 Erosion may be harmful in the following ways: -

- The soil and gravels detached in erosion are carried down by floods and sediments deposited over low lying area. Thus making the eroded surface unproductive and not support vegetative growth.
- Irrigation works and canals may be silted up and the fields, which were formerly enriched by annual deposits of fertile soil derived from the protected slopes, now receive only a coarse, sandy deposit.
- Erosion increases flood height; for the debris carried down by the water swells the stream volume to such an extent that the height of the water is raised far above what it would be if it were free from sediment.
- Silt deposition may entirely fill up a river-bed and responsible for constant flooding; or at least the bed may be so raised that overtopping of the banks.

Holland, 1928 reported that closure of the area against grazing is the only possible option to increase the forest cover otherwise in dry climate like Punjab forest conservancy was unlikely. Grover, 1944 reported that by 1900 the hills of Hoshiarpur District had been stripped almost bare by unrestricted browsing and grazing. To bring back this area under forest cover, protection of the area was the suitable choice. This was executed through Punjab Land Preservation Act (PLPA) in 1900.

PLPA of 1900 is regulatory in nature for "Conservation of sub-soil water or prevention of erosion in any area subject to erosion or likely to become liable to erosion" as provided in section 3 of the Act. At present there are 502 villages under PLPA in Punjab. The villages under PLPA are delineated through notifications from time to time. In past sustained efforts have been done by Department of Forest and Wildlife to rehabilitate the degraded lands falling under PLPA areas by implementing special projects like "Kandi Watershed Development Project", "Integrated Watershed Development Project (Hills) - I and II" Punjab Afforestation Project- I and II".

1.2 Development of Microwatershed Atlas

Microwatershed has been chosen as a viable unit for this study for identification and demarcation of priority in different part of SAS Nagar. A framework of watersheds is a pre-requisite for to plan the study. The watersheds should not only have a hierarchical system of delineating bigger hydrologic units into smaller watersheds but also systematic codification system to recognize each microwatershed as an individual entity without losing linkage with the bigger units, i.e. catchments, sub-catchment, etc., to which it belongs i.e. unique national code. To provide the overall framework of watersheds in the SAS Nagar district, SLUSI first developed microwatershed map of SAS Nagar district on the drainage map on 1:50 K scale. The has been hydrologically demarcated into **Two Water Resource Regions** (1 & 6), further subdivided into **two River Basins and Catchments, four Sub-catchments and six Watersheds** through systematic delineation and codification in district resulted in creation about **209 Micro-watersheds**.

Study involves carrying out detailed Priority Delineation survey using latest high resolution IKONOS satellite data and includes demarcating the soils of study areas under different erosion and sample collection using GPS based field work to enhance the accuracy in soil database generation.

Out total area of district 108687, the mapping of soil erosion status and other soil and land attributes studied for 55,028 ha on 1:5K scale in the forest areas prone to severe to very severe soil erosion and high soil erosion risk areas covered under PLPA and It includes the adjoining areas around moderately to very severely eroded areas (area described in total 82 grids for 1x1 minute and 25 numbers of grids of 3x3 minute interval), whereas the area under agriculture and settlements lands observed at lower intensities , present information of area less prone to none to slight soil erosion reported at scale of 1:50 K. The total area of 53659 ha area (described in total 28 number of grids of 3x3 minutes intervals) with following objectives.

- To carryout field survey and mapping for identification, characterization and delineation of area under Runoff Potential Mapping Units, subject to various degree of soil erosion in Sub Mountain of Shivalik Hills of Punjab.
- Mapping of extent of soil erosion under different erosion intensity classes.
- To demarcate the area under different erosion risk category based on estimated runoff potential weightage values and priority categorization of micro watershed based on values of Runoff Potential Index (RPI).
- To generate thematic maps on various soil and land parameters out of this survey.

2. GENERAL DESCRIPTION OF SURVEY AREA

2.1 Location and Extent

Sahibzada Ajit Singh Nagar (SAS Nagar) is a city which is a commercial hub in Punjab State. It was formed in April 2006 and is 18th district of Punjab. Sahibzada Ajit Singh Nagar has emerged as one of the most important cities in Punjab and the rest of northern India; Special emphasis has been made by the state government to make this city one of the best places to live in Punjab.

Geographically, the area of SAS Nagardistrict occupies an area of 108687 ha lies between $30^{\circ}23'38''$ to $30^{\circ}45'23''$ North Latitudes and $76^{\circ}31'20''$ to $76^{\circ}56'23''$ East Longitudes. The area is covered by the Survey of India on 1:50K scale 53 B/09, 53 B/10, 53 B/11, 53 B/13, 53 B/14 and 53 B/15 Toposheets.

2.2 Geology

Geologically, the area of the survey comprises of deposits of sand, conglomerates, and gravels in Shivalik hill region. The most important lithological character of the rocks is their lack of consolidation by geological pressure, certainly in those strata which lie exposed. The beds are stratified, and consist of loose, pebbly conglomerates, soft-earths and barely coherent sand-rock.

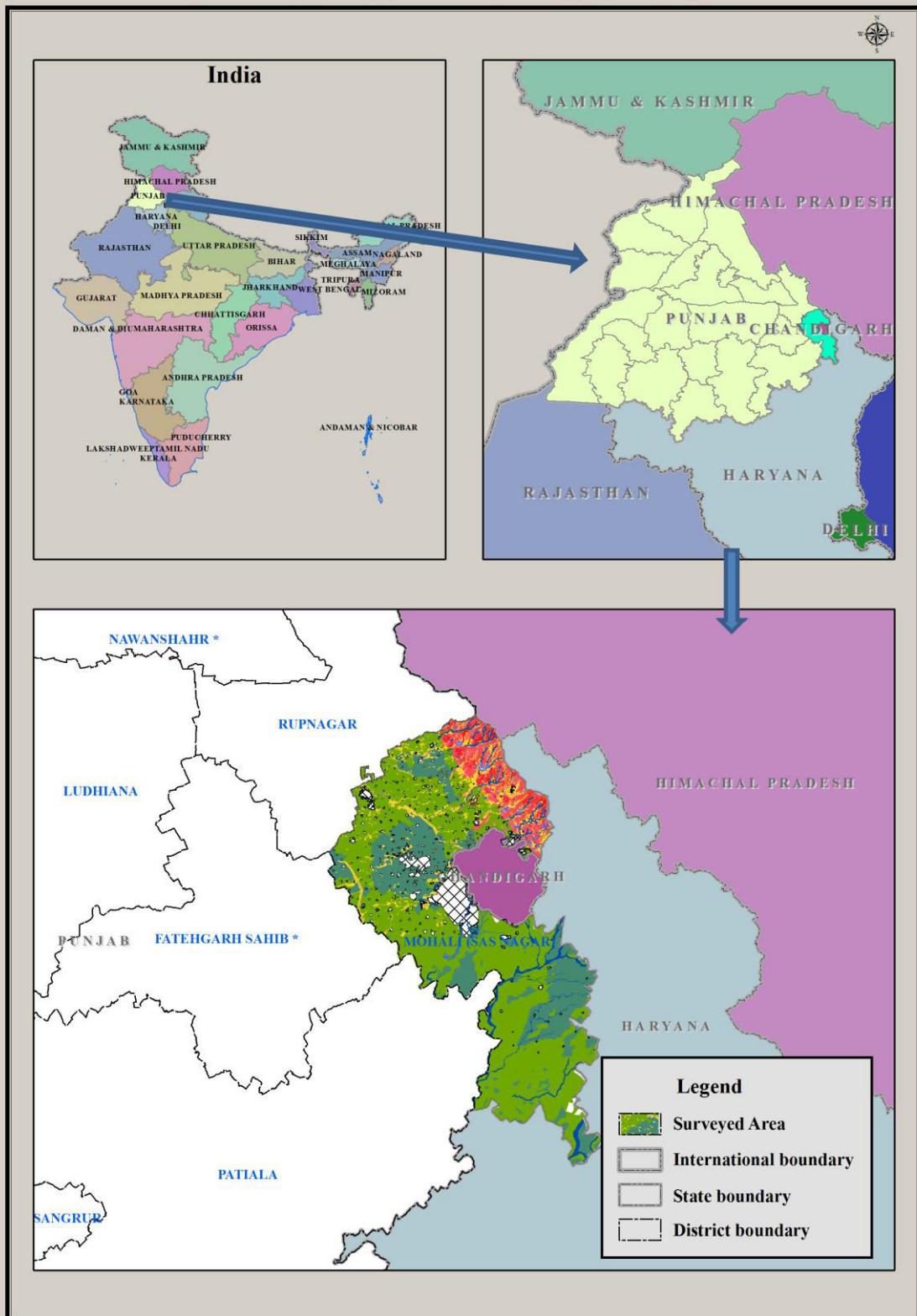
Most importantly, this part of Shivalik hills is found to contain the capping of **limestone** material over sand stone deposits and are **calcareous** in nature prominently observed in Siswan forest. It assists in aggregation of soil separates i.e. sand, silt and clay. The areas on the foothills slopes marked by presence of alluvial fans are deposited by hill torrents with a wavy plain. These deposits belong to Miocene to lower Pleistocene period. Adjacent to the alluvial fan are the alluvial plains which forms a part of large Indo-Gangetic Quaternary basin comprises of thick sand and silty sand layers inter-bedded with silt and clay beds of recent periods.

2.3 River and Drainage System

Hill topography is characterized by steep, slopes and gorges. The main drainage channels are fed by numerous precipitous side-streams, and on the upper slopes, by a network of converging feeders, which give rise to the channels catchment areas of a size and shape. The choe and their main feeders have indeed been cut to such a level by erosion that one may leave the practically flat stretches of sand in the plains.

The choe is best described as 'plains'; it is largely cultivated and the soil is sandy. The original drainage channels rapidly silted up when hill erosion and flooding started, with the

Location Map of SAS Nagar, Punjab



result that the floods have been forced out over the country and numerous branches have been formed.

Choe beds in the plains are broad rivers of sand with a very slight fall. Banks are often non-existent, composed of unstable sand liable to be washed away by any flood or of scarped cultivation which is being undercut by every flood. This shows that these choe have a most destructive effect on the lands over which they traverse to accelerate run-off and erosion. The choe frequently change their courses rising of bed due repeated deposition of sand.

2.4 Physiography and Relief

The study area in Sahibzada Ajit Singh Nagar district is physiographically divided into four main physiographic units namely:

- Moderate hills of Shivalik Hills
- Longitudinal valley
- Piedmont Plain
- Alluvial plain and flood plain

Topographically, the range belongs to the hills, geographically to the plains; for although its upheaval coincided with earth movements in the Himalaya, the latter were raised early in Tertiary times, while the Shivalik rocks are composed of sediments brought down from the rising ranges to the north. These freshwater sediments have been laid down along the front of the Himalaya ever since they started to rise.

The areas in Shivalik Hills were under various slope ranges and covered by soil of different depths. Landuse/Landcover shows moderate to excessive relief and responsible for generation of runoff in rainy season leading to flooding and water-logging in valley areas.

The areas in valleys, alluvial and flood plain having slope ranging from nearly level to gently sloping (1 to 5 %). The piedmont plain found in the area also has similar slope range of 1 to 5 per cent slope. The piedmont area is frequently dissected which consists of deposits of sand with some gravels and pebbles. The area is partly cultivated and partly under forests, scrubs and wastelands. The area shows normal relief. The general elevation of the area is in the range of 246 -310 meters above MSL.

2.5 Climate

SAS Nagar has a sub-tropical type of climate characterized by seasonal: hot summer, slightly cold winter, and variable rainy season. The great variation in temperature winter and summer season observed in the area. In winter, frost occurs during December and January. The

average annual rainfall is recorded at 617 millimeters (24.3 in). The south west monsoon during July-August months contributes about 80% of annual rainfall. The city also receives occasional winter rains from the west.

The recent change in climate phenomenon is responsible for floods which periodically sweep down the state rivers from snow melts. As the monsoon weather characterized by heavy storms succeeded by bright intervals, the conservation of water in the hills and a steadyng of the river discharges are most urgent.

2.6 Flora and Fauna

The major vegetation types from west to east along the increasing rainfall gradient area (*Champion and Seth, 1968*) Dodonea scrub, Subtropical Dry Evergreen Forest of oleo Cuspidate, Sub-tropical pine forest Northern dry Mixed Deciduous Forest Dry Shivalik Sal forest and Moist Mixed deciduous type The growing stock in Shivalik belt consists of scattered Khair (*Acacia catechu*), Chhal (*Anogeissus latifolia*), Jhingan (*Lannea coromandelica*), Kikar (*Acacia nilotica*), Phalahi (*Acacia modesta*), Ber (*Zizyphus mauritiana*), Shisham (*Dalbergia sissoos*), Neem (*Azadirachta indica*), Amb (*Mangifera indica*), Dhak (*Butea monosperma*) etc., trees in the upper canopy with thin or thick undergrowth of shrubs such as Garna (*Carissa spinarum*), Mehnder (*Dodona viscosa*), Mallah (*Zizyphus nummularia*), Basuti (*Adathoda vasica*), Jhav (*Artemesia spp*), Hins (*Capparis decidua*), Panwar (*Cassia tara*), Phulbuti (*Lantana camara*), etc. and grasses such as (*Saccharum bengalenese*). Bhabbar grass is most important and is used for rope making and paper pulp. Kana and kahi are used for thatch roof making and for pulp making. The rest of the species are mostly fed to the cattle. There are neither grass prevention plots nor any area set apart for grass cultivation. However, they grow in mixture with trees and shrubs naturally. Bhabbar grass is mostly confined to Shivalik and kana and kahi are found near choe beds. The most common weed found is sage (*Lantana camara*).

The main species of grass found in the district are Bhabbar (*Eulkaliopsis binata*), Dhaulu (*Chrysopagon fulvus*), Palwan (*Dicentrum annulatum*), Sariala (*Heteropogon contortus*), Khabbal (*Cynodon dactylon*), Khai (*Saccharum spontaneum*).

Strip forest in the plain have mostly artificially raised plantations where the upper canopy has Kikar (*Acacia nilotica*), Shisham (*Dalbergia sissoo*), Eucalyptus (*Eucalyptus spp*), Siris (*Albizzia lebbek*), Amb (*Mangifera indica*), Jamun (*Syzygium cumini*), Tun (*Cedrela toona*), Neem (*Azadirachta indica*) in pure or mixed plantations and Amaltas (*Cassia fistula*), Jacranda (*Jacaranda ovalifolia*), Kachnar (*Bauhinia variegata*), Bottle brush (*Callistemon viminalis*), Gulmohar (*Delonix regia*), Amla (*Emblica officinalis*) etc. in avenue lines along canals and roads.

The eastern part of northern Shivalik inhabited by Asian elephant tiger and associated prey species. Since Shivalik act as transient zone between Himalaya and tarai plains, several Himalayan elements present in this landscape which includes The Himalayan Yellow Throated

Marten, goral, black bear and several species of migrating birds in winter, freshwater catfish (*T. tandanus*), striped dwarf catfish (*Mystus vittatus*), spotted snakehead (*Channa punctate*).

2.7 Land Use and Agriculture

The hills in studied area are under dry deciduous vegetative cover mainly Khair, Kikar, Teak at places. This part of area is also suited for plantation of Shisham, Beri, Palash and Neem. In Valley area irrigation for agriculture is sourced by tank/reservoir has been observed but cultivators compliant about threat to standing crops from wild animals and stray animals as they pose damage to the crops resulting in poor yield of crops. The major crops cultivated are Wheat, Maize and Bajra etc. The area in alluvial plain area is covered for cultivation for vegetable crops, orchards and pulses. Due to very few employment opportunities available, seasonal migration to nearby towns for livelihood takes place.

SLUSI

3. METHODOLOGY

The procedure outlined in the Soil & Land Use Survey of India (Formerly All India Soil & Land Use Survey) Technical Bulletin No.9 entitled “Methodology of Priority Delineation Survey” issued by the Ministry of Agriculture and Farmers Welfare (Department of Agriculture, Cooperation and Farmers Welfare) in 1991 has been adopted for conducting soil erosion mapping for demarcation of priority micro watersheds and their categorization into various priority categories. Survey of India topographical maps on 1:50,000 scales were used as base maps for delineation of runoff potential mapping units.

The methodology adopted in the study consisted of various steps as described below. The key elements distinguishing the study is the use of High Resolution **IKONOS (a commercial Earth observation satellite)** satellite data, landuse/ land cover data sourced from Forest Department, Punjab State and **DEM (3D representation of a terrain's surface)** data downloaded from **BHUVAN (Indian Geo-Platform of ISRO)** that are used to prepare base maps for delineation of Runoff Potential Mapping Units.

The steps involved in soil erosion mapping using remote sensing technique including generation of digital database are described below:

3.1 Use of High Resolution Satellite Image

Soil information is abstracted indirectly from imagery by studying reflectance pattern of a surface feature portrayed on the image. Image elements, e.g. tone / colour, texture, size, shape, pattern, location and association are made use of to discern variations. These discernable variations are correlated with geology, physiography, land use / land cover condition and slope classes to interpret possible mapping units / association of soil classes.

Using high resolution IKONOS satellite images of 1 mt spatial resolution allow assessing the spatial distribution of area under different erosion classes such as **sheet, rill, gully and ravine erosion at 1:5 K scale in the forest areas of Shivalik hills and remaining area of district was studied at scale 1:50 K as it includes mostly area under agriculture and settlement.** This 1 mt resolution satellite data provides information of field parcel and precise information of **vegetative cover** (type and canopy). This further aids in accurate **separation of physiographic unit and segregation of area under very severe gully and ravine as well as landslide erosion up to an area of 1 hectare.** Similarly, the data also found useful in updating the road, rail, open well, canal network.

Thus, 1:5K scale erosion study maps can precisely and accurately be overlaid to the most widely available cadastral /micro level map (available in 1:4K to 1:8K scale) which depicts the field survey boundary and survey number and other cultural feature in great details like the drainage network, irrigation structures, choes, rivulets etc. The cartosat-DEM data available on

BHUVAN aids in assessing physical layout of land such as hill slopes, undulations, drainage flow and pattern. The reliability and cost-effectiveness of high-resolution images from Indian satellites provide scope for the generation of information for tank system studies as well as for micro-level natural resource management.

3.2 Onscreen Pre-Field Image Interpretation at Cadastral Scale & preparation of Image Analysis Map (IAM):

Further, detailed and careful study of subtle differences within discernible classes is carried out to segregate individual Runoff Potential mapping unit (homogenous in it within permissible limits of soil characteristics). An interpretation key is developed to segregate discernible image units and defined in terms of image elements. Thus, a valid correlation between image characters, soil and landscape characters is established to carry out the interpretation accordingly.

Sample areas are selected for ground truthing by representing well distributed sample strips so as to represent all landscapes/geology, physiography, slopes and soils to establish correlation between spectral signature of the image, soil and its associated land features.

3.3 Ground Truth Verification and Quality Assessment (QA)/Quality Check (QC):

A rapid traversing of the district is undertaken to study the broad landscape soil relationship and to locate sample strip area. Profiles are dug at different slope range to examine all types of soils. Soil samples are collected during profile study and brought to the soil laboratory to carryout physical, chemical and physico-chemical analysis.

For each and every soil mapping unit, a large number of observations are collected through auger bore / mini pit observations and profile examination and correlated with its satellite image signature. Well distributed observations are taken to cover all quadrants of a toposheet. Around 15-20% of the total area is studied on the ground covering all the tentatively identified run-off potential mapping units. Finally, run-off potential mapping unit is described by a set of soil and land characteristics, like depth, colour, texture, land use, physiography etc. along with its image characteristics. This information is used as a ground truth data for final interpretation of satellite data.

To conduct Detailed Soil Survey, the procedure outlined in the **Soil Survey Manual, 1970** published by **Soil & Land Use Survey of India (Formerly All India Soil & Land Use Survey)** has been adopted. This manual covered types of soil surveys, field work, study of soil profile, classification, correlation and interpretation of soils, etc. Further, it helps correlating with soil's characteristics of known behavior and predicting their adaptability to various uses

under defined sets of management practices. Broadly, it provides the fundamental concepts of soil map preparation using remote sensing, GIS and other spatial techniques.

3.4 Correlation of Image Analysis Map with Integrated Soil Legend, Onscreen Transformation:

Mapping legend is finalized according to ground truth data by merging mapping units / developing new mapping units. Maps are corrected accordingly.

The scientific database generated based on ground truthing/field work provides real time information on the soil and land characteristics, extent and distribution of area under different “Runoff Potential Mapping Unit” (RPMU) erosion risk categories based on assigned runoff weightage value using RDBMS model and priority categorization of areas contributing more runoff in SAS Nagar district. This data base can be utilized to formulate policy for re-notifying the areas prone to soil erosion and frame up the site specific plan for soil conservation measures and devise appropriate land use techniques aimed at enhancing the productivity of these lands for optimum use of natural resource.

The assessment of Potential Soil Erosion Risk based on Runoff Potential Mapping Units (RPMU) weightage and Priority Categorization of micro watersheds of district based on Runoff Potential Index (RPI) values estimated from RPMU mapping units parameters collected during ground truthing from Technical Bulletin No.9 entitled “**Methodology of Priority Delineation Survey**” published by **Soil & Land Use Survey of India (Formerly All India Soil & Land Use Survey)**, Ministry of Agriculture and Farmers Welfare (Department of Agriculture, Cooperation and Farmers Welfare) in 1991.

The runoff potential mapping units imply a set of relevant parameters that exert combined and reciprocal influence on the runoff potential. The factors considered include physiography and slope, which control amount and velocity of runoff, soil characteristics that decide potential for erosion, vegetation and cover condition that offer protection to the soil and land use indicating human interference. The description of runoff potential mapping units is given under chapter “Legend Description”. Physiographically, the survey area has been divided into different major landforms namely, aeolian plains, alluvial plain, basinal plain, hill tops, hills side slopes, foot hill slope, valleys, flood plain to paleo channels, levees, pediments, piedmont plain, point bar complex, recent flood plain and stream banks.

Further, landforms have been subdivided into different runoff potential units depending on the variables such as geology, physiography, slope, vegetation, land-use, management, soil characteristics and erosion hazards. The legend progressively built up traversing followed by ground observations and finally well-defined mapping legend developed for mapping program.

The RPMU generated out of rapid reconnaissance survey was transferred subsequently on the codified map to have a composite map for computation of Runoff Potential Index.

3.5 Delineation and Codification of Micro-watersheds:

The river basin of the country was taken as geographic reference and the systematic delineation of the entire river system of the country was made by Dr. A.N. Khosla of Central Water and Power Commission (CPWC) in 1949.

According to his system, the whole of India was delineated into six Water Resource Regions:

- Region No. 1: Indus drainage
- Region No. 2: Ganges drainage
- Region No. 3: Brahmaputra drainage
- Region No. 4: All drainage flowing into Bay of Bengal except those at 2 & 3
- Region No. 5: All drainage flowing into Bay of Arabian Sea except that at 1
- Region No. 6: The Ephemeral drainage in Rajasthan

The delineation up to watershed level is being followed Atlas published by Soil & Land Use Survey of India (2012).

3.5.1 Stages of Delineation

The first stage map prepared was further subjected to detailed delineation of hydrologic units at different stages as per details furnished hereunder:

1. The Water Resources Regions as segregated and the codes 1-6 have been assigned
2. Each Water Resources Region is divided into different basins. In some cases, where the drainage systems are too large, basins are divided into lower and upper basins or left bank and right bank basins.
3. The basins have been further sub divided into number of catchments, which mostly pertain to main tributaries or a group of contiguous small tributaries or individual streams.
4. As fourth stage of delineation the catchments are further divided into a number of sub-catchments, which are mainly smaller tributaries and streamlets.
5. Each sub-catchment has been subjected to further division in the number of watersheds, which have been taken as the smallest hydrologic entity on the 1:1 million scale maps.

It may be seen from the system explained above that in each case the divisions are made based on a hydrologic system from bigger to smaller entity. For practical developmental purposes the watershed is further subdivided into sub-watersheds and then into micro-watersheds so that the area coverage is amenable and manageable under land based development schemes. For this purpose, the further delineation and codification on 1:50,000 scales have been done maintaining the watershed codes of Watershed Atlas of India (1990) and subsequent version of digital Watershed Atlas of India (2012) as base.

3.5.2 Codification Systems

The different stages of delineation mentioned above have been codified in a systematic way alternating with Arabic numerals, English capital and small alphabets as follows:

Water Resource Regions	1, 2, 3, 4, 5, 6
Basins	A, B, C, E, F, etc.
Catchments	1, 2, 3, 4, 5, 6.....
Sub Catchments	A, B, C, D, E, F, G.....
Watersheds	1, 2, 3, 4, 5, 6...9
Subwatersheds	a, b, c, d, f, g.....
Microwatersheds	1, 2, 3, 4, 5, 6...9

Thus, at microwatershed level the code appears 2C6A1a1connotes,

2	Region (Ganga Drainage)
C	Basin (Yamuna River)
6	Catchment
A	Subcatchment
1	Watershed
a	Subwatershed (Subwatershed no. a)
1	Microwatershed (Microwatershed no.1)

The systematic delineation and codification leads to the creation micro watershed Atlas of SAS Nagar district contains the following water resource region, Basin, Catchments, Sub catchments, and Watersheds as

REGION	BASIN	CATCHMENT	SUBCATCHMENT	WATERSHED	AREA (ha)
1	1A	1A1	1A1B	1A1B6	25014
6	6D	6D2	6D2B	6D2B7	18808
6	6D	6D2	6D2C	6D2C9	13659
6	6D	6D2	6D2D	6D2D4	25153
6	6D	6D2	6D2D	6D2D5	23431
6	6D	6D2	6D2D	6D2D6	2622
Grand Total					108687

The six watersheds were further sub divided in to 209 micro watersheds for forming the viable size units for determining priority and framing soil and water conservation measures

3.5.3 Soil Erosion Assessment includes: -

- Estimation of Runoff potential map unit weightage using RDBMS (Relational Data Base Management System) model for identification and demarcation of location wise extent of risk areas in various studied area.

- Generation of Runoff Potential Index (RPI) for assessment of relative priority of studied area contributing higher Runoff in SAS Nagar District.

The assignment of weightage value to the RPMU for prioritization of studied area is based on the relative assessment of runoff generation from the area enclosed by the unit. The inertia factor “K” is taken as 50 signify equilibrium between run-off and run-in. Any addition to the factor K i.e. (50+X) is the suggestive of run-off in the ascending order, whereas subtraction from K i.e. (50-X) indicates deposition possibilities.

The categorization for soil erosion risk categories have been made as per the value of weightage assigned to RPMU in following five classes:

- Very High Risk weightage value of > 70
- High Risk weightage value of 66 to 70
- Medium Risk weightage value of 61 to 65
- Low weightage value of 56 to 60
- Very Low Risk weightage value of 55 & below

The RPI is calculated using the empirical formula given below-

$$RPI = \sum_{i=1}^{i=n} \frac{(A_i \times W_i)}{(A_w)} \times 100$$

where,

- | | | |
|----------------------|---|--|
| RPI | = | Runoff Potential Index |
| A_i | = | Area of the <i>i</i> th RPMU unit |
| W_i | = | Runoff Weightage value of the <i>i</i> th RPMU unit |
| A_w | = | Total of studied area |
| n | = | No. of mapping unit |

3.6 Lab Data Analysis:

Soil samples collected in the field during ground truthing are analyzed in the soil laboratory.

