

Carrying Capacity Study of Teesta Basin in Sikkim

Volume-III
**LAND ENVIRONMENT -
SOIL**



Commissioned by :

Ministry of Environment & Forests, Government of India

Sponsored by :

National Hydroelectric Power Corporation Ltd., Faridabad



**CENTRE FOR INTER-DISCIPLINARY STUDIES OF
MOUNTAIN & HILL ENVIRONMENT
CISMHE UNIVERSITY OF DELHI, DELHI**

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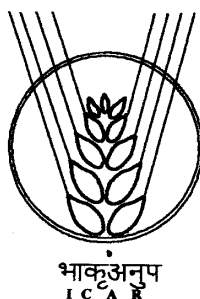
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Carrying Capacity Study Teesta Basin in Sikkim

SOIL RESOURCES OF MAJOR WATERSHEDS OF TEESTA RIVER BASIN IN SIKKIM



**REGIONAL CENTRE
KOLKATA**

**National Bureau of Soil Survey & Land Use Planning
(Indian Council of Agricultural Research)**

In cooperation with
**Centre for Inter-disciplinary Studies of
Mountain & Hill Environment
University of Delhi, Delhi**

PARTICIPATING INSTITUTIONS

- **Centre for Inter-disciplinary Studies of Mountain & Hill Environment, University of Delhi, Delhi**
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CHAPTER - 1

INTRODUCTION

INTRODUCTION

The state Sikkim is primarily the catchment of Teesta drainage system representing unique geological and geomorphological features. The main drainage system of Sikkim is the great Teesta River which originates from Chho Lhamu in North Sikkim (5,488 m) and divides the state into two geographical units following north to south. The river rises in the north district fed by snows from Khangchendzonga; its other tributaries join it from Lhonak, Zemu, Talung, glacier from Khangchendzonga group in west. The chief tributary of Teesta – the great Rangit river is fed from snow of Narsingh and Kabru peaks, south Khangchendzonga. All other high altitudes, near about snowline on eastern and western border and particularly in north, there are a large no. of lakes formed from receding glaciers, are the main source for originating no. of tributaries which ultimately join the river Teesta.

The Teesta Basin in Sikkim exhibits various climatically induced landforms and the landform assemblages containing relief elements in the profiles arising from the lag in response varied geomorphic and pedogenic processes and environmental changes. These micro and other, meso-topographic forms have been produced by the trunk system. Teesta and its innumerable tributaries – one of the important agents of denudation and deposition which has been engaged in attacking and moulding the emerging forms in the upper and burying others mainly in the lower reaches.

Since the hills and mountain in Teesta Basin, Sikkim spread over a great range of elevation from 300 m to more than 8,000 m above MSL and climatically takes a latitude from tropical to cold temperature, there is a great diversity in its natural vegetation. In addition, variation in precipitation, associated with the alignment and altitude of hill and mountain ranges determines the altitudinal adoption, growth and variety of vegetation. As a consequence, these areas possess a rich natural vegetation.

Soil is the basic natural resource for plant growth. Since the hill and mountaineous regions of Teesta Basin have a great diversity with regard to biological activity, various types of soils are met with. Again extensive heedless deforestation, haphazard constructional work, in adequate drainage, slope cultivation, in other words, unscientific and unplanned usages of land have led to the establishment of the vicious cycle of degradation leading to landslides or mass movement. So, soil and water conservation measure is utmost important in the hilly terrain of Teesta Basin, Sikkim for protection of the precious natural resource and to provide food, fuel, fibre to the burgoning population.

Keeping all these in view, the present studies have been undertaken with the following objectives.

- To delineate and identified different watersheds in Teesta Basin, Sikkim
- Inventorisation of soil resources in 17 watersheds in Teesta Basin, Sikkim
- To prepare different thematic maps in all the watersheds based on the information brought out during inventorisation soil resources with the help of Geographical Information System (GIS).

CHAPTER-2

GEOGRAPHICAL SETTINGS

GEOGRAPHICAL SETTINGS

2.1 LOCATION AND EXTENT

The Upper Teesta Basin is situated between 27°04' to 28°07' N and 88°01' to 88°55' E covering an area of 7,096 sq km (Fig. 2.1). The Basin belongs to east, west, south and north district of Sikkim state. It is bounded in north by the vast stretches of Tibetan Plateau in west by Nepal, in east by Bhutan and Chumbi valley of Tibet. Darjeeling district of West Bengal stretches along its southern boundary.

2.2 GEOLOGY

Tectono – straightigraphically the area has been classified under four tectonic belts – i) Foot hill belt, ii) Inner belt, iii) Axial belt and iv) Trans axial belt. The basin is predominantly covered by unfossiliferous metamorphic and crystalline rocks grouped under the inner and axial tectonic belt. The inner belt is essentially made up of pre-cambrian Daling and Darjeeling group of metasediments. There are two predominant zone viz. Gneissic and Daling group. Two forms of Gneiss are usually common i) In South Sikkim – Gneiss is highly micaceous and frequently passes into mica schist. The Daling group consists of predominantly phyllites. ii) In north Sikkim – gneiss is less micaceous.

2.3 GEOMORPHOLOGY

Geomorphological base map of 17 watershed have been prepared based on the visual interpretation of satellite imagery IRS 1C LISS-III false colour composite (1:50,000 scale) SOI toposheet and also traversing the area and 11 broad landforms regions *viz.* ridge, rocky cliff, escarpment, landslide zone, morainic zone, low mountain (< 1000 m), narrow valley, mid. mountain (1000-2000 m), high mountain (2000-3000 m), very high mountain (3000-4000 m), extremely high mountain (> 4000 m) along with glacier were identified in the Teesta Basin in Sikkim and based on the variations of the photo-elements *viz.* tone, texture, slope, size, pattern, shadow, etc. on the satellite imagery, these landform regions were again subdivided into 64 landform units (Table 2.1).

Soils of 17 watersheds in Teesta Basin of Sikkim have been mapped at the level of soil series association. A total of 62 soil series have been identified and mapped into 63 soil mapping units (1:50,000 scale) through the soil resource inventory of the Teesta Basin in Sikkim (Table 2.1). Soil map of Sikkim is given in Fig. 2.2.

Table 2.1 Landforms *vis-à-vis* soils in Teesta Basin, Sikkim

Landform Region	Form Units	Soil series association	Soil map unit
Ridge	1	Maling-Rayong	1
	2	Rubam – Salem	2
Rocky cliff	3	Rock outcrops – Jorpul	3
Escarpments	4,5	Hilley-Singrep – Chatten	4
	6,7	Bhusuk- Karporang – Tibik	5

Landform Region	Form Units	Soil series association	Soil map unit
Landslide zone	8,9	Karporang – Hilley	6
Morainic zone	10,11,12	Kalep – Rock outcrop	7
Low mountain (<1000m)	13,14	Bhasme – Chautare – Legship	8
>50 % slope		Singhik – Lingthem	9
Low mountain (<1000m)	15,16	Chalumthang – Rorethang – Bhasme	10
(30-50) % slope	17,19,20	Mangjing – Singrep – Rorethang	11
	18	Lingtse – Chautare – Chalumthang	12
Low mountain (< 1000m)	21	Mangjing – Dharamdin	13
(15-30) % slope	22,23	Dharamdin – Lingtse – Karfecter	14
Narrow valley (8-15) % slope	24	Mangreng – Karfecter- Mangjing	15
Mid mountain (1000-2000 m)	25	Tumin –Phong – Chautare	16
>50% slope	26	Chatten-Theng	17
	27	Phong – Khedi – Maniram	18
	28	Pakel – Tibik – Rock outcrop	19
	29	Chakung – Tumin – Sajong	20
	30	Singhik – Tibik – Lingthem	21
	31	Chongrang – Legship – Singgyang	22
	32	Singhik – Ruglo – Rapung	23
Mid mountain (1000-2000 m)	33	Doling – Khedi	24
(30-50)% slope	34	Gyer – Manul – Lema	25
	35	Dikling – Hilley	26
	36	Nung – Lingthem	27
	37	Samdur – Khedi – Bhusuk	28
	38	Lingthem – Lema – Singhik	29
	39	Rumtek – Tumin	30
	40	Bitchu – Ruglo – Pakel	31
	41	Bhusuk – Pirik – Namchi	32
	42	Manul – Gyer – Rock outcrop	33
	43	Namchi– Synggyang	34
	44	Ruglo – Lingthem – Theng	35
	45	Doling – Samdur – Rock outcrop	36
	46	Singhik- Pakel	37
Mid mountain	47,48	Rumtek – Pirik – Mangjing	38

Landform Region	Form Units	Soil series association	Soil map unit
(1000-2000m) (15-30) % slope	40,41	Daragoan – Gaucharan – Dharamdin	39
Mid mountain (1000-2000m) (<15% slope)	42	Dharamdin – Martam – Karfecter Mensithang – Lema – Bitchu	40 41
High mountain (2000-3000m) > 50% slope	43	Damthang – Chongrang – Rock outcrop	42
		Tibik-Byuma – Mensithang	43
	44	Singgyang – Maniram – Damthang Chatten-Lema – Tibik	44 45
	45,46,47	Maniram-Damthang – Jorpul	46 47
		Ship – Theng – Pakel	
High mountain (2000-3000m) (30- 50)% slope	48	Martam – Tarnu – Sajong Rapung – Mensithang – Rock outcrop	48 49
	49	Sajong –Tarnu Tibik – Bitchu – Rock outcrop	50 51
	50	Khedi – Maniram – Rongnek Bitchu – Lachen – Chatten	52 53
	51	Rongnek – Sajong Ship – Lingthem – Rock outcrop	54 55
	52	Khedi – Dikling Byuma-Ship	56 57
High mountain (2000-3000m) (15-30)% slope	53	Gaucharan – Tarnu Yumthang – Bitchu	58 59
Very high mountain (3000-4000m) (30-50)% slope	54,55,58 56,57 59	Lachung- Puchikongma – Byuma Yumthang – Thangu – Kalep Maltin – Lachen – Rock outcrop	60 61 62
Extremely high mountain (30-50)% slope	60,61,62,63,64	Thangu – Rock outcrop	63
Glacier			G

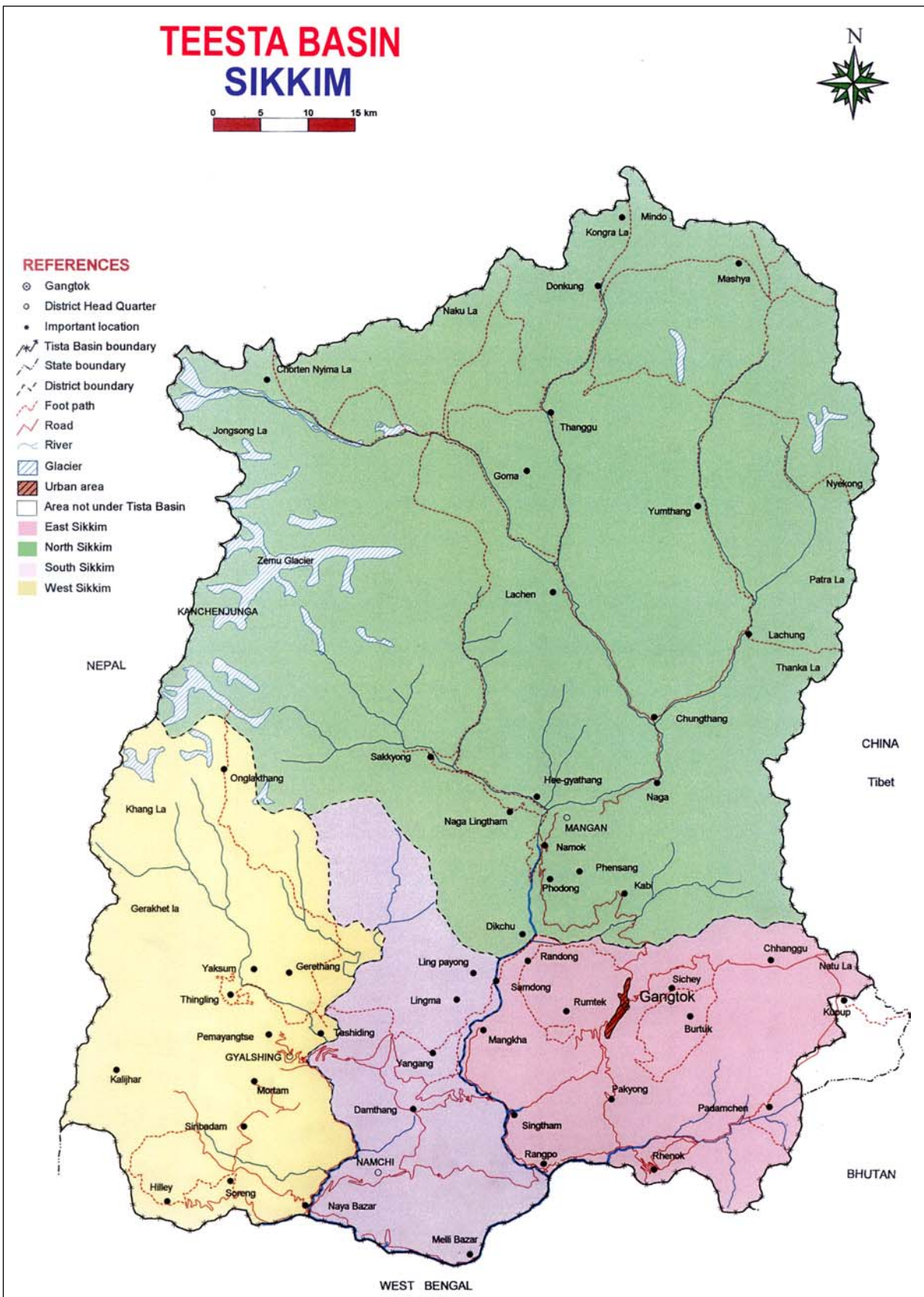


Fig.2.1. Teesta basin in Sikkim

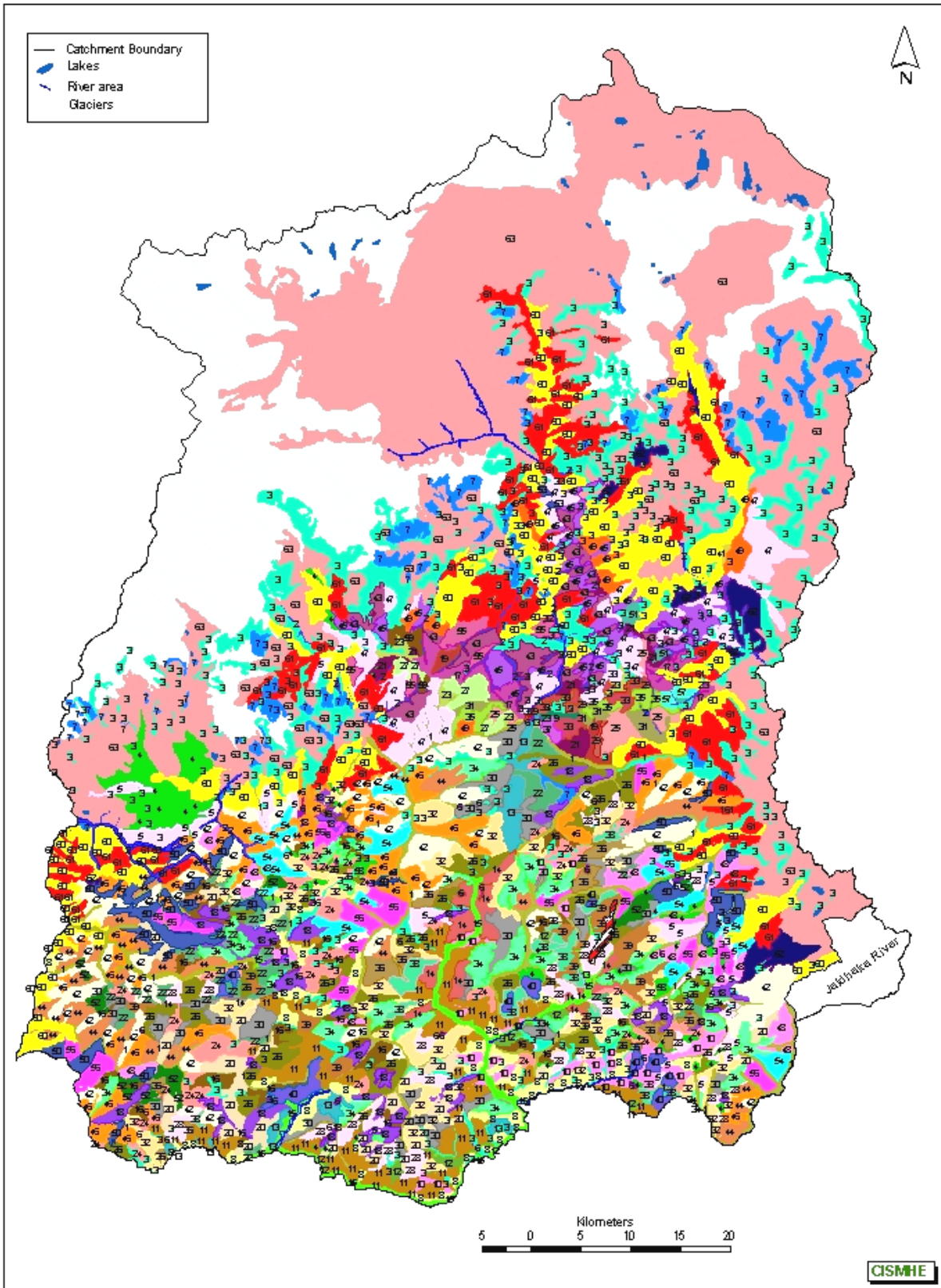



































Fig. 2.2 Soil map of Teesta Basin in Sikkim (For legend see Table 2.2)

Table 2.2 Legend to the Soil map of Teesta Basin in Sikkim

	Soil Unit	Soil Series
	1.	Maling-Rayong
	2.	Rubam-Salem
	3.	Rockoutcrops – Jorpul
	4.	Hilley-Singrep – Chatten
	5.	Bhusuk – Karporang - Tibik
	6.	Karporang - Hilley
	7.	Kalep - Rockoutcrop
	8.	Bhasme – Chautare - Legship
	9.	Singhik - Lingthem
	10.	Chalumthang – Rorethang - Bhasme
	11.	Mangjing – Singrep - Rorethang
	12.	Lingtse – Chautare - Chalumthang
	13.	Mangjing - Dharamdin
	14.	Dharamdin – Lingtse - Karfecter
	15.	Mangreg – Karfecter - Mangjing
	16.	Tumin – Phong – Chautare
	17.	Chatten - Theng
	18.	Phong – Khedi - Maniram
	19.	Pakel – Tibik - Rockoutcrop
	20.	Chakung – Tumin - Sajong
	21.	Singhik – Tibik - Lingthem
	22.	Chongrang – Legship - Singgyang
	23.	Singhik – Ruglo - Rapung
	24.	Doling - Khedi
	25.	Gyer – Manul – Lema
	26.	Dikling - Hilley
	27.	Nung – Lingthem
	28.	Samdur – Khedi – Bhusuk
	29.	Lingthem – Lema – Singhik
	30.	Rumtek-Tumin

	Soil Unit	Soil Series
	31.	Bitchu - Ruglo - Pakel
	32.	Bhusuk - Pirik - Namchi
	33.	Manul - Gyer - Rockoutcrop
	34.	Namchi - Synggyang
	35.	Ruglo - Lingthem - Theng
	36.	Doling - Samdur - Rockoutcrop
	37.	Singhik - Pakel
	38.	Rumtek – Pirik - Mangjing
	39.	Daragoan – Gaucharan – Dharamdin
	40.	Dharamdin – Martam – Karfecter
	41.	Mensithang – Lema – Bitchu
	42.	Damthang – Chongrang – Rockoutcrop
	43.	Tibik – Byuma - Mensithang
	44.	Singgyang – Maniram – Damthang
	45.	Chatten – Lema - Tibik
	46.	Maniram – Damthang – Jorpul
	47.	Ship – Theng – Pakel
	48.	Martam – Tarnu – Sajong
	49.	Rapung – Mensithang – Rockoutcrop
	50.	Sajong – Tarnu
	51.	Tibik – Bitchu – Rockoutcrop
	52.	Khedi – Maniram – Rongnek
	53.	Bitchu – Lachen – Chatten
	54.	Rongnek – Sajong
	55.	Ship – Lingthem – Rockoutcrop
	56.	Khedi – Dikling
	57.	Byuma – Ship
	58.	Gaucharan – Tarnu
	59.	Yumthang – Bitchu
	60.	Lachung – Puchikongma – Byuma
	61.	Yumthang – Thangu – Kalep
	62.	Maltin – Lachen – Rockoutcrop
	63.	Thangu – Rockoutcrop

2.4 CLIMATE

The climate of the Basin varies from sub-tropical to alpine depending upon the elevation of place and proximity of glacier. Within a watershed, the climate

often varies as sub-tropical at lower end of the hill and temperate to sub-alpine prevails in the upper reaches of the stream in high hills. Mean annual rainfall varies from 2000-5000 mm with intensity ranging from drizzling to torrential rain. There are two zones receiving the maximum rainfall i) In south east quadrant of Sikkim covering Mangan, Singhik, Dikchu, Gangtok areas, ii) In south west corner covering Hilley, Dentam, etc.