3.7 Digital Maps Generation and Reports Preparation:

The field sheets further processed using ArcGIS software and different maps prepared **on 1:5000 Scales**. The scale provides the finest details of the area including the field parcels /khasra boundary in the present study and also the scale has enabled the separation of area under various using highest ground resolution. Flowchart showing the methodology adopted in carrying out soil survey work is described in **Fig. 1**.

3.8 Report Submission to User Department:

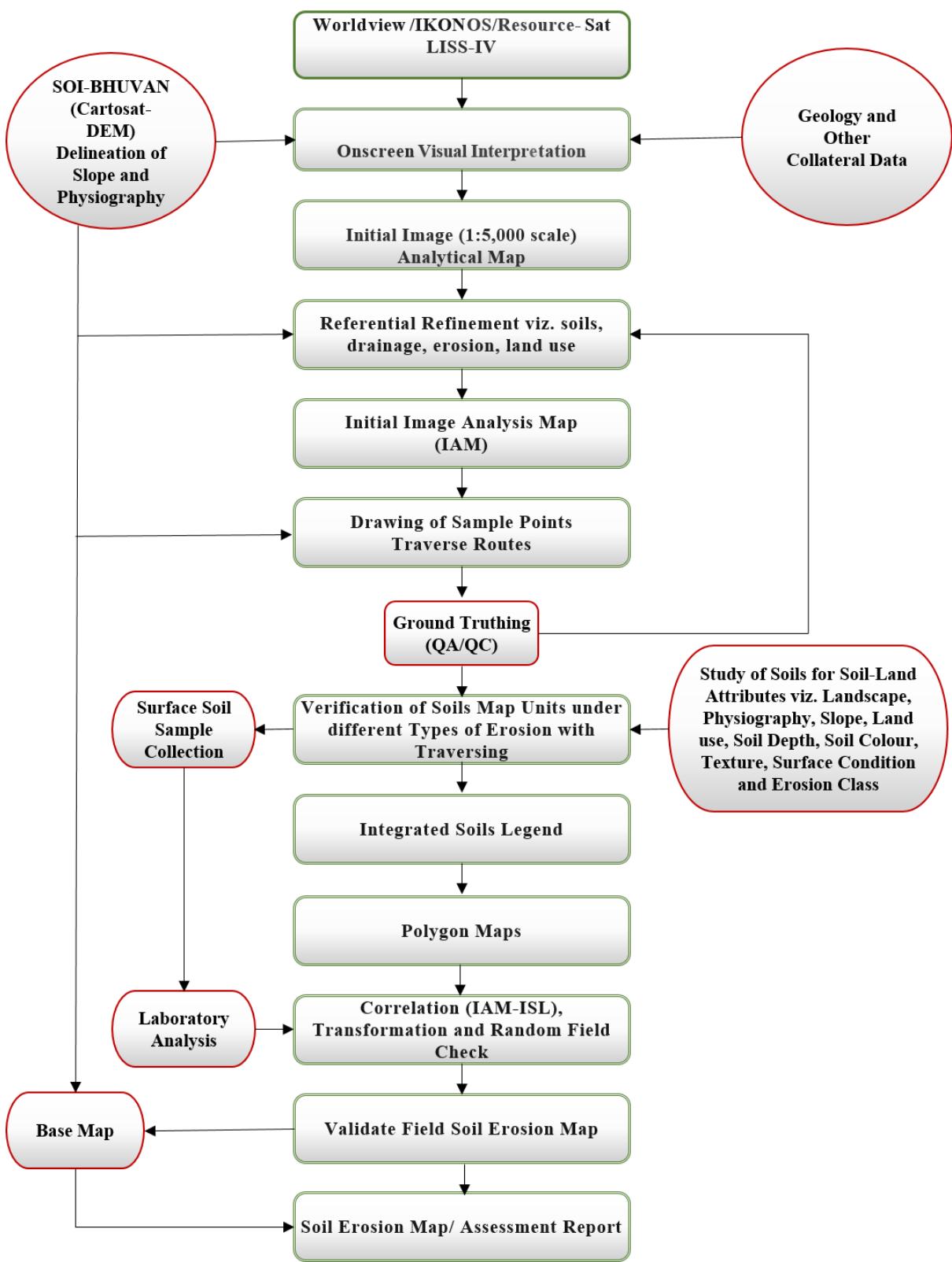


Figure 1: Flow Chart of Remote Sensing based Methodology for Erosion Assessment in Shivalik Hills of Punjab State

4. DEVELOPMENT OF RUNOFF POTENTIAL MAPPING UNIT (RPMU) LEGEND

Based on rapid traversing of the area and study of the topographic features using High Resolution Satellite Data, three landscapes namely Limestone, Alluvio-colluvial and Alluvial were identified and separated on the map. The landscapes were further subdivided into different physiographic units which in turn were subdivided based on slope, landuse, vegetation, soil erosion hazard to formulate the Runoff Potential Mapping Units (RPMU). These units have been represented by English Alphabets. Runoff Potential Mapping Units (RPMU) can be useful in selecting more responsive areas for watershed management for flood control. The data can be used for determining land development potential for different land use. The legend description is furnished in Table-1. The aerial extent of Runoff Potential Mapping Units (RPMU) of the district is given in Table- 2.

Table 1: Legend Description Punjab Shivalik Hills, SahibzadaAjit Singh Nagar District

RPMU	Description	Runoff Potential Weightage	Soil Erosion Risk Category
Alluvio-Colluvium Landscape			
AC08	Pediments; moderate (5-10%) slope; open scrub lands (when canopy cover is <10 %); very deep; yellowish brown to dark yellowish brown surface colour; coarse loamy surface and subsurface texture; well drained; severe erosion;	67	High
AC02	Piedmont plain; gentle (3-5%) slope; 50% area is under open scrub lands (when canopy cover is <10 %) and 50% area is under degraded forest F1 (<10% canopy cover); moderately deep; yellowish brown to dark yellowish brown surface colour; fine loamy surface texture; calcareous, moderately well drained; moderate erosion; unmanaged to poorly managed	63	Medium
AC04	Piedmont plain; gentle (3-5%) slope; open scrub lands (when canopy cover is <10 %); very deep; dark yellowish brown surface colour; fine loamy surface texture; calcareous, well drained; moderate to severe erosion; unmanaged to poorly managed	63	Medium
AC05	Piedmont plain; moderate (5-10%) slope; deciduous forest (single story veg) F2(10-20% canopy cover); deep; yellowish brown to dark yellowish brown surface colour; fine to fine loamy surface texture; calcareous, moderately well to well drained; moderate erosion; poorly to moderately well managed	62	Medium
AC01	Piedmont plain; gentle (3-5%) slope; multiple crop cultivation (ir/multi crop); very deep; dark yellowish brown surface colour; fine loamy surface texture; calcareous, moderately well to well drained; slight erosion; well managed	57	Low
AC06	Piedmont plain; gentle (3-5%) slope; open scrub lands (when canopy cover is <10 %); very deep; brown to	57	Low

RPMU	Description	Runoff Potential Weightage	Soil Erosion Risk Category
	strong brown surface colour; coarse loamy to sandy surface texture; calcareous, well drained; moderate erosion; unmanaged to poorly managed		
AC07	Piedmont plain; gentle (3-5%) slope; Plantation; very deep; yellowish brown to dark yellowish brown surface colour; fine loamy to coarse loamy surface texture; calcareous, moderately well to well drained; moderate erosion; moderately well managed	57	Low
AC03	Piedmont plain; very gentle (1-3%) slope; multiple crop cultivation (ir/multi crop); very deep; yellowish brown to dark yellowish brown surface colour; coarse loamy to fine loamy surface texture; calcareous, well drained; slight erosion; well managed	55	Very Low
Alluvium Landscape			
AL05	Alluvial plains; very gentle (1-3%) slope; open scrub lands (when canopy cover is <10 %); very deep; light yellowish brown to dark yellowish brown surface colour; coarse loamy surface texture; well drained; moderate erosion; unmanaged to poorly managed	57	Low
AL06	Alluvial plains; gentle (3-5%) slope; multiple crop cultivation(ir/multi crop); very deep; yellowish brown to dark yellowish brown surface colour; coarse loamy surface texture; well drained; slight to moderate erosion; well managed	56	Low
AL08	Alluvial plains; gentle (3-5%) slope; open scrub lands (when canopy cover is <10 %); very deep; dark yellowish brown surface colour; fine loamy to coarse loamy surface texture; poorly to imperfectly drained; moderate erosion; unmanaged to poorly managed	59	Low
AL09	Alluvial plains; very gentle (1-3%) slope; Plantation; very deep; yellowish brown to dark yellowish brown surface colour; fine loamy surface texture; moderately well drained; moderate erosion; moderately well to well managed	57	Low
AL02	Alluvial plains; very gentle (1-3%) slope; multiple crop cultivation (ir/multi crop); very deep; yellowish brown to dark yellowish brown surface colour; coarse loamy to fine loamy surface texture; well drained; slight erosion; well managed	55	Very Low
AL03	Alluvial plains; very gentle (1-3%) slope; multiple crop cultivation (ir/multi crop); very deep; yellowish brown to dark yellowish brown surface colour; coarse loamy to sandy surface texture; well drained; slight to moderate erosion; well managed	54	Very Low
Limestone Landscape			
LS02	Hill tops/ Pediment slope; moderate (5-10%) slope; 50% area is under degraded forest F1 (<10% canopy cover) and 50% area is under open scrub lands (when canopy cover is <10 %); moderately deep; brown to strong brown surface colour; fine loamy surface texture; calcareous, imperfectly to moderately well drained; severe erosion;	72	Very High

RPMU	Description	Runoff Potential Weightage	Soil Erosion Risk Category
	unmanaged to poorly managed		
LS03	Hills side slopes; strong (10-15%) slope; 50% area is under degraded forest F1 (<10% canopy cover) and 50% area is under open scrub lands (when canopy cover is <10 %); very deep; brown to strong brown surface colour; fine loamy to fine surface texture; calcareous, moderately well to excessively drained; severe erosion; unmanaged to poorly managed	72	Very High
LS05	Hills side slopes; strong (10-15%) slope; open scrub lands (when canopy cover is <10 %); moderately deep; brown surface colour; fine loamy surface texture; calcareous, imperfectly to moderately well drained; severe erosion; unmanaged	75	Very High
LS07	Hills side slopes; moderately steep (15-25%) slope; open scrub lands (when canopy cover is <10 %); shallow; brown surface colour; fine loamy surface texture; calcareous, excessively drained; very severe erosion; unmanaged	85	Very High
LS08	Hills side slopes; moderately steep (15-25%) slope; degraded forest F1 (<10% canopy cover); very deep; brown surface colour; fine loamy surface texture; calcareous, excessively drained; severe erosion; poorly managed	74	Very High
LS10	Hills side slopes; moderately steep (15-25%) slope; degraded forest F1 (<10% canopy cover); deep; brown surface colour; fine loamy surface texture; calcareous, well to excessively drained; moderate to severe erosion; poorly to moderately well managed	71	Very High
LS11	Hills side slopes; moderately steep (15-25%) slope; 50% area is under degraded forest F1 (<10% canopy cover) and 50% area is under open scrub lands (when canopy cover is <10 %); very deep; brown surface colour; fine loamy surface texture; calcareous, well to excessively drained; severe erosion; unmanaged to poorly managed	74	Very High
LS12	Hills side slopes; steep (25-33%) slope; deciduous forest (single story veg) F2 (10-20% canopy cover); shallow; brown surface colour; fine loamy surface texture; calcareous, excessively drained; moderate erosion; moderately well managed	72	Very High
LS13	Hills side slopes; steep (25-33%) slope; degraded forest F1(<10% canopy cover); moderately deep; brown surface colour; fine loamy surface texture; excessively drained; calcareous, severe erosion; unmanaged to poorly managed	82	Very High
LS14	Hills side slopes; steep (25-33%) slope; open scrub lands (when canopy cover is <10 %); moderately deep; brown to strong brown surface colour; fine loamy surface texture; calcareous, excessively drained; very severe erosion; unmanaged	88	Very High
LS15	Hills side slopes; very steep (33-50%) slope; 50% area is under open scrub lands (when canopy cover is <10 %)	91	Very High

RPMU	Description	Runoff Potential Weightage	Soil Erosion Risk Category
	and 50% area is under degraded forest F1 (<10% canopy cover); moderately deep; brown surface colour; fine loamy to fine surface texture; calcareous, moderately excessively drained; severe to very severe erosion; unmanaged		
LS16	Hills side slopes; very steep (33-50%) slope; open scrub lands (when canopy cover is <10 %); shallow; brown surface colour; fine loamy surface texture; calcareous, excessively drained; very severe erosion; unmanaged	94	Very High
LS24	Hills side slopes; steep (25-33%) slope; 50% area is under degraded forest F1(<10% canopy cover) and 50% area is under open scrub lands (when canopy cover is <10 %); shallow; yellowish brown to dark yellowish brown surface colour; fine loamy to very fine surface texture; calcareous, excessively drained; severe to very severe erosion; unmanaged	89	Very High
LS25	Hills side slopes; very steep (33-50%) slope; deciduous forest (single story veg) F2 (10-20% canopy cover); shallow; light brownish gray to yellowish brown surface colour; fine loamy to fine surface texture; calcareous, well to excessively drained; moderate to severe erosion; unmanaged	85	Very High
LS29	Foot hill slopes; moderate (5-10%) slope; 50% area is under degraded forest F1 (<10% canopy cover) and 50% area is under open scrub lands (when canopy cover is <10 %); moderately deep; yellowish brown to dark yellowish brown surface colour; fine loamy surface texture; calcareous, well drained; moderate erosion; poorly to moderately well managed	72	Very High
LS06	Hills side slopes; strong (10-15%) slope; degraded forest F1(<10% canopy cover); moderately deep; strong brown to brown surface colour; fine loamy surface texture; calcareous, moderately well drained; moderate to severe erosion; poorly to moderately well managed	70	High
LS09	Hills side slopes; moderately steep (15-25%) slope; deciduous forest (single story veg) F2 (10-20% canopy cover); moderately deep; brown surface colour; fine loamy surface texture; calcareous, well to excessively drained; moderate erosion; moderately well managed	68	High
LS23	Narrow hill valleys; gentle (3-5%) slope; 50% area is under degraded forest F1(<10% canopy cover) and 50% area is under open scrub lands (when canopy cover is <10 %); very deep; brown surface colour; fine loamy surface texture; calcareous, moderately well drained; severe erosion; poorly to moderately well managed	66	High
LS26	Hills side slopes; strong (10-15%) slope; single crop cultivation (rf/single crop); moderately deep; brown surface colour; fine loamy to fine surface texture; calcareous, well to excessively drained; moderate erosion; unmanaged	70	High
LS22	Narrow hill valleys; gentle (3-5%) slope; 50% area is	63	Medium

RPMU	Description	Runoff Potential Weightage	Soil Erosion Risk Category
	under degraded forest F1(<10% canopy cover) and 50% area is under open scrub lands (when canopy cover is <10 %); very deep; brown surface colour; fine loamy surface texture; calcareous, moderately well drained; moderate to severe erosion; unmanaged to poorly managed		
LS04	Hills side slopes; strong (10-15%) slope; deciduous forest (single story veg) F2 (10-20% canopy cover); very deep; brown to strong brown surface colour; fine loamy to fine surface texture; calcareous, moderately well drained; moderate erosion; moderately well to well managed	62	Medium
LS19	Narrow hill valleys; very gentle (1-3%) slope; degraded forest F1 (<10% canopy cover); very deep; brown surface colour; fine loamy surface texture; moderately well drained; moderate to severe erosion; poor to moderately managed	62	Medium
LS28	Hill tops; moderate (5-10%) slope; deciduous forest (single story veg) F2(10-20% canopy cover); moderately deep; yellowish brown to dark yellowish brown surface colour; fine loamy surface texture; calcareous, moderately well drained; moderate erosion; moderately well to well managed	62	Medium
LS21	Narrow hill valleys; gentle (3-5%) slope; deciduous forest (single story veg) F2(10-20% canopy cover); very deep; brown surface colour; fine surface texture; moderately well drained; moderate erosion; poorly managed	61	Medium
LS01	Hill tops; very gentle (1-3%) slope; multiple crop cultivation (ir/multi crop); very deep; brown surface colour; fine loamy to fine surface texture; calcareous, moderately well drained; moderate erosion; well managed	58	Low
LS18	Narrow hill valleys; very gentle (1-3%) slope; multiple crop cultivation (ir/multi crop); very deep; brown surface colour; fine loamy surface texture; moderately well drained; moderate erosion; very well managed	56	Low
LS20	Narrow hill valleys; very gentle (1-3%) slope; terraced cultivation (rf/multiple crop); very deep; brown to strong brown surface colour; fine loamy surface texture; calcareous, poorly drained; slight erosion; well managed	56	Low

LS27: Landslide; **AL01, AL04, LS17:** Falls under Roopnagar District;

AL07: Falls under Dasuya District

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H	Piedmonts; moderate to strong (5-15%) slope; single crop cultivation (rf/single crop); very deep; light yellowish brown to dark yellowish brown surface colour; coarse loamy to sandy surface texture; unmanaged; slight to moderate erosion; poorly managed	65	Low
S	Basinal plain; very gentle to gentle (1-5%) slope; unculturable wastelands; very deep; pale brown to dark yellowish brown surface colour; fine loamy surface texture; none-slight to moderate erosion; poorly managed	60	Low

RPMU	Description	Runoff Potential Weightage	Soil Erosion Risk Category
U	Stream banks; moderate to strong (5-15%) slope; grasslands/ pasture; very deep; yellowish brown to dark yellowish brown surface colour; fine loamy to coarse loamy surface texture; none-slight to moderate erosion; poorly managed	55	Very Low
J	Piedmonts; very gentle to gentle (1-5%) slope; single crop cultivation (rf/single crop); very deep; light yellowish brown to dark yellowish brown surface colour; coarse loamy to sandy surface texture; moderately managed; moderate erosion; well managed	55	Very Low
M	Recent flood plain; gentle to moderate (3-10%) slope; single crop cultivation (rf/single crop); very deep; yellowish brown to dark yellowish brown surface colour; coarse loamy surface texture; moderately managed; none-slight to moderate erosion; well managed	40	Very Low
P	Levees; plain-nearly level to very gentle (0-3%) slope; single crop cultivation (rf/single crop); very deep; light yellowish brown to dark yellowish brown surface colour; coarse loamy surface texture; well managed; none-slight erosion; very well managed	30	Very Low
Q	Aeolian plains; very gentle to gentle (1-5%) slope; single crop cultivation (rf/single crop); very deep; dark yellowish brown surface colour; coarse loamy to sandy surface texture; none-slight to moderate erosion; well managed	45	Very Low
R	Basinal plain; plain-nearly level to very gentle (0-3%) slope; single crop cultivation (rf/single crop); very deep; brown to dark yellowish brown surface colour; fine loamy surface texture; well managed; none to slight erosion; very well managed	40	Very Low
R2	Flood plain; plain-nearly level to very gentle (0-3%) slope; single crop cultivation (rf/single crop); very deep; dark yellowish brown to reddish brown surface colour; coarse loamy surface texture; none to slight erosion; very well managed	35	Very Low
T	Alluvial plain; very gentle to gentle (1-5%) slope; Forest (Teak, Eucalyptus, Casuarina, etc); very deep; dark brown to yellowish brown surface colour; coarse loamy to fine loamy surface texture; none to slight erosion; poorly managed	40	Very Low
W	Point bar complex; plain-nearly level to very gentle (0-3%) slope; plantation-forest; very deep; pale brown to brown surface colour; sandy to sandy skeletal surface texture; unmanaged; none to slight erosion; poorly managed	20	Very Low
Miscellaneous Area		-	-

Table- 2: Areal Extent of Different Runoff Potential Mapping Units (RPMUs)

S. No.	RPMU	Runoff Potential Mapping unit Weightage	Soil Erosion Risk Category	Area(ha)	Area (%)
1	AC08	67	High	160	0.15%
2	AC02	63	Medium	152	0.14%
3	AC04	63	Medium	232	0.21%
4	AC05	62	Medium	34	0.03%
5	AC01	57	Low	1419	1.31%
6	AC06	57	Low	191	0.18%
7	AC07	57	Low	268	0.25%
8	AC03	55	Very Low	1494	1.37%
9	AL08	59	Low	1525	1.40%
10	AL05	57	Low	907	0.83%
11	AL09	57	Low	1193	1.10%
12	AL06	56	Low	10379	9.55%
13	AL02	55	Very Low	17812	16.39%
14	AL03	54	Very Low	1635	1.50%
15	LS16	94	Very High	192	0.18%
16	LS15	91	Very High	834	0.77%
17	LS24	89	Very High	771	0.71%
18	LS14	88	Very High	802	0.74%
19	LS07	85	Very High	349	0.32%
20	LS25	85	Very High	853	0.78%
21	LS13	82	Very High	1251	1.15%
22	LS05	75	Very High	207	0.19%
23	LS08	74	Very High	630	0.58%

S. No.	RPMU	Runoff Potential Mapping unit Weightage	Soil Erosion Risk Category	Area(ha)	Area (%)
24	LS11	74	Very High	626	0.58%
25	LS02	72	Very High	211	0.19%
26	LS03	72	Very High	324	0.30%
27	LS12	72	Very High	693	0.64%
28	LS29	72	Very High	11	0.01%
29	LS10	71	Very High	516	0.47%
30	LS06	70	High	466	0.43%
31	LS26	70	High	28	0.03%
32	LS09	68	High	242	0.22%
33	LS23	66	High	473	0.44%
34	LS22	63	Medium	196	0.18%
35	LS04	62	Medium	423	0.39%
36	LS19	62	Medium	691	0.64%
37	LS28	62	Medium	70	0.06%
38	LS21	61	Medium	146	0.13%
39	LS01	58	Low	2	0.00%
40	LS18	56	Low	585	0.54%
41	LS20	56	Low	115	0.11%
42	H	65	Medium	3829	3.52%
43	S	60	Low	1159	1.07%
44	U	55	Very Low	1862	1.71%
45	J	55	Very Low	13	0.01%
46	Q	45	Very Low	5029	4.63%
47	T	40	Very Low	567	0.52%

S. No.	RPMU	Runoff Potential Mapping unit Weightage	Soil Erosion Risk Category	Area(ha)	Area (%)
48	M	40	Very Low	529	0.49%
49	R	40	Very Low	28039	25.80%
50	P	30	Very Low	7151	6.58%
51	R2	35	Very Low	371	0.34%
52	W	20	Very Low	310	0.29%
53	Brick Kiln			190	0.17%
54	Dam			3	0.00%
55	HB			7556	6.95%
56	Landslide (LS27)			21	0.02%
57	River			2654	2.44%
58	Rock Quarry			1	0.00%
59	Water bodies			295	0.27%
Grand Total				108687	100.00

5. SOILS OF THE AREA

Soil formation is influenced largely by different soil forming factors like climate, vegetation, parent material, geomorphic setting, relief/micro relief and anthropogenic factors have contributed in the development of soils of the area. Climate of the area is the most significant and major factor controlling the type and rate of soil formation. Corresponding to different hydro geomorphic units, different pedogenic processes such as gains, losses, transformation & translocations are operational in the survey area.

Remotely sensed high resolution satellite data (IKONOS) and Cartosat-DEM of BHUVAN have been analysed to delineate five different physiographic units in the Shivalik Hills in a semiarid tract of the Punjab State. Soils from unstable geomorphic surfaces (undifferentiated hill slopes, river bank and rivulet) showed A-C profiles, while soils developed on relatively stable geomorphic surfaces (backslope and foot hills slope) had a well-developed “cambic” subsurface horizon and showed A-Bw-C profile development.

The soils in this region are mainly developed on capping of lime stone parent material over sand deposits in hills and alluvio-colluvial deposits formed in valleys and plain were influenced by climate followed by topography and time.

Topography, along with the nature of parent material and time, was found to be responsible for the pedogenic differences in the soils developed on different landscapes. The soil forming process e.g. eluviations and illuviation of clay, leaching of bases resulting in the development of argillic and “cambic”. The steep to very steep slope with poor vegetative cover leads to high run off, moderate to severe accelerated erosion resulting in the formation of weakly developed profile with loamy skeletal to fine loamy soils.

The eroded soils from undifferentiated hill slopes and river stream bank were classified as Typic Ustorthents and the coarse-textured soils from rivulet as Typic Ustipsammens. The moderately developed soils from alluvial plain and foot hill slope were classified as Typic Haplustepts. This study established a well-defined relationship between physiographic surfaces and development of soils. Concatenation of soils on these geomorphic surfaces was the result of surface and subsurface movement of materials.

5.1 Morphology

Colour of the soils under moist condition varies from reddish brown to yellowish brown. Clay loam to sandy loam is the dominant texture. A Consistency of these soils is dominantly sticky and plastic. Upper horizons have few fine roots. Many concretions of calcareous nature are present in the lower horizon of Ramgarh and upper horizons of Panchkula pedon. Both the soils

are calcareous in nature. They have clear irregular to gradual irregular horizon boundaries. The topography of the area is plain to highly steep and undulating. Soil is subject from slight to severe water erosion on different physiographic settings and land use /land cover conditions.

The major soil type includes weakly to moderately developed sub-tropical brown soils developed under semiarid zone. The soils of the project area show variation in depth, colour and texture based on its occurrence on, physiographic, slope and land use and parent material. On undifferentiated hills slopes of strong to steep slope (10-33 %), the soils of moderately deep to deep depth, fine loamy to moderately fine texture under thin forest vegetative cover are noticed and soils of very deep depth with fine loamy to fine texture and dark brown colour found in moderately dense forest (F2) lands. The area under scrub on different slope ranges from 5 to 33 percent slope found have shallow to moderately deep soils and, coarse loamy to fine loamy texture formed because of higher rate of runoff due lack of vegetative cover are observed. Similarly the soils in valley areas were very deep , fine loamy texture type in agriculture land use and it is moderately deep to deep coarse loamy texture in scrub land use were noticed, whereas the soils on flood plain were of deep, sandy to coarse loamy texture under scrubby vegetation and the soils of alluvial plains are of vital economic value as it supports the dense population were found to be very deep, fine loamy to fine texture having of the moderate to high water and nutrient holding capacity indicated in higher CEC value.

The soils over all were calcareous in nature and contains medium textured, susceptible to runoff owing to the inherent nature and steeper slope gradient in about 50 percent of surveyed area of district accelerate the process of detachment and transport of sediments from these land surfaces to the lower valley area, where in repeated deposition of sediments results in raising level of river /choes beds thus making it susceptible to flood due occasional heavy storms.

6. ASSESSMENT AND REPORTING OF THE SURVEYED AREA

The study of the individual erosion intensity mapping units provides information on geology/landscape, physiography, slope, land use/ land cover, soil depth, soil colour, texture, erosion and management status. The watershed characteristics in the form of legend can be used for broad level planning purpose.

This is to mention here that this study only took in to consideration the all the area excepts for those classified under miscellaneous category such as Habitation, Rivers / streams, Water bodies, rock quarry, etc. for categorization of erosion class in district and also for estimation of RPMU weightage estimation and identification of risk areas prone to erosion as the constitute non soil part in the study.

6.1 Physiography Classes

The areal extension of the different classes of physiography, slope, landuse, depth and erosion are provided in the following **Tables-3 (a, b, c and d)** and **Figures**.

Table 3(a): Distribution of the Surveyed Area under different Physiography Class in Sahibzada Ajit Singh Nagar District

S. No.	PHYSIOGRAPHY	AREA (ha)	AREA (%)
1	Aeolian plains	5029	4.63
2	Alluvial plain	34018	31.30
3	Basinal plain	29198	26.86
4	Flood plain to paleo channels	900	0.83
5	Foot Hill Slope	11	0.01
6	Hill Side Slope	9207	8.47
7	Hill Tops	283	0.26
8	Levees	7151	6.58
9	Narrow hill valleys	2206	2.03
10	Pediments	160	0.15
11	Piedmont plain	7632	7.02
12	Point bar complex	310	0.29
13	Stream banks	1862	1.71
14	Landslide	21	0.02
15	Miscellaneous Area (Brick Kiln, Dam, Habitation, River, Rock Quarry, Water Bodies)	10699	9.84
GRAND TOTAL		108687	100.00

Areal distribution of the surveyed area under different physiography showed that major part of the area is under Alluvial plain (31.30 %) class, followed by Basinal plain (26.86%), Levees (6.58 %), Hill side slope (8.47 %), Aeolian plain (4.63 %), similarly 7.02 % and 2.03 %

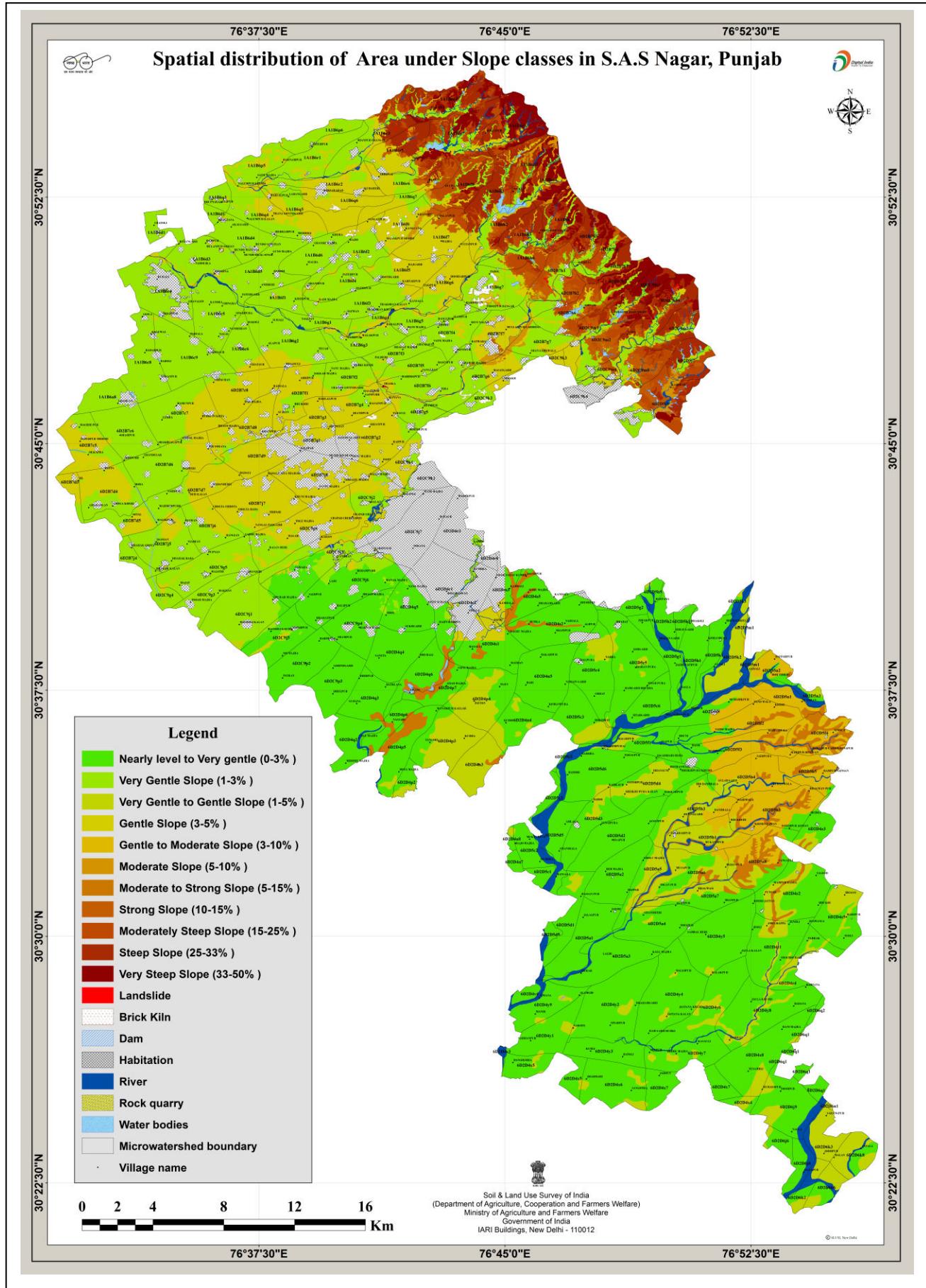
area under piedmonts and narrow hill valleys, respectively.

6.2 Slope Classes

Similarly, distribution of area under different slope show that major part of the area in studied district covered under plain-nearly level to very gentle sloping 35500 ha (32.66 %), followed by very gentle sloping 24434 ha (22.48 %). Similarly, gentle sloping land covers 14981 ha (13.78 %). The hilly areas of the district found to occur on >10 % sloping lands. The aerial distribution of hill slope classes shows about 5396 ha area found to have steep to very steep slope class, similarly about 3811 ha land found to be covered under strong to moderately steep slope.

Table 3(b): Distribution of the Surveyed Area under different Slope Class in Sahibzada Ajit Singh Nagar District

S. No.	DESCRIPTION (PERCENT SLOPE)	AREA (ha)	AREA (%)
1	Plain-nearly level to very gentle (0-3%)	35500	32.66
2	Very Gentle Slope (1-3%)	24434	22.48
3	Very gentle to gentle (1-5%)	7668	7.06
4	Gentle Slope (3-5%)	14981	13.78
5	Gentle to strong (3-10%)	3829	3.52
6	Moderate Slope (5-10%)	486	0.45
7	Moderate to Strong slope (5-15%)	1862	1.71
8	Strong Slope (10-15%)	1448	1.33
9	Moderately Steep Slope (15-25%)	2363	2.17
10	Steep Slope (25-33%)	3517	3.24
11	Very Steep Slope (33-50%)	1879	1.73
12	Landslide	21	0.02
13	Miscellaneous Area (Brick Kiln, Dam, Habitation, River, Rock Quarry, Water Bodies)	10699	9.84
GRAND TOTAL		108687	100.00



6.3 Surface Texture

Areal distribution of the surveyed area under different surface textural class showed that major part of the area is under fine loamy with 40520 ha (37.28 %) area, which is followed by Coarse loamy to fine loamy textural class covered about 19873 ha (18.28 %), followed by coarse loamy textural class 19497ha (17.94 %), coarse loamy to sandy loamy covers 10697 ha (9.84 %), sandy to sandy skeletal (0.29 %). Lowest area covered under fine textural class with an area of about 146 ha (0.13 %).

Table 3(c): Distribution of the Surveyed Area under different Surface Textural Class in Sahibzada Ajit Singh Nagar District

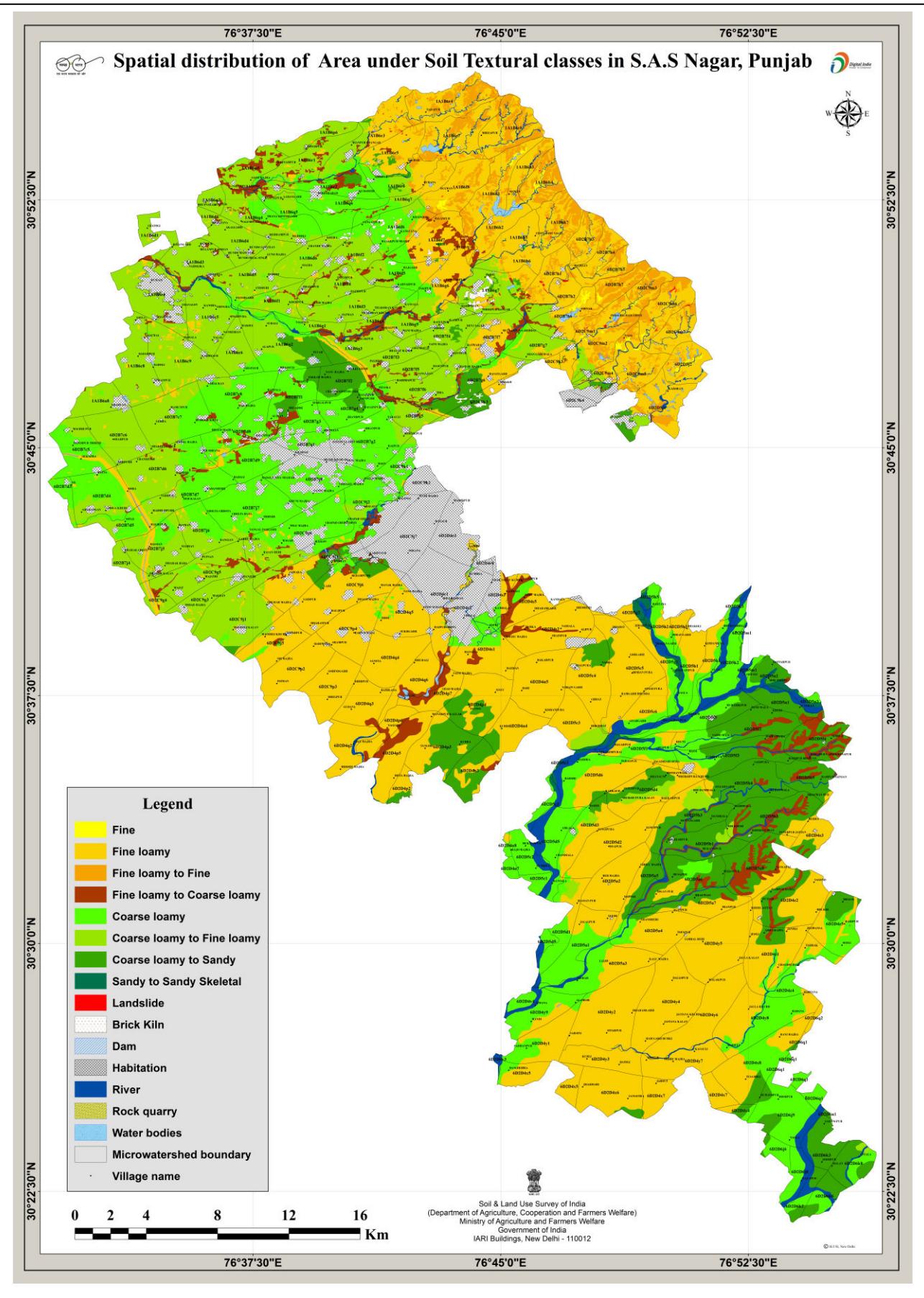
S. No.	Soil Textural Class	AREA (ha)	AREA (%)
1	Fine	146	0.13
2	Fine Loamy	40520	37.28
3	Coarse Loamy	19497	17.94
4	Fine loamy to Fine	3269	3.01
5	Fine Loamy to Coarse Loamy	3655	3.36
6	Coarse Loamy to Fine Loamy	19873	18.28
7	Coarse Loamy to Sandy	10697	9.84
8	Sandy to Sandy Skeletal	310	0.29
9	Landslide	21	0.02
10	Miscellaneous Area (Brick Kiln, Dam, Habitation, River, Rock Quarry, Water Bodies)	10699	9.84
GRAND TOTAL		108687	100.00

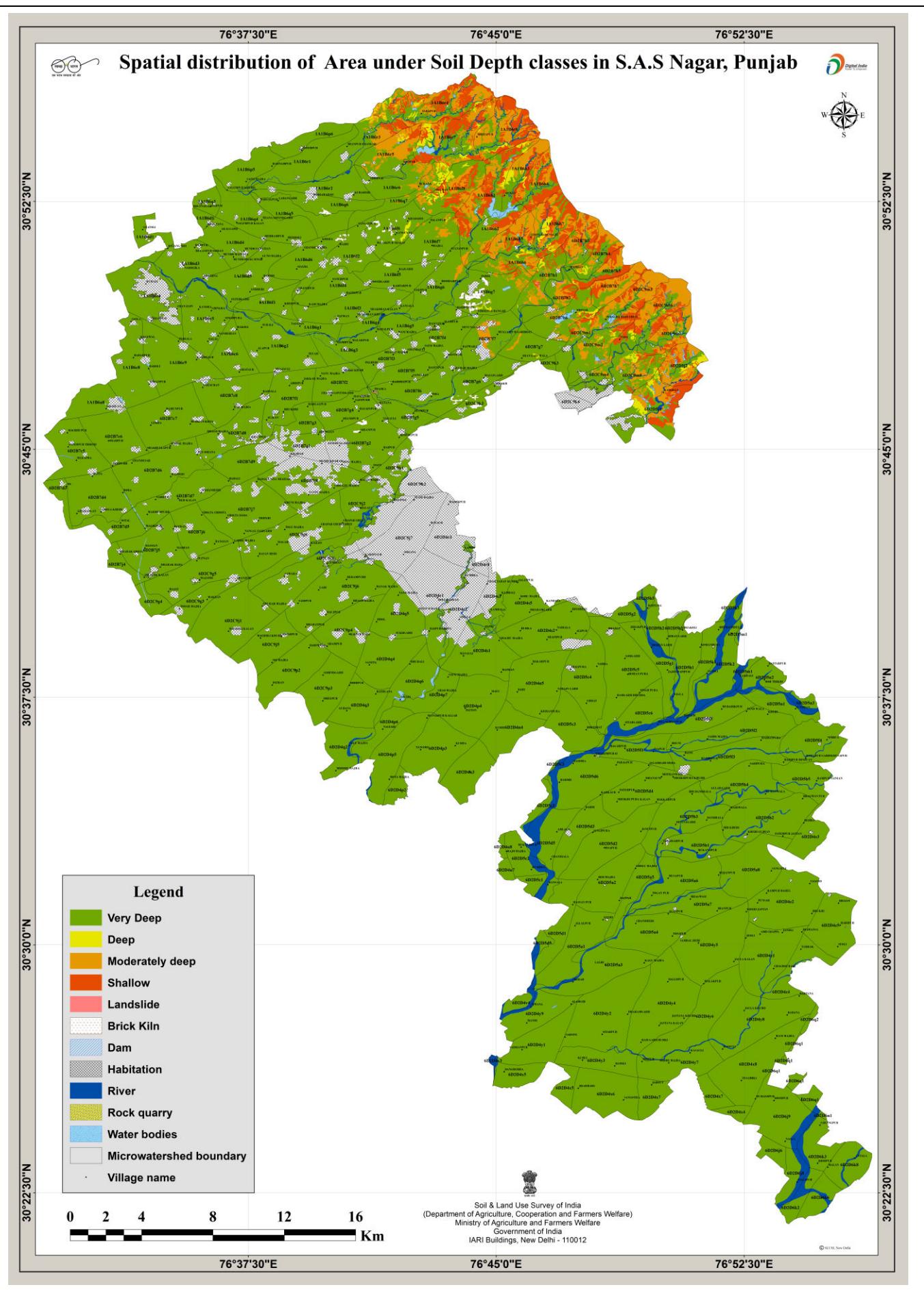
6.4 Depth Classes

Depth wise distribution of the surveyed area shows that, around 90285 ha (83.09 %) area in district is under very deep soil depth class followed by moderately deep soil depth class covering an area of about 3.93 %. Shallow soil depth class covering an area of about 2.63 % and deep soil depth class covering least area of about 0.51 %.

Table 3(d): Distribution of the Surveyed Area under different Depth Class in Sahibzada Ajit Singh Nagar District

S. No.	DEPTH	AREA (ha)	AREA (%)
1	Very deep	90285	83.07
2	Deep	550	0.51
3	Moderately deep	4274	3.93
4	Shallow	2858	2.63
5	Landslide	21	0.02
6	Miscellaneous Area (Brick Kiln, Dam, Habitation, River, Rock Quarry, Water Bodies)	10699	9.84
GRAND TOTAL		108687	100.00





6.5 Land Capability Classification

Land capability classification aims at classifying each kind of soil shown on the map by taking into consideration its potentialities as well as limitations for sustainable agriculture production. Land capability classification is a system of grouping soil based on their inherent soil characteristics, external landscape feature and other climatic conditions. In this system, soils are grouped at three level viz. land capability class, land capability subclass and land capability unit as described below:

6.5.1 Land Capability Class:

The land capability classes are designated by Roman number I to VIII which indicates intensities of limitation in increasing order. The soils in class I to IV are suitable for agriculture with progressive increasing limitations that affect their use under agriculture.

6.5.2 Land Capability Subclass:

The subclass is subdivision of land capability classes indicating various kinds of limitations, such as erosion and run-off (e), unfavorable texture affecting vegetation and root zone limitation (s), drainage, wetness, over flow hazard (w) and the climate limitations (c).

These are indicated in the maps by adding lower case alphabets such as e, w, s and c to Land Capability Class, e.g. IIe, IIes, IIIes.

6.5.3 Land Capability Units:

The sub classes are further subdivided into the land capability units based on the degree of limitations where group of soils that are alike in their management requirements and suitable for similar crops having similar response to treatment and have same kind of productivity they are indicated on the maps as I-1, II-1, IIe-1, IIes-1, IIIes-1, IIIs-1, IIIs-2.

6.5.4 Land Capability Units:

Mapping unit wise distribution of area under different land capability class and subclass is summarized as given below:

6.5.4.1 Land capability class II:

This unit consists of very deep, coarse loamy to fine loamy surface texture, occurring on plain-nearly to very gentle sloping. They are susceptible to slight to moderate erosion.

The following mapping unit is placed in this class:

S. No.	MAPPING UNIT	AREA (ha)
1.	AC03	1494
2.	P	7151
3.	R	28039
4.	R2	371
TOTAL		37055

6.5.4.2 Land capability subclass IIe:

This unit consists of very deep, coarse loamy to fine loamy surface texture, gentle to very gentle sloping. They are susceptible to slight to moderate erosion.

The following mapping unit is placed in this class:

S. No.	MAPPING UNIT	AREA (ha)
1.	AC01	1419
2.	AL02	17812
3.	AL09	1193
TOTAL		20424

6.5.4.3 Land capability subclass IIs:

This unit consists of very deep, coarse loamy surface texture, occurring on very gentle to gentle sloping. They are susceptible to slight to moderate erosion.

The following mapping unit is placed in this class:

S. No.	MAPPING UNIT	AREA (ha)
1.	M	529
TOTAL		529

6.5.4.4 Land capability subclass IIes:

This unit consists of very deep and moderately deep, fine loamy, coarse loamy to sandy surface texture, occurring on very gentle to strong sloping. They are susceptible to slight to moderate erosion.

The following mapping unit is placed in this class:

S. No.	MAPPING UNIT	AREA (ha)
1.	AL03	1635
2.	AL06	10379
3.	H	3829
4.	J	13
5.	LS29	11
6.	Q	5029
TOTAL		20896

6.5.4.5 Land capability class III:

This unit consists of very deep, coarse loamy surface texture, occurring on very gentle sloping. They are susceptible to moderate erosion.

The following mapping unit is placed in this class:

S. No.	MAPPING UNIT	AREA (ha)
1.	LS18	585
TOTAL		585

6.5.4.6 Land capability subclass IIIe:

This unit consists of very deep, fine loamy, coarse loamy surface texture, occurring on very gentle to gentle sloping. They are susceptible to moderate erosion.

The following mapping unit is placed in this class:

S. No.	MAPPING UNIT	AREA (ha)
1.	AC07	268
2.	AL05	907
3.	LS01	2
TOTAL		1177

6.5.4.7 Land capability subclass IIIs:

This unit consists of very deep, fine loamy surface texture, occurring on very gentle sloping. They are susceptible to slight erosion.

The following mapping unit is placed in this class:

S. No.	MAPPING UNIT	AREA (ha)
1.	LS20	115
TOTAL		115

6.5.4.8 Land capability subclass IVe:

This unit consists of very deep, fine loamy surface texture, occurring on gentle sloping. They are susceptible to slight to moderate erosion.

The following mapping unit is placed in this class:

S. No.	MAPPING UNIT	AREA (ha)
1.	AC04	232
2.	AL08	1525
TOTAL		1757

6.5.4.9 Land capability subclass IVes:

This unit consists of very deep, coarse loamy surface texture, occurring on gentle to moderate sloping. They are susceptible to moderate to severe erosion.

The following mapping unit is placed in this class:

S. No.	MAPPING UNIT	AREA (ha)
1.	AC06	191
2.	AC08	160
TOTAL		356

6.5.4.10 Land capability class VI:

This unit consists of very deep, fine loamy surface texture, occurring on very gentle to gentle sloping. They are susceptible to slight to moderate erosion.

The following mapping unit is placed in this class:

S. No.	MAPPING UNIT	AREA (ha)
1.	S	1159
	TOTAL	1159

6.5.4.11 Land capability subclass VIe:

This unit consists of very deep, fine loamy to coarse loamy surface texture, occurring on gentle to strong sloping. They are susceptible to slight to moderate erosion.

The following mapping unit is placed in this class:

S. No.	MAPPING UNIT	AREA (ha)
1.	U	1862
	TOTAL	1862

6.5.4.12 Land capability subclass VIIs:

This unit consists of very deep, sandy to sandy skeletal surface texture, occurring on plain-nearly to very gentle sloping. They are susceptible to slight erosion.

The following mapping unit is placed in this class:

S. No.	MAPPING UNIT	AREA (ha)
1.	W	310
	TOTAL	310

6.5.4.13 Land capability subclass VIes:

This unit consists of very deep and moderately deep, fine loamy surface texture, occurring on strong sloping. They are susceptible to moderate to severe erosion.

The following mapping unit is placed in this class:

S. No.	MAPPING UNIT	AREA (ha)
1.	LS03	324
2.	LS26	28
	TOTAL	352

6.5.4.14 Land capability subclass VIIes:

This unit consists of shallow to moderately deep, fine loamy surface texture, occurring on strong to moderately steep sloping. They are susceptible to severe to very severe erosion.

The following mapping unit is placed in this class:

S. No.	MAPPING UNIT	AREA (ha)
1.	LS05	207
2.	LS07	349
	TOTAL	556

6.5.4.15 Land capability subclass VIIIes:

This unit consists of shallow to moderately deep, fine loamy surface texture, occurring on steep to very steep sloping. They are susceptible to very severe erosion.

The following mapping unit is placed in this class:

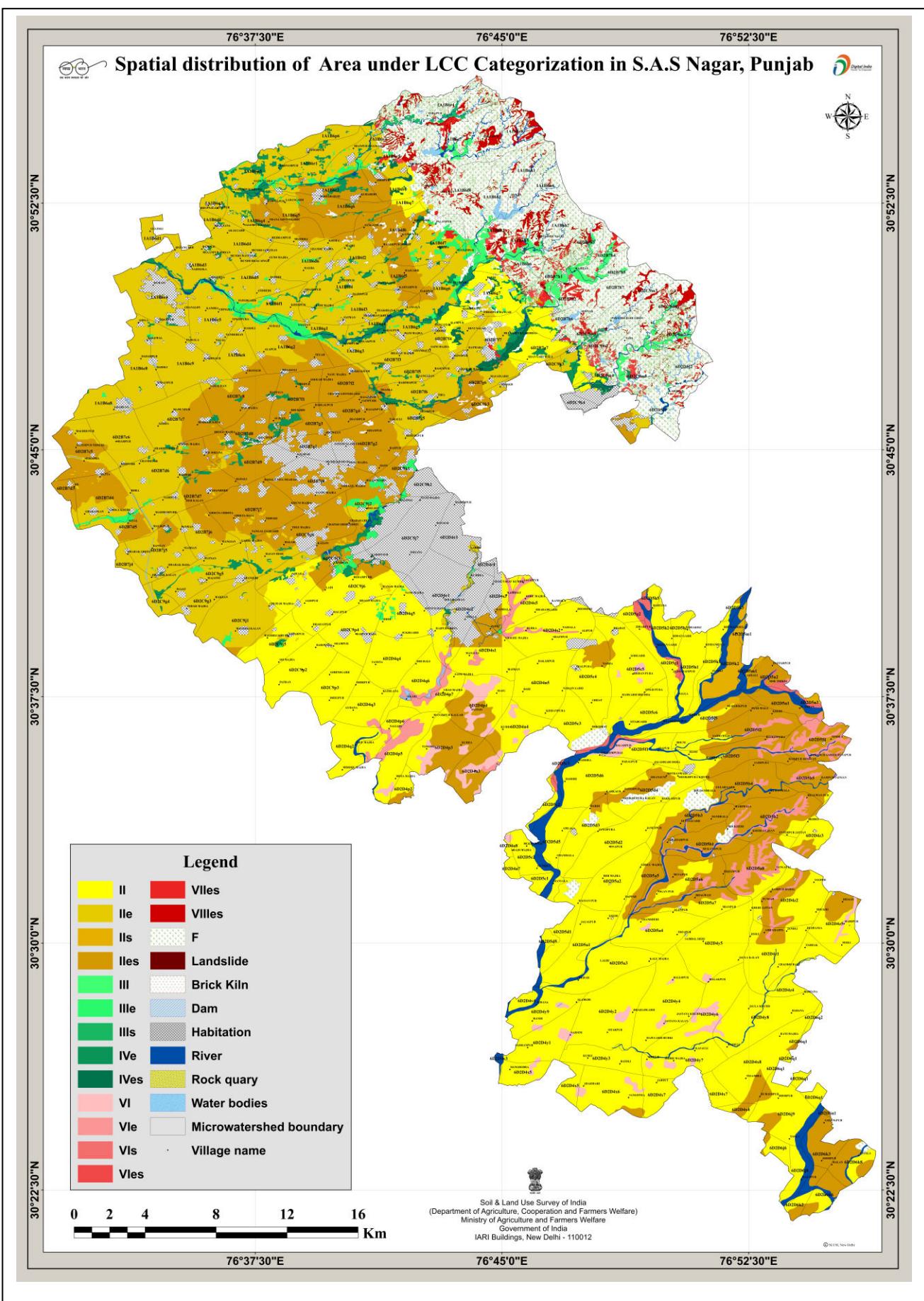
S. No.	MAPPING UNIT	AREA (ha)
1.	LS14	802
2.	LS16	192
TOTAL		994

6.5.4.16 Forest:

This unit consists of the mapping units covered under degraded and deciduous forests under different physiography. They are susceptible moderate to severe erosion hazards.