Temperature varies with altitude and slopes – it generally decreases with increasing altitude. Three types of soil temperature classes have been identified as Thermic, Mesic and Isofrigid. Throughout the year the relative humidity remains above 70% in almost all parts of the basin. To have a better understanding of climate with respect to land use pattern, the following climatic types are found.

1. Alpine - It prevails above 4000 m above MSL, Precipitation occurs mainly through snow.
2. Sub-alpine - This includes the climate between 2700-4000 m above MSL.
3. Temperature - It comprises climate prevailing in between 1500-2700 m above MSL

4. Subtropical - It occurs at an elevation of 500-1500 m above MSL.

2.4 Delineation of Watersheds

Based on geomorphic features in association with geology, altitude and slope, Teesta Basin in Sikkim have been divided into 17 watersheds (Fig. 2.3).

Rangpo Chhu, Rani Khola, Dik Chhu belongs to East district of Sikkim. Lachung Chhu, Yumthang Chhu, Chhombu Chhu, Zemu Chhu. Rangyong Chhu and Lachen Chhu lies in North Sikkim. Prek Chhu, Rel Chhu, Rathong Chhu, Kalej Khola, Ramam Khola and Rangit River belong to West Sikkim. Manpur Khola and Teesta (Lower Part) lies in South Sikkim.

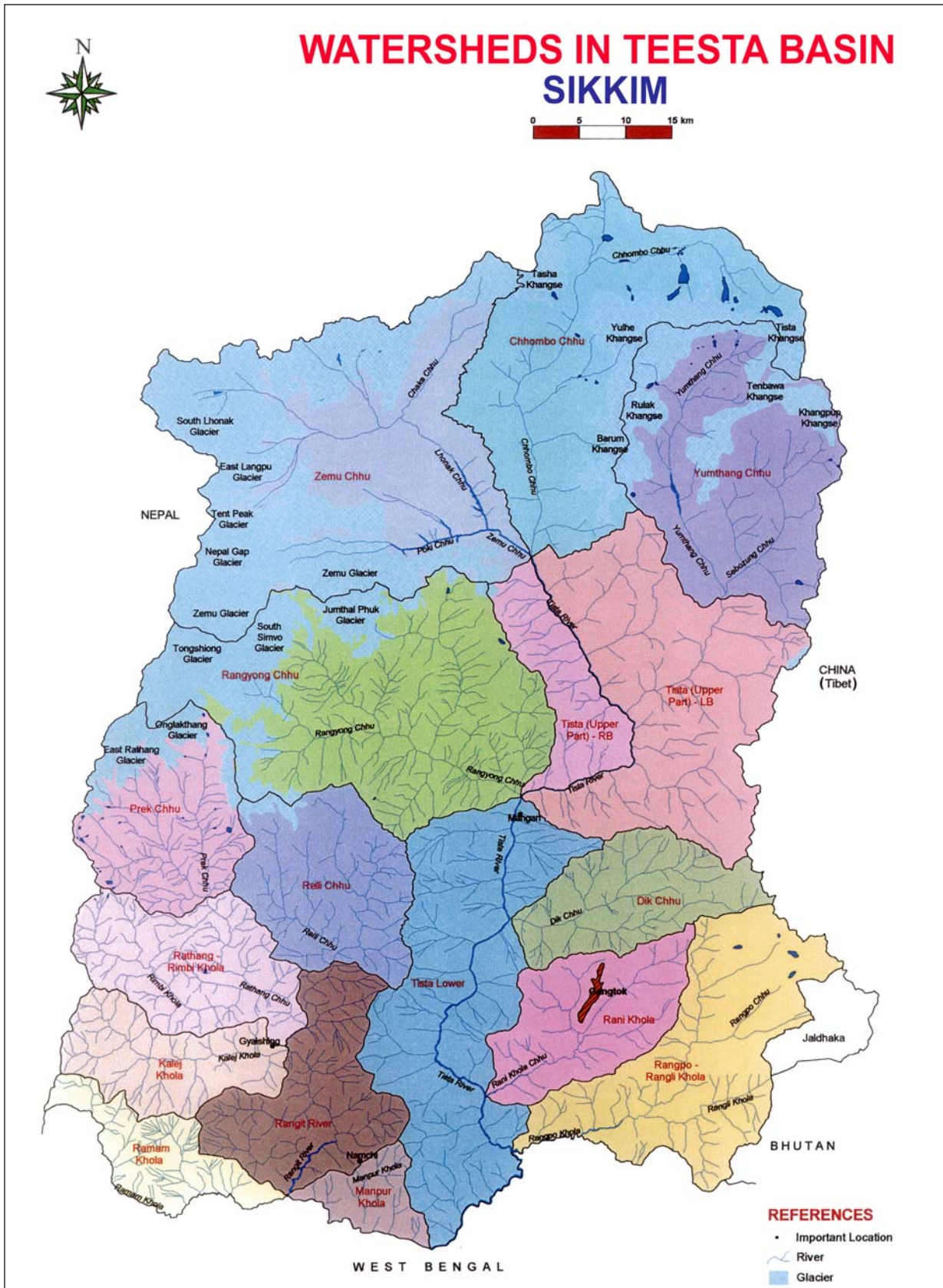


Fig. 2.3 Watersheds in Teesta Basin

CHAPTER-3
MORPHOMETRIC CHARACTERISTICS
IN RANI KHOLA WATERSHED

MORPHOMETRIC CHARACTERISTICS IN RANI KHOLA WATERSHED

The component of landform of Northern Himalayan Mountain is essentially a output of climatological, structural and ecological factors. Interaction between different controlling factors (endogenic & exogenic, etc.) has brought out a wide range of attainment of ranges of morphometric attributes. Morphometric attributes like absolute relief, relative relief, slope and dissection index are some of the features to project the configuration of Teesta Basin - surface and of the shape and dimension of its landform. The morphometric attributes in respect of the Ranikhola watershed of East Sikkim is given below.

3.1 ABSOLUTE RELIEF

The Rani Khola Watershed has a great diversity of landscape with many striking contrast of landform and morphogenic condition. It has been reflected in the nature of absolute relief. The area has a wide range of altitude starting from 800 m to 4,000 m. Absolute relief has been categorized into seven groups ranging from low (< 1,000 m) to very high (> 3,500 m). Moderately low (1,000 to 1,500 m) is the most dominant category which covers 82.7 ha (32.6%) area of the watershed (Table 3.1 and represented in Fig.3.1).

Table 3.1 Absolute relief of Rani Khola watershed

Sl.No.	Absolute relief	Range (in m)	Area (ha)	Percent (%)
1.	Very high	>3500	2.8	1.1
2.	High	3000-3500	6.0	2.4
3.	Moderately high-high	2500-3000	16.1	6.4
4.	Moderately high	2000-2500	38.4	15.1
5.	Moderately low-moderately high	1500-2000	69.4	27.4
6.	Moderately low	1000-1500	82.7	32.6
7.	Low	<1000	33.2	13.1
8.	Urban area		4.6	1.8
9.	Miscellaneous		0.3	0.1

3.2 RELATIVE RELIEF

Relative relief is amplitude of relief or local relief which represents actual variation of altitude in a unit area with respect to its local base level. It is closely associated with slopes and more expressive and also useful in understanding morphogenesis.

Rani Khola watershed is dominated with moderate relative relief (350-550 m) covering 124.0 ha (48.9%) area of the watershed. Only 2.1 ha (0.08%) area belongs to low category indicating the nature of topography (Table 3.2 and Fig.3.2).

Table 3.2 Relative relief of Rani Khola watershed

Sl.No.	Absolute relief	Range (in m)	Area (ha)	Percent (%)
1.	Very high	> 950 m	0.4	0.2
2.	High	750-950 m	10.4	4.1
3.	Moderately high	550-750 m	62.6	24.7

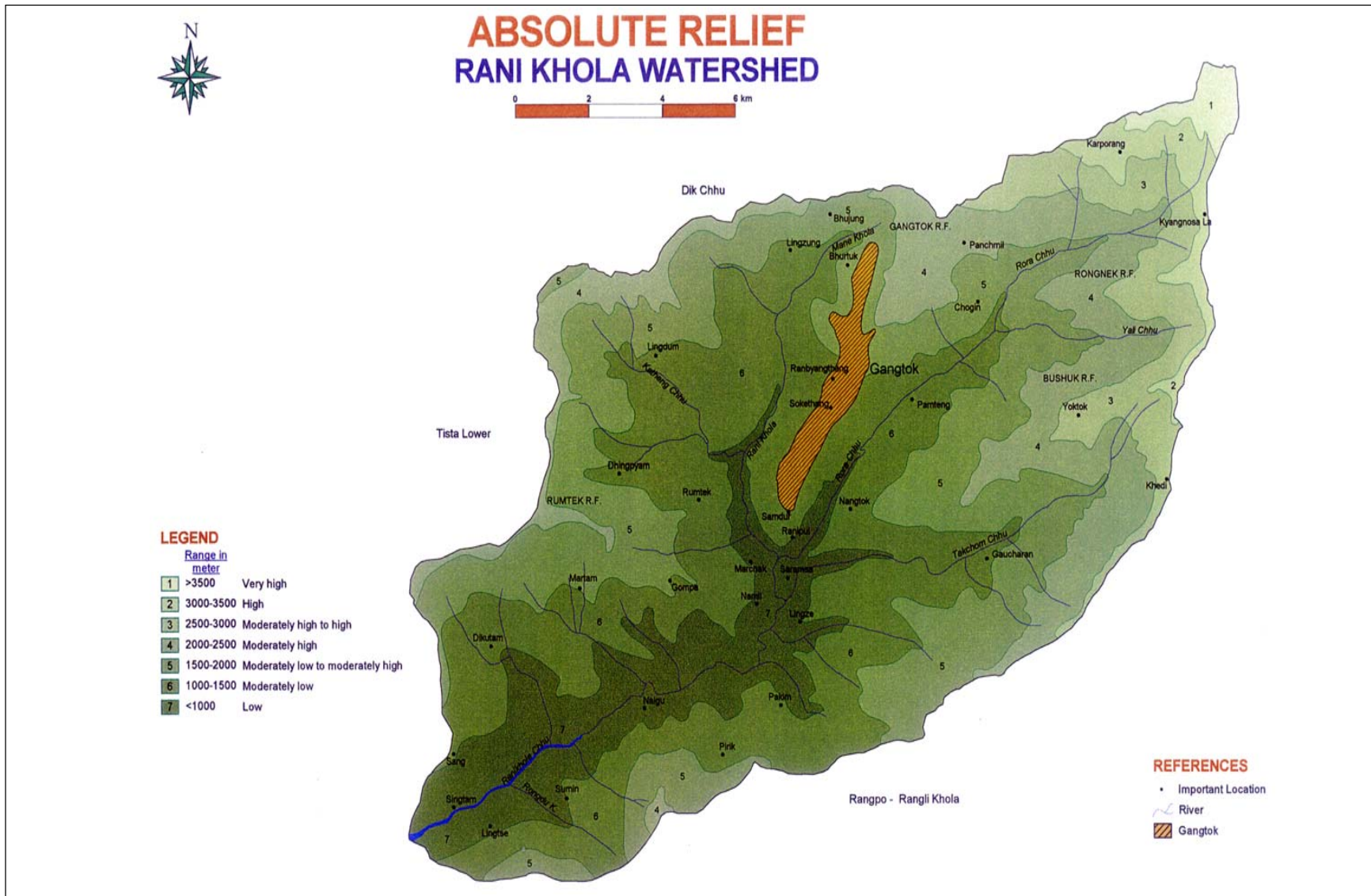


Fig. 3.1 Absolute relief of Rani Khola watershed

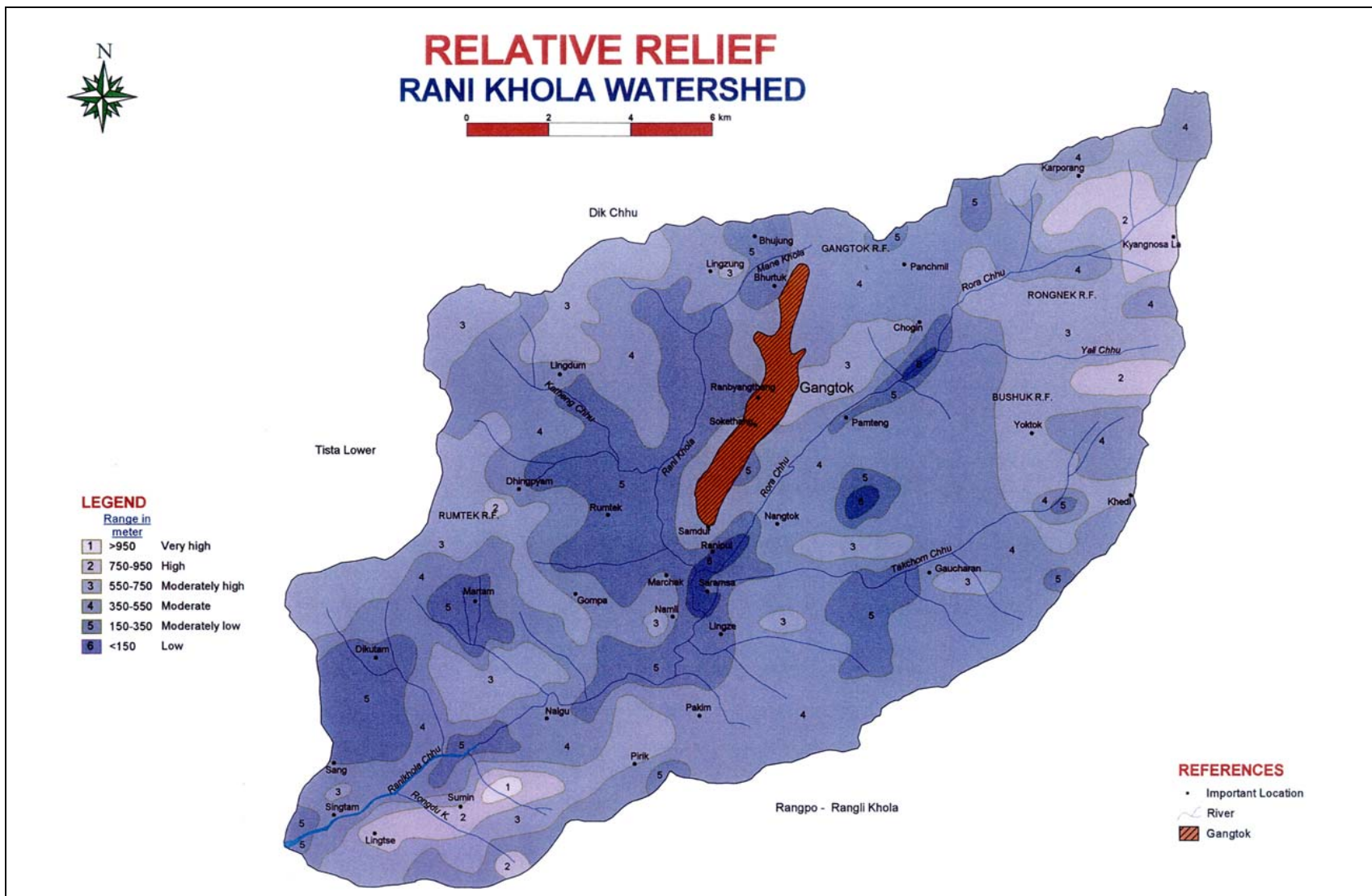


Fig.3.1 Relative relief of Rani Khola watershe

4.	Moderate	350-550 m	124.0	48.9
5.	Moderately low	150-350 m	49.2	19.4
6.	Low	<150	2.1	0.8
7.	Urban area	-	4.6	1.8
8.	Miscellaneous	-	0.3	0.1

3.3 DISSECTION INDEX

Dissection Index is a ratio between relative relief and absolute altitude. It is an important parameter to understand the terrain condition and drainage basin dynamics – the stage attained by the stream in the course of evaluation of the basin.

Dissection Index of Rani Khola Watershed ranges between very low (<0.08) to very high (>0.64). Two category of dissection index viz., low (0.08 to 0.24) and moderate (0.24 to 0.40) are dominant which covered 112.3 ha (44.3%) and 111.5 ha (44.0%) area respectively (Table 3.3 and Fig.3.3).

Table 3.3 Dissection index of Rani Khola watershed

SI.No.	Absolute relief	Range	Area (ha)	Per cent (%)
1.	Very low	<0.08	0.4	0.2
2.	Low	0.08-0.24	112.3	44.3
3.	Moderate	0.24-0.40	111.5	44.0
4.	Moderately high	0.40-0.56	20.4	8.0
5.	High	0.56-0.64	3.3	1.3
6.	Very high	>0.64	0.8	0.3
7.	Urban area	-	4.6	1.8
8.	Miscellaneous	-	0.3	0.1

3.4 SLOPE

High altitude, folded structure, local disturbances alongwith the sculpturing effects of glacio-fluvial and fluvial processes are the determinant factors in the development of higher degrees of slope in Rani Khola watershed. The slope class (Slope in ($^{\circ}$) degree) ranges from strongly sloping ($10-15^{\circ}$) to very steep ($36-40^{\circ}$). Steep slope ($26-30^{\circ}$) is dominant which covered 109.7 ha (43.2%) area in Rani Khola Watershed (Table 3.4 and Fig.3.4).