The following mapping units are placed in this class:

S. No.	MAPPING UNIT	AREA (ha)
1.	AC02	152
2.	AC05	34
3.	LS02	211
4.	LS04	423
5.	LS06	466
6.	LS08	630
7.	LS09	242
8.	LS10	516
9.	LS11	626
10.	LS12	693
11.	LS13	1251
12.	LS15	834
13.	LS19	691
14.	LS21	146
15.	LS22	196
16.	LS23	473
17.	LS24	771
18.	LS25	853
19.	LS28	70
20.	T	567
TOTAL		9845



6.6 Analysis of Soil Erosion Status

In all of the studied area under project area, it was observed that due to rains, extensive loss of soil occurs. This results in degradation of lands under Shivalik and poor regeneration. The erosion material brought by the streams from sloping hills is deposited in the gently sloping piedmont around the rivulets. The repeated deposition of coarse sediments render land waste with comparatively lower agriculture production in valley areas which are adjoin to the high eroded areas.

The rain water is the main cause of erosion in the area falling under district. However upper catchment areas found to be affected from severe to very severe erosion been studied at 1:5K scale and depicted in 1X1 min grid (82 in number). Under these grids, it is observed that out of the **19599 ha** area studied in **1x1 min** grids about **7026 ha** mapped as **moderate to severe and very severe soil erosion** classes, out of which about **2948 ha** found under deep gullies and ravenous resulting in massive loss of soils, responsible for formation of landslides/ steep sloping peaks often observed and mapped in **21 ha area** and about **2758 ha and 4078 ha** under severe rills and strong gullies mapped as moderate to severe and severe erosion. About **3002 ha** area under rill erosion mapped as moderate erosion. Similarly, about **5379 ha** found under different degree of sheet and rill erosion mapped as slight to moderate erosion together causing huge loss of top soils, responsible for raising of bed area of the choes and flooding in lower areas resulting in loss of crops in plain areas. Whereas, **1413 ha** area are mapped under miscellaneous uses. Similarly, the areas studied on **1:5 K** and **1:50 K** scale and presented in **3x3 min** grids, covering total area of **89088 ha**, shows that about **57278 ha** identified under slight sheet erosion. About **19043 ha** and **3481 ha** were mapped as slight to moderate and moderate **sheet erosion** respectively. Whereas, **9286 ha** area are mapped as miscellaneous land.

The table showing distribution of area under various erosion classes depicts the extent of the area under various Runoff Potential Mapping Units (RPMU) suffered in past due to rain water erosion and it is mainly observed in the field as sheet, rills and gully erosion and during ground truthing.

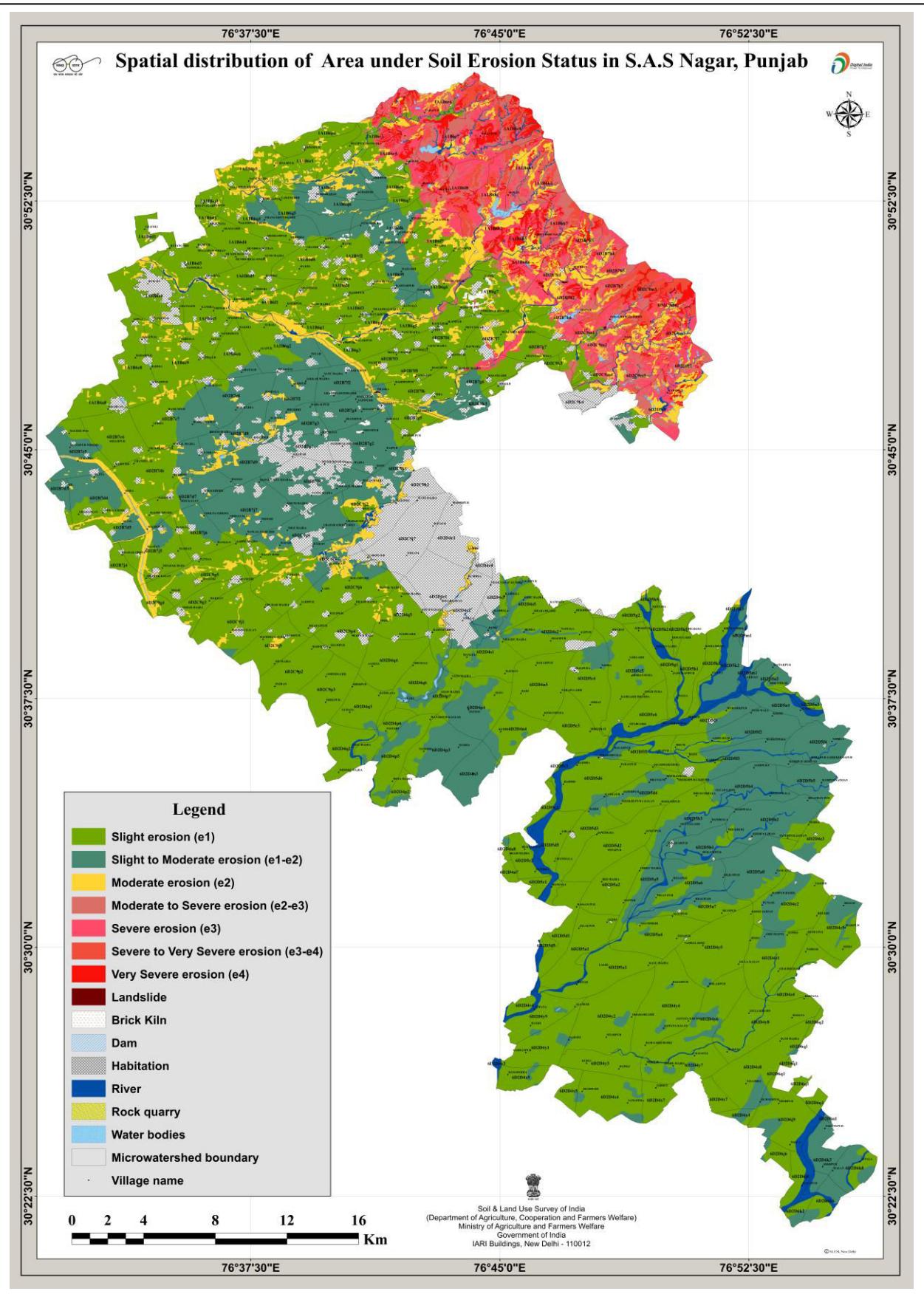
The areas suffer from all four type of erosions have been correlated with image signatures for accurately mapping remotely located in-accessible eroded areas of the district. Soil erosion in respect of sheet is observed in plain agricultural lands and about 52.70 % of area in district mapped as slight erosion, similarly area suffers due to more severe erosion, which gives rise to rills were mapped under slight to moderate and moderate soil erosion covers 22.47 % and 5.96 % of area respectively. Around 6.47% land suffers from gully erosion which was mapped under severe to very severe and very severe erosion depending upon the depth and width of gullies. Most part of all, about 3.75% of area under gullies mapped under severe erosion, followed by area under medium to deep gullies and shallow ravines mapped under

severe to very severe erosion i.e. 1.48 %. Similarly, area under medium deep ravines mapped under very severe erosion and covers 1.24% area and about 0.02 % area in district suffered from landslides on hill slopes.

Table: 3(e) Distribution of the Surveyed Area under different Erosion Class in Sahibzada Ajit Singh Nagar District

S. No.	EROSION CLASS / DESCRIPTION	Area (ha)	Area (%)
1	Slight erosion (Strong sheet erosion)	57278	52.70
2	Slight to Moderate erosion	24422	22.47
3	Moderate erosion (Severe sheet and strong rill erosion)	6483	5.96
4	Moderate to Severe erosion (Severe rill and slight gully erosion)	2758	2.54
5	Severe erosion (Strong Gully erosion)	4078	3.75
6	Severe to Very severe erosion (Severe Gully and Ravine)	1605	1.48
7	Very severe erosion (severe gully to Ravine)	1343	1.24
8	Landslide	21	0.02
9	Miscellaneous Land	10699	9.84
Grand Total		108687	100.00

There is direct relation of soil erosion and runoff observed in the area which positively correlated with slope gradient and vegetative cover. The areas of higher elevation or top of hills, found to suffers from gully erosion and landslides associated with loss of vegetation exhibits peculiar image signature, whereas the lower slopes of the same hills have more vegetative cover and show moderate erosion.



7. RISK CHARACTERIZATION AND PRIORITY CATEGORIZATION

The prime objective of Soil Erosion mapping survey in the Shivalik Hills of Punjab State is to determine soil erodibility index for demarcation of potential risk areas for soil erosion he areas of studied in 1x1 min grid at 1:5K scale and 3x3 min grids at 1:50k scale. The classes of risk categorization were simulated form weightage values assigned to the mapping units (RPMU). It is measures the relative potential for soils to erode. Similarly, the values of weightage were for determination of Runoff Potential Index (RPI).

The Runoff Potential Index (RPI) combines the inherent erodibility of a soil type (known as K-factor); with the position of the soil on the landscape and land parameters such as physiography, slope and vegetation to rank each Runoff Potential Mapping Unit (RPMU) by its erosion potential. Soil types vary in their erodibility depending on their depth, texture, structure and other physical properties. Additionally, erosion potential increases with slope. Every soil and attribute of RPMU assigned weightage value which has been derived parametrically in RDBMS to evaluate soil erodibility (K-factor) from the most detailed available soil data and it is based on class of soil attribute which influences soil detachment process. The combined RPMU weightage derived by incorporating relative values of slope and Land use factors. The weightage value of 50 were taken as the state of equilibrium where in there is no runoff or erosion and run on or deposition. The percent slope was calculated from the 20meter national grid DEM dataset available on BHUVAN portal. The percent slope was then used to create slope classes for use as a multiplier for the K-factor. Many studies demonstrate a linear or greater increase in soil erosion as slope increases (*Fox and Bryan, 2000*). Thus RPMU weightage for every RPMU estimated for accurate assessment of erosion and also for identifying location-wise risk areas for erosion in studied area.

The values of weightage for each attribute of RPMU were assigned by entering the data in Relational Database Management System software (RDBMS).

Table 4(a): Weightage Runoff Potential values for Slope Factor

S. No.	SLOPECLASS	SLOPEPERCENT & DESCRIPTION	RP Value
1	A	0-1(Nearly Level slope)	0.25
2	A-B	0-3 (Nearly Level to Very Gently Sloping)	0.75
3	B	1-3	1.00
4	B-C	1-5	1.50
5	C	3-5	2.00
6	C-D	3-10	3.25
7	D	5-10	3.75
8	D-E	5-15	4.95
9	E	10-15	6.20
10	E-F	10-25	8.55
11	F	15-25	9.75
12	F-G	15-33	11.50
13	G	25-33	13.90

14	G-H	25-50	17.25
15	H	33-50	19.00
16	H-I	33->50	22.00
17	I	>50	25.00

Table 4(b): Weightage Runoff Potential values for Land Cover Factor

S. No.	Description	RP Value
1	Single crop cultivation (RF/Single Crop)	1
2	Multiple crop cultivation(IR/Multi Crop)	1
3	Terraced cultivation (RF/Single Crop)	1
4	Terraced cultivation (RF/Multiple Crop)	1
5	Jhum/shifting cultivation	1
6	Deciduous forest (Single Story Veg) F2 (10-20%)	0.89
7	Deciduous forest (Single Story Veg) F3 (20-40%)	0.78
8	Deciduous forest (Single Story Veg) F4 (40-60%)	0.63
9	Deciduous forest (Single Story Veg) F5 (>60%)	0.48
10	Deciduous forest (Double Story Veg) F2 (10-20%)	0.87
11	Deciduous forest (Double Story Veg) F3 (20-40%)	0.73
12	Deciduous forest (Double Story Veg) F4 (40-60%)	0.55
13	Deciduous forest (Double Story Veg) F5 (>60%)	0.36
14	Evergreen forest (Single Story Veg) F2 (10-20%)	0.91
15	Evergreen forest (Single Story Veg) F3 (20-40%)	0.8
16	Evergreen forest (Single Story Veg) F4 (40-60%)	0.65
17	Evergreen forest (Single Story Veg) F5 (>60%)	0.5
18	Evergreen forest (Double Story Veg) F2 (10-20%)	0.89
19	Evergreen forest (Double Story Veg) F3 (20-40%)	0.78
20	Evergreen forest (Double Story Veg) F4 (40-60%)	0.63
21	Evergreen forest (Double Story Veg) F5 (>60%)	0.48
22	Thin forest Vegetation (F1 , when canopy cover is <10 %)	0.96
23	Grasslands/Pasture (>10% canopy)	0.9
24	Grasslands/Pasture (<10% canopy)	0.96
25	Open scrub lands (when canopy cover is >10 %)	0.9
26	Open scrub lands (when canopy cover is <10 %)	0.96
27	Orchards(Coconut, Citrus, Mango, Areca nut) with	0.87
28	Orchards(Coconut, Citrus, Mango, Areca nut) without	0.96
29	Estates(Tea, Coffee, Rubber, Cashew)	0.7
30	Built-up lands	0
31	River/Stream	0
32	Lakes/Tanks/Ponds	0
33	Reservoirs	0
34	Bays/Estuaries/Lagoons	0

35	River/Stream courses	0
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Table4(c): Weightage Runoff Potential values for Soil Depth Factor

S. No.	Depth Class	Description	RP Value
1	d0	Zero depth	10.00
2	d1	Very shallow	6.25
3	d1-d2	Very shallow to shallow	5.94
4	d2	Shallow	5.63
5	d2-d3	Shallow to Moderately deep	5.00
6	d3	Moderately deep	4.38
7	d3-d4	Moderately deep to deep	3.13
8	d4	Deep	1.88
9	d4-d5	Deep to very deep	1.25
10	d5	Very deep	0.63

Table 4(d): Weightage Runoff Potential values for Soil Texture Factor

S. No.	Description	RP Value
1	Very fine	10.60
2	Fine	7.60
3	Fine silty	7.25
4	Coarse silty	6.25
5	Fine loamy	5.25
6	Coarse loamy	3.00
7	Sandy	1.00
8	Gravelly very fine	8.00
9	Gravelly fine	5.75
10	Gravelly fine silty	5.50
11	Gravelly coarse silty	4.75
12	Gravelly fine loamy	4.00
13	Gravelly coarse loamy	2.25
14	Gravelly sandy	0.75
15	Clayey skeletal	4.50
16	Loamy skeletal	2.75
17	Sandy skeletal	0.50
18	Fragmental	0.25

Table4 (e): Weightage Runoff Potential value for Erosion Factor

S. No.	Erosion	Description	RP Value
1	e0	None	0.00
2	e0-e1	None to slight erosion	0.63
3	e1	slight erosion	1.25
4	e1-e2	Slight to Moderate erosion	1.88
5	e2	Moderate erosion	2.50
6	e2-e3	Moderate to Severe erosion	6.25
7	e3	Severe erosion	10.00
8	e3-e4	Severe to Very severe erosion	12.50
9	e4	Very severe erosion	15.00

Table 4 (f): Weightage RP values for Surface condition

S. No.	Description	RP Value **
1	Rockiness	15% of average percent of ROC coverage of area
2	Boulderiness	15 % of average percent of boulders coverage of area
3	Stoniness	10 % of average percent of stones coverage of area
4	Gravelliness	5 % of average percent of gravels coverage of area

Table 4 (g): Weightage RP values for Management

Sl. No.	Management	Description	RP Value
1	M0	Unmanaged	1
2	M0-M1	Unmanaged to Poorly Managed	0.95
3	M1	Poorly Managed	0.9
4	M1- M2	Poorly Managed to Moderately Managed	0.825
5	M2	Moderately Managed	0.75
6	M2- M3	Moderately Managed to Well Managed	0.625
7	M3	Well Managed	0.5
8	M3- M4	Well Managed to Very Well Managed	0.375
9	M4	Very Well Managed	0.25

Calculation for Soil Erosion Risk Categorization:

$$\text{RPMU weightage} = 50 + (\text{Slope+ Soil Texture+ Soil Depth+ Erosion+ Surface Condition}) \times (\text{Land Cover} \times \text{Management})$$

The categorization for soil erosion risk classes have been made as per the value of weightage assigned to RPMU in following five categories:

- Very High Risk weightage value of > 70
- High Risk weightage value of 66 to 70
- Medium Risk weightage value of 61 to 65
- Low weightage value of 56 to 60
- Very Low Risk weightage value of 55 & below

7.1 Soil Erosion Risk Categories of Grids of SAS Nagar

The distribution of area under different soil erosion risk categories shows that around **8270 ha, 1369 ha and 5773 ha** area under study found under **very high, high and medium risk of soil erosion** respectively. This mainly attributed to the loss of vegetative cover, steep slopes and lack of proper conservation measures to arrest soil erosion. Area under **low risk** covering about **17743 ha (16.32 %)** land. These are mainly plain agricultural lands, well bunded and conserved. The area covered under **Very low risk** covering about **64812 ha** having well to moderately conserved and less conserved lands on plain and hills having different conservation needs.

The risk characterization of area was carried on the values of weightages assign to RPMU this does not includes the area under **landslide, river, stream/ choe, habitation, waterbodies,**

rock quarry/mines, brick kiln as it constitutes the non-soil part of surveyed area under model.

Table 5: Areal Extent of Area under different Soil Erosion Risk categories

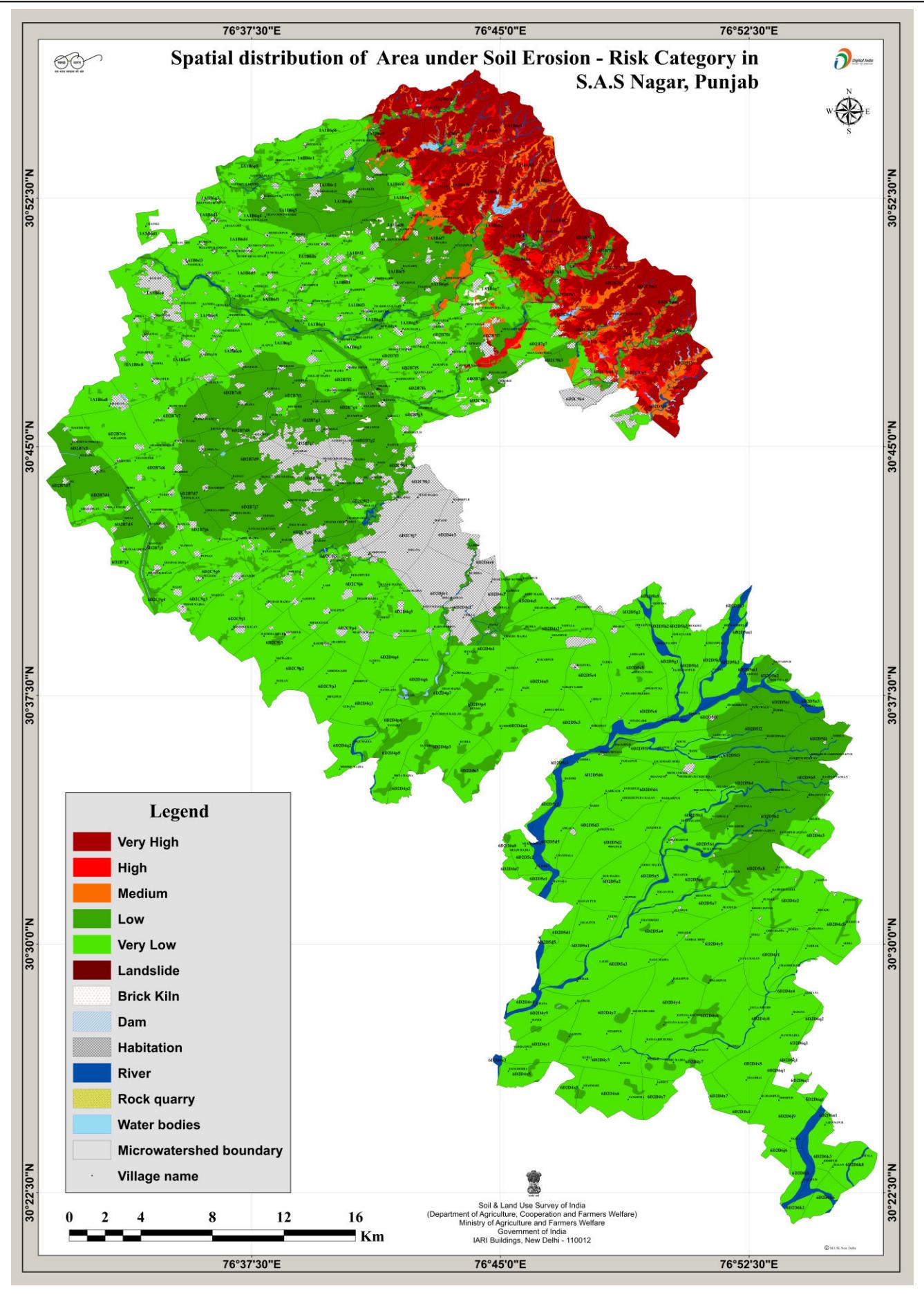
S. No.	Soil Erosion Risk categories / (RPI value)	Area under 1x1min grid	Area under 3x3 min grid	Area (ha)	Area (%)
1	Very High (above 70)	8270	0	8270	7.61
2	High (66-70)	1369	0	1369	1.26
3	Medium (61-65)	2484	3289	5773	5.31
4	Low (56-60)	1159	16584	17743	16.32
5	Very Low (55 & below)	4883	59929	64812	59.63
6	Landslide	21	0	21	0.02
7	Miscellaneous Area	1413	9286	10699	9.84
GRAND TOTAL		19599	89088	108687	100.00

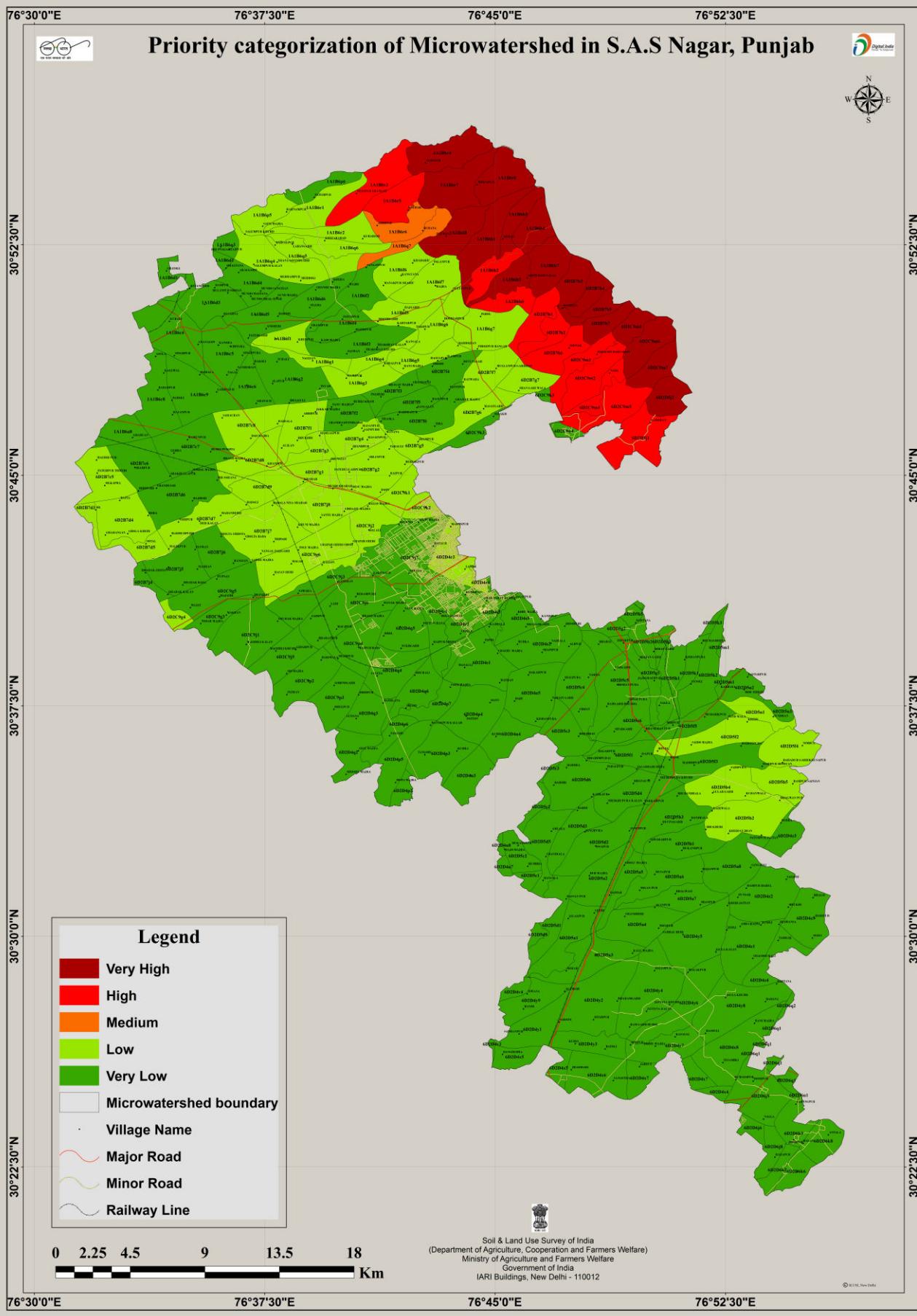
7.2 Priority Categorization of Micro-watersheds of SAS Nagar

The Runoff Potential Index (RPI) is defined as the runoff generated per unit area which is derived by taking the weighted arithmetic mean of the products of the Runoff potential weightage value with area of individual RPMU over the entire area of the hydrologic unit. This is to identify and demarcate the priority micro watersheds area in the district based on the Runoff Potential Index (RPI). The priority categorization of studied area was carried out to identify very high and high priority areas under micro-watershed so as to plan the action on priority basis selectively in phased manner. The numbers of partly and fully covered micro-watersheds along with the area distribution under different priority category have been summarized in Table-6. Out of the total 209 micro-watersheds, about 34 are fully covered in 1x1 minute grid interval, 151 are fully covered in 3x3 minutes interval and 24 micro-watersheds are partly covered in 1x1 as well as in 3x3. Out of 209 micro-watersheds Seventeen micro-watersheds falls under very high priority category with 7796 ha (7.20 %) of surveyed area and twelve micro-watersheds falls under high priority category with 5667 ha (4.41 %) area. Two micro-watersheds fall under medium priority category with 676 ha (0.62 %) area. The area 25100 ha (23.09 %) under low priority category covered 48 micro-watersheds whereas, the area 69448 ha (63.90 %) under very low priority category covered 130 micro-watersheds.

Table 6: Micro-watershed Wise Priority Categorization

S. No.	Priority Category	Area under 1x1min grid	Area under 3x3 min grid	Area (ha)	Area (%)
1	Very High (above 70)	7826	0	7826	7.20
2	High (66-70)	5637	0	5637	5.19
3	Medium (61-65)	615	61	676	0.62
4	Low (56-60)	5521	19579	25100	23.09
5	Very Low (55 & below)	0	69448	69448	63.90
GRAND TOTAL		19599	89088	108687	100.00





8. SALIENT FEATURES AND RECOMMENDATIONS

1. The present study of Soil Erosion Assessment in SAS Nagar District carried out following Modern Geospatial Technique using remotely sensed high resolution Satellite data in Geographic Information System (GIS) for development of real time scientific information on soil erosion, for the purpose of identification and location specific delineation of the area under priority categories based on their assessed Runoff Potential Index (RPI). The study in the part of district conducted on cadastral scale i.e. **1:5K scale** in **55028 ha** includes areas which suffer from moderate, severe and very severe erosion hazard and are prone to erosion risk. The remaining area of the district i.e. **53659 ha** studied in **1:50K scale**, which includes the area prone to none-slight soil erosion and same is covered under low and very low erosion risk categories.
2. Fixation of priority was done micro-watershed wise on the basis of Runoff Potential Index (RPI) value. Out of the total area of **19599 ha** falling in **1x1 minute** grids, **7826 ha** area having RPI >70 was assigned very High Priority Category; **5637 ha** area having RPI between 65 to 70 was accorded High Priority Category and about **615 ha** having RPI between 60 to 65 was categorized as Medium Priority Category whereas about **5521 ha** area categorized under low to very low priority. Micro-watersheds contributing very high, high and medium runoff, sediment and soil erosion were accorded very high, high and medium priorities.

The study recommends that based on number of parameters as detailed in the methodology, the areas of very high, high and medium priority micro-watersheds which also include the area under miscellaneous use such as habitation, stream/choe and other uses need to be protected and conserved as they form part of highly fragile area and are prone to higher intensities of soil erosion and consequently require more substantive measures to prevent and control soil erosion and enhance vegetative cover.

Areas which are prone to none to slight and moderate erosion were studied on **1:50K** scale and presented in **3x3 minute** grids is mostly under agriculture, habitation and other miscellaneous uses. Out of the total area of **89088 ha** area covered under the grids, about **19579 ha** falls in the low priority category, **69448 ha** falls under very low priority category and the area in medium priority is **61 ha**. Sustainable Management Techniques such as minimum tillage, Agro-forestry, rain water harvesting etc. are required to be adopted in such areas.

3. In the present study, run off potential was estimated for every micro-watershed falling the district. The RPI has been computed taking into account a set of soil and land attributes and precisely mapped the location of the areas subject to different types and severity of soil erosion.

The soil erosion risks were evaluated considering soil and land parameters. It is recommended that the area which fall under the very high and high priority category, marked with different shades of red colour in the maps, should be protected from further degradation. **Various activities leading to soil erosion such as clearing or breaking of land, mining, quarrying, grazing or collection and removal of grasses etc should be restricted or regulated. Removal of trees on steep slopes should also be restricted. Trees whose removal can accelerate erosion should not be allowed for felling.**

4. The study confirms that the areas of all the Runoff Potential Mapping Units conforming to very high, high and moderate priority categories in various micro-watersheds need to be protected entirely. These areas can precisely be located on the ground as well as on the map, as their boundaries follow natural hydrological boundaries. The holistic management of the entire area draining in to a common channel/choe can only be achieved by following micro-watershed as basic unit for planning and protection. The synergistic interaction of natural resources managed on watershed basis in turn induce sustainability in the eco-system in the areas with high slope. From the layman point of view also, it is easier to demarcate the area, if protection of the area is planned on natural features of the watersheds.

5. The analysis of Spatial distribution of RPMU shows that soils on upper reaches on very steep slope (>25 % slope) were reduced to shallow to moderate depth as a result of severe gully erosion. The land use in these upper reaches (LS16, 25 and 15) varies from open scrub to thin forest having 10-20 % canopy covers **1880 ha** area. Similarly, the soils on steep slope (25-33 % slope) were reduced to moderate depth owing to moderate soil erosion due to the presence of moderately dense forest cover. The soils of shallow depth were affected by severe to very severe erosion and such areas bear bushes and open scrub. These soils are fine loamy texture cover about **3520 ha** (LS 12, 13, 14, and 24).

Similarly, on moderately steep sloping lands (15-25 %), soils of shallow depth are found as a result of very severe erosion in the land under open scrub use. The soils under forest cover are moderately deep in thin forest and deep to very deep under moderately dense forest. These soils are prone to severe erosion because of relative impermeable nature being fine loamy to fine textured (LS 7, 8, 9, 10 and 11). Together, lands of this slope class covers **1991 ha** area in the district. The soil on strong slopes are (LS 3, 4, 5 6 and 26) are moderately deep to deep, fine loamy textured and are under thin to moderately dense forest covers **1416 ha**.

The development and physical strength of soil on hill slopes is found to be positively correlated with vegetation cover. The study confirms that shallow depth of soil at higher slope mainly due to removal or absence of vegetation. As regards the area under moderate slopes (LS 2, 28, 29 and AC5, 8) of foot hills, the soils are moderately deep having fine loamy texture

and are prone to moderate to severe erosion. These soils are under thin and open forest vegetation occupying **2726 ha** area. Similarly, in the areas under narrow valleys, all the sediments detached by water erosion flow as overland flow. As such these areas are susceptible to flooding on occurrence of high intensity storms in the upper reaches. Regular flooding of the lower areas swells up the choe beds and thus making it more prone to flooding (LS18, 19, 20). The area of the choes is included in the miscellaneous area as per the Technical Bulletin No. 9 title as “”Methodology of priority Delineation Survey” issued by Ministry of Agriculture and Farmers Welfare, Government of India.

The study recommends that all the area having more than 10 % slope and all adjoining areas in the foot hills and in the narrow valleys including the miscellaneous area under choes in the hills need to be protected through closure under PLPA as any diversion of such area from or exposure to commercial use shall further degrade these fragile land forms and may threaten the stability of the watersheds in the region.

6. The Shivaliks have been identified as one of the eight most degraded rainfed agro ecosystems of the country (Agrawal *et al.*, 2002). This study confirms that water erosion is the major cause of soil degradation. It is observed that out of the **19599 ha** area studied in **1x1 min** grids about **7026 ha** was found under strong to severe gully erosion and were mapped in **moderate to severe and very severe soil erosion** classes, out of which about **2948 ha** found under deep gullies and ravenous resulting in massive loss of soils, responsible for formation of landslides/ steep sloping peaks often observed and mapped in **21 ha area** and about **2758 ha and 4078 ha** under severe rills and strong gullies mapped as moderate to severe and severe erosion. About **3002 ha** area under rill erosion mapped as moderate erosion also cause profuse loss of soil every year. Similarly, about **5379 ha** found under different degree of sheet and rill erosion mapped as slight to moderate erosion together causing huge loss of top soils, responsible for raising of bed area of the choes and flooding in lower areas resulting in loss of crops in plain areas. Whereas, **1413 ha** area are mapped under miscellaneous uses. The very severely eroded areas (escarpment and ravines) may be taken up for growing local and indigenous species of grasses, whereas the plantation of tree, shrubs, herbs and bushes of dry deciduous species needs to be carried out particularly in areas which are devoid of vegetation or under scrub forest affected by severe and severe to very severe erosion (medium deep gully erosion).

Similarly, the areas studied on **1:5 K** and **1:50 K** scale and presented in **3x3 min** grids, covering total area of **89088 ha**, shows that about **57278 ha** identified under slight sheet erosion. About **19043 ha** and **3481 ha** were mapped under slight to moderate and moderate **sheet erosion** respectively. Whereas, **9286 ha** area are mapped as miscellaneous land. These areas are covered in nearly level to very gently sloping plains under cultivation require

improved agricultural practices like minimum tillage, crop rotation, crop diversification, vegetative mulching etc. for ensuring optimal use of soil, water and land resource for sustainable development.

Study recommends that in above mentioned areas, efforts must be made for undertaking appropriate soil and water conservation measures like gully plugging, silt trap, and protection of gully heads through construction of peripheral bund etc. These areas are also to be protected through closure to ensure natural regeneration of vegetation which in turn gives rise to development of soils and provide much needed stability to the areas.

7. The location specific categorization of the area was carried out under different soil erosion risk categories estimated as summation of weightage value assigned to the different attributes of the soil and land parameters governing the soil detachment. The relationship of these factors with soil detachment is quite complex and thus the absolute values of the quantum of detached soil could not be determined. Soil erosion from one point has been simulated with combined and reciprocal effect of soil and land attributes mapped in the form of Runoff Potential Map Unit (RPMU). The tabular distribution of **19599 ha** area studied at **1:5K in 1x1 min grids** shows that around **8270 ha, 1369 ha** and **2484 ha** area of the district was found under **very high, high** and **medium** risk of soil erosion respectively and constitute about **61.86 %** of area. This mainly attributed to the **loss of vegetative cover, steep sloping landforms, and lack of soil conservation measures to arrest soil erosion**. The landslide covers about **21 ha** having **very very high risk** for soil erosion. About **6042 ha** area was found prone to low and very low risk of runoff. Whereas, 1413 ha were mapped under miscellaneous uses. Similarly, in the remaining part of the district studied at **1:5K and 1:50K** scale the tabular distribution of **88922 ha** area studied at **3x3 min grid** shows that around **57237 ha** area is under **low risk**. These are mainly plain agricultural lands, well bunded and conserved.

8. The lands under capability classification of the study area in **SAS Nagar district**, shows that about **3683 ha** falls under land capability **class VI, 556 ha** placed under land capability class **VII** having **major soil and land limitation** suitable only for forestry purpose as these areas are on very steep sloping land, highly unstable because of relative high runoff potential of soils **and the closure of area under these lands under PLPA needs to be continued**. About **994 ha** falls under land capability class **VIII** suitable for recreation and wild life. It also indicates lack of resilience in the landforms if not been protected and its stability largely depends on continuous protection.

Similarly, around **9249 ha** area fall under forest on steep sloping hills need to be conserved through forestry practices and should not be diverted to other use as all these forests

are real treasure of the nature and wild life. Similarly, about **3683 ha** land form part of the upper valley are placed in land capability **class II, III, IV** which also needs to be taken up for agroforestry and agri-horti-silviculture for building up of green cover. About **1434 ha** land were covered under miscellaneous uses and landslide.

The area studied at **1:5K** and **1:50K scale** presented in **3x3 minute** grids covers remaining **89088 ha** area of district, land capability class **II** to **IV** are suitable for cultivation indicating increasing risk with higher number of class from **II** to **IV**. About **78304 ha** area is classified as land capability class **II**, these are fairly good lands for cultivation requiring improved cultural practices to ensure optimal use resource while **534 ha** area falls under land capability class **III** are the good lands with major one or more soil and land limitation requires major conservation measures for sustainable agriculture management and **964 ha** area falling under land capability class **IV**, marginally suitable for cultivation because of soil erosion, slope, depth of soil etc. which requires comprehensive land based planning for sustainable land management. Whereas, **9286 ha** area were mapped as forest and miscellaneous categories.

The areas under Shivalik hills in Punjab state **categorized under very high and high priority** not only serve as the **repository of biological diversity** but also provide variety of biological services like availability of life supporting system such **water and soil**. Any unsustainable diversion in the uses of these areas will lead to increased soil erosion and the further process of desertification as these lands were described to be fragile to any change and may leads to disastrous consequences, whereas for the areas under **low and very low category** may be planned for **intensive uses** by adopting sustainable land management practices

9. Under the present climate change scenario, the occurrence of extreme weather events are likely to increase in numbers and the rainfall pattern of the region has become more erratic with increasing frequency of high intensity storm and prolonged dry spells during the year leading to decreased vegetation. This loss of vegetative cover will further induce soil erosion leading to degradation. To build resilience against erratic climatic events there is an urgent need to increase forest cover under more climatic resilient species and also improve moisture through extensive soil and water conservation measures by construction of ponds, masonry drop structure, silt traps etc.

10. The villages under **PLPA** settlement another miscellaneous areas have been delisted in past could be brought under plantation to increase greenery and also the efforts should be initiated for installation of rain water harvesting structure at every house in village. Similarly, the efforts should have initiated to train every villager for skill development activity for cultivation and processing of medicinal and aromatic plant with buy back guarantee for livelihood generation of stakeholder residing in these areas.

ANNEXURE- I

Gridwise (1x1 Minute) Distribution of Runoff Potential Mapping Units (RPMU), their Erosion Class, Risk Category and Runoff Potential Mapping Unit Weightage

Grid Number	RPMU	Erosion Class	Risk Category	Runoff Potential Mapping unit Weightage	Area (ha)
53B09q6	AC01	Slight erosion (e1)	Low	57	4
	AC04	Moderate to Severe erosion (e2-e3)	Medium	63	3
	AC06	Moderate erosion (e2)	Low	57	5
	AL02	Slight erosion (e1)	Very Low	55	229
	AL05	Moderate erosion (e2)	Low	57	3
	AL08	Moderate erosion (e2)	Low	59	8
	AL09	Moderate erosion (e2)	Low	57	3
	HB	Habitation	Habitation	HB	1
	LS10	Moderate to Severe erosion (e2-e3)	Very High	71	1
	River	River	River	River	2
53B09q6 Total					259
53B09q8	HB	Habitation	Habitation	HB	1
	LS03	Severe erosion (e3)	Very High	72	1
	LS07	Very Severe erosion (e4)	Very High	85	13
	LS08	Severe erosion (e3)	Very High	74	19
	LS10	Moderate to Severe erosion (e2-e3)	Very High	71	26
	LS11	Severe erosion (e3)	Very High	74	5
	LS12	Moderate erosion (e2)	Very High	72	6
	LS13	Severe erosion (e3)	Very High	82	22
	LS14	Very Severe erosion (e4)	Very High	88	9
	LS19	Moderate to Severe erosion (e2-e3)	Medium	62	4
	LS20	Slight erosion (e1)	Low	56	5

	LS22	Moderate to Severe erosion (e2-e3)	Medium	63	4
	LS23	Severe erosion (e3)	High	66	3
	River	River	River	River	1
53B09q8 Total					119
53B09q9	AC01	Slight erosion (e1)	Low	57	61
	AC02	Moderate erosion (e2)	Medium	63	2
	AC04	Moderate to Severe erosion (e2-e3)	Medium	63	1
	AC06	Moderate erosion (e2)	Low	57	4
	AC07	Moderate erosion (e2)	Low	57	5
	AL02	Slight erosion (e1)	Very Low	55	1
	AL08	Moderate erosion (e2)	Low	59	1
	HB	Habitation	Habitation	HB	3
	Landslide (LS27)	Landslide	Landslide	Landslide (LS27)	1
	LS03	Severe erosion (e3)	Very High	72	1
	LS05	Severe erosion (e3)	Very High	75	2
	LS06	Moderate to Severe erosion (e2-e3)	High	70	13
	LS07	Very Severe erosion (e4)	Very High	85	4
	LS08	Severe erosion (e3)	Very High	74	5
	LS10	Moderate to Severe erosion (e2-e3)	Very High	71	5
	LS11	Severe erosion (e3)	Very High	74	4
	LS12	Moderate erosion (e2)	Very High	72	19
	LS13	Severe erosion (e3)	Very High	82	67
	LS14	Very Severe erosion (e4)	Very High	88	47
	LS19	Moderate to Severe erosion (e2-e3)	Medium	62	4
	LS20	Slight erosion (e1)	Low	56	18
	LS22	Moderate to Severe erosion (e2-e3)	Medium	63	3
	LS23	Severe erosion (e3)	High	66	3
	LS24	Severe to Very Severe erosion (e3-e4)	Very High	89	8
	River	River	River	River	5

53B09q9 Total						287
53B09r4	AC01	Slight erosion (e1)	Low		57	24
	AC02	Moderate erosion (e2)	Medium		63	2
	AL02	Slight erosion (e1)	Very Low		55	55
	AL03	Slight to Moderate erosion (e1-e2)	Very Low		54	41
	AL05	Moderate erosion (e2)	Low		57	43
	AL06	Slight to Moderate erosion (e1-e2)	Low		56	57
	AL08	Moderate erosion (e2)	Low		59	35
	AL09	Moderate erosion (e2)	Low		57	6
	HB	Habitation	Habitation	HB		21
	River	River	River	River		10
53B09r4 Total						294
53B09r7	AC01	Slight erosion (e1)	Low		57	91
	AC02	Moderate erosion (e2)	Medium		63	23
	AC03	Slight erosion (e1)	Very Low		55	26
	AC06	Moderate erosion (e2)	Low		57	34
	AC07	Moderate erosion (e2)	Low		57	2
	AL05	Moderate erosion (e2)	Low		57	5
	AL06	Slight to Moderate erosion (e1-e2)	Low		56	53
	HB	Habitation	Habitation	HB		25
	LS03	Severe erosion (e3)	Very High		72	9
	LS05	Severe erosion (e3)	Very High		75	14
	LS06	Moderate to Severe erosion (e2-e3)	High		70	3
	LS13	Severe erosion (e3)	Very High		82	7
	LS14	Very Severe erosion (e4)	Very High		88	2
	River	River	River	River		1
53B09r7 Total						295
53B09r8	AC02	Moderate erosion (e2)	Medium		63	2
	AC03	Slight erosion (e1)	Very Low		55	51

	AC06	Moderate erosion (e2)	Low	57	9
	AL06	Slight to Moderate erosion (e1-e2)	Low	56	224
	AL08	Moderate erosion (e2)	Low	59	8
53B09r8 Total					294
53B09r9	AC08	Severe erosion (e3)	High	67	1
	AL02	Slight erosion (e1)	Very Low	55	12
	AL06	Slight to Moderate erosion (e1-e2)	Low	56	222
	AL08	Moderate erosion (e2)	Low	59	1
	AL09	Moderate erosion (e2)	Low	57	10
	Brick Kiln	Brick Kiln	Brick Kiln	Brick Kiln	31
	HB	Habitation	Habitation	HB	17
53B09r9 Total					294
53B09v2	Landslide (LS27)	Landslide	Landslide	Landslide (LS27)	1
	LS03	Severe erosion (e3)	Very High	72	2
	LS07	Very Severe erosion (e4)	Very High	85	1
	LS08	Severe erosion (e3)	Very High	74	17
	LS09	Moderate erosion (e2)	High	68	6
	LS10	Moderate to Severe erosion (e2-e3)	Very High	71	12
	LS11	Severe erosion (e3)	Very High	74	18
	LS12	Moderate erosion (e2)	Very High	72	26
	LS13	Severe erosion (e3)	Very High	82	21
	LS14	Very Severe erosion (e4)	Very High	88	29
	LS15	Severe to Very Severe erosion (e3-e4)	Very High	91	14
	LS19	Moderate to Severe erosion (e2-e3)	Medium	62	18
	LS20	Slight erosion (e1)	Low	56	14
	LS23	Severe erosion (e3)	High	66	24
	LS24	Severe to Very Severe erosion (e3-e4)	Very High	89	20
	River	River	River	River	3
	Water bodies	Water bodies	Water bodies	Water bodies	4

53B09v2 Total						230
53B09v3	Landslide (LS27)	Landslide	Landslide	Landslide (LS27)		1
	LS02	Severe erosion (e3)	Very High		72	7
	LS07	Very Severe erosion (e4)	Very High		85	2
	LS10	Moderate to Severe erosion (e2-e3)	Very High		71	46
	LS11	Severe erosion (e3)	Very High		74	10
	LS12	Moderate erosion (e2)	Very High		72	37
	LS13	Severe erosion (e3)	Very High		82	73
	LS14	Very Severe erosion (e4)	Very High		88	22
	LS15	Severe to Very Severe erosion (e3-e4)	Very High		91	14
	LS19	Moderate to Severe erosion (e2-e3)	Medium		62	14
	LS20	Slight erosion (e1)	Low		56	6
	LS23	Severe erosion (e3)	High		66	6
	LS24	Severe to Very Severe erosion (e3-e4)	Very High		89	34
	River	River	River	River		3
	Water bodies	Water bodies	Water bodies	Water bodies		17
53B09v3 Total						292
53B09v4	LS12	Moderate erosion (e2)	Very High		72	2
	LS16	Very Severe erosion (e4)	Very High		94	2
	LS25	Moderate to Severe erosion (e2-e3)	Very High		85	3
53B09v4 Total						7
53B09v5	HB	Habitation	Habitation	HB		1
	LS02	Severe erosion (e3)	Very High		72	1
	LS03	Severe erosion (e3)	Very High		72	2
	LS04	Moderate erosion (e2)	Medium		62	4
	LS06	Moderate to Severe erosion (e2-e3)	High		70	3
	LS07	Very Severe erosion (e4)	Very High		85	14
	LS09	Moderate erosion (e2)	High		68	1
	LS11	Severe erosion (e3)	Very High		74	9

	LS12	Moderate erosion (e2)	Very High	72	31
	LS13	Severe erosion (e3)	Very High	82	22
	LS14	Very Severe erosion (e4)	Very High	88	13
	LS15	Severe to Very Severe erosion (e3-e4)	Very High	91	31
	LS16	Very Severe erosion (e4)	Very High	94	1
	LS19	Moderate to Severe erosion (e2-e3)	Medium	62	4
	LS20	Slight erosion (e1)	Low	56	30
	LS22	Moderate to Severe erosion (e2-e3)	Medium	63	2
	LS23	Severe erosion (e3)	High	66	12
	LS24	Severe to Very Severe erosion (e3-e4)	Very High	89	16
	LS25	Moderate to Severe erosion (e2-e3)	Very High	85	50
	LS28	Moderate erosion (e2)	Medium	62	2
	River	River	River	River	8
	Water bodies	Water bodies	Water bodies	Water bodies	1
53B09v5 Total					258
53B09v6	HB	Habitation	Habitation	HB	4
	LS02	Severe erosion (e3)	Very High	72	3
	LS04	Moderate erosion (e2)	Medium	62	1
	LS07	Very Severe erosion (e4)	Very High	85	22
	LS08	Severe erosion (e3)	Very High	74	5
	LS10	Moderate to Severe erosion (e2-e3)	Very High	71	10
	LS11	Severe erosion (e3)	Very High	74	22
	LS13	Severe erosion (e3)	Very High	82	20
	LS14	Very Severe erosion (e4)	Very High	88	37
	LS18	Moderate erosion (e2)	Low	56	33
	LS19	Moderate to Severe erosion (e2-e3)	Medium	62	46
	LS20	Slight erosion (e1)	Low	56	3
	LS21	Moderate erosion (e2)	Medium	61	1
	LS22	Moderate to Severe erosion (e2-e3)	Medium	63	4

	LS23	Severe erosion (e3)	High	66	2
	LS25	Moderate to Severe erosion (e2-e3)	Very High	85	57
	Water bodies	Water bodies	Water bodies	Water bodies	5
	River	River	River	River	18
53B09v6 Total					293
53B09v7	LS07	Very Severe erosion (e4)	Very High	85	5
	LS08	Severe erosion (e3)	Very High	74	5
	LS11	Severe erosion (e3)	Very High	74	4
	LS13	Severe erosion (e3)	Very High	82	4
	LS15	Severe to Very Severe erosion (e3-e4)	Very High	91	1
	LS24	Severe to Very Severe erosion (e3-e4)	Very High	89	10
	LS25	Moderate to Severe erosion (e2-e3)	Very High	85	9
53B09v7 Total					38
53B09v8	LS03	Severe erosion (e3)	Very High	72	3
	LS04	Moderate erosion (e2)	Medium	62	3
	LS08	Severe erosion (e3)	Very High	74	9
	LS09	Moderate erosion (e2)	High	68	16
	LS10	Moderate to Severe erosion (e2-e3)	Very High	71	10
	LS11	Severe erosion (e3)	Very High	74	8
	LS12	Moderate erosion (e2)	Very High	72	17
	LS13	Severe erosion (e3)	Very High	82	50
	LS14	Very Severe erosion (e4)	Very High	88	17
	LS15	Severe to Very Severe erosion (e3-e4)	Very High	91	51
	LS20	Slight erosion (e1)	Low	56	1
	LS23	Severe erosion (e3)	High	66	4
	LS24	Severe to Very Severe erosion (e3-e4)	Very High	89	43
	LS25	Moderate to Severe erosion (e2-e3)	Very High	85	36
	River	River	River	River	7
53B09v8 Total					275

53B09v9	LS02	Severe erosion (e3)	Very High	72	3
	LS04	Moderate erosion (e2)	Medium	62	4
	LS06	Moderate to Severe erosion (e2-e3)	High	70	2
	LS07	Very Severe erosion (e4)	Very High	85	5
	LS08	Severe erosion (e3)	Very High	74	22
	LS09	Moderate erosion (e2)	High	68	2
	LS10	Moderate to Severe erosion (e2-e3)	Very High	71	12
	LS11	Severe erosion (e3)	Very High	74	13
	LS13	Severe erosion (e3)	Very High	82	28
	LS14	Very Severe erosion (e4)	Very High	88	79
	LS15	Severe to Very Severe erosion (e3-e4)	Very High	91	8
	LS18	Moderate erosion (e2)	Low	56	7
	LS19	Moderate to Severe erosion (e2-e3)	Medium	62	11
	LS22	Moderate to Severe erosion (e2-e3)	Medium	63	13
	LS23	Severe erosion (e3)	High	66	35
	LS24	Severe to Very Severe erosion (e3-e4)	Very High	89	15
	LS25	Moderate to Severe erosion (e2-e3)	Very High	85	23
	River	River	River	River	12
53B09v9 Total					294
53B09w1	AC01	Slight erosion (e1)	Low	57	13
	AC02	Moderate erosion (e2)	Medium	63	2
	AC03	Slight erosion (e1)	Very Low	55	26
	AC06	Moderate erosion (e2)	Low	57	8
	HB	Habitation	Habitation	HB	4
	LS03	Severe erosion (e3)	Very High	72	11
	LS04	Moderate erosion (e2)	Medium	62	3
	LS06	Moderate to Severe erosion (e2-e3)	High	70	2
	LS07	Very Severe erosion (e4)	Very High	85	2
	LS08	Severe erosion (e3)	Very High	74	8

	LS11	Severe erosion (e3)	Very High	74	40
	LS13	Severe erosion (e3)	Very High	82	4
	LS14	Very Severe erosion (e4)	Very High	88	72
	LS19	Moderate to Severe erosion (e2-e3)	Medium	62	8
	LS22	Moderate to Severe erosion (e2-e3)	Medium	63	11
	LS23	Severe erosion (e3)	High	66	31
	LS25	Moderate to Severe erosion (e2-e3)	Very High	85	41
	River	River	River	River	4
	Water bodies	Water bodies	Water bodies	Water bodies	5
53B09w1 Total					295
53B09w2	AC01	Slight erosion (e1)	Low	57	25
	AC02	Moderate erosion (e2)	Medium	63	6
	AC03	Slight erosion (e1)	Very Low	55	113
	AC04	Moderate to Severe erosion (e2-e3)	Medium	63	5
	AC06	Moderate erosion (e2)	Low	57	1
	AC07	Moderate erosion (e2)	Low	57	3
	AC08	Severe erosion (e3)	High	67	4
	AL06	Slight to Moderate erosion (e1-e2)	Low	56	24
	HB	Habitation	Habitation	HB	8
	LS02	Severe erosion (e3)	Very High	72	14
	LS03	Severe erosion (e3)	Very High	72	2
	LS04	Moderate erosion (e2)	Medium	62	28
	LS05	Severe erosion (e3)	Very High	75	2
	LS06	Moderate to Severe erosion (e2-e3)	High	70	19
	LS07	Very Severe erosion (e4)	Very High	85	4
	LS09	Moderate erosion (e2)	High	68	3
	LS10	Moderate to Severe erosion (e2-e3)	Very High	71	9
	LS11	Severe erosion (e3)	Very High	74	8
	LS14	Very Severe erosion (e4)	Very High	88	2