Table 3.4 Slope category of Rani Khola watershed

Sl.No.	Absolute relief	Range in degree	Area (ha)	Percent (%)
1.	Strongly sloping	10-15	4.3	1.7
2.	Moderately steep	16-20	10.3	4.1
3.	Moderately steep-steep	21-25	35.7	14.1
4.	Steep	26-30	109.7	43.2
5.	Steep-very steep	31-35	63.4	25.0
6.	Very steep	36-40	25.3	10.0
7.	Urban area	-	4.6	1.8
8.	Miscellaneous	-	0.3	0.1

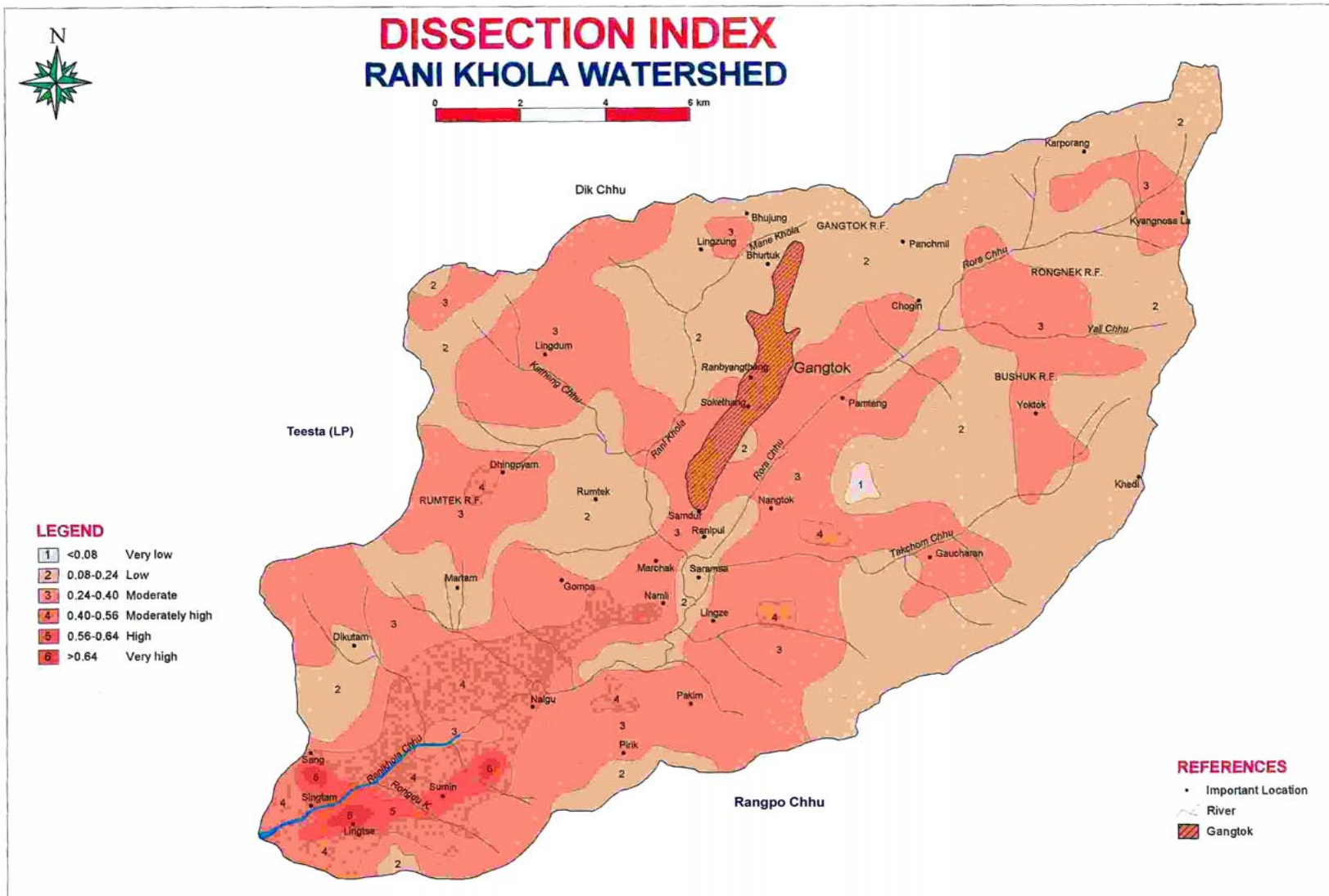


Fig. 3.3.3 Dissection index of Rani Khola watershed



Fig. 3.4 Slope of Rani Khola watershed

CHAPTER-4

WATERSHEDS IN

TEESTA BASIN

WATERSHEDS IN TEESTA BASIN

4.1 RANGPO CHHU WATERSHED

4.1.1 Landforms

Rangpo Chhu Watershed have been divided into ten broad landform regions viz. ridge, rocky cliff, escarpments, landslide zone, morainic zone, low mountain, mid mountain, high mountain, extremely high mountain and valley. These broad landform regions have been further sub-divided into 53 landform units based on terrain features identified through satellite imagery, toposheet and field traverse (Fig. 4.1).

4.1.2 Soils

Soil maps generated through soil resource inventory provide the basic information on geomorphic units, soils, their extent and characteristics. In addition, information on problems and potentials, land capability are also included. It is very useful for planners and administrators for preparing any developmental plans. Land evaluation was carried out for the different use of land by different agencies. Based on soil characteristics and crop requirement criteria, suitability maps of different crops, interpretative maps for LCC have been generated. For preparation of different thematic maps, the criteria outlined in Field Manual (Sehgal *et al.*, 1989) have been used. Soils occurring on 53 sub-geomorphic units have been mapped at 34 soil map units at the level of soil series association (Table 4.1 and Fig. 4.2).

Table 4.1 Soils of Rangpo Chhu watershed

Soil Unit	Soil Series Association	Area (In ha)	% of watershed
1	Maling-Rayong	3348.9	7.5
3	Rock outcrops – Jorpul	2605.8	5.8
4	Hilley-Singrep – Chatten	1067.7	2.4
5	Bhusuk- Karporang – Tibik	1331.0	3.0
6	Karporang – Hilley	102.2	0.2
8	Bhasme – Chautare – Legship	1535.6	3.4
10	Chalumthang – Rorethang – Bhasme	2371.7	5.3
11	Mangjing-Singrep-Rorethang	629.3	1.4
12	Lingtse – Chautare – Chalumthang	77.8	0.2
15	Mangreng – Karfecter- Mangjing	22.7	0.1
16	Tumin –Phong – Chautare	328.8	0.7
18	Phong – Khedi – Maniram	1058.5	2.4
20	Chakung – Tumin – Sajong	860.9	1.9
22	Chongrang – Legship – Singgyang	230.0	0.5
24	Doling – Khedi	519.7	1.2
26	Dikling – Hilley	1363.4	3.0
28	Samdur – Khedi – Bhusuk	1079.2	2.4
30	Rumtek – Tumin	266.0	0.6
32	Bhusuk – Pirik – Namchi	1520.1	3.4
34	Namchi– Synggyang	2202.1	4.9
36	Doling – Samdur – Rock outcrop	720.4	1.6
38	Rumtek – Pirik – Mangjing	289.1	0.6
40	Dharamdin – Martam – Karfecter	968.3	2.2
42	Damthang – Chongrang – Rock outcrop	2533.8	5.7
44	Singgyang – Maniram – Damthang	780.6	1.7
46	Maniram-Damthang – Jorpul	453.3	1.0
48	Martam – Tarnu – Sajong	2276.9	5.1
50	Sajong –Tarnu	1239.6	2.8

Soil Unit	Soil Series Association	Area (In ha)	% of watershed
54	Rongnek – Sajong	966.8	2.2
56	Khedi – Dikling	819.0	1.8
60	Lachung- Puchikongma – Byuma	2165.3	4.8
61	Yumthang – Thangu – Kalep	1025.4	2.3
62	Maltin – Lachen – Rock outcrop	1668.0	3.7
63	Thangu – Rock outcrop	6153.5	13.7
	Miscellaneous	212.0	0.5
	Total	44793.5	100.0

A total of 45 soil series have been identified in the watershed. Dominant soils are Thangu, Maling, Jorpul, Chalumthang, Damthang, Martam and Lachung (see Fig. 4.1).

4.1.3 Soil depth

Effective soil depth is an important soil parameter which decides the type of vegetations and its performance. The occurrence of limiting layer in soil which is impenetrable to roots is indicated by introduction of term Lithic (suggestive a soil depth of less than 50 cm).

Soil depth class has been mapped at the level of association of depth class in 10 mapping units (Table 4.2 and presented in Fig. 4.3). Moderately shallow - rock association (mapping unit 8) of extremely high mountain covers an area of 6,153.5 ha (13.7%). Deep-moderately deep association (mapping unit 1) is extensive in 14,111.2 ha (31.5%) area mostly representing escarpments, low mountain, mid mountain and narrow valley of the watershed. The most problematic classes i.e. Rock –

very shallow association of rocky cliff (mapping unit 9) occupies 2,605.8 ha (5.8%) of the watershed. Deep – very shallow association (mapping unit 3) occupies least area of 1,025.4 ha (2.3%) of the watershed.

Table 4.2. Soil depth of Rangpo Chhu watershed

Map unit	Description	Soil Map units	Area (In ha)	% of watershed
1	Deep-mod.deep	22,24,28,34,38,42,44,46,48, 4,11,15,18,40	14111.2	31.5
2	Deep-mod. Shallow	20,26,30,36	3210.7	7.2
3	Deep-very shallow	61	1025.4	2.3
4	Mod.deep-deep	1,10,56	6539.6	14.6
5	Mod deep-shallow	62	1668.0	3.7
6	Mod shallow	5,6	1433.2	3.2
7	Mod. Shallow-deep	8,12,16,32,50	4701.9	10.5
8	Mod.shallow-Rock	63	6153.5	13.7
9	Rock – very shallow	3	2605.8	5.8
10	Shallow-mod.deep	54,60	3132.1	7.0
		Miscellaneous	212.0	0.5

4.1.4 Surface Texture

Soil texture is a nearly permanent characteristic of soil. It is directly related to structure, porosity, adhesion and consistency. Surface texture have been mapped at association levels into 17 Units (Table 4.3) and presented in Fig. 4.4.

Silt loam-loam (sil-l) association under mapping unit 16 is most extensive which occurs in 7,041.9 ha (15.7%) area. Loam-rock (l-r), loam-sandy loam (l-sl) and sandy loam – silty clay loam (sl-sicl) association covers an area of 6,153.5 ha (13.8%), 5,962.4 ha (13.3%) and 4,167.9 ha

LANDFORMS RANGPO CHHU WATERSHED



LEGEND

1	24	39
3	25	42
4	26	43
5	27	44
6	28	45
7	29	48
8	30	49
9	31	51
13	32	52
14	33	54
15	34	55
16	35	56
18	36	57
19	37	59
20	38	60

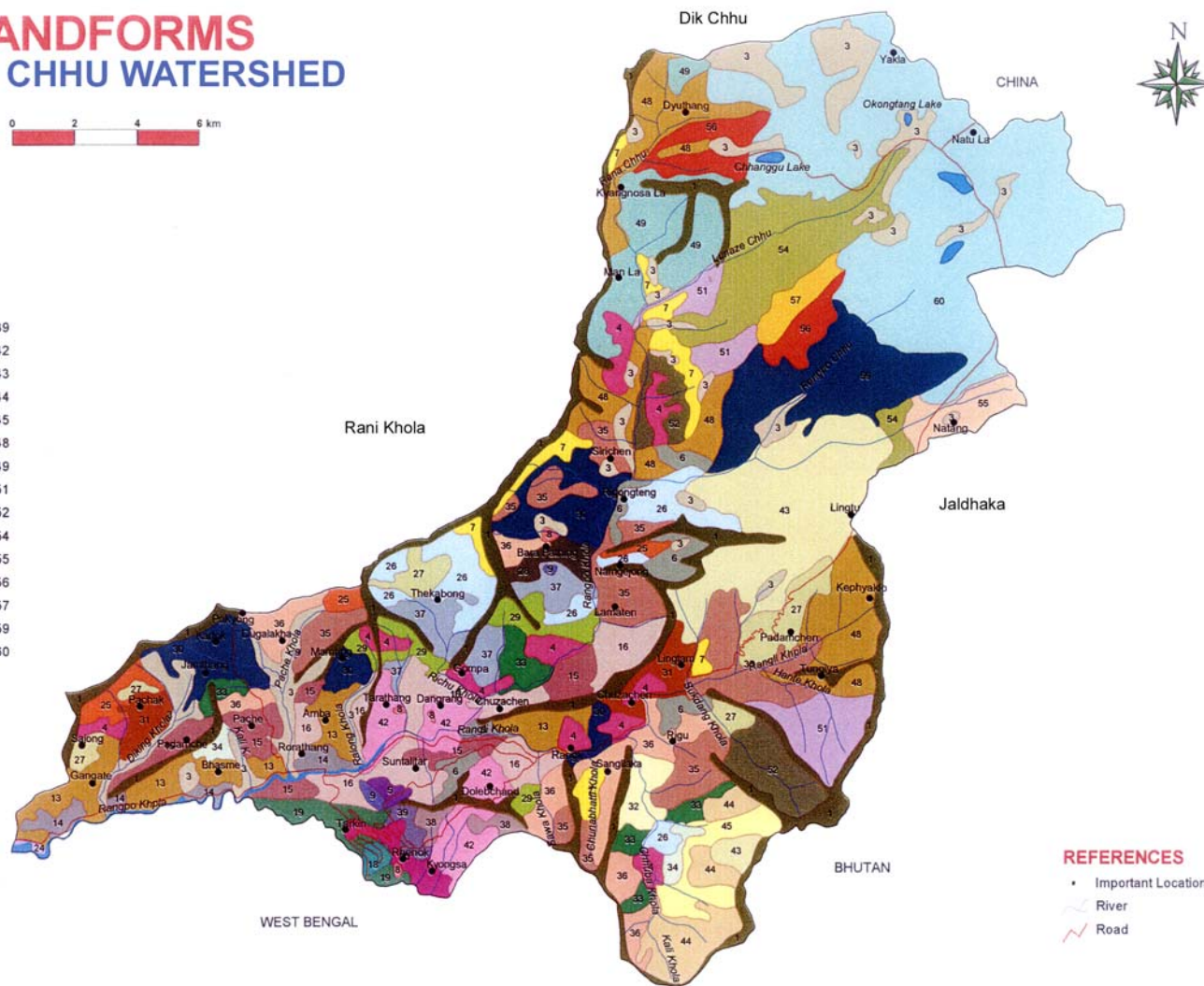


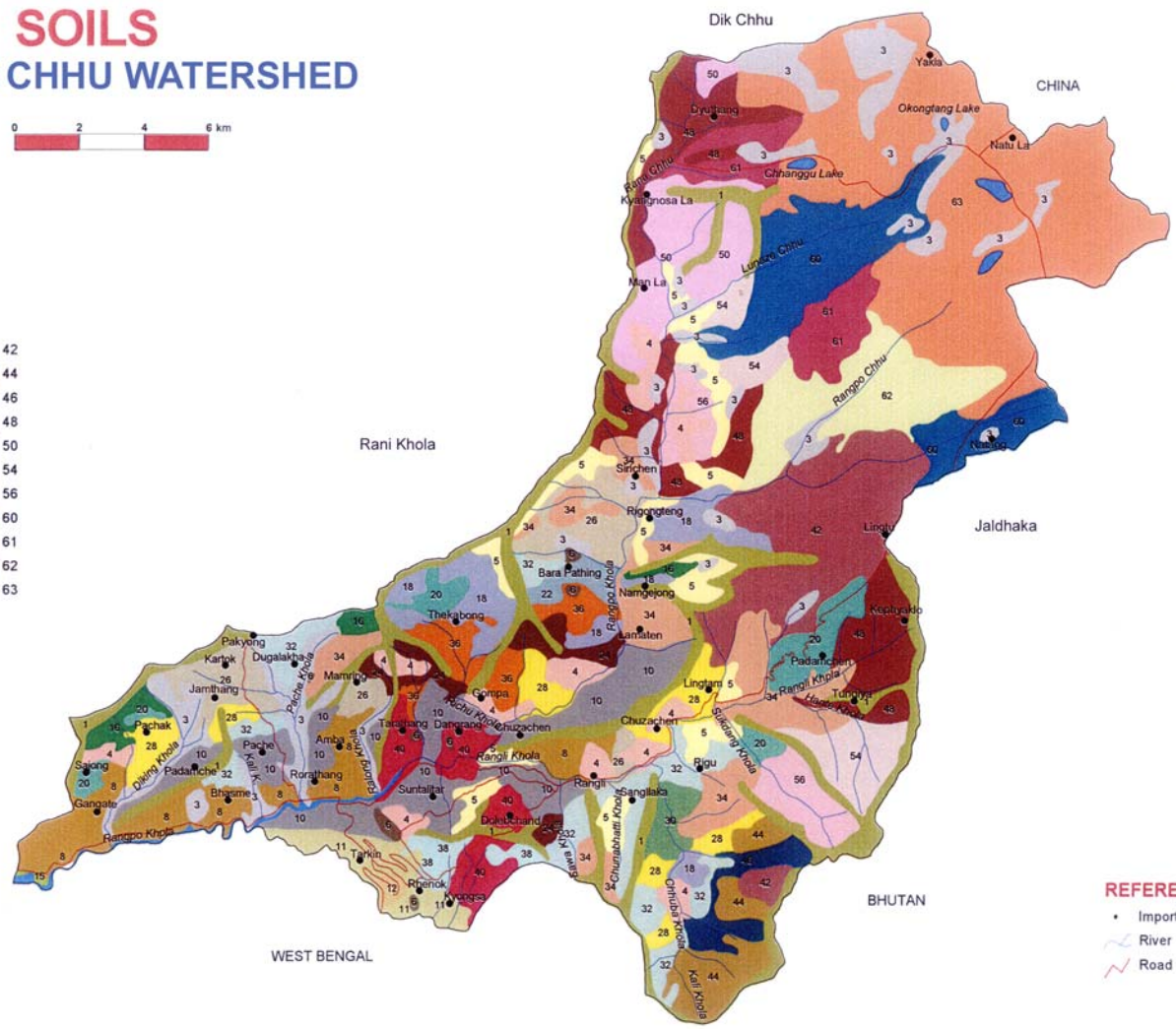
Fig. 4.1 Landforms of Rangpo Chhu watershed

SOILS RANGPO CHHU WATERSHED



LEGEND

1	18	42
3	20	44
4	22	46
5	24	48
6	26	50
8	28	54
10	30	56
11	32	60
12	34	61
15	36	62
16	38	63
	40	