	LS19	Moderate to Severe erosion (e2-e3)	Medium	62	4
	LS22	Moderate to Severe erosion (e2-e3)	Medium	63	5
	LS23	Severe erosion (e3)	High	66	5
	Water bodies	Water bodies	Water bodies	Water bodies	2
53B09w2 Total					296
53B09w3	AC01	Slight erosion (e1)	Low	57	152
	AC02	Moderate erosion (e2)	Medium	63	3
	AC03	Slight erosion (e1)	Very Low	55	3
	AC04	Moderate to Severe erosion (e2-e3)	Medium	63	5
	AC05	Moderate erosion (e2)	Medium	62	18
	AC06	Moderate erosion (e2)	Low	57	1
	AC07	Moderate erosion (e2)	Low	57	14
	AC08	Severe erosion (e3)	High	67	17
	AL06	Slight to Moderate erosion (e1-e2)	Low	56	53
	HB	Habitation	Habitation	HB	8
	LS04	Moderate erosion (e2)	Medium	62	18
	LS05	Severe erosion (e3)	Very High	75	2
53B09w3 Total					294
53B09w4	Landslide (LS27)	Landslide	Landslide	Landslide (LS27)	1
	LS03	Severe erosion (e3)	Very High	72	14
	LS04	Moderate erosion (e2)	Medium	62	5
	LS05	Severe erosion (e3)	Very High	75	1
	LS07	Very Severe erosion (e4)	Very High	85	7
	LS08	Severe erosion (e3)	Very High	74	24
	LS09	Moderate erosion (e2)	High	68	2
	LS10	Moderate to Severe erosion (e2-e3)	Very High	71	56
	LS11	Severe erosion (e3)	Very High	74	35
	LS13	Severe erosion (e3)	Very High	82	42
	LS14	Very Severe erosion (e4)	Very High	88	25

	LS18	Moderate erosion (e2)	Low	56	16
	LS19	Moderate to Severe erosion (e2-e3)	Medium	62	22
	LS22	Moderate to Severe erosion (e2-e3)	Medium	63	6
	LS23	Severe erosion (e3)	High	66	12
	LS24	Severe to Very Severe erosion (e3-e4)	Very High	89	6
	LS25	Moderate to Severe erosion (e2-e3)	Very High	85	11
	River	River	River	River	4
	Water bodies	Water bodies	Water bodies	Water bodies	1
53B09w4 Total					290
53B09w5	LS02	Severe erosion (e3)	Very High	72	3
	LS03	Severe erosion (e3)	Very High	72	1
	LS04	Moderate erosion (e2)	Medium	62	13
	LS05	Severe erosion (e3)	Very High	75	2
	LS06	Moderate to Severe erosion (e2-e3)	High	70	5
	LS07	Very Severe erosion (e4)	Very High	85	27
	LS08	Severe erosion (e3)	Very High	74	33
	LS09	Moderate erosion (e2)	High	68	7
	LS10	Moderate to Severe erosion (e2-e3)	Very High	71	20
	LS11	Severe erosion (e3)	Very High	74	31
	LS13	Severe erosion (e3)	Very High	82	16
	LS14	Very Severe erosion (e4)	Very High	88	15
	LS19	Moderate to Severe erosion (e2-e3)	Medium	62	24
	LS21	Moderate erosion (e2)	Medium	61	16
	LS23	Severe erosion (e3)	High	66	16
	LS24	Severe to Very Severe erosion (e3-e4)	Very High	89	52
	LS25	Moderate to Severe erosion (e2-e3)	Very High	85	10
53B09w5 Total					291
53B09w6	AC01	Slight erosion (e1)	Low	57	73
	AC02	Moderate erosion (e2)	Medium	63	1

	AC06	Moderate erosion (e2)	Low	57	4
	AC07	Moderate erosion (e2)	Low	57	85
	HB	Habitation	Habitation	HB	1
	LS02	Severe erosion (e3)	Very High	72	7
	LS04	Moderate erosion (e2)	Medium	62	27
	LS05	Severe erosion (e3)	Very High	75	21
	LS06	Moderate to Severe erosion (e2-e3)	High	70	6
	LS08	Severe erosion (e3)	Very High	74	35
	LS09	Moderate erosion (e2)	High	68	2
	LS10	Moderate to Severe erosion (e2-e3)	Very High	71	1
	LS11	Severe erosion (e3)	Very High	74	9
	LS24	Severe to Very Severe erosion (e3-e4)	Very High	89	21
53B09w6 Total					293
53B09w7	LS02	Severe erosion (e3)	Very High	72	6
	LS04	Moderate erosion (e2)	Medium	62	1
	LS06	Moderate to Severe erosion (e2-e3)	High	70	2
	LS08	Severe erosion (e3)	Very High	74	41
	LS10	Moderate to Severe erosion (e2-e3)	Very High	71	6
	LS11	Severe erosion (e3)	Very High	74	20
	LS12	Moderate erosion (e2)	Very High	72	5
	LS13	Severe erosion (e3)	Very High	82	71
	LS14	Very Severe erosion (e4)	Very High	88	3
	LS19	Moderate to Severe erosion (e2-e3)	Medium	62	34
	LS22	Moderate to Severe erosion (e2-e3)	Medium	63	2
	LS23	Severe erosion (e3)	High	66	20
	LS24	Severe to Very Severe erosion (e3-e4)	Very High	89	77
	LS25	Moderate to Severe erosion (e2-e3)	Very High	85	3
	River	River	River	River	4
53B09w7 Total					295

53B09w8	HB	Habitation	Habitation	HB		1
	LS02	Severe erosion (e3)	Very High		72	1
	LS04	Moderate erosion (e2)	Medium		62	6
	LS06	Moderate to Severe erosion (e2-e3)	High		70	3
	LS08	Severe erosion (e3)	Very High		74	8
	LS12	Moderate erosion (e2)	Very High		72	36
	LS13	Severe erosion (e3)	Very High		82	67
	LS14	Very Severe erosion (e4)	Very High		88	26
	LS18	Moderate erosion (e2)	Low		56	4
	LS19	Moderate to Severe erosion (e2-e3)	Medium		62	33
	LS23	Severe erosion (e3)	High		66	17
	LS24	Severe to Very Severe erosion (e3-e4)	Very High		89	52
	LS25	Moderate to Severe erosion (e2-e3)	Very High		85	5
	River	River	River	River		3
	Water bodies	Water bodies	Water bodies	Water bodies		32
53B09w8 Total						294
53B09w9	AC01	Slight erosion (e1)	Low		57	4
	AC02	Moderate erosion (e2)	Medium		63	2
	AC07	Moderate erosion (e2)	Low		57	19
	HB	Habitation	Habitation	HB		8
	LS03	Severe erosion (e3)	Very High		72	26
	LS05	Severe erosion (e3)	Very High		75	1
	LS06	Moderate to Severe erosion (e2-e3)	High		70	13
	LS07	Very Severe erosion (e4)	Very High		85	1
	LS08	Severe erosion (e3)	Very High		74	26
	LS12	Moderate erosion (e2)	Very High		72	6
	LS13	Severe erosion (e3)	Very High		82	14
	LS14	Very Severe erosion (e4)	Very High		88	38
	LS18	Moderate erosion (e2)	Low		56	58

	LS19	Moderate to Severe erosion (e2-e3)	Medium	62	23
	LS22	Moderate to Severe erosion (e2-e3)	Medium	63	9
	LS23	Severe erosion (e3)	High	66	12
	LS24	Severe to Very Severe erosion (e3-e4)	Very High	89	23
	LS25	Moderate to Severe erosion (e2-e3)	Very High	85	7
	River	River	River	River	6
	Water bodies	Water bodies	Water bodies	Water bodies	1
53B09w9 Total					297
53B09x1	AC01	Slight erosion (e1)	Low	57	142
	AC04	Moderate to Severe erosion (e2-e3)	Medium	63	3
	AC06	Moderate erosion (e2)	Low	57	1
	AC07	Moderate erosion (e2)	Low	57	13
	AL06	Slight to Moderate erosion (e1-e2)	Low	56	115
	Brick Kiln	Brick Kiln	Brick Kiln	Brick Kiln	4
	HB	Habitation	Habitation	HB	16
	Water bodies	Water bodies	Water bodies	Water bodies	1
53B09x1 Total					295
53B09x2	AC01	Slight erosion (e1)	Low	57	9
	AC04	Moderate to Severe erosion (e2-e3)	Medium	63	3
	AL02	Slight erosion (e1)	Very Low	55	109
	AL05	Moderate erosion (e2)	Low	57	7
	AL06	Slight to Moderate erosion (e1-e2)	Low	56	136
	AL08	Moderate erosion (e2)	Low	59	11
	AL09	Moderate erosion (e2)	Low	57	3
	HB	Habitation	Habitation	HB	12
	River	River	River	River	3
53B09x2 Total					293
53B09x3	AC04	Moderate to Severe erosion (e2-e3)	Medium	63	1
	AL02	Slight erosion (e1)	Very Low	55	238

	AL05	Moderate erosion (e2)	Low	57	7
	AL06	Slight to Moderate erosion (e1-e2)	Low	56	1
	AL08	Moderate erosion (e2)	Low	59	22
	AL09	Moderate erosion (e2)	Low	57	2
	HB	Habitation	Habitation	HB	21
	River	River	River	River	3
53B09x3 Total					295
53B09x4	AC01	Slight erosion (e1)	Low	57	177
	AC02	Moderate erosion (e2)	Medium	63	22
	AC03	Slight erosion (e1)	Very Low	55	1
	AC04	Moderate to Severe erosion (e2-e3)	Medium	63	39
	AC06	Moderate erosion (e2)	Low	57	3
	AC07	Moderate erosion (e2)	Low	57	34
	HB	Habitation	Habitation	HB	16
	River	River	River	River	3
53B09x4 Total					295
53B09x5	AC01	Slight erosion (e1)	Low	57	85
	AC03	Slight erosion (e1)	Very Low	55	101
	AC04	Moderate to Severe erosion (e2-e3)	Medium	63	36
	AC06	Moderate erosion (e2)	Low	57	12
	AC07	Moderate erosion (e2)	Low	57	25
	AL02	Slight erosion (e1)	Very Low	55	9
	AL06	Slight to Moderate erosion (e1-e2)	Low	56	1
	Brick Kiln	Brick Kiln	Brick Kiln	Brick Kiln	5
	HB	Habitation	Habitation	HB	13
	River	River	River	River	9
53B09x5 Total					296
53B09x6	AC02	Moderate erosion (e2)	Medium	63	2
	AC03	Slight erosion (e1)	Very Low	55	102

	AC04	Moderate to Severe erosion (e2-e3)	Medium	63	4
	AC06	Moderate erosion (e2)	Low	57	33
	AL02	Slight erosion (e1)	Very Low	55	141
	Brick Kiln	Brick Kiln	Brick Kiln	Brick Kiln	5
	HB	Habitation	Habitation	HB	9
53B09x6 Total					296
53B09x7	AC01	Slight erosion (e1)	Low	57	5
	AC02	Moderate erosion (e2)	Medium	63	22
	AC03	Slight erosion (e1)	Very Low	55	139
	AC04	Moderate to Severe erosion (e2-e3)	Medium	63	27
	AC06	Moderate erosion (e2)	Low	57	6
	AC07	Moderate erosion (e2)	Low	57	25
	AC08	Severe erosion (e3)	High	67	1
	Brick Kiln	Brick Kiln	Brick Kiln	Brick Kiln	7
	HB	Habitation	Habitation	HB	9
	LS05	Severe erosion (e3)	Very High	75	6
	LS06	Moderate to Severe erosion (e2-e3)	High	70	9
	LS07	Very Severe erosion (e4)	Very High	85	4
	LS08	Severe erosion (e3)	Very High	74	1
	LS13	Severe erosion (e3)	Very High	82	4
	LS14	Very Severe erosion (e4)	Very High	88	1
	LS18	Moderate erosion (e2)	Low	56	19
	LS22	Moderate to Severe erosion (e2-e3)	Medium	63	5
	River	River	River	River	6
	Water bodies	Water bodies	Water bodies	Water bodies	1
53B09x7 Total					297
53B09x8	AC01	Slight erosion (e1)	Low	57	19
	AC03	Slight erosion (e1)	Very Low	55	114
	AC04	Moderate to Severe erosion (e2-e3)	Medium	63	8

	AC05	Moderate erosion (e2)	Medium	62	11
	AC06	Moderate erosion (e2)	Low	57	10
	AC07	Moderate erosion (e2)	Low	57	11
	AC08	Severe erosion (e3)	High	67	2
	AL02	Slight erosion (e1)	Very Low	55	32
	AL05	Moderate erosion (e2)	Low	57	2
	Brick Kiln	Brick Kiln	Brick Kiln	Brick Kiln	61
	HB	Habitation	Habitation	HB	26
	Water bodies	Water bodies	Water bodies	Water bodies	1
53B09x8 Total					297
53B09x9	AC01	Slight erosion (e1)	Low	57	87
	AC02	Moderate erosion (e2)	Medium	63	46
	AC03	Slight erosion (e1)	Very Low	55	13
	AC07	Moderate erosion (e2)	Low	57	5
	AL02	Slight erosion (e1)	Very Low	55	90
	AL08	Moderate erosion (e2)	Low	59	2
	HB	Habitation	Habitation	HB	45
	LS05	Severe erosion (e3)	Very High	75	5
	Water bodies	Water bodies	Water bodies	Water bodies	2
53B09x9 Total					295
53B09y4	AC08	Severe erosion (e3)	High	67	3
	AL02	Slight erosion (e1)	Very Low	55	222
	AL03	Slight to Moderate erosion (e1-e2)	Very Low	54	16
	AL05	Moderate erosion (e2)	Low	57	3
	AL08	Moderate erosion (e2)	Low	59	8
	AL09	Moderate erosion (e2)	Low	57	9
	HB	Habitation	Habitation	HB	31
	River	River	River	River	2
	Water bodies	Water bodies	Water bodies	Water bodies	1

53B09y4 Total						295
53B09y7	AC01	Slight erosion (e1)	Low		57	112
	AC08	Severe erosion (e3)	High		67	53
	AL02	Slight erosion (e1)	Very Low		55	25
	AL03	Slight to Moderate erosion (e1-e2)	Very Low		54	42
	AL06	Slight to Moderate erosion (e1-e2)	Low		56	2
	AL08	Moderate erosion (e2)	Low		59	9
	HB	Habitation	Habitation	HB		40
	LS03	Severe erosion (e3)	Very High		72	2
	LS05	Severe erosion (e3)	Very High		75	5
	River	River	River	River		3
53B09y7 Total						293
53B13b2	LS11	Severe erosion (e3)	Very High		74	1
	LS13	Severe erosion (e3)	Very High		82	4
	LS14	Very Severe erosion (e4)	Very High		88	3
	LS15	Severe to Very Severe erosion (e3-e4)	Very High		91	42
	LS16	Very Severe erosion (e4)	Very High		94	41
	LS19	Moderate to Severe erosion (e2-e3)	Medium		62	7
	LS25	Moderate to Severe erosion (e2-e3)	Very High		85	45
	River	River	River	River		5
53B13b2 Total						148
53B13b3	LS02	Severe erosion (e3)	Very High		72	4
	LS03	Severe erosion (e3)	Very High		72	3
	LS06	Moderate to Severe erosion (e2-e3)	High		70	1
	LS07	Very Severe erosion (e4)	Very High		85	3
	LS10	Moderate to Severe erosion (e2-e3)	Very High		71	20
	LS11	Severe erosion (e3)	Very High		74	5
	LS13	Severe erosion (e3)	Very High		82	4
	LS14	Very Severe erosion (e4)	Very High		88	18

	LS15	Severe to Very Severe erosion (e3-e4)	Very High	91	69
	LS16	Very Severe erosion (e4)	Very High	94	35
	LS19	Moderate to Severe erosion (e2-e3)	Medium	62	14
	LS21	Moderate erosion (e2)	Medium	61	2
	LS22	Moderate to Severe erosion (e2-e3)	Medium	63	3
	LS23	Severe erosion (e3)	High	66	15
	LS24	Severe to Very Severe erosion (e3-e4)	Very High	89	15
	LS25	Moderate to Severe erosion (e2-e3)	Very High	85	63
	LS28	Moderate erosion (e2)	Medium	62	1
	River	River	River	River	18
53B13b3 Total					293
53B13b6	LS02	Severe erosion (e3)	Very High	72	6
	LS07	Very Severe erosion (e4)	Very High	85	1
	LS13	Severe erosion (e3)	Very High	82	15
	LS14	Very Severe erosion (e4)	Very High	88	5
	LS15	Severe to Very Severe erosion (e3-e4)	Very High	91	29
	LS16	Very Severe erosion (e4)	Very High	94	15
	LS23	Severe erosion (e3)	High	66	1
	LS24	Severe to Very Severe erosion (e3-e4)	Very High	89	1
	LS25	Moderate to Severe erosion (e2-e3)	Very High	85	11
	LS28	Moderate erosion (e2)	Medium	62	22
	River	River	River	River	2
53B13b6 Total					108
53B13c1	LS03	Severe erosion (e3)	Very High	72	6
	LS06	Moderate to Severe erosion (e2-e3)	High	70	2
	LS08	Severe erosion (e3)	Very High	74	8
	LS09	Moderate erosion (e2)	High	68	20
	LS10	Moderate to Severe erosion (e2-e3)	Very High	71	44
	LS11	Severe erosion (e3)	Very High	74	9

	LS12	Moderate erosion (e2)	Very High	72	20
	LS13	Severe erosion (e3)	Very High	82	28
	LS14	Very Severe erosion (e4)	Very High	88	13
	LS19	Moderate to Severe erosion (e2-e3)	Medium	62	30
	LS21	Moderate erosion (e2)	Medium	61	15
	LS22	Moderate to Severe erosion (e2-e3)	Medium	63	6
	LS23	Severe erosion (e3)	High	66	6
	LS24	Severe to Very Severe erosion (e3-e4)	Very High	89	46
	LS25	Moderate to Severe erosion (e2-e3)	Very High	85	8
	LS28	Moderate erosion (e2)	Medium	62	25
	River	River	River	River	7
	Water bodies	Water bodies	Water bodies	Water bodies	3
53B13c1 Total					296
53B13c2	LS02	Severe erosion (e3)	Very High	72	6
	LS03	Severe erosion (e3)	Very High	72	6
	LS04	Moderate erosion (e2)	Medium	62	2
	LS08	Severe erosion (e3)	Very High	74	46
	LS10	Moderate to Severe erosion (e2-e3)	Very High	71	5
	LS12	Moderate erosion (e2)	Very High	72	30
	LS13	Severe erosion (e3)	Very High	82	13
	LS14	Very Severe erosion (e4)	Very High	88	20
	LS19	Moderate to Severe erosion (e2-e3)	Medium	62	49
	LS22	Moderate to Severe erosion (e2-e3)	Medium	63	9
	LS23	Severe erosion (e3)	High	66	21
	LS24	Severe to Very Severe erosion (e3-e4)	Very High	89	19
	LS25	Moderate to Severe erosion (e2-e3)	Very High	85	27
	River	River	River	River	6
	Water bodies	Water bodies	Water bodies	Water bodies	34
53B13c2 Total					293

53B13c3	AC08	Severe erosion (e3)	High	67	2
	AL03	Slight to Moderate erosion (e1-e2)	Very Low	54	1
	HB	Habitation	Habitation	HB	5
	LS02	Severe erosion (e3)	Very High	72	5
	LS05	Severe erosion (e3)	Very High	75	1
	LS06	Moderate to Severe erosion (e2-e3)	High	70	8
	LS07	Very Severe erosion (e4)	Very High	85	35
	LS08	Severe erosion (e3)	Very High	74	6
	LS10	Moderate to Severe erosion (e2-e3)	Very High	71	2
	LS11	Severe erosion (e3)	Very High	74	9
	LS12	Moderate erosion (e2)	Very High	72	51
	LS13	Severe erosion (e3)	Very High	82	59
	LS14	Very Severe erosion (e4)	Very High	88	54
	LS18	Moderate erosion (e2)	Low	56	32
	LS22	Moderate to Severe erosion (e2-e3)	Medium	63	2
	LS23	Severe erosion (e3)	High	66	12
	LS26	Moderate erosion (e2)	High	70	4
	River	River	River	River	7
	Water bodies	Water bodies	Water bodies	Water bodies	1
53B13c3 Total					296
53B13c4	LS02	Severe erosion (e3)	Very High	72	5
	LS04	Moderate erosion (e2)	Medium	62	2
	LS09	Moderate erosion (e2)	High	68	4
	LS11	Severe erosion (e3)	Very High	74	5
	LS12	Moderate erosion (e2)	Very High	72	1
	LS13	Severe erosion (e3)	Very High	82	8
	LS14	Very Severe erosion (e4)	Very High	88	2
	LS15	Severe to Very Severe erosion (e3-e4)	Very High	91	53
	LS16	Very Severe erosion (e4)	Very High	94	3

	LS19	Moderate to Severe erosion (e2-e3)	Medium	62	11
	LS21	Moderate erosion (e2)	Medium	61	8
	LS22	Moderate to Severe erosion (e2-e3)	Medium	63	6
	LS23	Severe erosion (e3)	High	66	3
	LS24	Severe to Very Severe erosion (e3-e4)	Very High	89	5
	LS25	Moderate to Severe erosion (e2-e3)	Very High	85	78
	LS28	Moderate erosion (e2)	Medium	62	14
	River	River	River	River	6
53B13c4 Total					214
53B13c5	LS02	Severe erosion (e3)	Very High	72	17
	LS04	Moderate erosion (e2)	Medium	62	22
	LS10	Moderate to Severe erosion (e2-e3)	Very High	71	1
	LS12	Moderate erosion (e2)	Very High	72	20
	LS13	Severe erosion (e3)	Very High	82	31
	LS14	Very Severe erosion (e4)	Very High	88	29
	LS15	Severe to Very Severe erosion (e3-e4)	Very High	91	8
	LS16	Very Severe erosion (e4)	Very High	94	18
	LS19	Moderate to Severe erosion (e2-e3)	Medium	62	6
	LS21	Moderate erosion (e2)	Medium	61	8
	LS22	Moderate to Severe erosion (e2-e3)	Medium	63	19
	LS23	Severe erosion (e3)	High	66	3
	LS24	Severe to Very Severe erosion (e3-e4)	Very High	89	2
	LS25	Moderate to Severe erosion (e2-e3)	Very High	85	101
	River	River	River	River	6
53B13c5 Total					291
53B13c6	AL06	Slight to Moderate erosion (e1-e2)	Low	56	1
	HB	Habitation	Habitation	HB	1
	LS02	Severe erosion (e3)	Very High	72	4
	LS04	Moderate erosion (e2)	Medium	62	4

	LS07	Very Severe erosion (e4)	Very High	85	8
	LS08	Severe erosion (e3)	Very High	74	4
	LS09	Moderate erosion (e2)	High	68	1
	LS10	Moderate to Severe erosion (e2-e3)	Very High	71	41
	LS12	Moderate erosion (e2)	Very High	72	17
	LS13	Severe erosion (e3)	Very High	82	41
	LS14	Very Severe erosion (e4)	Very High	88	40
	LS15	Severe to Very Severe erosion (e3-e4)	Very High	91	9
	LS18	Moderate erosion (e2)	Low	56	11
	LS19	Moderate to Severe erosion (e2-e3)	Medium	62	25
	LS20	Slight erosion (e1)	Low	56	2
	LS22	Moderate to Severe erosion (e2-e3)	Medium	63	1
	LS23	Severe erosion (e3)	High	66	26
	LS24	Severe to Very Severe erosion (e3-e4)	Very High	89	24
	LS25	Moderate to Severe erosion (e2-e3)	Very High	85	18
	River	River	River	River	12
53B13c6 Total					290
53B13c8	LS02	Severe erosion (e3)	Very High	72	1
	LS06	Moderate to Severe erosion (e2-e3)	High	70	2
	LS08	Severe erosion (e3)	Very High	74	4
	LS12	Moderate erosion (e2)	Very High	72	3
	LS13	Severe erosion (e3)	Very High	82	2
	LS15	Severe to Very Severe erosion (e3-e4)	Very High	91	12
	LS19	Moderate to Severe erosion (e2-e3)	Medium	62	8
	LS22	Moderate to Severe erosion (e2-e3)	Medium	63	3
	LS24	Severe to Very Severe erosion (e3-e4)	Very High	89	28
	LS25	Moderate to Severe erosion (e2-e3)	Very High	85	19
53B13c8 Total					82
53B13c9	HB	Habitation	Habitation	HB	1

	LS02	Severe erosion (e3)	Very High	72	2
	LS03	Severe erosion (e3)	Very High	72	2
	LS06	Moderate to Severe erosion (e2-e3)	High	70	10
	LS07	Very Severe erosion (e4)	Very High	85	6
	LS08	Severe erosion (e3)	Very High	74	6
	LS09	Moderate erosion (e2)	High	68	4
	LS11	Severe erosion (e3)	Very High	74	7
	LS12	Moderate erosion (e2)	Very High	72	48
	LS13	Severe erosion (e3)	Very High	82	42
	LS14	Very Severe erosion (e4)	Very High	88	27
	LS15	Severe to Very Severe erosion (e3-e4)	Very High	91	52
	LS16	Very Severe erosion (e4)	Very High	94	10
	LS18	Moderate erosion (e2)	Low	56	13
	LS19	Moderate to Severe erosion (e2-e3)	Medium	62	6
	LS23	Severe erosion (e3)	High	66	2
	LS24	Severe to Very Severe erosion (e3-e4)	Very High	89	9
	LS25	Moderate to Severe erosion (e2-e3)	Very High	85	35
	River	River	River	River	6
53B13c9 Total					288
53B13d1	AC02	Moderate erosion (e2)	Medium	63	2
	AC03	Slight erosion (e1)	Very Low	55	17
	AC04	Moderate to Severe erosion (e2-e3)	Medium	63	6
	AC06	Moderate erosion (e2)	Low	57	6
	AC07	Moderate erosion (e2)	Low	57	3
	LS02	Severe erosion (e3)	Very High	72	2
	LS03	Severe erosion (e3)	Very High	72	7
	LS04	Moderate erosion (e2)	Medium	62	17
	LS05	Severe erosion (e3)	Very High	75	12
	LS06	Moderate to Severe erosion (e2-e3)	High	70	15

	LS07	Very Severe erosion (e4)	Very High	85	31
	LS08	Severe erosion (e3)	Very High	74	17
	LS09	Moderate erosion (e2)	High	68	28
	LS10	Moderate to Severe erosion (e2-e3)	Very High	71	7
	LS11	Severe erosion (e3)	Very High	74	44
	LS13	Severe erosion (e3)	Very High	82	17
	LS18	Moderate erosion (e2)	Low	56	38
	LS19	Moderate to Severe erosion (e2-e3)	Medium	62	4
	LS22	Moderate to Severe erosion (e2-e3)	Medium	63	9
	LS23	Severe erosion (e3)	High	66	4
	River	River	River	River	3
	Water bodies	Water bodies	Water bodies	Water bodies	2
53B13d1 Total					291
53B13d2	AC01	Slight erosion (e1)	Low	57	6
	AC03	Slight erosion (e1)	Very Low	55	170
	AC05	Moderate erosion (e2)	Medium	62	1
	AC06	Moderate erosion (e2)	Low	57	15
	AC07	Moderate erosion (e2)	Low	57	19
	AC08	Severe erosion (e3)	High	67	6
	AL08	Moderate erosion (e2)	Low	59	14
	LS03	Severe erosion (e3)	Very High	72	17
	LS04	Moderate erosion (e2)	Medium	62	10
	LS05	Severe erosion (e3)	Very High	75	2
	LS06	Moderate to Severe erosion (e2-e3)	High	70	12
	LS08	Severe erosion (e3)	Very High	74	4
	LS19	Moderate to Severe erosion (e2-e3)	Medium	62	4
	LS21	Moderate erosion (e2)	Medium	61	2
	LS29	Moderate erosion (e2)	Very High	72	5
	River	River	River	River	5