REFERENCES

- Important Location
- ~ River
- Road

Fig. 4.2 Soil of Rangpo Chhu watershed

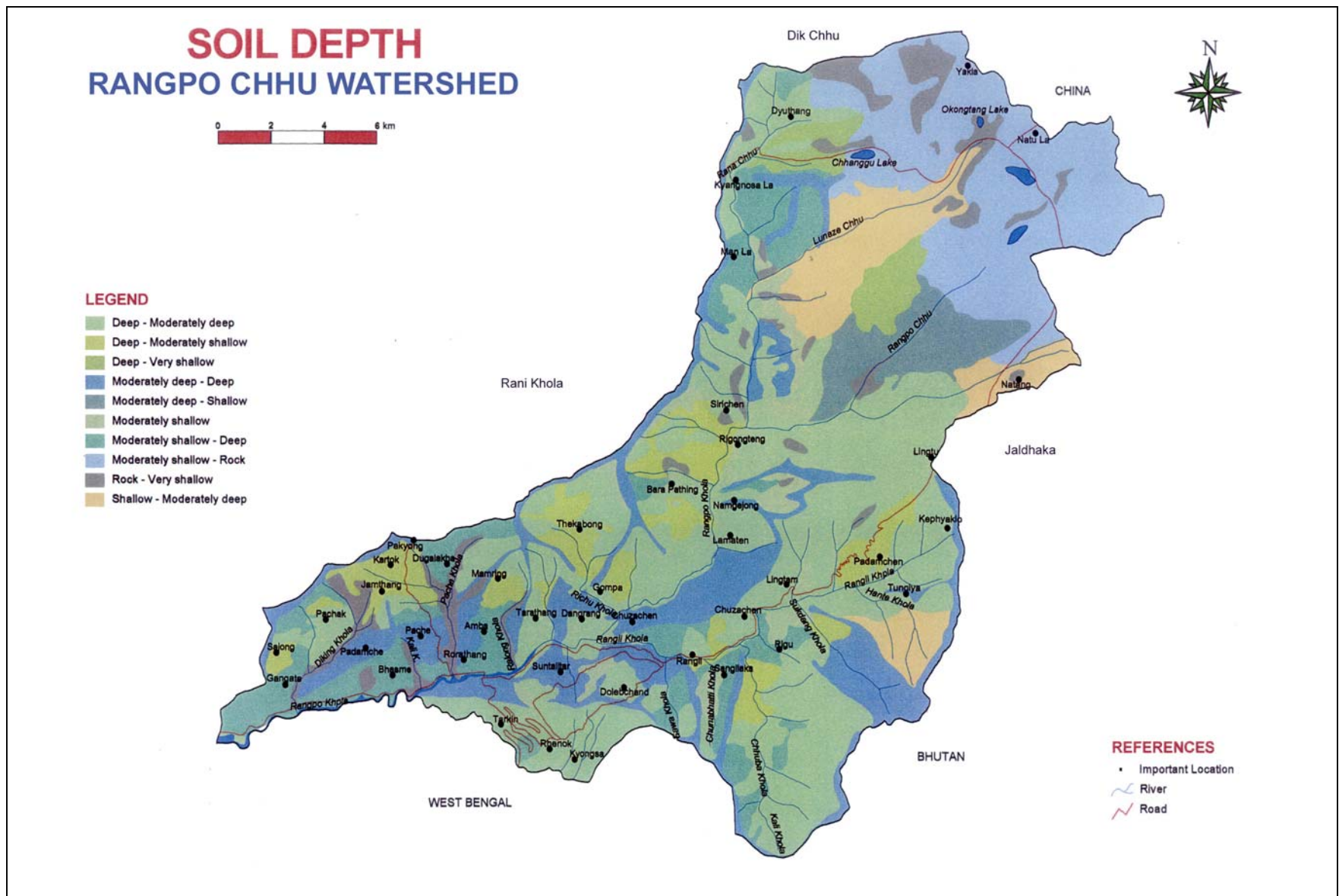


Fig. 4.3 Soil depth class of Rangpo Chhu watershed

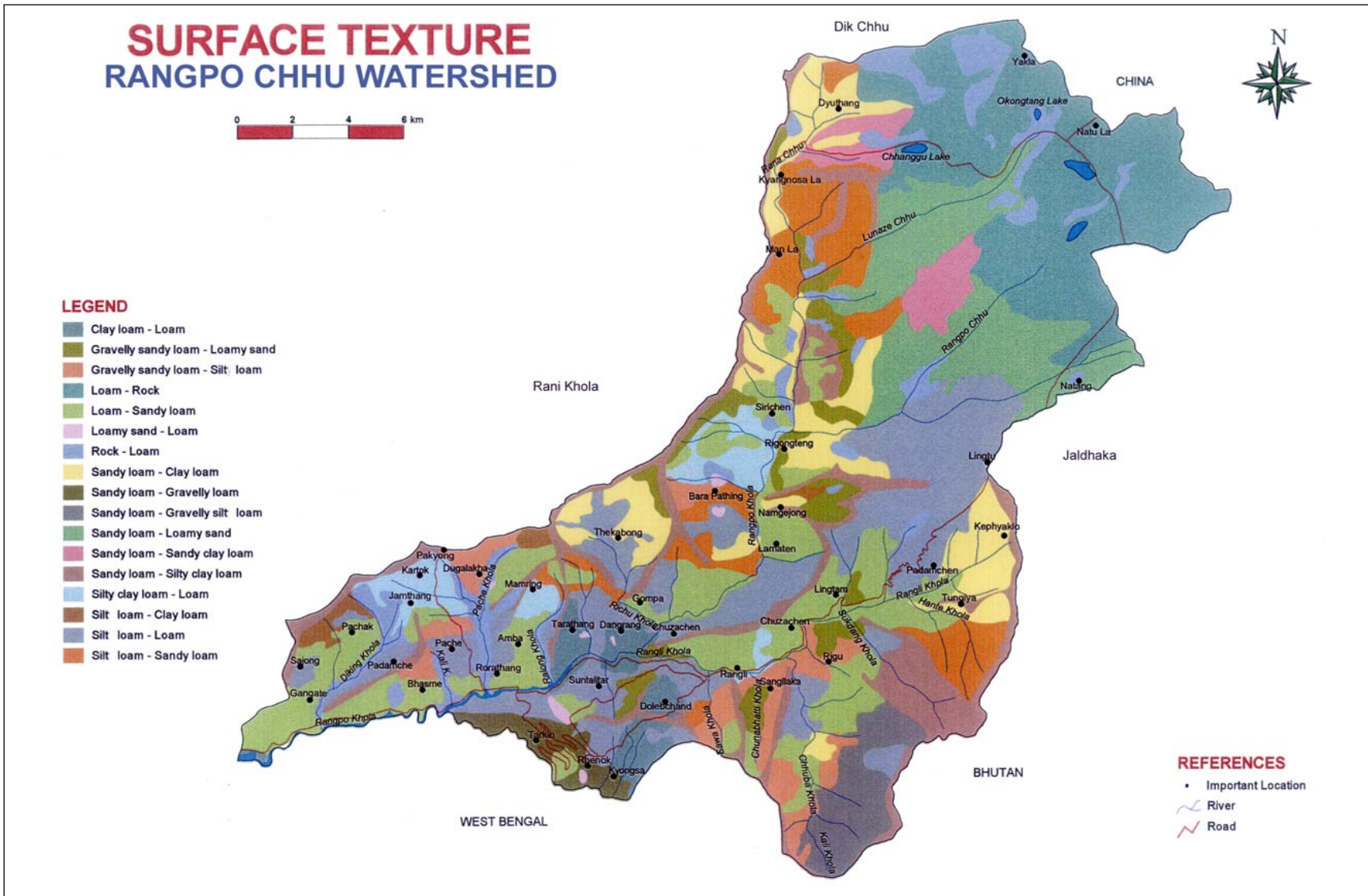


Fig. 4.4 Surface texture class of Rangpo Chhu watershed

area (9.3%) respectively. From the table, it is evident that loamy sand – loam (ls-l) association of landslide zone under mapping unit 6 occupies least area of 102.2 ha (0.2%) of the watershed.

Table 4.3 Surface texture of Rangpo Chhu watershed

Map unit	Description	Soil Map units	Area (In ha)	% of watershed
1	cl-l	15,40	991.0	2.2
2	gsl-ls	5	1331.0	3.0
3	gsl-sil	32	1520.1	3.4
4	l-r	63	6153.5	13.8
5	l-sl	4,8,12,28,34	5962.4	13.3
6	ls-l	6	102.2	0.2
7	R-l	3	2605.8	5.8
8	sl-cl	18, 48	3335.4	7.4
9	sl-gl	11	629.3	1.4
10	sl-gsil	44, 46	1233.9	2.8
11	sl-ls	60, 62	3833.3	8.6
12	sl-scl	61	1025.4	2.3
13	sl-sicl	1,56	4167.9	9.3
14	sicl-l	26	1363.4	3.0
15	sil-cl	16	328.8	0.7
16	sil-l	10, 30, 36, 38, 42, 20	7041.9	15.7
17	sil-sl	22, 24, 50, 54	2956.1	6.6
		Miscellaneous	212.0	0.5

4.1.5 Soil erosion

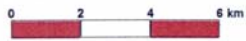
Soil erosion is the major degradational process in mountaineous terrains. Steep side slope of mountains with high rainfall are often subjected to soil loss by water erosion and landslide. Three erosion classes viz. moderate (M), severe (S) and very severe (VS) along with rock (R) have been mapped into 8 mapping units at the level of association of erosion class (Table 4.4) and presented in Fig. 4.5.

Moderate erosion class alone (mapping unit 1) and association of moderate – severe (M-S) erosion class (mapping unit 3) are most extensive covering 13,329.5 ha (29.8%) and 13,293.4 ha (29.7%) area, respectively. The most problematic association of very severe – severe erosion class (mapping unit 8) occupies 2,982.17 ha (6.6%) area of the watershed which require immediate conservation measure. The very severe – moderate erosion class association (mapping unit 7) of mid. mountain (> 50% slope) occupies least area of 860.9 ha (1.9%) of the watershed.

Table 4.4 Soil erosion of Rangpo Chhu watershed

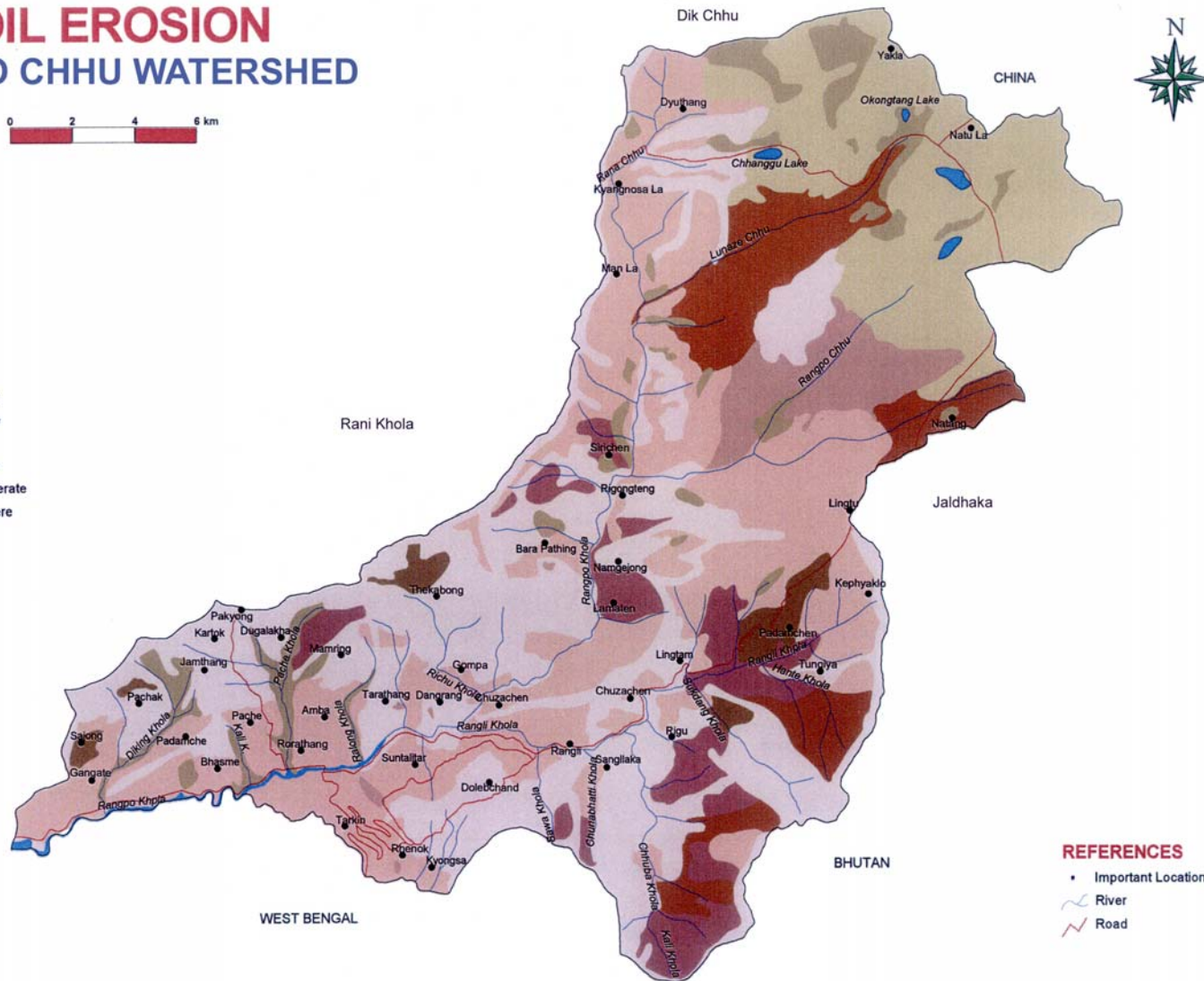
Map unit	Description	Soil Map units	Area (In ha)	% of watershed
1	M	1,16,24,26,28,30,32,36,38,56,61,15,18,40	13329.5	29.8
2	M-R	63	6153.5	13.7
3	M-S	10,22,42,48,50,4,5,8,11,12	13293.4	29.7

SOIL EROSION RANGPO CHHU WATERSHED



LEGEND

- Moderate
- Moderate - Rock
- Moderate - Severe
- Rock - Very severe
- Severe
- Severe - Moderate
- Very severe - Moderate
- Very severe - Severe



REFERENCES

- Important Location
- ~ River
- ~ Road

Fig. 4.5 Soil erosion class of Rangpo Chhu watershed

4	R-VS	3	2605.8	5.8
5	S	46,54,60	3585.4	8.0
6	S-M	6,62	1770.2	4.0
7	VS-M	20	860.9	1.9
8	VS-S	34,44	2982.7	6.6
		Miscellaneous	212.0	0.5

4.1.6 Soil reaction

Soil reaction (pH) is an important property of soils which reflects the availability of different plant nutrients. Its measurement is helpful to quantify the amendments used for amelioration of soils. Five soil reaction classes viz. slightly acidic (SL), moderately acidic (M), strongly acidic (S), very strongly acidic (VS) and extremely acidic (EX) have been identified and mapped into 12 mapping units at the level of association of soil reaction class (Table 4.5) and presented in Fig. 4.6.

Very strongly acidic – strongly acidic (VS-S) association (mapping unit 12) is extensive in 10,402.6 ha (23.2%) area followed by extremely acidic – strongly acidic (EX-S) association (mapping unit 1) covering 9,325.7 ha (20.8%). The most problematic association i.e. extremely acidic – very strongly acidic class (mapping unit 2), mostly from the hill slopes of low and mid. mountain requires more attention towards soil reaction for land use planning. Probably steep hill slope, high rainfall along with forest vegetation is the cause of these type of soil acidity.

Table 4.5 Soil reaction of Rangpo Chhu watershed

Map unit	Description	Soil Map units	Area (In ha)	% of watershed
1	EX-S	8,20,22,24,30,36,42,46,50,54	9325.7	20.8
2	EX-VS	11,16,38	1247.2	2.8
3	M-VS	15,48	2299.6	5.1
4	R-S	3	2605.8	5.8
5	SL-VS	10	2371.7	5.3
6	S-EX	1	3348.9	7.5
7	S-M	12,62	1745.8	3.9
8	S-R	63	6153.5	13.7
9	S-VS	6,40,56	1889.5	4.3
10	VS	60	2165.3	4.8
11	VS-M	61	1025.4	2.3
12	VS-S	Miscellaneous	212.0	0.5

4.1.7 Land capability class (LCC)

Land Capability Class (LCC) depicts the capability of soils for proper utilization of land on sustain basis. This provides clues to the management and improvement of different soils for increasing production (Dent and Young, 1981). Five land capability classes and seven land capability subclasses have been identified in this watershed based on the number and severity of different limitations *viz.* IIIe, IVe2, VIe2, VIe2s, VIIe3s, VIIe3 and VIIe4s (Table 4.6) and mapped in Fig. 4.7. The land capability subclasses VIe2s having moderate limitation of erosion and soil (mapping unit 4) occupies largest area of 19,257.6 ha (43.0%) while the land capability

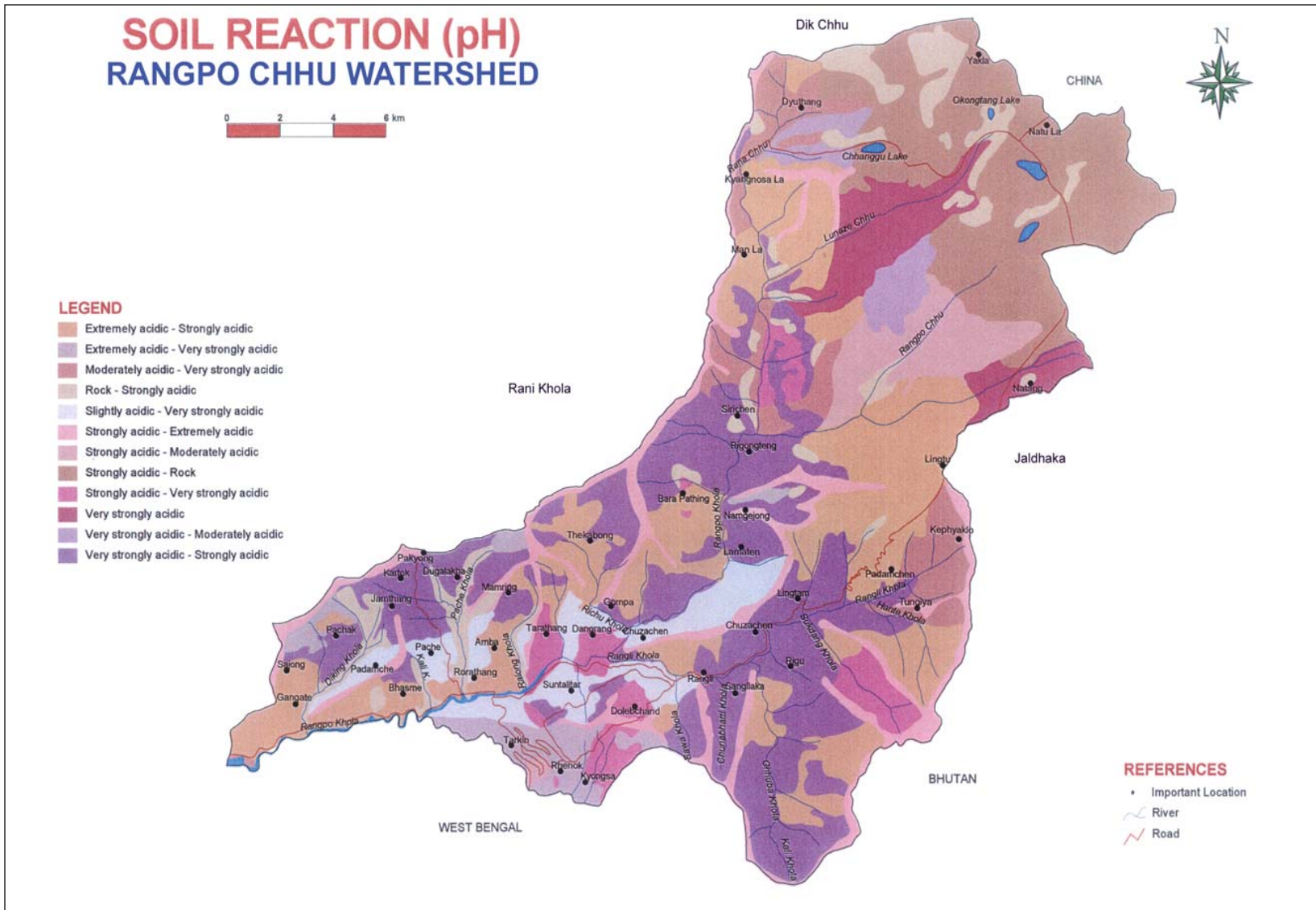


Fig. 4.6 Soil reaction class of Rangpo Chhu watershed

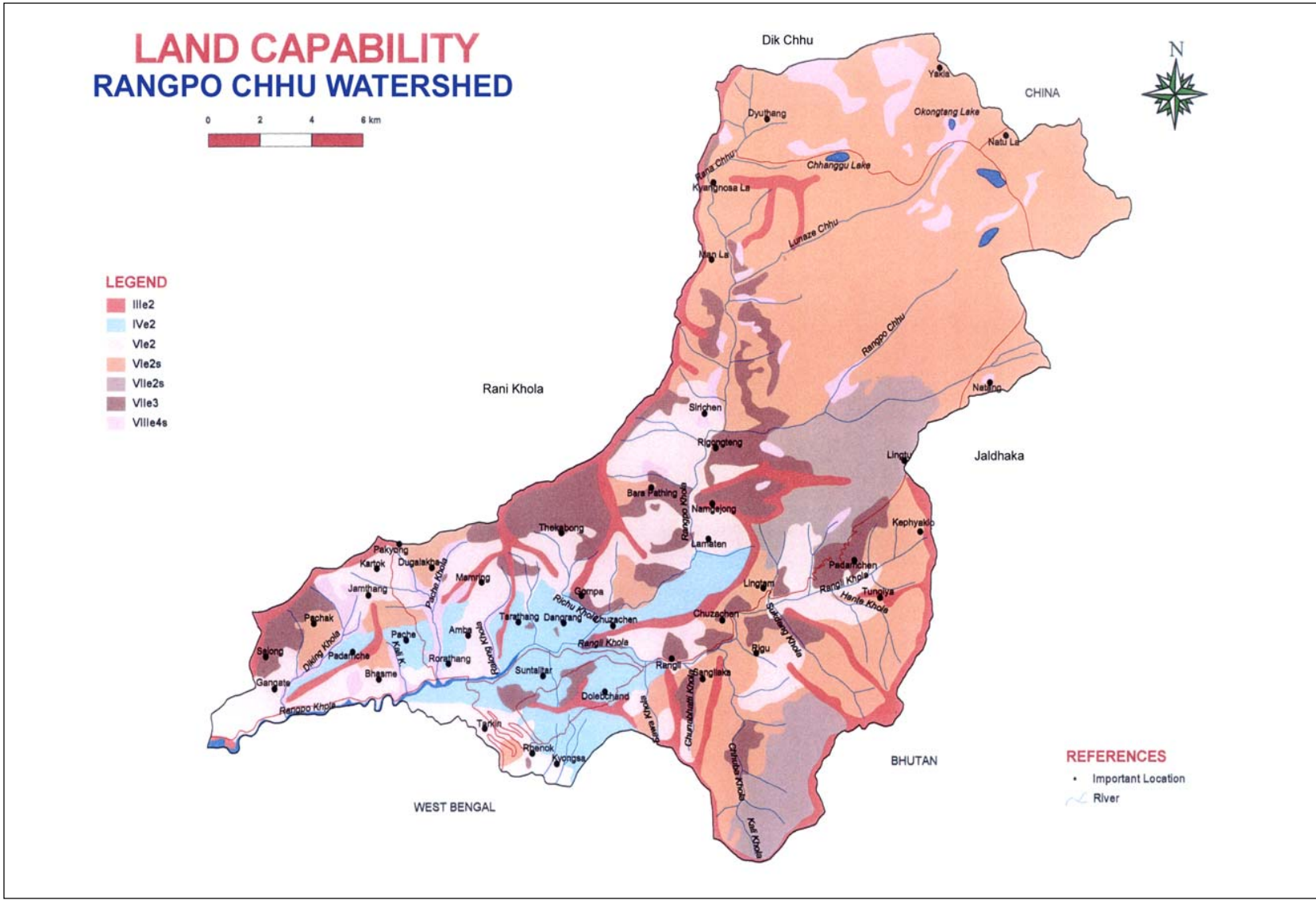


Fig. 4.7 Land capability class of Rangpo Chhu watershed

sub-class VIIIe4s, which is most problematic class having very severe limitation of erosion and soil (mapping unit 7) occupies least area of 2,605.8 (5.8%) of the watershed.