	Water bodies	Water bodies	Water bodies	Water bodies		5
53B13d2 Total						297
53B13d3	AC01	Slight erosion (e1)	Low	57		40
	AC02	Moderate erosion (e2)	Medium	63		16
	AC03	Slight erosion (e1)	Very Low	55		116
	AC08	Severe erosion (e3)	High	67		53
	AL08	Moderate erosion (e2)	Low	59		60
	River	River	River	River		9
53B13d3 Total						294
53B13d4	HB	Habitation	Habitation	HB		8
	Landslide (LS27)	Landslide	Landslide	Landslide (LS27)		3
	LS02	Severe erosion (e3)	Very High	72		2
	LS03	Severe erosion (e3)	Very High	72		7
	LS04	Moderate erosion (e2)	Medium	62		24
	LS05	Severe erosion (e3)	Very High	75		7
	LS06	Moderate to Severe erosion (e2-e3)	High	70		11
	LS07	Very Severe erosion (e4)	Very High	85		36
	LS08	Severe erosion (e3)	Very High	74		27
	LS09	Moderate erosion (e2)	High	68		27
	LS10	Moderate to Severe erosion (e2-e3)	Very High	71		14
	LS11	Severe erosion (e3)	Very High	74		30
	LS12	Moderate erosion (e2)	Very High	72		12
	LS13	Severe erosion (e3)	Very High	82		2
	LS18	Moderate erosion (e2)	Low	56		43
	LS19	Moderate to Severe erosion (e2-e3)	Medium	62		12
	LS23	Severe erosion (e3)	High	66		19
	River	River	River	River		2
53B13d4 Total						286
53B13d5	AC02	Moderate erosion (e2)	Medium	63		1

	AC03	Slight erosion (e1)	Very Low	55	49
	AC05	Moderate erosion (e2)	Medium	62	1
	AL08	Moderate erosion (e2)	Low	59	3
	HB	Habitation	Habitation	HB	17
	Landslide (LS27)	Landslide	Landslide	Landslide (LS27)	2
	LS03	Severe erosion (e3)	Very High	72	13
	LS04	Moderate erosion (e2)	Medium	62	4
	LS05	Severe erosion (e3)	Very High	75	35
	LS06	Moderate to Severe erosion (e2-e3)	High	70	19
	LS07	Very Severe erosion (e4)	Very High	85	3
	LS08	Severe erosion (e3)	Very High	74	12
	LS09	Moderate erosion (e2)	High	68	23
	LS11	Severe erosion (e3)	Very High	74	18
	LS18	Moderate erosion (e2)	Low	56	54
	LS19	Moderate to Severe erosion (e2-e3)	Medium	62	3
	LS20	Slight erosion (e1)	Low	56	1
	LS22	Moderate to Severe erosion (e2-e3)	Medium	63	5
	LS23	Severe erosion (e3)	High	66	15
	LS26	Moderate erosion (e2)	High	70	1
	LS29	Moderate erosion (e2)	Very High	72	7
	River	River	River	River	6
	Water bodies	Water bodies	Water bodies	Water bodies	1
53B13d5 Total					293
53B13d6	AC01	Slight erosion (e1)	Low	57	7
	AC03	Slight erosion (e1)	Very Low	55	192
	AC04	Moderate to Severe erosion (e2-e3)	Medium	63	7
	AL08	Moderate erosion (e2)	Low	59	15
	Dam	Dam	Dam	Dam	2
	HB	Habitation	Habitation	HB	18

	LS03	Severe erosion (e3)	Very High	72	2
	LS04	Moderate erosion (e2)	Medium	62	5
	LS05	Severe erosion (e3)	Very High	75	8
	LS06	Moderate to Severe erosion (e2-e3)	High	70	1
	LS08	Severe erosion (e3)	Very High	74	4
	LS09	Moderate erosion (e2)	High	68	5
	LS11	Severe erosion (e3)	Very High	74	7
	LS19	Moderate to Severe erosion (e2-e3)	Medium	62	6
	LS22	Moderate to Severe erosion (e2-e3)	Medium	63	3
	LS23	Severe erosion (e3)	High	66	2
	Water bodies	Water bodies	Water bodies	Water bodies	7
53B13d6 Total					291
53B13d7	HB	Habitation	Habitation	HB	1
	LS02	Severe erosion (e3)	Very High	72	4
	LS03	Severe erosion (e3)	Very High	72	10
	LS04	Moderate erosion (e2)	Medium	62	14
	LS05	Severe erosion (e3)	Very High	75	8
	LS06	Moderate to Severe erosion (e2-e3)	High	70	9
	LS07	Very Severe erosion (e4)	Very High	85	4
	LS08	Severe erosion (e3)	Very High	74	21
	LS09	Moderate erosion (e2)	High	68	26
	LS10	Moderate to Severe erosion (e2-e3)	Very High	71	13
	LS11	Severe erosion (e3)	Very High	74	26
	LS12	Moderate erosion (e2)	Very High	72	18
	LS13	Severe erosion (e3)	Very High	82	5
	LS15	Severe to Very Severe erosion (e3-e4)	Very High	91	7
	LS18	Moderate erosion (e2)	Low	56	77
	LS19	Moderate to Severe erosion (e2-e3)	Medium	62	12
	LS20	Slight erosion (e1)	Low	56	1

	LS21	Moderate erosion (e2)	Medium	61	3
	LS23	Severe erosion (e3)	High	66	17
	LS25	Moderate to Severe erosion (e2-e3)	Very High	85	1
	River	River	River	River	10
53B13d7 Total					287
53B13d8	LS03	Severe erosion (e3)	Very High	72	9
	LS04	Moderate erosion (e2)	Medium	62	12
	LS05	Severe erosion (e3)	Very High	75	3
	LS06	Moderate to Severe erosion (e2-e3)	High	70	45
	LS07	Very Severe erosion (e4)	Very High	85	45
	LS08	Severe erosion (e3)	Very High	74	28
	LS10	Moderate to Severe erosion (e2-e3)	Very High	71	10
	LS11	Severe erosion (e3)	Very High	74	36
	LS12	Moderate erosion (e2)	Very High	72	9
	LS13	Severe erosion (e3)	Very High	82	4
	LS19	Moderate to Severe erosion (e2-e3)	Medium	62	27
	LS21	Moderate erosion (e2)	Medium	61	32
	LS22	Moderate to Severe erosion (e2-e3)	Medium	63	2
	LS23	Severe erosion (e3)	High	66	3
	LS24	Severe to Very Severe erosion (e3-e4)	Very High	89	14
	LS25	Moderate to Severe erosion (e2-e3)	Very High	85	7
	Water bodies	Water bodies	Water bodies	Water bodies	10
53B13d8 Total					296
53B13d9	AC01	Slight erosion (e1)	Low	57	6
	AC03	Slight erosion (e1)	Very Low	55	6
	AC04	Moderate to Severe erosion (e2-e3)	Medium	63	1
	AC06	Moderate erosion (e2)	Low	57	3
	HB	Habitation	Habitation	HB	13
	Landslide (LS27)	Landslide	Landslide	Landslide (LS27)	1

	LS03	Severe erosion (e3)	Very High	72	31
	LS04	Moderate erosion (e2)	Medium	62	23
	LS05	Severe erosion (e3)	Very High	75	30
	LS06	Moderate to Severe erosion (e2-e3)	High	70	30
	LS07	Very Severe erosion (e4)	Very High	85	2
	LS08	Severe erosion (e3)	Very High	74	11
	LS10	Moderate to Severe erosion (e2-e3)	Very High	71	4
	LS11	Severe erosion (e3)	Very High	74	36
	LS13	Severe erosion (e3)	Very High	82	7
	LS18	Moderate erosion (e2)	Low	56	4
	LS19	Moderate to Severe erosion (e2-e3)	Medium	62	12
	LS20	Slight erosion (e1)	Low	56	27
	LS21	Moderate erosion (e2)	Medium	61	7
	LS22	Moderate to Severe erosion (e2-e3)	Medium	63	1
	LS23	Severe erosion (e3)	High	66	5
	LS24	Severe to Very Severe erosion (e3-e4)	Very High	89	23
	River	River	River	River	3
	Water bodies	Water bodies	Water bodies	Water bodies	5
53B13d9 Total					291
53B13e1	AC01	Slight erosion (e1)	Low	57	77
	AC03	Slight erosion (e1)	Very Low	55	92
	AC04	Moderate to Severe erosion (e2-e3)	Medium	63	2
	AC08	Severe erosion (e3)	High	67	18
	AL08	Moderate erosion (e2)	Low	59	2
	HB	Habitation	Habitation	HB	14
53B13e1 Total					205
53B13e2	AC01	Slight erosion (e1)	Low	57	5
	HB	Habitation	Habitation	HB	3
53B13e2 Total					8

53B13e4	AC01	Slight erosion (e1)	Low	57	99
	AC03	Slight erosion (e1)	Very Low	55	23
	AC04	Moderate to Severe erosion (e2-e3)	Medium	63	13
	AC05	Moderate erosion (e2)	Medium	62	4
	AC06	Moderate erosion (e2)	Low	57	3
	AC07	Moderate erosion (e2)	Low	57	3
53B13e4 Total					145
53B13e7	AC01	Slight erosion (e1)	Low	57	31
	AC02	Moderate erosion (e2)	Medium	63	1
	AC03	Slight erosion (e1)	Very Low	55	110
	AC04	Moderate to Severe erosion (e2-e3)	Medium	63	50
	AC06	Moderate erosion (e2)	Low	57	4
	AC07	Moderate erosion (e2)	Low	57	5
HB	Habitation		Habitation	HB	17
LS01	Moderate erosion (e2)	Low		58	1
LS03	Severe erosion (e3)	Very High		72	26
LS04	Moderate erosion (e2)	Medium		62	2
LS05	Severe erosion (e3)	Very High		75	7
LS06	Moderate to Severe erosion (e2-e3)	High		70	12
LS11	Severe erosion (e3)	Very High		74	4
LS19	Moderate to Severe erosion (e2-e3)	Medium		62	4
LS20	Slight erosion (e1)	Low		56	2
LS21	Moderate erosion (e2)	Medium		61	1
LS23	Severe erosion (e3)	High		66	3
River	River		River	River	5
Rock Quarry	Rock Quarry		Rock Quarry	Rock Quarry	1
Water bodies	Water bodies		Water bodies	Water bodies	1
53B13e7 Total					287
53B13e8	AC03	Slight erosion (e1)	Very Low	55	26

	AC04	Moderate to Severe erosion (e2-e3)	Medium	63	6
	AC06	Moderate erosion (e2)	Low	57	10
	HB	Habitation	Habitation	HB	182
	River	River	River	River	1
53B13e8 Total					225
53B13h3	LS03	Severe erosion (e3)	Very High	72	13
	LS05	Severe erosion (e3)	Very High	75	12
	LS06	Moderate to Severe erosion (e2-e3)	High	70	2
	LS13	Severe erosion (e3)	Very High	82	44
	LS15	Severe to Very Severe erosion (e3-e4)	Very High	91	16
	LS16	Very Severe erosion (e4)	Very High	94	4
	LS18	Moderate erosion (e2)	Low	56	11
	LS19	Moderate to Severe erosion (e2-e3)	Medium	62	2
	LS22	Moderate to Severe erosion (e2-e3)	Medium	63	1
	LS24	Severe to Very Severe erosion (e3-e4)	Very High	89	5
	LS25	Moderate to Severe erosion (e2-e3)	Very High	85	35
	River	River	River	River	1
53B13h3 Total					146
53B13i1	HB	Habitation	Habitation	HB	2
	LS02	Severe erosion (e3)	Very High	72	11
	LS03	Severe erosion (e3)	Very High	72	1
	LS07	Very Severe erosion (e4)	Very High	85	1
	LS08	Severe erosion (e3)	Very High	74	1
	LS12	Moderate erosion (e2)	Very High	72	20
	LS13	Severe erosion (e3)	Very High	82	54
	LS15	Severe to Very Severe erosion (e3-e4)	Very High	91	28
	LS18	Moderate erosion (e2)	Low	56	40
	LS19	Moderate to Severe erosion (e2-e3)	Medium	62	15
	LS23	Severe erosion (e3)	High	66	15

	LS24	Severe to Very Severe erosion (e3-e4)	Very High	89	32
	LS25	Moderate to Severe erosion (e2-e3)	Very High	85	48
	River	River	River	River	5
53B13i1 Total					273
53B13i2	LS02	Severe erosion (e3)	Very High	72	2
	LS03	Severe erosion (e3)	Very High	72	1
	LS04	Moderate erosion (e2)	Medium	62	21
	LS06	Moderate to Severe erosion (e2-e3)	High	70	4
	LS08	Severe erosion (e3)	Very High	74	16
	LS10	Moderate to Severe erosion (e2-e3)	Very High	71	3
	LS11	Severe erosion (e3)	Very High	74	1
	LS12	Moderate erosion (e2)	Very High	72	5
	LS13	Severe erosion (e3)	Very High	82	42
	LS14	Very Severe erosion (e4)	Very High	88	9
	LS15	Severe to Very Severe erosion (e3-e4)	Very High	91	87
	LS16	Very Severe erosion (e4)	Very High	94	7
	LS19	Moderate to Severe erosion (e2-e3)	Medium	62	39
	LS21	Moderate erosion (e2)	Medium	61	3
	LS22	Moderate to Severe erosion (e2-e3)	Medium	63	8
	LS23	Severe erosion (e3)	High	66	10
	LS24	Severe to Very Severe erosion (e3-e4)	Very High	89	19
	LS25	Moderate to Severe erosion (e2-e3)	Very High	85	13
	River	River	River	River	2
	Water bodies	Water bodies	Water bodies	Water bodies	4
53B13i2 Total					296
53B13i3	Dam	Dam	Dam	Dam	1
	Landslide (LS27)	Landslide	Landslide	Landslide (LS27)	3
	LS02	Severe erosion (e3)	Very High	72	2
	LS03	Severe erosion (e3)	Very High	72	11

	LS04	Moderate erosion (e2)	Medium	62	28
	LS05	Severe erosion (e3)	Very High	75	1
	LS06	Moderate to Severe erosion (e2-e3)	High	70	25
	LS07	Very Severe erosion (e4)	Very High	85	1
	LS08	Severe erosion (e3)	Very High	74	28
	LS09	Moderate erosion (e2)	High	68	2
	LS10	Moderate to Severe erosion (e2-e3)	Very High	71	9
	LS11	Severe erosion (e3)	Very High	74	22
	LS12	Moderate erosion (e2)	Very High	72	9
	LS13	Severe erosion (e3)	Very High	82	15
	LS14	Very Severe erosion (e4)	Very High	88	2
	LS15	Severe to Very Severe erosion (e3-e4)	Very High	91	9
	LS18	Moderate erosion (e2)	Low	56	6
	LS19	Moderate to Severe erosion (e2-e3)	Medium	62	20
	LS20	Slight erosion (e1)	Low	56	3
	LS21	Moderate erosion (e2)	Medium	61	15
	LS22	Moderate to Severe erosion (e2-e3)	Medium	63	2
	LS23	Severe erosion (e3)	High	66	15
	LS24	Severe to Very Severe erosion (e3-e4)	Very High	89	36
	LS25	Moderate to Severe erosion (e2-e3)	Very High	85	13
	River	River	River	River	5
	Water bodies	Water bodies	Water bodies	Water bodies	10
53B13i3 Total					293
53B13i4	LS02	Severe erosion (e3)	Very High	72	5
	LS13	Severe erosion (e3)	Very High	82	13
	LS15	Severe to Very Severe erosion (e3-e4)	Very High	91	105
	LS16	Very Severe erosion (e4)	Very High	94	21
	LS19	Moderate to Severe erosion (e2-e3)	Medium	62	3
	LS25	Moderate to Severe erosion (e2-e3)	Very High	85	3

53B13i4 Total						150
53B13i5	LS02	Severe erosion (e3)	Very High	72		6
	LS04	Moderate erosion (e2)	Medium	62		3
	LS06	Moderate to Severe erosion (e2-e3)	High	70		1
	LS07	Very Severe erosion (e4)	Very High	85		1
	LS08	Severe erosion (e3)	Very High	74		6
	LS09	Moderate erosion (e2)	High	68		3
	LS10	Moderate to Severe erosion (e2-e3)	Very High	71		1
	LS12	Moderate erosion (e2)	Very High	72		8
	LS13	Severe erosion (e3)	Very High	82		55
	LS14	Very Severe erosion (e4)	Very High	88		15
	LS15	Severe to Very Severe erosion (e3-e4)	Very High	91		95
	LS16	Very Severe erosion (e4)	Very High	94		30
	LS18	Moderate erosion (e2)	Low	56		2
	LS19	Moderate to Severe erosion (e2-e3)	Medium	62		15
	LS21	Moderate erosion (e2)	Medium	61		4
	LS22	Moderate to Severe erosion (e2-e3)	Medium	63		3
	LS23	Severe erosion (e3)	High	66		1
	LS24	Severe to Very Severe erosion (e3-e4)	Very High	89		13
	LS25	Moderate to Severe erosion (e2-e3)	Very High	85		28
	River	River	River	River		3
53B13i5 Total						293
53B13i6	HB	Habitation	Habitation	HB		3
	Landslide (LS27)	Landslide	Landslide	Landslide (LS27)		1
	LS02	Severe erosion (e3)	Very High	72		1
	LS03	Severe erosion (e3)	Very High	72		3
	LS04	Moderate erosion (e2)	Medium	62		12
	LS05	Severe erosion (e3)	Very High	75		1
	LS06	Moderate to Severe erosion (e2-e3)	High	70		2

	LS08	Severe erosion (e3)	Very High	74	8
	LS09	Moderate erosion (e2)	High	68	6
	LS10	Moderate to Severe erosion (e2-e3)	Very High	71	10
	LS11	Severe erosion (e3)	Very High	74	1
	LS12	Moderate erosion (e2)	Very High	72	40
	LS13	Severe erosion (e3)	Very High	82	18
	LS14	Very Severe erosion (e4)	Very High	88	16
	LS15	Severe to Very Severe erosion (e3-e4)	Very High	91	16
	LS18	Moderate erosion (e2)	Low	56	53
	LS19	Moderate to Severe erosion (e2-e3)	Medium	62	27
	LS21	Moderate erosion (e2)	Medium	61	5
	LS22	Moderate to Severe erosion (e2-e3)	Medium	63	8
	LS23	Severe erosion (e3)	High	66	13
	LS24	Severe to Very Severe erosion (e3-e4)	Very High	89	26
	LS25	Moderate to Severe erosion (e2-e3)	Very High	85	6
	River	River	River	River	11
53B13i6 Total					288
53B13i7	LS13	Severe erosion (e3)	Very High	82	12
	LS14	Very Severe erosion (e4)	Very High	88	1
	LS15	Severe to Very Severe erosion (e3-e4)	Very High	91	27
	LS16	Very Severe erosion (e4)	Very High	94	1
53B13i7 Total					41
53B13i8	Landslide (LS27)	Landslide	Landslide	Landslide (LS27)	4
	LS03	Severe erosion (e3)	Very High	72	3
	LS04	Moderate erosion (e2)	Medium	62	5
	LS06	Moderate to Severe erosion (e2-e3)	High	70	1
	LS07	Very Severe erosion (e4)	Very High	85	8
	LS08	Severe erosion (e3)	Very High	74	8
	LS10	Moderate to Severe erosion (e2-e3)	Very High	71	2

	LS11	Severe erosion (e3)	Very High	74	7
	LS12	Moderate erosion (e2)	Very High	72	9
	LS13	Severe erosion (e3)	Very High	82	35
	LS14	Very Severe erosion (e4)	Very High	88	66
	LS15	Severe to Very Severe erosion (e3-e4)	Very High	91	47
	LS16	Very Severe erosion (e4)	Very High	94	7
	LS18	Moderate erosion (e2)	Low	56	17
	LS22	Moderate to Severe erosion (e2-e3)	Medium	63	7
	LS23	Severe erosion (e3)	High	66	1
	LS24	Severe to Very Severe erosion (e3-e4)	Very High	89	17
	LS25	Moderate to Severe erosion (e2-e3)	Very High	85	6
	River	River	River	River	4
	Water bodies	Water bodies	Water bodies	Water bodies	1
53B13i8 Total					255
53B13i9	HB	Habitation	Habitation	HB	5
	LS02	Severe erosion (e3)	Very High	72	1
	LS03	Severe erosion (e3)	Very High	72	2
	LS04	Moderate erosion (e2)	Medium	62	1
	LS05	Severe erosion (e3)	Very High	75	2
	LS06	Moderate to Severe erosion (e2-e3)	High	70	6
	LS07	Very Severe erosion (e4)	Very High	85	3
	LS08	Severe erosion (e3)	Very High	74	10
	LS09	Moderate erosion (e2)	High	68	2
	LS10	Moderate to Severe erosion (e2-e3)	Very High	71	3
	LS12	Moderate erosion (e2)	Very High	72	31
	LS13	Severe erosion (e3)	Very High	82	69
	LS14	Very Severe erosion (e4)	Very High	88	41
	LS18	Moderate erosion (e2)	Low	56	29
	LS19	Moderate to Severe erosion (e2-e3)	Medium	62	3

	LS22	Moderate to Severe erosion (e2-e3)	Medium	63	3
	LS23	Severe erosion (e3)	High	66	12
	LS24	Severe to Very Severe erosion (e3-e4)	Very High	89	18
	River	River	River	River	8
53B13i9 Total					249
53B13j1	AC03	Slight erosion (e1)	Very Low	55	6
	AC04	Moderate to Severe erosion (e2-e3)	Medium	63	12
	AC06	Moderate erosion (e2)	Low	57	3
	HB	Habitation	Habitation	HB	14
	LS03	Severe erosion (e3)	Very High	72	41
	LS04	Moderate erosion (e2)	Medium	62	14
	LS05	Severe erosion (e3)	Very High	75	6
	LS06	Moderate to Severe erosion (e2-e3)	High	70	41
	LS08	Severe erosion (e3)	Very High	74	10
	LS09	Moderate erosion (e2)	High	68	7
	LS10	Moderate to Severe erosion (e2-e3)	Very High	71	3
	LS18	Moderate erosion (e2)	Low	56	42
	LS19	Moderate to Severe erosion (e2-e3)	Medium	62	17
	LS20	Slight erosion (e1)	Low	56	1
	LS21	Moderate erosion (e2)	Medium	61	5
	LS22	Moderate to Severe erosion (e2-e3)	Medium	63	24
	LS23	Severe erosion (e3)	High	66	32
	River	River	River	River	7
	Water bodies	Water bodies	Water bodies	Water bodies	8
53B13j1 Total					293
53B13j2	AC01	Slight erosion (e1)	Low	57	3
	AC04	Moderate to Severe erosion (e2-e3)	Medium	63	1
	AC06	Moderate erosion (e2)	Low	57	16
	AC07	Moderate erosion (e2)	Low	57	2

	AL03	Slight to Moderate erosion (e1-e2)	Very Low	54	15
	HB	Habitation	Habitation	HB	46
	LS03	Severe erosion (e3)	Very High	72	11
	LS04	Moderate erosion (e2)	Medium	62	5
	LS19	Moderate to Severe erosion (e2-e3)	Medium	62	6
	LS20	Slight erosion (e1)	Low	56	1
	LS22	Moderate to Severe erosion (e2-e3)	Medium	63	6
	LS23	Severe erosion (e3)	High	66	3
	LS24	Severe to Very Severe erosion (e3-e4)	Very High	89	2
	River	River	River	River	2
	Water bodies	Water bodies	Water bodies	Water bodies	1
53B13j2 Total					120
53B13j3	AL02	Slight erosion (e1)	Very Low	55	2
	AL03	Slight to Moderate erosion (e1-e2)	Very Low	54	51
	HB	Habitation	Habitation	HB	50
53B13j3 Total					103
53B13j4	LS03	Severe erosion (e3)	Very High	72	13
	LS04	Moderate erosion (e2)	Medium	62	13
	LS05	Severe erosion (e3)	Very High	75	5
	LS06	Moderate to Severe erosion (e2-e3)	High	70	56
	LS07	Very Severe erosion (e4)	Very High	85	7
	LS08	Severe erosion (e3)	Very High	74	49
	LS09	Moderate erosion (e2)	High	68	11
	LS10	Moderate to Severe erosion (e2-e3)	Very High	71	33
	LS11	Severe erosion (e3)	Very High	74	49
	LS12	Moderate erosion (e2)	Very High	72	6
	LS13	Severe erosion (e3)	Very High	82	8
	LS14	Very Severe erosion (e4)	Very High	88	5
	LS18	Moderate erosion (e2)	Low	56	1

	LS19	Moderate to Severe erosion (e2-e3)	Medium	62	3
	LS21	Moderate erosion (e2)	Medium	61	3
	LS22	Moderate to Severe erosion (e2-e3)	Medium	63	2
	LS23	Severe erosion (e3)	High	66	1
	LS24	Severe to Very Severe erosion (e3-e4)	Very High	89	21
	River	River	River	River	3
53B13j4 Total					289
53B13j5	AC01	Slight erosion (e1)	Low	57	7
	HB	Habitation	Habitation	HB	6
	LS02	Severe erosion (e3)	Very High	72	31
	LS03	Severe erosion (e3)	Very High	72	14
	LS04	Moderate erosion (e2)	Medium	62	46
	LS06	Moderate to Severe erosion (e2-e3)	High	70	52
	LS07	Very Severe erosion (e4)	Very High	85	1
	LS08	Severe erosion (e3)	Very High	74	6
	LS09	Moderate erosion (e2)	High	68	2
	LS10	Moderate to Severe erosion (e2-e3)	Very High	71	42
	LS11	Severe erosion (e3)	Very High	74	21
	LS12	Moderate erosion (e2)	Very High	72	15
	LS19	Moderate to Severe erosion (e2-e3)	Medium	62	3
	LS21	Moderate erosion (e2)	Medium	61	1
	LS24	Severe to Very Severe erosion (e3-e4)	Very High	89	5
	River	River	River	River	14
	Water bodies	Water bodies	Water bodies	Water bodies	10
53B13j5 Total					276
53B13j6	AL02	Slight erosion (e1)	Very Low	55	49
	AL03	Slight to Moderate erosion (e1-e2)	Very Low	54	4
	AL08	Moderate erosion (e2)	Low	59	2
	HB	Habitation	Habitation	HB	15