Table 4.6 Land capability of Rangpo Chhu watershed

Map unit	Description	Soil Map Units	Area (In ha)	% of watershed
1	IIIe2	1,15	3371.6	7.5
2	IVe2	10,38,40	3629.1	8.1
3	Vie2	8,11,24,26,34,36	6970.5	15.6
4	Vie2	12,28,30,32,48,50,54,56, 60,61,62,63	19257.6	43.0
5	VIIe2	42,44,46	3767.7	8.4
6	VIIe3	4,5,6,16,18,20,22	4979.1	11.1
7	VIIIe4	3	2605.8	5.8
		Miscellaneous	212.0	0.5

4.1.8 Soil-site suitability for rice

In Rangpo Chhu watershed about 1,601.2 ha area has been found to be moderately to marginally suitable (S2-S3) for rice and marginally to moderately suitable (S3-S2) in 2,149.4 ha. (Table 4.7 and Fig. 4.8) indicating that hill slopes of low to mid mountain (30-50% slope class) can be used for terraced cultivation of rice. It is only marginally suitable (S3) in 12,486.3 ha mostly belong to the low to high mountain with >50% slope. Unsuitability (N) alone and in combination occupy 28,344.6 ha area mostly due to severe to very severe limitation of topography and soil.

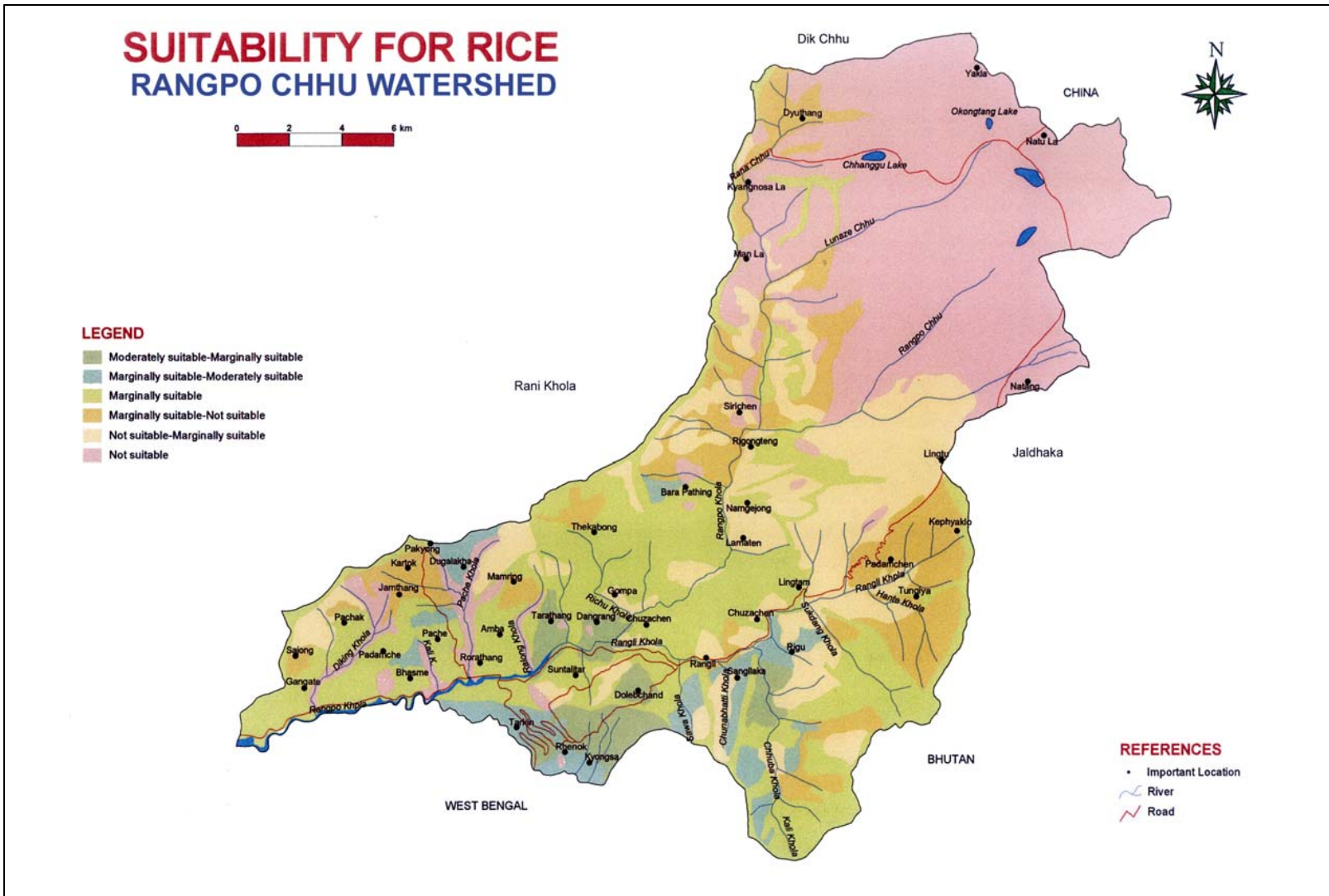


Fig. 4.8 Soil site suitability for rice in Rangpo Chhu watershed

Table 4.7 Soil-site suitability for rice of Rangpo Chhu watershed

Sl.No.	Suitability class	Map unit nos.	Area (ha)
1.	S2-S3	12,30,38,40	1601.2
2.	S3-S2	11,32	2149.4
3.	S3	1,8,10,15,18,22,24,28,36,44,56	12486.3
4.	S3-N	20,26,46,48,54	5921.3
5.	N-S3	4,5,16,34,42	7463.5
6.	N	3,6,50,60,61,62,63	14959.8
	Miscellaneous		212.0
Total			44793.5

4.1.9 Soil-site suitability for maize

Maize is found to be moderately suitable (S2) in 14,557.0 ha areas in Rangpo Chhu watershed, moderately to marginally suitable (S2-S3) in 5561.4 ha and marginally to moderately suitable (S3-S2) in 6105.0 ha (Table 4.8 and Fig. 4.9). The result indicates that low to medium hill slope (<50%) can be used for terraced cultivation of maize. It is found to be unsuitable mostly in high mountain rocky cliff and landslide zone areas due to severe to very severe limitation of topography and soil.

Table 4.8 Soil-site suitability for maize of Rangpo Chhu watershed

Sl.No.	Suitability class	Map unit nos.	Area (ha)
1.	S2	1,12,18,22,24,28,30,32,34,36, 38,40,48	14557.0
2.	S2-S3	15,20,26,42,44	5561.4

3.	S3-S2	8,10,11,16,50	6105.0
4.	S3	4,5	2398.7
5.	N-S2	46,54,56	2239.2
6.	N	3,6,60,61,62,63	13720.2
	Miscellaneous		212.0
Total			44793.5

4.2 RANI KHOLA WATERSHED

4.2.1 Landforms

Eight broad landform regions have been identified in Rani Khola Watershed i.e. ridge, rocky cliff, escarpment, landslide zone, morainic zone, low mountain, mid mountain and high mountain (Fig.4.10).

4.2.2 Soil

Soils of Rani Khola watershed have been mapped in to 31 soil mapping units at the level of soil series associations (Table 4.9) and presented in Fig. 4.11. They occur predominantly on side slope of mountains. Soil map units 8 to 14 belong to side slopes of lower mountain whereas 16 to 40 were under mid mountain. The most extensive soils are soil map unit 39 (Daragaon -Gaucharan - Dharamdin), 38 (Rumtek – Pirik – Mangjing), 28 (Samdur-Khedi-Bhushuk) and 11 (Mangjing – Singrep – Rorthang). Soil map unit 7 belong to morainic zone (Kalep - Rockout crop association) occupies

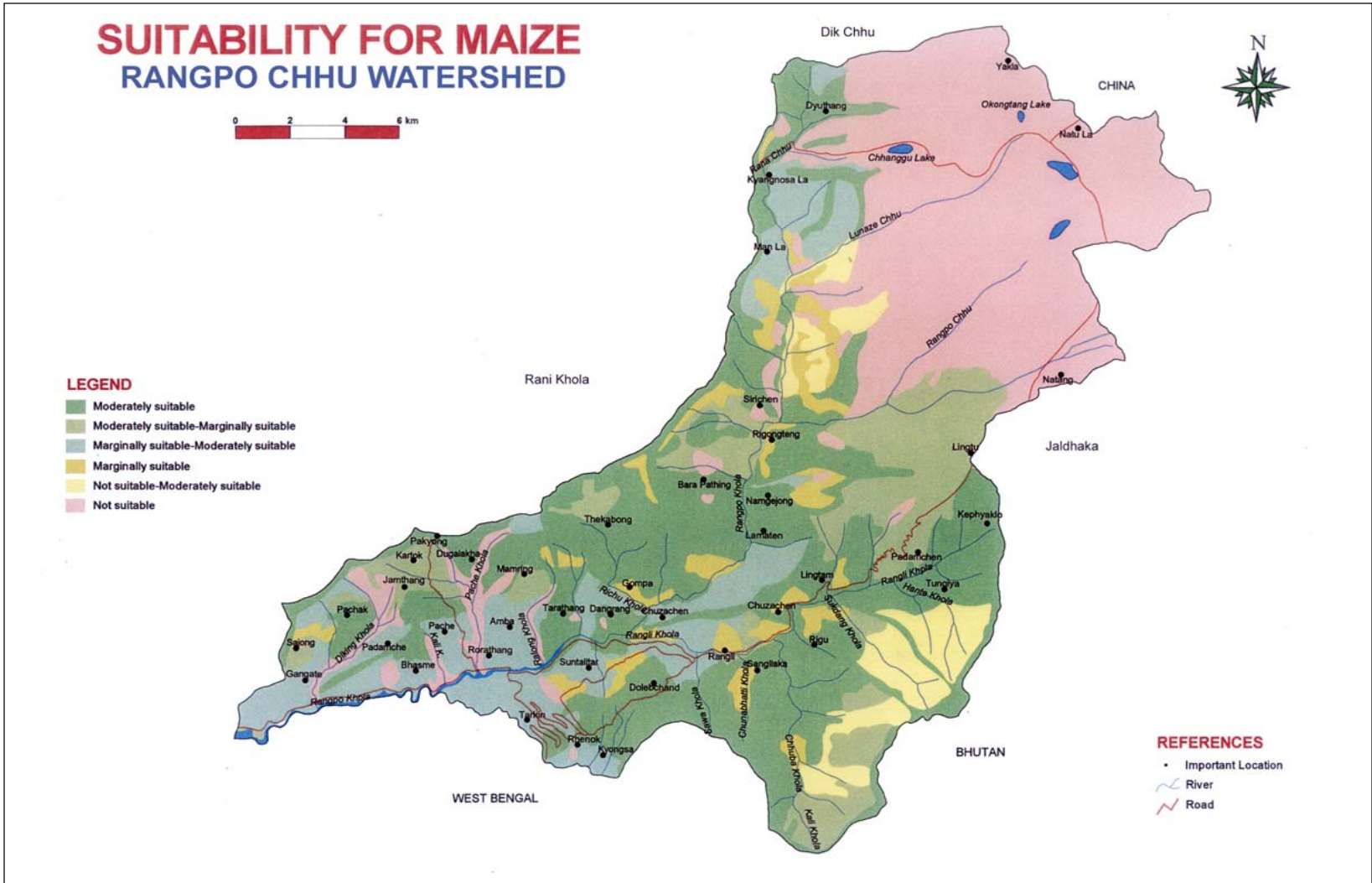
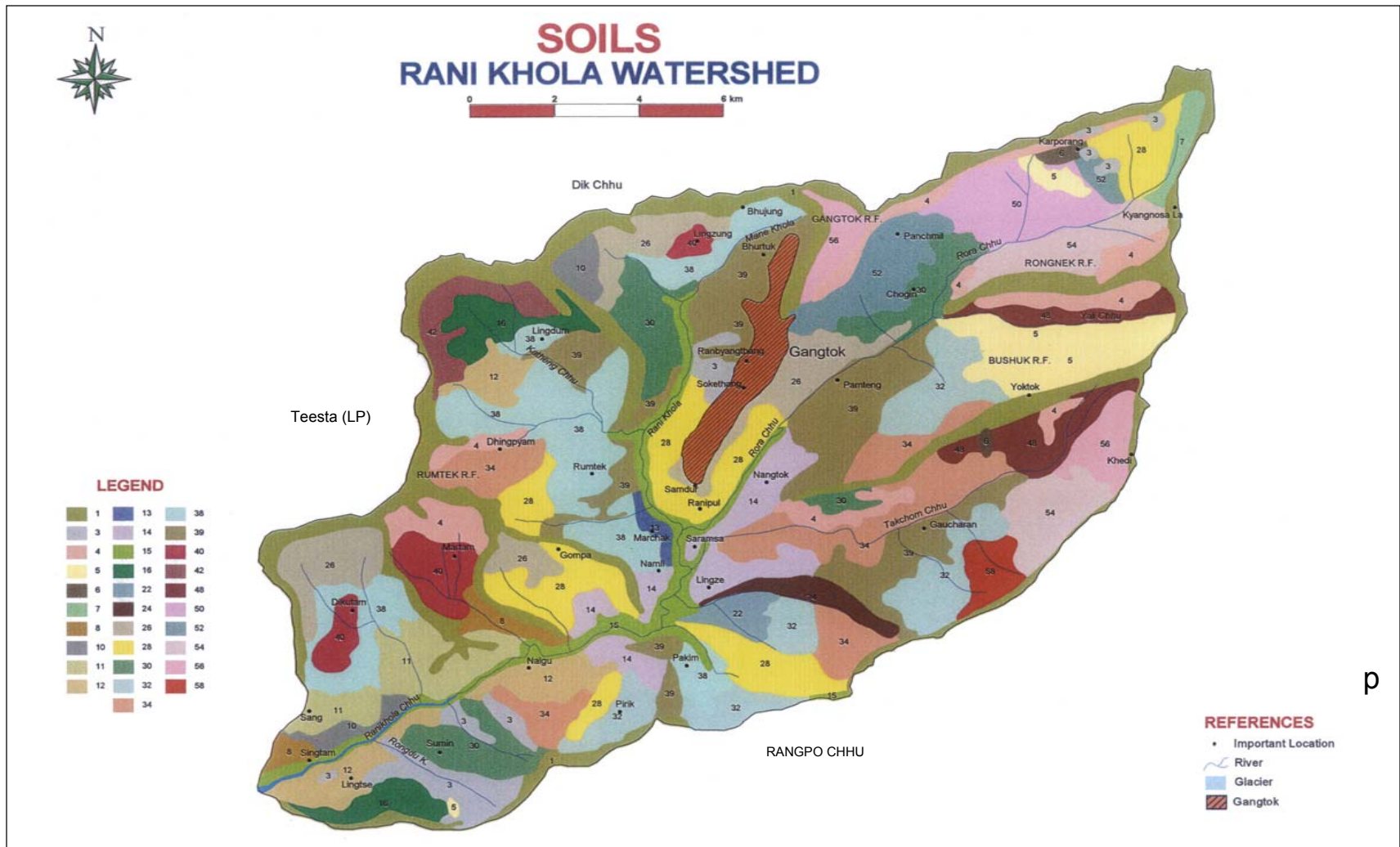


Fig. 4.9 Soil site suitability for maize in Rangpo Chhu watershed



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Fig. 4.11 Soil site suitability for maize in Rani Khola watershed

125.9 ha (0.5%) area. Landslide areas have been mapped at soil map units-6 where Karporang-Hilley soil series association was identified. Soils of hill mountain were mapped at soil map units of 42 to 58. Damthang, Khedi, Sajong were some of the dominant soil series found in this watershed.