	LS02	Severe erosion (e3)	Very High	72	3
	LS04	Moderate erosion (e2)	Medium	62	3
	LS11	Severe erosion (e3)	Very High	74	11
	LS25	Moderate to Severe erosion (e2-e3)	Very High	85	25
	River	River	River	River	1
	Water bodies	Water bodies	Water bodies	Water bodies	1
53B13j6 Total					114
53B13j7	AC07	Moderate erosion (e2)	Low	57	1
	LS02	Severe erosion (e3)	Very High	72	14
	LS04	Moderate erosion (e2)	Medium	62	8
	LS05	Severe erosion (e3)	Very High	75	3
	LS06	Moderate to Severe erosion (e2-e3)	High	70	12
	LS07	Very Severe erosion (e4)	Very High	85	12
	LS08	Severe erosion (e3)	Very High	74	8
	LS09	Moderate erosion (e2)	High	68	25
	LS10	Moderate to Severe erosion (e2-e3)	Very High	71	16
	LS11	Severe erosion (e3)	Very High	74	6
	LS12	Moderate erosion (e2)	Very High	72	22
	LS13	Severe erosion (e3)	Very High	82	67
	LS19	Moderate to Severe erosion (e2-e3)	Medium	62	36
	LS21	Moderate erosion (e2)	Medium	61	13
	LS23	Severe erosion (e3)	High	66	3
	LS24	Severe to Very Severe erosion (e3-e4)	Very High	89	19
	River	River	River	River	10
	Water bodies	Water bodies	Water bodies	Water bodies	13
53B13j7 Total					288
53B13j8	AC07	Moderate erosion (e2)	Low	57	3
	LS02	Severe erosion (e3)	Very High	72	38
	LS07	Very Severe erosion (e4)	Very High	85	24

	LS08	Severe erosion (e3)	Very High	74	6
	LS09	Moderate erosion (e2)	High	68	6
	LS11	Severe erosion (e3)	Very High	74	2
	LS12	Moderate erosion (e2)	Very High	72	89
	River	River	River	River	6
	Water bodies	Water bodies	Water bodies	Water bodies	8
53B13j8 Total					182
53B13j9	LS04	Moderate erosion (e2)	Medium	62	6
	LS06	Moderate to Severe erosion (e2-e3)	High	70	7
	LS08	Severe erosion (e3)	Very High	74	18
	LS11	Severe erosion (e3)	Very High	74	21
	LS12	Moderate erosion (e2)	Very High	72	7
	LS25	Moderate to Severe erosion (e2-e3)	Very High	85	10
	Water bodies	Water bodies	Water bodies	Water bodies	1
53B13j9 Total					70
53B13n3	LS13	Severe erosion (e3)	Very High	82	3
53B13n3 Total					3
53B13o1	LS07	Very Severe erosion (e4)	Very High	85	4
	LS08	Severe erosion (e3)	Very High	74	1
	LS10	Moderate to Severe erosion (e2-e3)	Very High	71	20
	LS11	Severe erosion (e3)	Very High	74	5
	LS12	Moderate erosion (e2)	Very High	72	12
	LS13	Severe erosion (e3)	Very High	82	5
	LS19	Moderate to Severe erosion (e2-e3)	Medium	62	10
	LS21	Moderate erosion (e2)	Medium	61	2
	River	River	River	River	2
53B13o1 Total					61
Grand Total					19599

ANNEXURE- II

Gridwise (3x3 Minute) Distribution of Runoff Potential Mapping Units (RPMU), their Erosion Class, Risk Category and Runoff Potential Mapping Unit Weightage

Grid Number	RPMU	Erosion Class	Risk Category	Runoff Potential Mapping unit Weightage	Area (ha)
53B09e	AL02	Slight erosion (e1)	Very Low	55	441
	AL05	Moderate erosion (e2)	Low	57	5
	AL06	Slight to Moderate erosion (e1-e2)	Low	56	168
	AL08	Moderate erosion (e2)	Low	59	1
	AL09	Moderate erosion (e2)	Low	57	5
	HB	Habitation	Habitation	HB	10
53B09e Total					630
53B09h	AL02	Slight erosion (e1)	Very Low	55	257
	AL09	Moderate erosion (e2)	Low	57	3
	Brick Kiln	Brick Kiln	Brick Kiln	Brick Kiln	1
	HB	Habitation	Habitation	HB	8
53B09h Total					269
53B09i	AL02	Slight erosion (e1)	Very Low	55	1462
	AL05	Moderate erosion (e2)	Low	57	9
	AL08	Moderate erosion (e2)	Low	59	64
	AL09	Moderate erosion (e2)	Low	57	100
	HB	Habitation	Habitation	HB	349
	River	River	River	River	23
	Water bodies	Water bodies	Water bodies	Water bodies	1
53B09i Total					2008
53B09j	AL02	Slight erosion (e1)	Very Low	55	1968
	AL05	Moderate erosion (e2)	Low	57	4

	AL06	Slight to Moderate erosion (e1-e2)	Low	56	315
	AL08	Moderate erosion (e2)	Low	59	9
	AL09	Moderate erosion (e2)	Low	57	79
	HB	Habitation	Habitation	HB	137
	Water bodies	Water bodies	Water bodies	Water bodies	7
53B09j Total					2519
53B09l	AL02	Slight erosion (e1)	Very Low	55	85
	AL05	Moderate erosion (e2)	Low	57	2
	AL08	Moderate erosion (e2)	Low	59	3
	AL09	Moderate erosion (e2)	Low	57	4
53B09l Total					94
53B09m	AL02	Slight erosion (e1)	Very Low	55	1560
	AL05	Moderate erosion (e2)	Low	57	60
	AL06	Slight to Moderate erosion (e1-e2)	Low	56	343
	AL08	Moderate erosion (e2)	Low	59	252
	AL09	Moderate erosion (e2)	Low	57	59
	HB	Habitation	Habitation	HB	71
	River	River	River	River	9
	Water bodies	Water bodies	Water bodies	Water bodies	1
53B09m Total					2355
53B09n	AL02	Slight erosion (e1)	Very Low	55	2101
	AL03	Slight to Moderate erosion (e1-e2)	Very Low	54	56
	AL05	Moderate erosion (e2)	Low	57	269
	AL08	Moderate erosion (e2)	Low	59	39
	AL09	Moderate erosion (e2)	Low	57	35
	Brick Kiln	Brick Kiln	Brick Kiln	Brick Kiln	1
	HB	Habitation	Habitation	HB	103
	River	River	River	River	37
	Water bodies	Water bodies	Water bodies	Water bodies	4

53B09n Total					2645
53B09o	AL02	Slight erosion (e1)	Very Low	55	437
	AL03	Slight to Moderate erosion (e1-e2)	Very Low	54	104
	AL05	Moderate erosion (e2)	Low	57	3
	AL06	Slight to Moderate erosion (e1-e2)	Low	56	1614
	AL08	Moderate erosion (e2)	Low	59	148
	AL09	Moderate erosion (e2)	Low	57	21
	HB	Habitation	Habitation	HB	322
	Water bodies	Water bodies	Water bodies	Water bodies	3
53B09o Total					2652
53B09q	AL02	Slight erosion (e1)	Very Low	55	173
	AL05	Moderate erosion (e2)	Low	57	1
	AL06	Slight to Moderate erosion (e1-e2)	Low	56	4
	AL08	Moderate erosion (e2)	Low	59	17
	AL09	Moderate erosion (e2)	Low	57	5
	HB	Habitation	Habitation	HB	4
53B09q Total					204
53B09r	AL02	Slight erosion (e1)	Very Low	55	390
	AL03	Slight to Moderate erosion (e1-e2)	Very Low	54	3
	AL05	Moderate erosion (e2)	Low	57	46
	AL06	Slight to Moderate erosion (e1-e2)	Low	56	815
	AL08	Moderate erosion (e2)	Low	59	98
	AL09	Moderate erosion (e2)	Low	57	13
	Brick Kiln	Brick Kiln	Brick Kiln	Brick Kiln	21
	HB	Habitation	Habitation	HB	78
	River	River	River	River	7
53B09r Total					1471
53B09s	AL02	Slight erosion (e1)	Very Low	55	1931
	AL03	Slight to Moderate erosion (e1-e2)	Very Low	54	71

	AL05	Moderate erosion (e2)	Low	57	66
	AL06	Slight to Moderate erosion (e1-e2)	Low	56	125
	AL08	Moderate erosion (e2)	Low	59	219
	AL09	Moderate erosion (e2)	Low	57	54
	Brick Kiln	Brick Kiln	Brick Kiln	Brick Kiln	9
	HB	Habitation	Habitation	HB	139
	River	River	River	River	30
	Water bodies	Water bodies	Water bodies	Water bodies	5
53B09s Total					2649
53B09t	AL02	Slight erosion (e1)	Very Low	55	457
	AL03	Slight to Moderate erosion (e1-e2)	Very Low	54	634
	AL06	Slight to Moderate erosion (e1-e2)	Low	56	1177
	AL08	Moderate erosion (e2)	Low	59	70
	AL09	Moderate erosion (e2)	Low	57	76
	Brick Kiln	Brick Kiln	Brick Kiln	Brick Kiln	14
	HB	Habitation	Habitation	HB	214
	Landslide (LS27)	Landslide	Landslide	Landslide (LS27)	2
	River	River	River	River	5
	Water bodies	Water bodies	Water bodies	Water bodies	4
53B09t Total					2653
53B09y	AC01	Slight erosion (e1)	Low	57	55
	AL02	Slight erosion (e1)	Very Low	55	724
	AL03	Slight to Moderate erosion (e1-e2)	Very Low	54	309
	AL06	Slight to Moderate erosion (e1-e2)	Low	56	15
	AL08	Moderate erosion (e2)	Low	59	58
	AL09	Moderate erosion (e2)	Low	57	37
	Brick Kiln	Brick Kiln	Brick Kiln	Brick Kiln	33
	HB	Habitation	Habitation	HB	72
	River	River	River	River	13

	Water bodies	Water bodies	Water bodies	Water bodies		1
53B09y Total						1317
53B10a	AL02	Slight erosion (e1)	Very Low	55	208	
	AL05	Moderate erosion (e2)	Low	57	19	
	AL06	Slight to Moderate erosion (e1-e2)	Low	56	563	
	AL09	Moderate erosion (e2)	Low	57	44	
	HB	Habitation	Habitation	HB	44	
	Water bodies	Water bodies	Water bodies	Water bodies		2
53B10a Total						880
53B10f	AL02	Slight erosion (e1)	Very Low	55	1399	
	AL05	Moderate erosion (e2)	Low	57	56	
	AL06	Slight to Moderate erosion (e1-e2)	Low	56	796	
	AL08	Moderate erosion (e2)	Low	59	41	
	AL09	Moderate erosion (e2)	Low	57	206	
	HB	Habitation	Habitation	HB	109	
	Water bodies	Water bodies	Water bodies	Water bodies		11
53B10f Total						2618
53B10g	AL02	Slight erosion (e1)	Very Low	55	1087	
	AL05	Moderate erosion (e2)	Low	57	18	
	AL06	Slight to Moderate erosion (e1-e2)	Low	56	6	
	AL08	Moderate erosion (e2)	Low	59	29	
	AL09	Moderate erosion (e2)	Low	57	123	
	HB	Habitation	Habitation	HB	86	
	Water bodies	Water bodies	Water bodies	Water bodies		12
53B10g Total						1361
53B10k	AL02	Slight erosion (e1)	Very Low	55	188	
	AL06	Slight to Moderate erosion (e1-e2)	Low	56	1961	
	AL08	Moderate erosion (e2)	Low	59	29	
	AL09	Moderate erosion (e2)	Low	57	98	

	HB	Habitation	Habitation	HB		372
	Water bodies	Water bodies	Water bodies	Water bodies		4
53B10k Total						2652
53B10l	AL02	Slight erosion (e1)	Very Low	55		1645
	AL05	Moderate erosion (e2)	Low	57		21
	AL06	Slight to Moderate erosion (e1-e2)	Low	56		647
	AL08	Moderate erosion (e2)	Low	59		114
	AL09	Moderate erosion (e2)	Low	57		82
	HB	Habitation	Habitation	HB		117
53B10l Total						2626
53B10m	Q	Slight to Moderate erosion (e1-e2)	Very Low	45		22
	R	Slight erosion (e1)	Very Low	40		619
	R2	Slight erosion (e1)	Very Low	35		25
53B10m Total						666
53B10p	AL02	Slight erosion (e1)	Very Low	55		96
	AL03	Slight to Moderate erosion (e1-e2)	Very Low	54		10
	AL05	Moderate erosion (e2)	Low	57		131
	AL06	Slight to Moderate erosion (e1-e2)	Low	56		1276
	AL08	Moderate erosion (e2)	Low	59		72
	AL09	Moderate erosion (e2)	Low	57		16
	HB	Habitation	Habitation	HB		1024
	River	River	River	River		26
	Water bodies	Water bodies	Water bodies	Water bodies		2
53B10p Total						2653
53B10q	AL02	Slight erosion (e1)	Very Low	55		23
	AL03	Slight to Moderate erosion (e1-e2)	Very Low	54		278
	AL05	Moderate erosion (e2)	Low	57		87
	AL06	Slight to Moderate erosion (e1-e2)	Low	56		1761
	AL08	Moderate erosion (e2)	Low	59		57

	AL09	Moderate erosion (e2)	Low	57	28
	HB	Habitation	Habitation	HB	409
	River	River	River	River	10
	Water bodies	Water bodies	Water bodies	Water bodies	3
53B10q Total					2656
53B10r	R	Slight erosion (e1)	Very Low	40	2292
	River	River	River	River	12
	U	Slight to Moderate erosion (e1-e2)	Low	60	100
	Water bodies	Water bodies	Water bodies	Water bodies	1
53B10r Total					2405
53B10s	Q	Slight to Moderate erosion (e1-e2)	Very Low	45	30
	R	Slight erosion (e1)	Very Low	40	544
	River	River	River	River	20
	S	Slight to Moderate erosion (e1-e2)	Low	60	30
	U	Slight to Moderate erosion (e1-e2)	Low	60	50
53B10s Total					674
53B10u	AL05	Moderate erosion (e2)	Low	57	28
	AL06	Slight to Moderate erosion (e1-e2)	Low	56	39
	AL09	Moderate erosion (e2)	Low	57	20
	HB	Habitation	Habitation	HB	1164
	River	River	River	River	3
53B10u Total					1254
53B10v	AL05	Moderate erosion (e2)	Low	57	9
	AL06	Slight to Moderate erosion (e1-e2)	Low	56	727
	AL08	Moderate erosion (e2)	Low	59	9
	AL09	Moderate erosion (e2)	Low	57	55
	HB	Habitation	Habitation	HB	1748
	River	River	River	River	19
	Water bodies	Water bodies	Water bodies	Water bodies	1

53B10v Total					2568
53B10w	Q	Slight to Moderate erosion (e1-e2)	Very Low	45	608
	R	Slight erosion (e1)	Very Low	40	1487
	S	Slight to Moderate erosion (e1-e2)	Low	60	232
	U	Slight to Moderate erosion (e1-e2)	Low	60	301
	Water bodies	Water bodies	Water bodies	Water bodies	29
53B10w Total					2657
53B10x	Q	Slight to Moderate erosion (e1-e2)	Very Low	45	525
	R	Slight erosion (e1)	Very Low	40	193
	S	Slight to Moderate erosion (e1-e2)	Low	60	234
	U	Slight to Moderate erosion (e1-e2)	Low	60	22
53B10x Total					974
53B11v	P	Slight erosion (e1)	Very Low	30	10
	River	River	River	River	22
53B11v Total					32
53B14b	HB	Habitation	Habitation	HB	87
	P	Slight erosion (e1)	Very Low	30	62
	Q	Slight to Moderate erosion (e1-e2)	Very Low	45	8
	R	Slight erosion (e1)	Very Low	40	1102
	U	Slight to Moderate erosion (e1-e2)	Low	60	207
53B14b Total					1466
53B14c	HB	Habitation	Habitation	HB	17
	Q	Slight to Moderate erosion (e1-e2)	Very Low	45	80
	R	Slight erosion (e1)	Very Low	40	2240
	S	Slight to Moderate erosion (e1-e2)	Low	60	40
	T	Slight erosion (e1)	Very Low	40	97
53B14c Total					2474
53B14d	HB	Habitation	Habitation	HB	9
	P	Slight erosion (e1)	Very Low	30	721

	Q	Slight to Moderate erosion (e1-e2)	Very Low	45	51
	R	Slight erosion (e1)	Very Low	40	384
	River	River	River	River	259
	S	Slight to Moderate erosion (e1-e2)	Low	60	19
	T	Slight erosion (e1)	Very Low	40	53
	W	Slight erosion (e1)	Very Low	20	51
53B14d Total					1547
53B14e	P	Slight erosion (e1)	Very Low	30	830
	R	Slight erosion (e1)	Very Low	40	760
	River	River	River	River	136
	T	Slight erosion (e1)	Very Low	40	50
53B14e Total					1776
53B14g	HB	Habitation	Habitation	HB	30
	J	Moderate erosion (e2)	Very Low	55	5
	P	Slight erosion (e1)	Very Low	30	169
	Q	Slight to Moderate erosion (e1-e2)	Very Low	45	23
	R	Slight erosion (e1)	Very Low	40	662
	River	River	River	River	67
	W	Slight erosion (e1)	Very Low	20	95
53B14g Total					1051
53B14h	HB	Habitation	Habitation	HB	1
	P	Slight erosion (e1)	Very Low	30	715
	Q	Slight to Moderate erosion (e1-e2)	Very Low	45	61
	R	Slight erosion (e1)	Very Low	40	1430
	River	River	River	River	276
	S	Slight to Moderate erosion (e1-e2)	Low	60	65
	T	Slight erosion (e1)	Very Low	40	30
	W	Slight erosion (e1)	Very Low	20	81
53B14h Total					2659

53B14i	HB	Habitation	Habitation	HB		34
	P	Slight erosion (e1)	Very Low	30		322
	Q	Slight to Moderate erosion (e1-e2)	Very Low	45		549
	R	Slight erosion (e1)	Very Low	40		1424
	River	River	River	River		69
	S	Slight to Moderate erosion (e1-e2)	Low	60		43
	T	Slight erosion (e1)	Very Low	40		199
	U	Slight to Moderate erosion (e1-e2)	Low	60		17
	W	Slight erosion (e1)	Very Low	20		3
53B14i Total						2660
53B14j	HB	Habitation	Habitation	HB		8
	P	Slight erosion (e1)	Very Low	30		189
	Q	Slight to Moderate erosion (e1-e2)	Very Low	45		762
	R	Slight erosion (e1)	Very Low	40		1537
	River	River	River	River		95
	S	Slight to Moderate erosion (e1-e2)	Low	60		13
	U	Slight to Moderate erosion (e1-e2)	Low	60		57
53B14j Total						2661
53B14l	H	Slight to Moderate erosion (e1-e2)	Low	58		2
	HB	Habitation	Habitation	HB		1
	J	Moderate erosion (e2)	Very Low	55		7
	M	Slight to Moderate erosion (e1-e2)	Very Low	40		104
	P	Slight erosion (e1)	Very Low	30		57
	R	Slight erosion (e1)	Very Low	40		100
	River	River	River	River		126
53B14l Total						397
53B14m	H	Slight to Moderate erosion (e1-e2)	Low	58		1152
	HB	Habitation	Habitation	HB		10
	M	Slight to Moderate erosion (e1-e2)	Very Low	40		396

	P	Slight erosion (e1)	Very Low	30	209
	R	Slight erosion (e1)	Very Low	40	102
	River	River	River	River	308
	U	Slight to Moderate erosion (e1-e2)	Low	60	116
	W	Slight erosion (e1)	Very Low	20	60
53B14m Total					2353
53B14n	H	Slight to Moderate erosion (e1-e2)	Low	58	1764
	HB	Habitation	Habitation	HB	2
	P	Slight erosion (e1)	Very Low	30	62
	Q	Slight to Moderate erosion (e1-e2)	Very Low	45	190
	R	Slight erosion (e1)	Very Low	40	160
	River	River	River	River	115
	T	Slight erosion (e1)	Very Low	40	114
	U	Slight to Moderate erosion (e1-e2)	Low	60	250
53B14n Total					2657
53B14o	H	Slight to Moderate erosion (e1-e2)	Low	58	285
	HB	Habitation	Habitation	HB	7
	P	Slight erosion (e1)	Very Low	30	42
	Q	Slight to Moderate erosion (e1-e2)	Very Low	45	705
	R	Slight erosion (e1)	Very Low	40	1118
	River	River	River	River	23
	U	Slight to Moderate erosion (e1-e2)	Low	60	377
53B14o Total					2557
53B14r	H	Slight to Moderate erosion (e1-e2)	Low	58	189
	HB	Habitation	Habitation	HB	2
	J	Moderate erosion (e2)	Very Low	55	1
	M	Slight to Moderate erosion (e1-e2)	Very Low	40	29
	River	River	River	River	52
	U	Slight to Moderate erosion (e1-e2)	Low	60	186

	W	Slight erosion (e1)	Very Low	20	21
53B14r Total					480
53B14s	H	Slight to Moderate erosion (e1-e2)	Low	58	439
	HB	Habitation	Habitation	HB	3
	Q	Slight to Moderate erosion (e1-e2)	Very Low	45	15
	R	Slight erosion (e1)	Very Low	40	219
	River	River	River	River	19
	U	Slight to Moderate erosion (e1-e2)	Low	60	162
53B14s Total					857
53B14t	HB	Habitation	Habitation	HB	3
	P	Slight erosion (e1)	Very Low	30	195
	Q	Slight to Moderate erosion (e1-e2)	Very Low	45	243
	R	Slight erosion (e1)	Very Low	40	503
	S	Slight to Moderate erosion (e1-e2)	Low	60	48
	U	Slight to Moderate erosion (e1-e2)	Low	60	20
53B14t Total					1012
53B15a	P	Slight erosion (e1)	Very Low	30	1208
	R	Slight erosion (e1)	Very Low	40	618
	River	River	River	River	162
	S	Slight to Moderate erosion (e1-e2)	Low	60	71
	Water bodies	Water bodies	Water bodies	Water bodies	1
53B15a Total					2060
53B15b	P	Slight erosion (e1)	Very Low	30	177
	R	Slight erosion (e1)	Very Low	40	940
	River	River	River	River	4
	S	Slight to Moderate erosion (e1-e2)	Low	60	53
53B15b Total					1174
53B15f	P	Slight erosion (e1)	Very Low	30	49
	R	Slight erosion (e1)	Very Low	40	2500

	River	River	River	River		2
	S	Slight to Moderate erosion (e1-e2)	Low		60	110
53B15f Total						2661
53B15g	Q	Slight to Moderate erosion (e1-e2)	Very Low		45	42
	R	Slight erosion (e1)	Very Low		40	1444
	River	River	River	River		20
	S	Slight to Moderate erosion (e1-e2)	Low		60	82
53B15g Total						1588
53B15k	P	Slight erosion (e1)	Very Low		30	413
	Q	Slight to Moderate erosion (e1-e2)	Very Low		45	8
	R	Slight erosion (e1)	Very Low		40	1817
	R2	Slight erosion (e1)	Very Low		35	252
	River	River	River	River		33
	S	Slight to Moderate erosion (e1-e2)	Low		60	120
53B15k Total						2643
53B15l	P	Slight erosion (e1)	Very Low		30	810
	Q	Slight to Moderate erosion (e1-e2)	Very Low		45	289
	R	Slight erosion (e1)	Very Low		40	793
	R2	Slight erosion (e1)	Very Low		35	56
	River	River	River	River		12
53B15l Total						1960
53B15m	P	Slight erosion (e1)	Very Low		30	294
	Q	Slight to Moderate erosion (e1-e2)	Very Low		45	34
	River	River	River	River		30
53B15m Total						358
53B15p	P	Slight erosion (e1)	Very Low		30	144
	Q	Slight to Moderate erosion (e1-e2)	Very Low		45	1
	R	Slight erosion (e1)	Very Low		40	265
	R2	Slight erosion (e1)	Very Low		35	39

	River	River		River	River		3
53B15p Total							452
53B15q	P	Slight erosion (e1)		Very Low	30	211	
	Q	Slight to Moderate erosion (e1-e2)		Very Low	45	137	
	River	River		River	River		91
53B15q Total							439
53B15r	P	Slight erosion (e1)		Very Low	30	262	
	Q	Slight to Moderate erosion (e1-e2)		Very Low	45	649	
	River	River		River	River		196
	T	Slight erosion (e1)		Very Low	40	25	
53B15r Total							1132
Grand Total							89088

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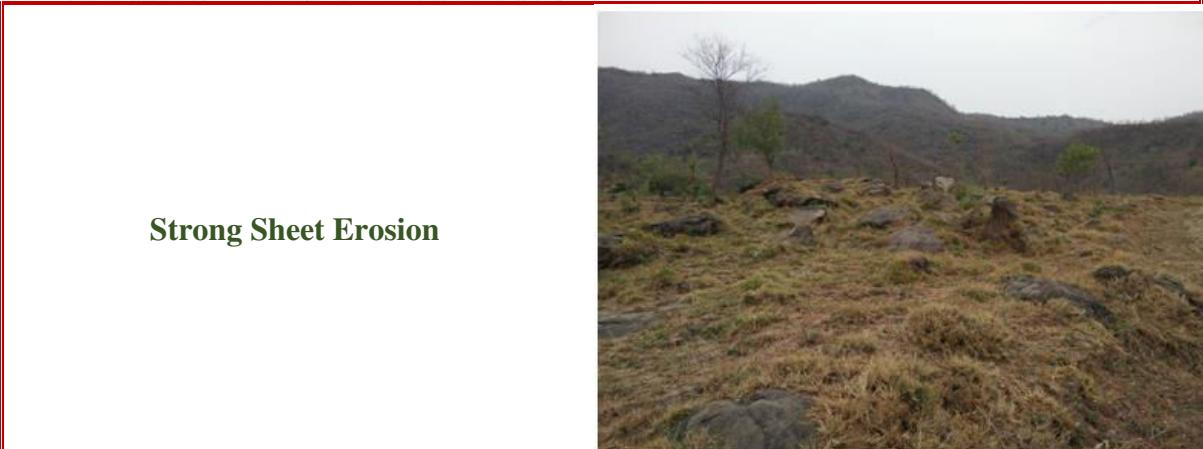
Long Range View of Undifferentiated Hill Slopes with Severe Gully Erosion



Hill Tops with Gully Heads under Strong Gully Erosion



Severe Sheet Erosion in Valley



Strong Sheet Erosion



Active Land Slide Erosion



Severe Stream Bank Erosion



Moderate Forest



Moderate Forest



Profile Examination in Alluvial Plain Landscape having Slight Sheet Erosion

Soil Profile showing different Horizons



Survey Party (Group 1)



मुख्य मुद्रा सर्वेक्षण अधिकारी,
भारतीय मुद्रा एवं भू-उपयोग सर्वेक्षण
कृषि, सहकारिता एवं किसान कल्याण विभाग,
भारतीय कृषि अनुसंधान संस्थान परिसर (पूसा), नई दिल्ली - ११००१२
ई-मेल पता : csso-slusi@nic.in, Phone : 011-25841263, Fax: 25843811

Chief Soil Survey Officer,
Soil and Land Use Survey of India
Department of Agriculture, Cooperation and Farmers Welfare
IARI Campus (PUSA), New Delhi - 110012
(E-Mail) : csso-slusi@nic.in, Phone : 011-25841263, Fax: 25843811