Table 4.9 Soils of Rani Khola watershed

Soil unit	Soil Series Association	Area (In ha)	% of watershed
1	Maling-Rayong	2795.0	11.0
3	Rock outcrops – Jorpul	587.6	2.3
4	Hilley-Singrep – Chatten	993.2	3.9
5	Bhusuk- Karporang - Tibik	792.1	3.1
6	Karporang – Hilley	62.0	0.2
7	Kalep – Rock outcrop	125.9	0.5
8	Bhasme – Chautare - Legship	194.8	0.8
10	Chalumthang – Rorethang – Bhasme	238.9	0.9
11	Mangjing – Singrep - Rorethang	603.1	2.4
12	Lingtse – Chautare - Chalumthang	704.1	2.8
13	Mangjing – Dharamdin	62.2	0.2
14	Dharamdin – Lingtse - Karfecter	751.6	3.0
15	Mangreng – Karfecter- Mangjing	836.8	3.3
16	Tumin –Phong - Chautare	518.1	2.0
22	Chongrang – Legship - Singgyang	160.7	0.6
24	Doling – Khedi	205.4	0.8
26	Dikling – Hilley	1189.3	4.7
28	Samdur – Khedi - Bhusuk	1765.2	7.0

30	Rumtek – Tumin	1134.0	4.5
32	Bhusuk – Pirik – Namchi	1308.5	5.2
34	Namchi– Synggyang	1510.3	6.0
38	Rumtek – Pirik - Mangjing	2014.9	7.9
39	Daragoan – Gaucharan – Dharamdin	2186.3	8.6
40	Dharamdin – Martam - Karfecter	527.4	2.1
42	Damthang – Chongrang – Rock outcrop	329.2	1.3
48	Martam – Tarnu – Sajong	587.7	2.3
50	Sajong –Tarnu	577.3	2.3
52	Khedi – Maniram - Rongnek	594.1	2.3
54	Rongnek – Sajong	847.9	3.3
56	Khedi – Dikling	452.9	1.8
58	Gaucharan – Tarnu	208.5	0.8
	Miscellaneous	485.6	1.9
	Total	25350.6	100.0

4.2.3 Soil depth

Eight soil depth classes have been identified and mapped in Rani Khola watershed as the association of soil depth classes, ranging from very shallow to deep (Table 4.10) and presented in Fig. 4.12

Table 4.10 Soil depth of Rani Khola watershed

Map Unit	Description	Soil Map units	Area (In ha)	% of watershed
1	Deep-mod deep	4,13,15,24,28,34,38,39, 40,48,58,11,22,42	11990.9	47.3

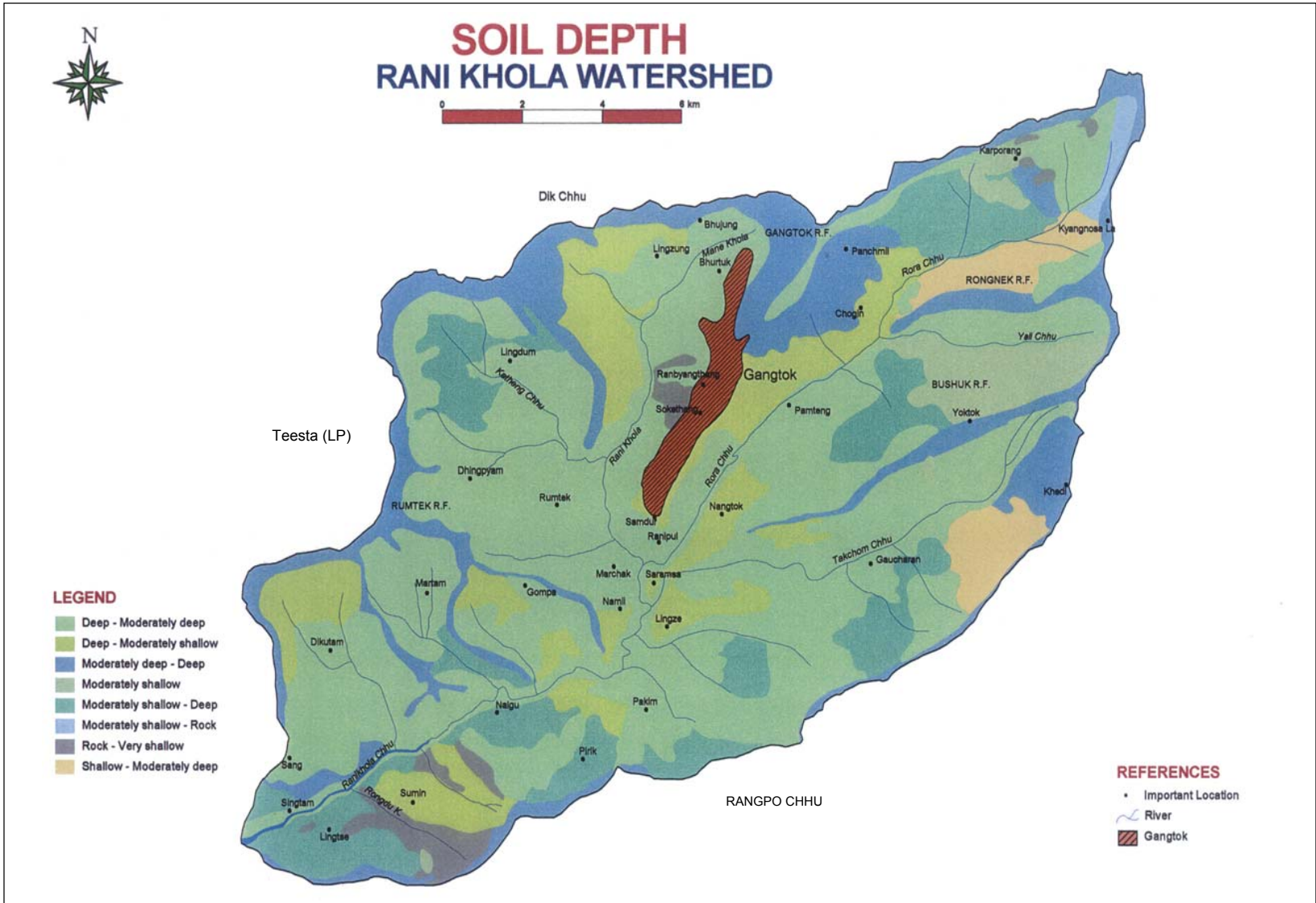


Fig. 4.12 Soil depth class of Rani Khola watershed

2	Deep-mod.shallow	14,26,30	3074.9	12.1
3	Mod deep-deep	1,52,56,10	4080.9	16.1
4	Mod shallow	5,6	854.1	3.4
5	Mod shallow-deep	8,32,50,12,16	3302.8	13.0
6	Mod shallow-Rock	7	125.9	0.6
7	Rock-veryshallow	3	587.6	2.3
8	Shallow-mod deep	54	847.9	3.3
	Miscellaneous		485.6	1.9

Soil map unit 1 comprising the association of deep - moderately deep depth classes covered an area of 11,990.9 ha (47.3%) followed by map unit 3 (Moderately deep - deep association), map unit 5 (Moderately shallow - deep association) and map unit 2 (Deep – Moderately shallow association) which covered an area of 4,080.9 ha (16.1%), 3,302.8 ha (13.0%) and 3,074.9 ha (12.1%) respectively. Rock, in association with very shallow depth covered an area of 587.6 ha (2.3%).

4.2.4 Surface Texture

Surface texture is a very important factor for determining the plant growth. Ten soil textural class had been identified in Rani Khola watershed and mapped into 16 mapping units at the level of surface textural class association (Table 4.11 and presented in Fig. 4.13). Loam - sandy loam (l-sl) association (map unit 4) was the dominant map unit of the watershed covering an area of 5,167.6 ha (20.5%). Map unit 15 of silt loam – loam (sil-l) association and map unit 12 of sandy loam – silt clay loam (sl-sicl) association covered an area of 3,717.0 ha (7.1%) and 3247.9 ha (12.8%) respectively. Sandy loam surface texture occurred in

the watershed in association with the other textural class viz. map unit 4,8,9,10,12,16.

Table 4.11 Surface texture of Rani Khola watershed

Map Unit	Description	Soil Map units	Area (In ha)	% of watershed
1	cl-l	14,15,40	2115.8	8.3
2	gsl-ls	5	792.1	3.1
3	gsl-sil	32	1308.5	5.2
4	l-sl	4,8,28,34,12	5167.6	20.5
5	ls-l	6	62.0	0.2
6	R-l	3	587.6	2.3
7	sc-scl	39,58	2394.8	9.4
8	sl-cl	13,48	649.9	2.6
9	sl-gl	11	603.1	2.4
10	sl-gsil	52	594.1	2.3
11	sl-R	7	125.9	0.5
12	sl-sicl	1,56	3247.9	12.8
13	sicl-l	26	1189.3	4.7
14	sil-cl	16	518.1	2.0
15	sil-l	30,38,10,42	3717.0	14.7
16	sil-sl	24,50,54,22	1791.3	5.9
		Miscellaneous	485.6	1.9

4.2.5 Soil Erosion

The watershed was characterized by different landforms viz. ridge, rocky cliff, side slopes at different elevations and were subjected to soil erosion mainly caused by intensive rain. Three types of erosion class viz. moderate, severe and very severe were identified and mapped into

seven mapping units (Table 4.12) and presented in Fig. 4.14 at the level of association of erosion class. About 15747.6 ha (62.1%) area was subjected to only moderate erosion alone. Moderate - severe (M-S) erosion class association counted for 23.6% area of the watershed. In spite of steepness of slope and high intensity of rain, erosion of hill to some extent was checked by thick vegetative covers

Table 4.12 Soil erosion of Rani Khola watershed

Map Unit	Description	Soil Map units	Area (In ha)	% of watershed
1	M	1,13,14,15,24,26,28,30,32, 38,39,40,56,16	15747.6	62.1
2	M-R	7	125.9	0.5
3	M-S	4,5,8,48,50,52,58,10,11,12, 22,42	5983.7	23.6
4	R-VS	3	587.6	2.3
5	S	54	847.9	3.3
6	S-M	6	62.0	0.2
7	VS-S	34	1510.3	6.0
		Miscellaneous	485.6	1.9

4.2.6 Soil reaction (pH)

Six classes of soil reaction was identified during soil resource inventory of Rani Khola watershed (Table 4.13) and mapped in Fig. 4.15. Soils were mostly acidic due to intensive leaching favoured by high intensity of rainfall and steep side slope. Soil reaction map included 12

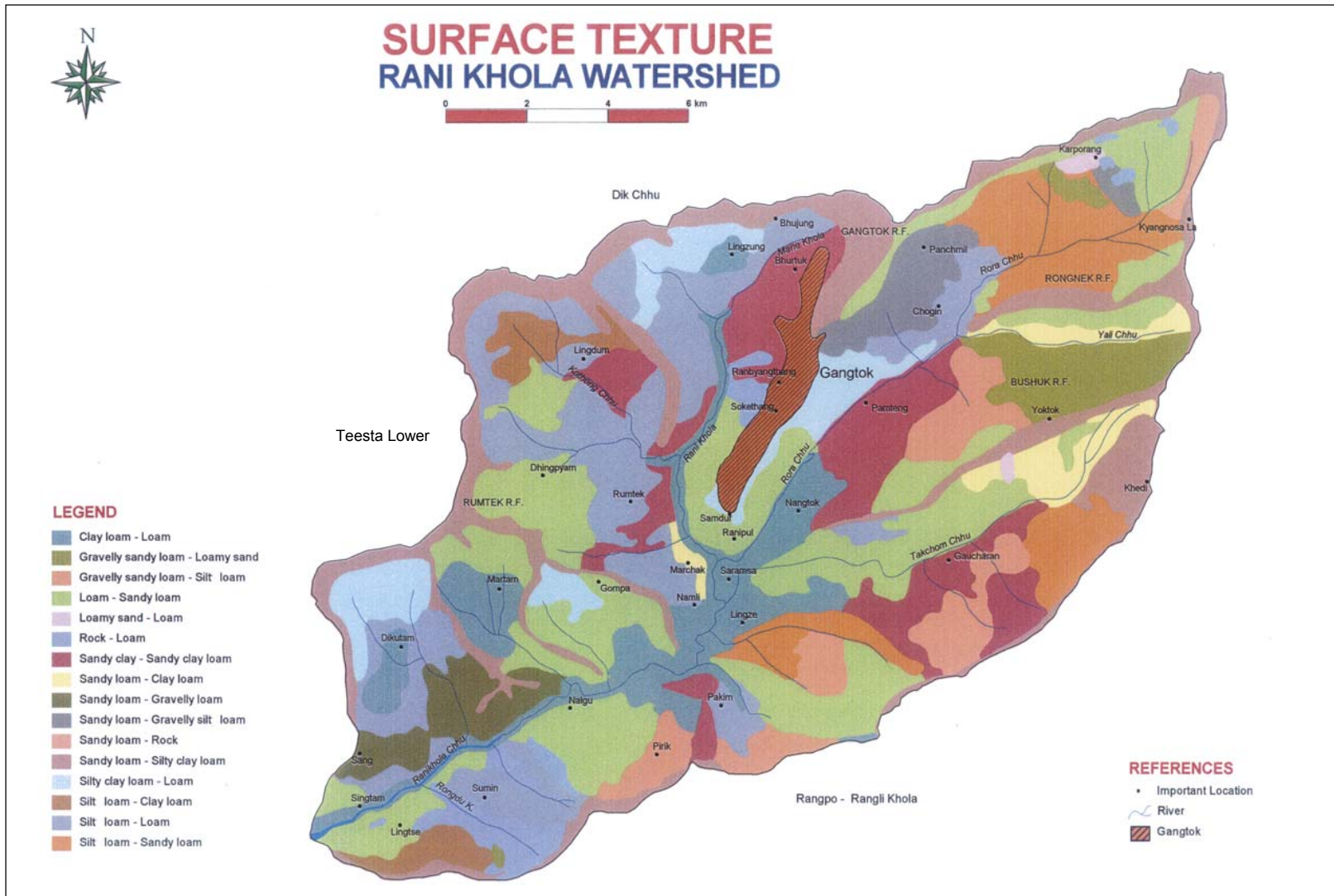


Fig. 4.13 Surface texture class of Rani Khola watershed

mapping units prepared at the level of association of reaction class. Very strongly acidic - strongly acidic (VS-S) association, moderately acidic - very strongly acidic (M-VS) association and extremely acidic - strongly acidic (EX-S) association were the dominant map units covered 7,758.6 ha (29.8%), 3,610.8 ha (14.2%), 3,511.5 ha (13.9%) respectively. The extremely acidic – very strongly acidic association (mapping unit 3) is the most problematic soil so far as the soil acidity is concerned, which should be managed through growing acid tolerant crops or forest species, which covers about 12.4 per cent area of the watershed.

Table 4.13 Soil reaction of Rani Khola watershed

Map Unit	Description	Soil Map units	Area (In ha)	% of watershed
1	EX-R	7	125.9	0.5
2	EX-S	8,13,24,30,50,54,22,42	3511.5	13.9
3	EX-VS	38,11,16	3136.1	12.4
5	M-VS	15,39,48	3610.8	14.2
6	N-S	58	208.5	0.8
7	R-S	3	587.6	2.3
8	SL-VS	10	238.9	0.9
9	S-EX	1	2795.0	11.0
10	S-M	14,52,12	2049.8	8.1
11	S-VS	6,56,40	1942.3	4.2
12	VS-S	4,5,26,28,32,34	7558.6	29.8
		Miscellaneous	485.6	1.9

4.2.7 Land capability class (LCC)

Five land capability classes (III, IV, VI, VII, VIII) and seven land capability sub-classes identified as IIIe2, IVe2, VIe2, VIe2s, VIIe2s, VIIe3 and VIIIe4s in the watershed (Table 4.14 and presented in Fig. 4.16). Map unit 4 representing VIe2s land capability sub-class covered an area of 8,097.6 ha (31.9%). Rocky cliff represented by (mapping unit 7) VIIIe4s land capability sub- class with very severe erosion and extreme limitation of soil depth covers an area of 2.3 per cent of the watershed. Land capability class VII with different degree of erosion covered 2,855.3 ha (11.4%) area of the watershed.

Table 4.14 Land capability of Rani Khola watershed

Map Unit	Description	Soil Map Units	Area (In ha)	% of Watershed
1	IIIe2	1,13,14,15	4445.6	17.5
2	IVe2	38,39,40,58,10	5176.0	20.4
3	VIe2	8,24,26,34,11	3702.9	14.7
4	VIe2s	7,28,30,32,48,50,52,54,56,12	8097.6	31.9
5	VIIe2s	42	329.2	1.3
6	VIIe3	4,5,6,16,22	2526.1	10.0
7	VIIIe4s	3	587.6	2.3
		Miscellaneous	485.6	1.9

4.2.8 Soil-site suitability for rice

Rani Khola soils are found to be moderately to marginally suitable (S2-S3) in 5,132.0 ha areas for rice cultivation and marginally to

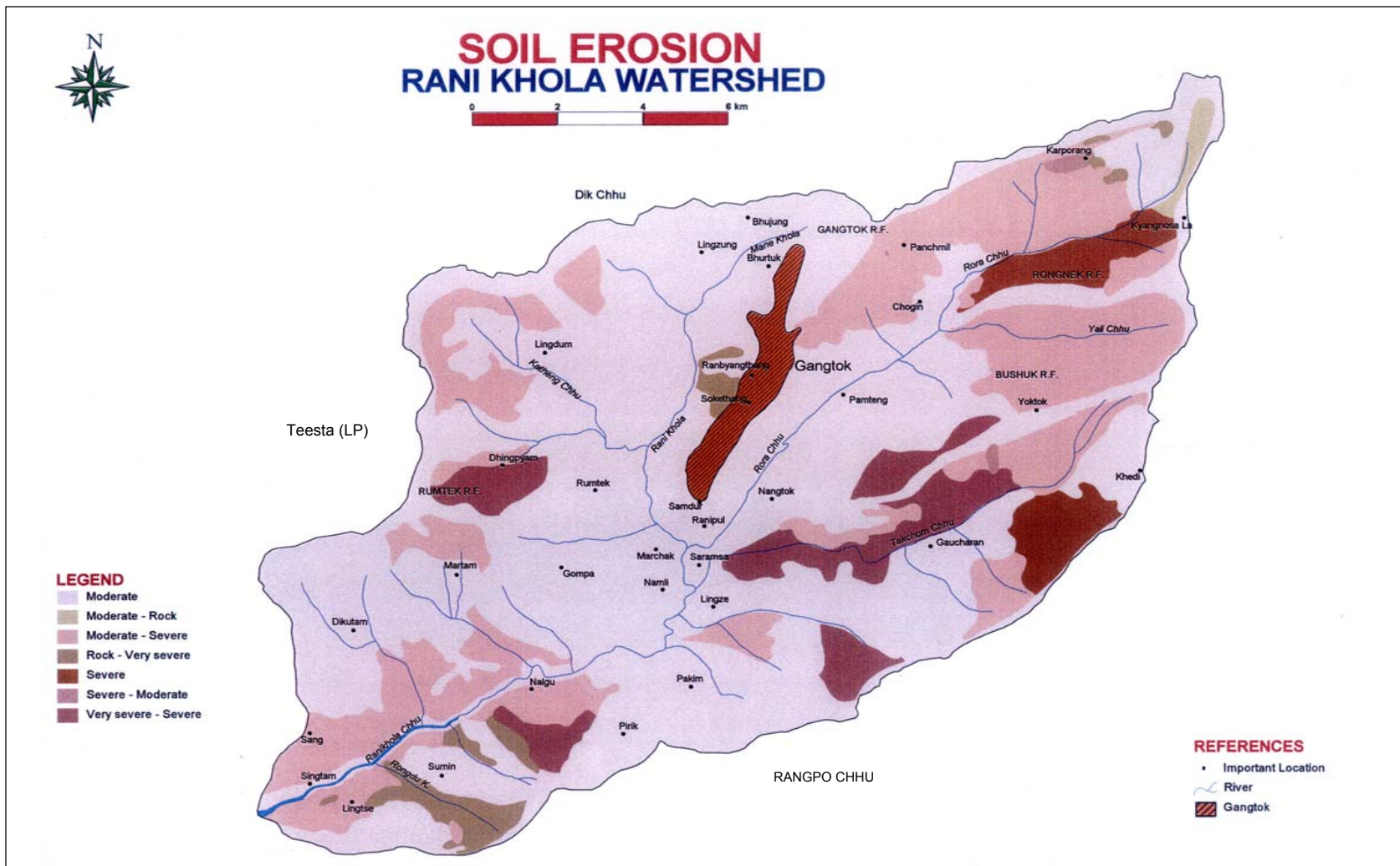


Fig. 4.14 Soil erosion class of Rani Khola watershed

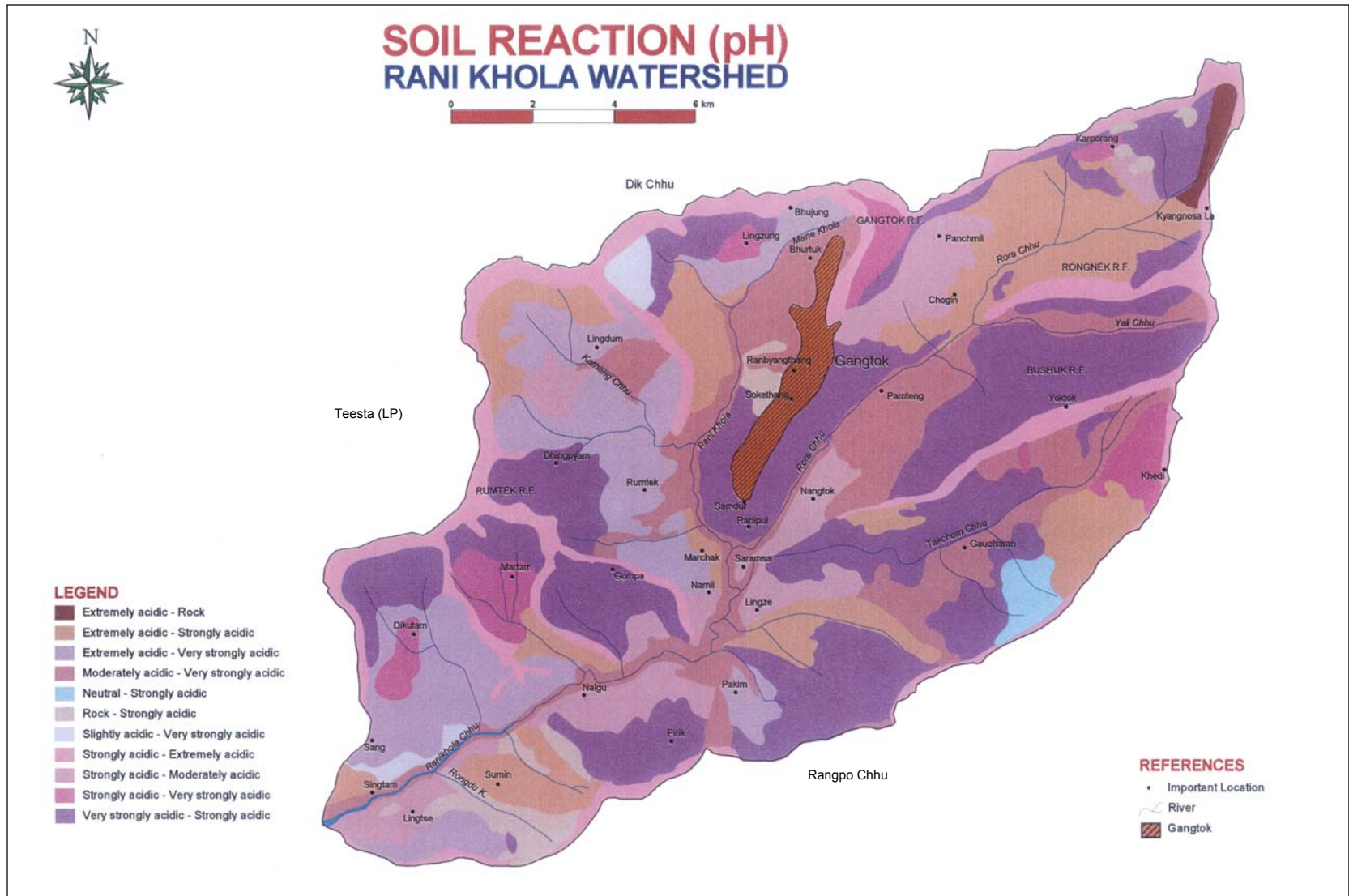


Fig. 4.15 Soil reaction class of Rani Khola watershed

Moderately suitable (S3-S2) in 1,973.8 ha area (Table 4.15 and Fig. 4.17). It is only marginally suitable (S3) in 9,430.1 ha area of the watershed (mapping unit 3). It is found to be mostly unsuitable or in association of unsuitable and marginally suitable in rocky cliff, escarpments, morainic zone, landslide zone, mid. mountain to high mountain with higher slope occupying 8,329.1 ha area of the watershed.

Table 4.15 Soil-site suitability for rice of Rani Khola watershed

SI.No.	Suitability class	Map unit nos.	Area (ha)
1.	S2-S3	12,14,30,38,40	5132.0
2.	S3-S2	11,13,32	1973.8
3.	S3	1,8,10,15,22,24,28,39,52,56	9430.1
4.	S3-N	26,48,54,58	2833.4
5.	N-S3	4,5,16,34,42	4142.9
6.	N	3,6,7,50	1352.8
	Miscellaneous		485.6
Total			25350.6

4.2.9 Soil-site suitability for maize

Rani Khola soils are only moderately suitable (S2) in 15,859.6 ha areas for maize cultivation, moderately to marginally suitable (S2-S3) in 2,355.3 ha; marginally to moderately suitable (S3-S2) in 2,193.4 ha and only marginally suitable (S3) in 1,785.3 ha areas of the watershed (Table 4.16 and Fig. 4.18). It is almost unsuitable in mapping unit 5 and 6 due to very severe to severe limitations of topography and soil.

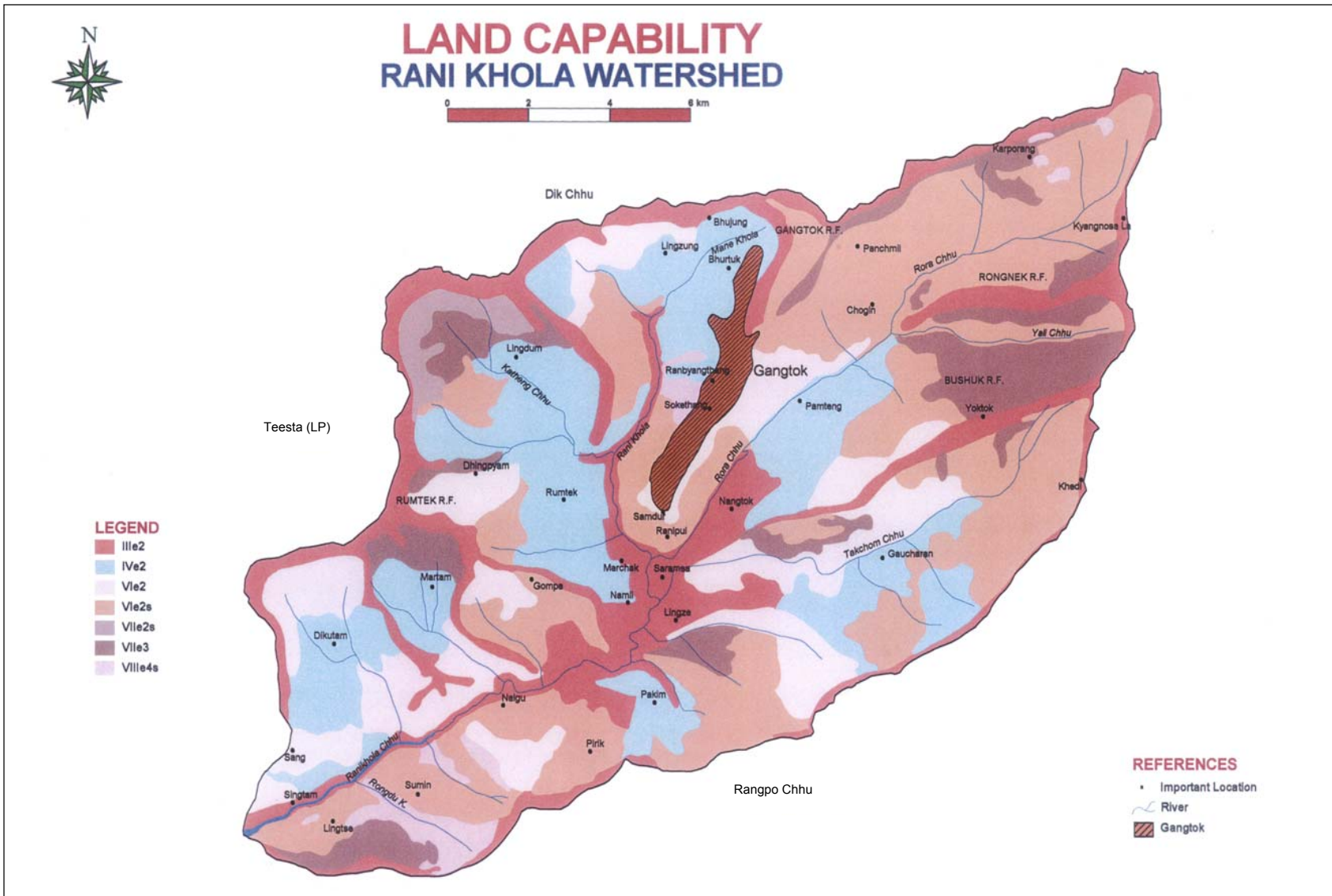


Fig. 4.16 Land capability class of Rani Khola watershed

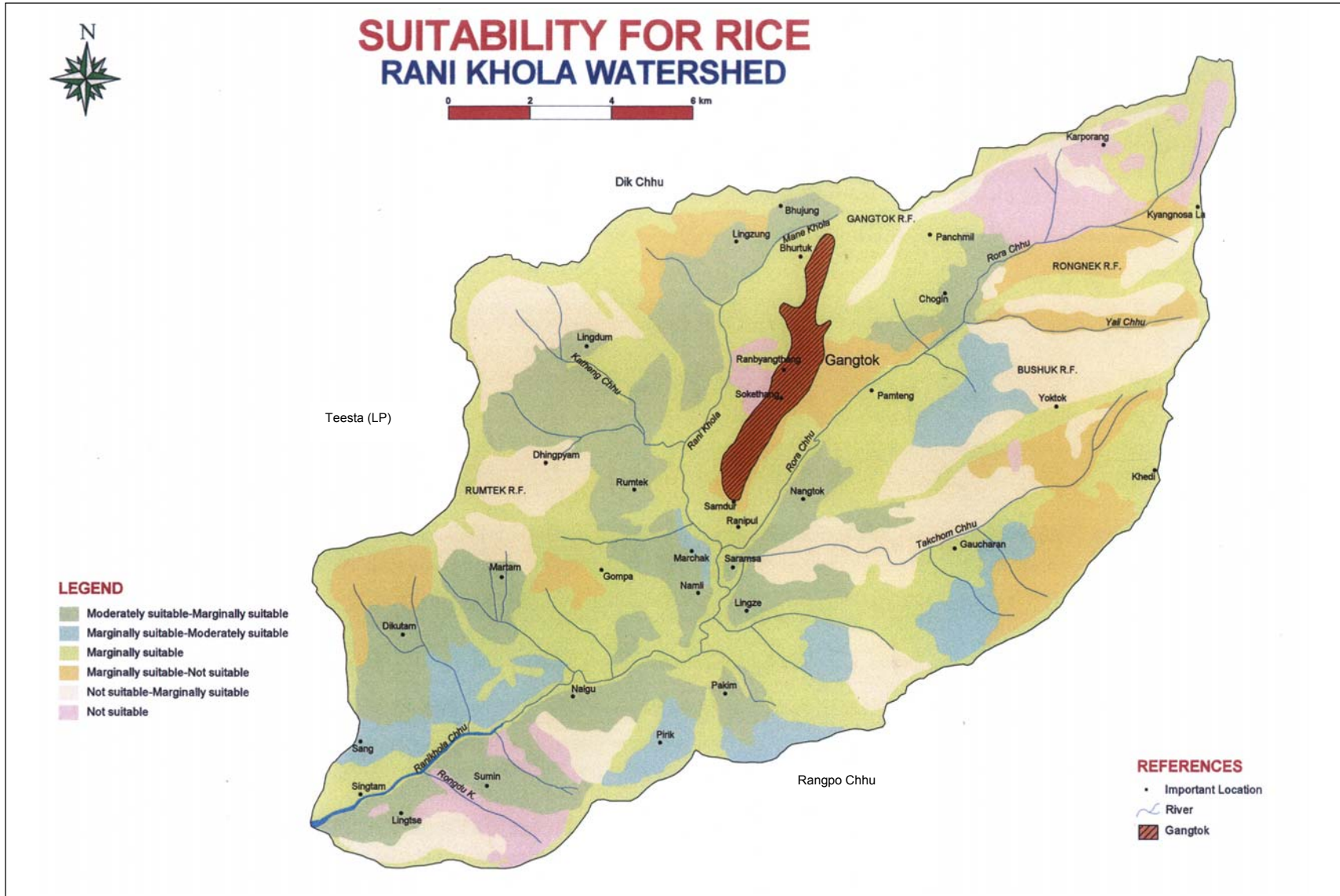


Fig. 4.17 Soil-site suitability for rice in Rani Khola watershed

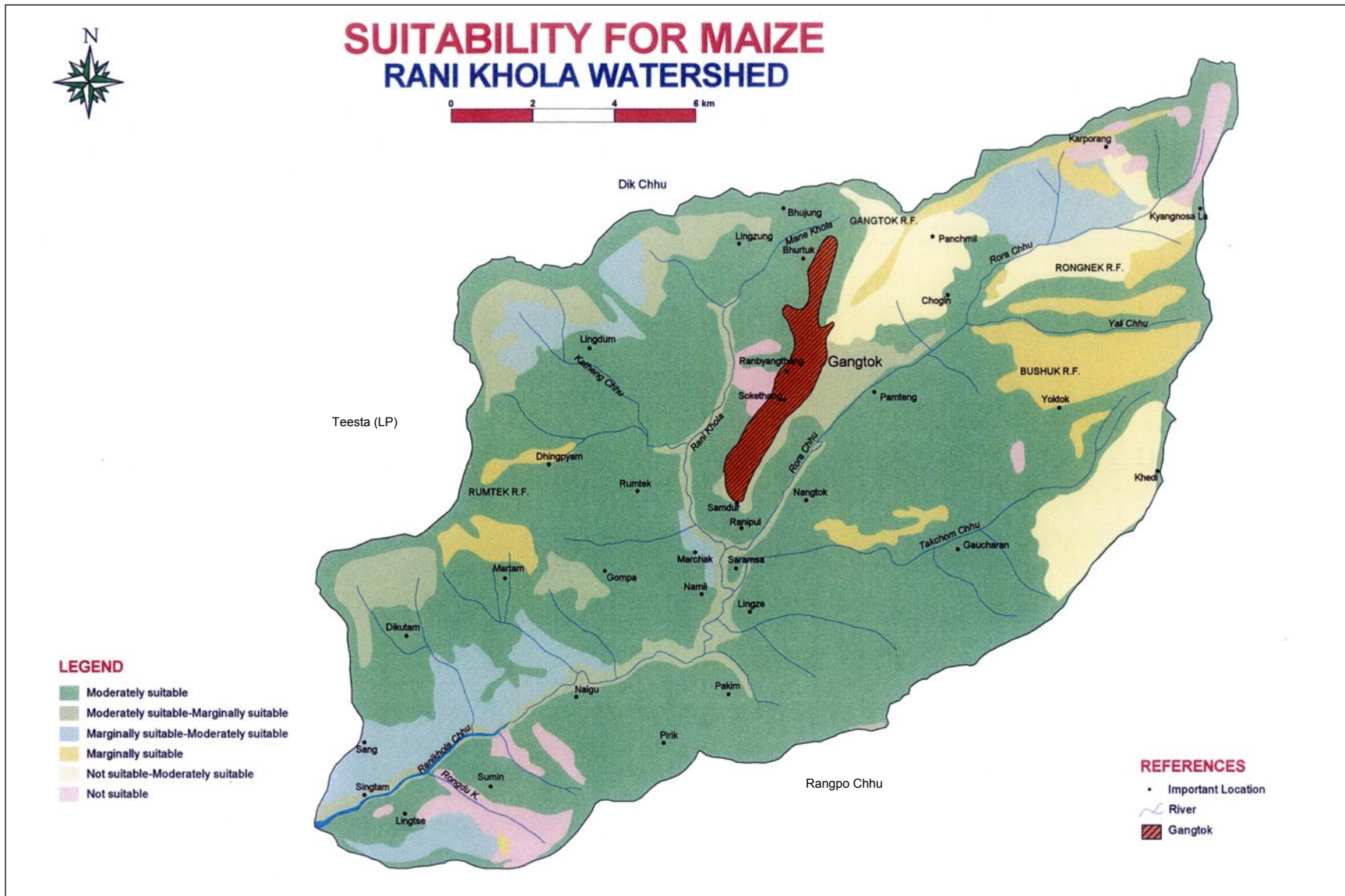


Fig. 4.18 Soil-site suitability for maize in Rani Khola watershed

Table 4.16 Soil-site suitability for maize of Rani Khola watershed

Sl.No.	Suitability class	Map unit nos.	Area (ha)
1.	S2	1,12,14,22,24,28,30,32,34,38,39,40,48,58	15859.6
2.	S2-S3	15,26,42	2355.3
3.	S3-S2	8,10,11,13,16,50	2193.4
4.	S3	4,5	1785.3
5.	N-S2	52,54,56	1894.9
6.	N	3,6,7	775.5
	Miscellaneous		485.6
		Total	25350.6

4.3 TEESTA (LOWER PART) WATERSHED

4.3.1 Landforms

Total nine broad landform regions viz. ridge, rocky cliff, escarpment, landslide zone, morainic zone, low mountain, narrow valley, mid mountain and high mountain were identified in the watershed. These broad landform regions were sub-divided into 26 landform units based on the features identified through satellite imagery (IRS 1C LISS-III), toposheet and field traverse (Fig. 4.19).

4.3.2 Soils

The Lower Teesta watershed of Sikkim represents the wide variety of soils developed on different geomorphic units with the influence of wide range of climate, geomorphology, geology and vegetation. Soils had been

mapped into 26 mapping units at the level of association of soil series (Table 4.17) and presented in Fig. 4.20. The most extensive soil units are 11, 32 and 30. Dominant soil series are Mangjing, Bhusuk and Rumtek. The landslide zone (mapping unit 6) represents least area of 184.9 ha (0.3%).

Table 4.17 Soils of Teesta (Lower Part) watershed

Soil unit	Soil Series Association	Area (In ha)	% of watershed
1	Maling-Rayong	4099.7	6.8
3	Rock outcrops – Jorpul	3088.1	5.2
5	Bhusuk- Karporang – Tibik	700.3	1.2
6	Karporang – Hilley	184.9	0.3
7	Kalep – Rock outcrop	360.0	0.6
8	Bhasme – Chautare – Legship	2716.6	4.5
10	Chalumthang – Rorethang – Bhasme	1142.5	1.9
11	Mangjing – Singrep – Rorethang	6274.7	10.5
12	Lingtse – Chautare – Chalumthang	499.1	0.8
13	Mangjing – Dharamdin	2391.2	4.0
14	Dharamdin – Lingtse – Karfecter	3402.8	5.7
15	Mangreng – Karfecter- Mangjing	1798.5	3.0
18	Phong – Khedi – Maniram	1539.6	2.6
20	Chakung – Tumin – Sajong	1370.8	2.3
22	Chongrang – Legship – Singgyang	1505.8	2.5
24	Doling – Khedi	716.3	1.2
26	Dikling – Hilley	3067.2	5.1
28	Samdur – Khedi – Bhusuk	991.3	1.7
30	Rumtek – Tumin	4640.6	7.8
32	Bhusuk – Pirik – Namchi	6110.0	10.2
34	Namchi– Synggyang	4362.4	7.3

36	Doling – Samdur – Rock outcrop	1428.6	2.4
	Rumtek – Pirik – Mangjing	998.5	1.7
42	Damthang – Chongrang – Rock outcrop	3247.5	5.4
44	Singgyang – Maniram - Damthang	1059.2	1.7
46	Maniram-Damthang - Jorpul	2167.0	3.6
	Miscellaneous	0.8	0.0
Total		59861.0	100.0

4.3.3 Soil depth

Four types of soil depth class *viz.* deep, moderately deep, moderately shallow and very shallow have been identified in this watershed (Table 4.18) and presented in Fig. 4.21. Deep soils are mostly distributed in mapping units 1,2,3,5 in association with mod deep, mod shallow depth classes. Rocks associated with very shallow and moderately shallow soils are distributed in mapping unit 6 and 7. The mapping unit 7 comprising rock – very shallow depth class association is the real problematic area which should be protected through soil conservation measure.

Table 4.18 Soil depth of Teesta (Lower Part) watershed

Map unit	Description	Soil Map units	Area (In ha)	% of watershed
1	Deep-mod deep	13,15,24,28,34,38,44,46,11,18, 22,42	27049.0	45.2
2	Deep-mod.shallow	14,20,26,30,36	13910.0	23.2
3	Mod.deep-deep	1,10	5242.2	8.8

4	Mod shallow	5,6	885.2	1.5
5	Mod shallow- deep	8,32,12	9325.7	15.6
6	Mod shallow- Rock	7	360.0	0.6
7	Rock-very shallow	3	3088.1	5.2
		Miscellaneous	0.8	0.0

4.3.4 Surface texture

Ten surface textural classes have been identified in this watershed and have been mapped into 14 mapping units at the level of association of surface textural classes (Table 4.19) and presented in Fig. 4.22. Loam and sandy loam association (Mapping Unit 4) have been distributed in 8,569.4 ha (14.3%) and silt loam and loam association (Map Unit 13) in 12,828.5 ha (21.4%). Rocks are distributed in Map Unit 6 and Map Unit 10.

Table 4.19 Surface texture of Teesta (Lower Part) watershed

Map unit	Description	Soil Map units	Area (In ha)	% of watershed
1	cl-l	14,15	5201.3	8.7
2	gsl-ls	5	700.3	1.2
3	gsl;-sil	32	6110.0	10.2
4	l-sl	8,28,34,12	8569.4	14.3
5	Ls-l	6	184.9	0.3
6	R-l	3	3088.1	5.2

7	sl-cl	13,18	3930.8	6.6
8	sl-gl	11	6274.7	10.5
9	sl-gsil	44,46	3223.2	5.4
10	sl-R	7	360.0	0.6
11	sl-sicl	1	4099.7	6.8
12	sicl-l	26	3067.2	5.1
13	sil-l	20,30,36,38,10,42	12828.5	21.4
14	Sil-sl	24,22	2222.1	3.7
		Miscellaneous	0.8	0.0

4.3.5 Soil erosion

Moderate, severe and very severe erosion class have been identified in this watershed and mapped into 8 mapping units at the level of erosion class association (Table 4.20) and presented in Fig. 4.23. Moderate erosion alone (mapping unit 1) covers 31,884.3 ha (52.1%). Moderate erosion also has been distributed in Map Unit 2, 3, 6 & 7. Very severe erosion has been distributed in Map Unit 4, 7 and 8. The mapping unit 8 comprising very severe – severe erosion class association is highly susceptible to landslide or mass movement. Hence soil conservation measures should be taken in this area to protect the natural resources.

Table 4.20 Soil erosion of Teesta (Lower Part) watershed

Map Unit	Description	Soil Map Units	Area (In ha)	% of Watershed
1	M	1,13,14,15,24,26,28,30,32,36,38,18	31184.3	52.1

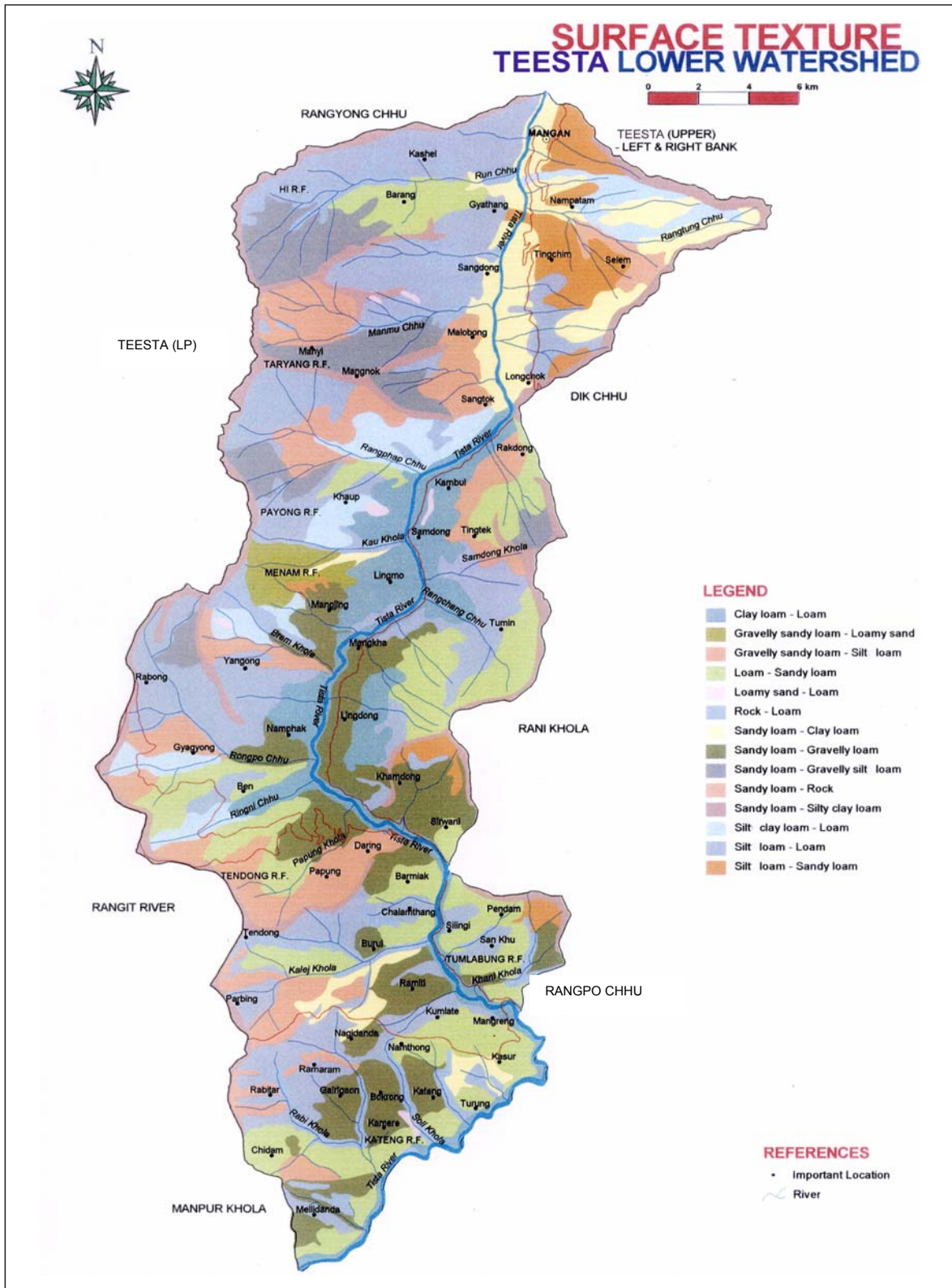


Fig. 4.22 Surface texture class of Teesta (LP) watershed

2	M-R	7	360.0	0.6
3	M-S	5,8,10,11,12,22,42	16086.5	26.9
4	R-VS	3	3088.1	5.1
5	S	46	2164.0	3.6
6	S-M	6	184.9	0.3
7	VS-M	20	1370.8	2.3
8	VS-S	34,44	5421.6	9.1
		Miscellaneous	0.8	0.0

4.3.6 Soil reaction

Five types of soil reaction viz. extremely acidic, very strongly acidic, strongly acidic, moderately acidic and slightly acidic have been identified and mapped in 10 mapping units at the level of association of soil reaction class (Table 4.21) and presented in Fig. 4.24. Extremely acidic and strongly acidic association (mapping unit 2) covers 20,181.4 ha (33.7%) area followed by very strongly and strongly acidic (mapping unit 10) in 17,830.0 ha (29.8%). Slightly acidic reaction class in association with very strongly acidic reaction class occurs mostly in low mountain (30-50% slope) and occupies 1.9 per cent area of the watershed.

Table 4.21 Soil reaction of Teesta (Lower Part) watershed

Map Unit	Description	Soil Map Units	Area (In ha)	% of Watershed
1	EX-R	7	360.0	0.6
2	EX-S	8,13,20,24,30,46,16,22,42	20181.4	33.7

3	EX-VS	38,11	7273.2	12.2
4	M-VS	15	1798.5	3.0
5	R-S	3	3088.1	5.2
6	SL-VS	10	1142.5	1.9
7	S-EX	1	4099.7	6.8
8	S-M	14,12	3901.9	6.5
9	S-VS	6	184.9	0.3
10	VS-S	5,26,28,32,34,44,18	17830.0	29.8
		Miscellaneous	0.8	0.0

4.3.6 Land capability class (LCC)

Five land capability classes viz. III, IV, VI, VII and VIII and seven land capability sub-classes have been identified in this watershed based on type and degree of limitations (Table 4.22) and presented in Fig. 4.25. The land capability sub-class VIe2s (mapping unit 4) covers maximum area of 1,260.1 ha (21.0%) while land capability sub-class IVe2 (mapping unit 2) covers least area of 2,141.0 ha (3.6%). About 3,088.1 ha (5.2%) area under rocky cliff were classified under land capability sub-class VIIIe4s showing very severe erosion and soil limitations.

Table 4.22 Land capability of Teesta (Lower Part) watershed

Map Unit	Description	Soil Map Units	Area (In ha)	% of Watershed
1	IIIe2	1,13,14,15	11692.2	19.5
2	IVe2	38,10	2141.0	3.6
3	VIe2	8,24,26,34,36,11,	18565.8	31.0

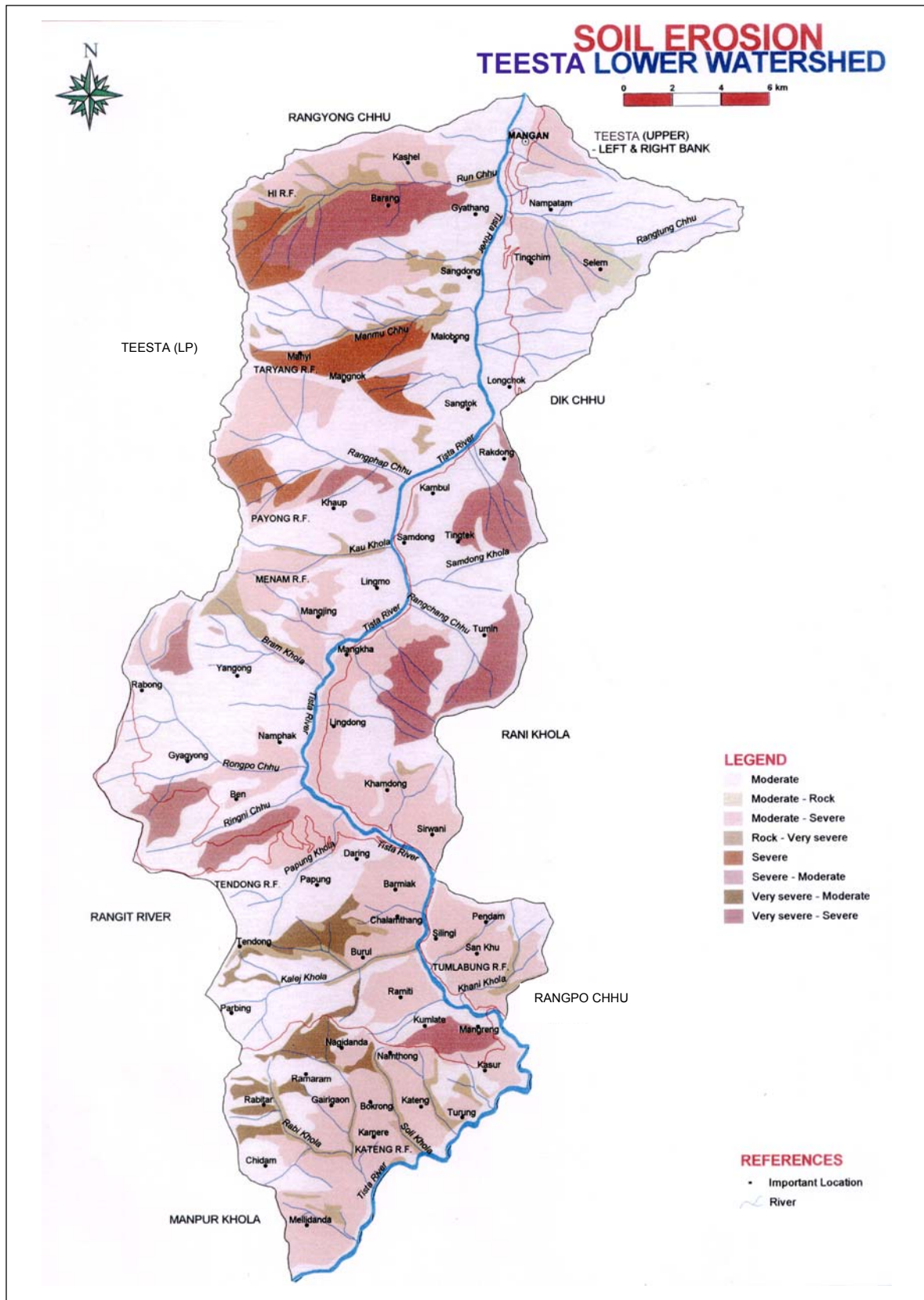


Fig. 4.23 Soil erosion class of Teesta (LP) watershed

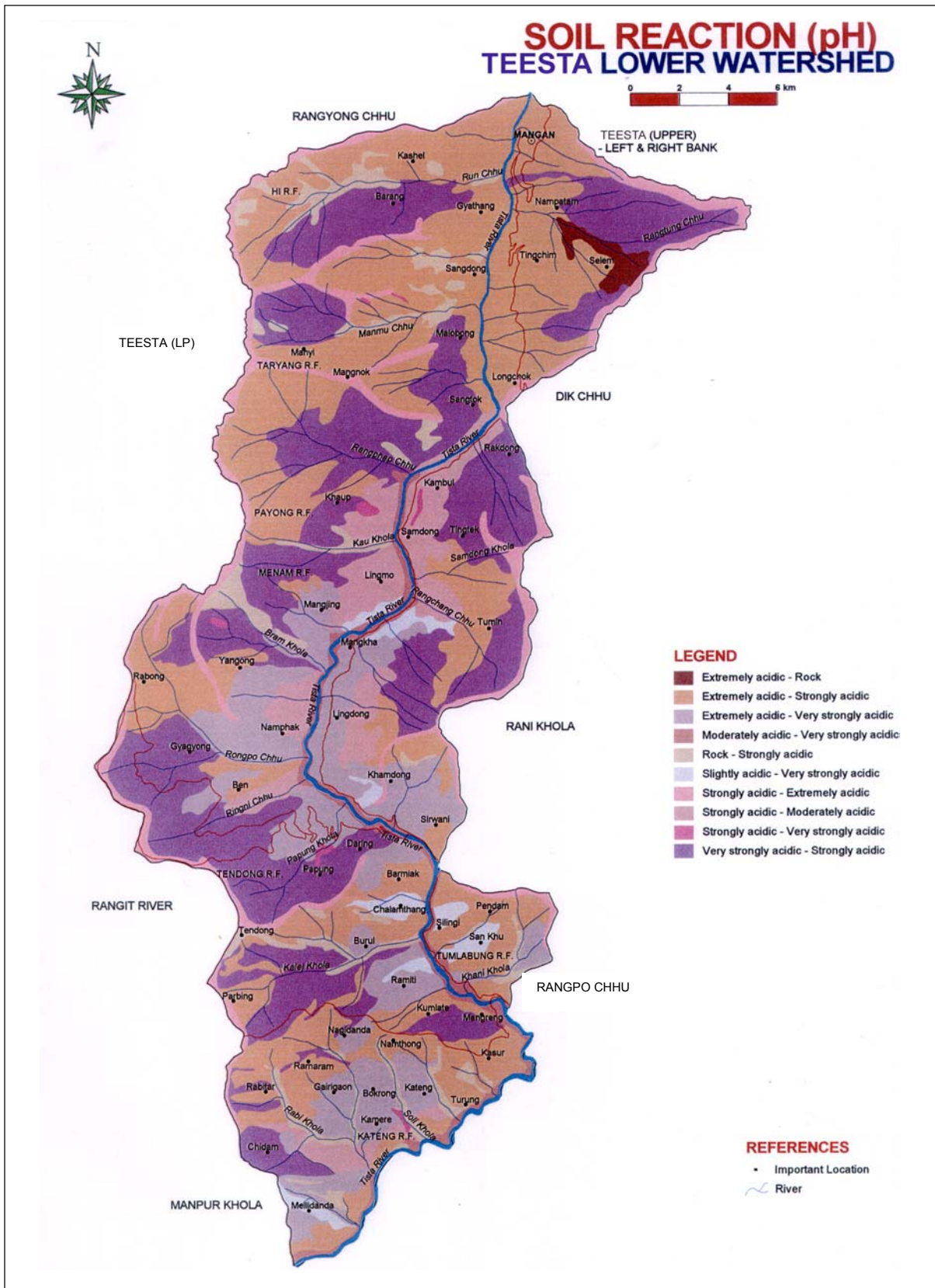


Fig. 4.24 Soil reaction class of Teesta (LP) watershed

4	Vie2s	7,28,30,32,12	12601.0	21.0
5	VIIe2s	44,46,42	6470.7	10.8
6	VIIe3	5,6,20,18,22	5301.4	8.9
7	VIIIe4s	3	3088.1	5.2
8		Miscellaneous	0.8	0.0

4.3.8 Soil-site suitability for rice

Rice is found to be moderately to marginally suitable (S2-S3) in 9,541.0 ha in Teesta Lower Part Watershed areas and marginally to moderately suitable (S3-S2) in 14,775.9 ha (Table 4.23 and Fig. 4.26). It is only marginally suitable (S3) in 16,998.1 ha area due to severe limitation of soil, topography, etc. Almost unsuitable areas mostly belong to the rocky cliff, landslide zone and morainic zone occupy about 3,633 ha area of the watershed.

Table 4.23 Soil-site suitability for rice of Teesta (Lower part) watershed

Sl.No.	Suitability class	Map unit nos.	Area (ha)
1.	S2-S3	12,14,30,38	9541.0
2.	S3-S2	11,13,32	14775.9
3.	S3	1,8,10,15,18,22,24,28,36,44,	16998.1
4.	S3-N	20,26,46	6602.0
5.	N-S3	5,34,42	8310.2
6.	N	3,6,7	3633.0
	Miscellaneous		0.8
Total			59861.0

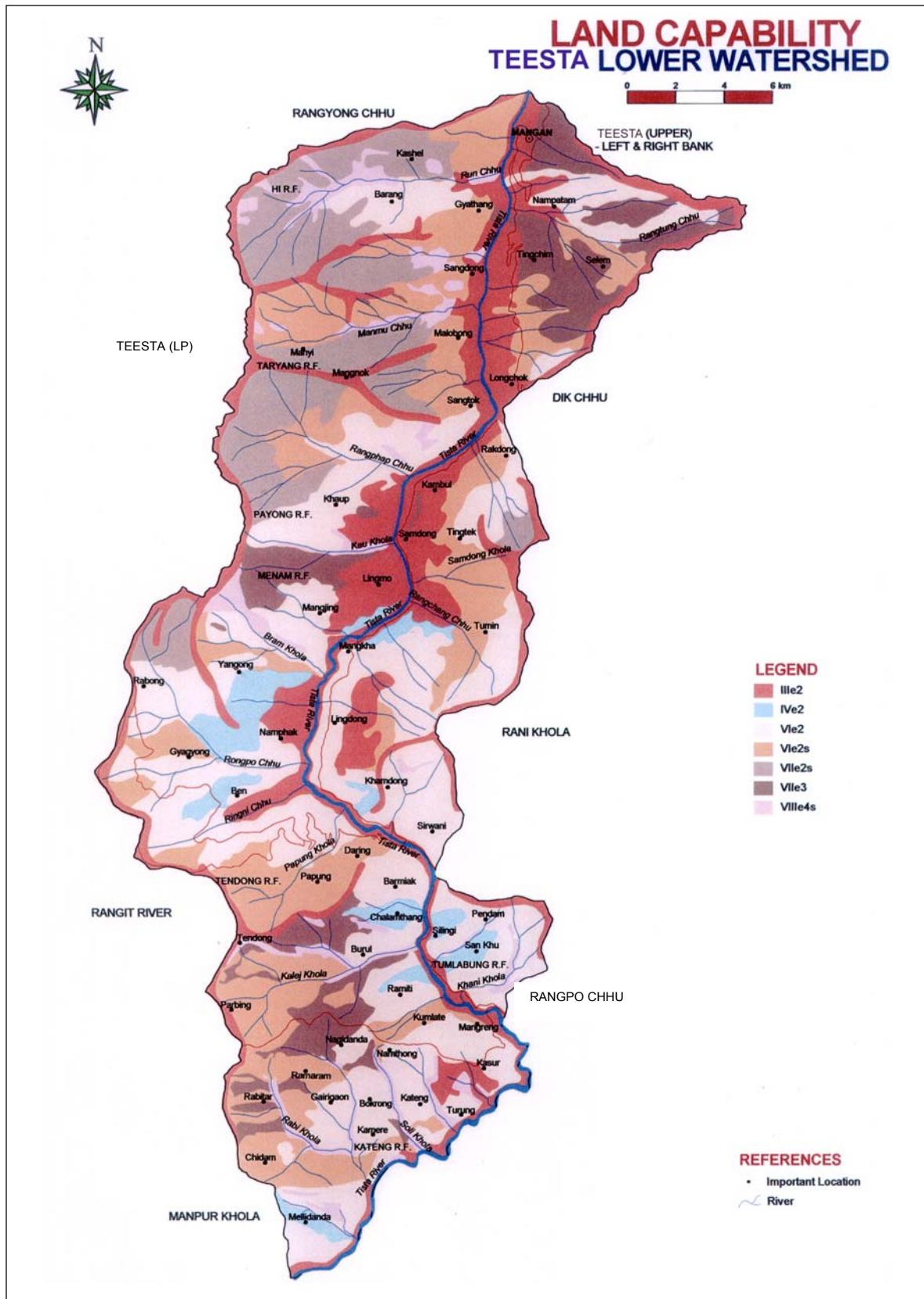


Fig. 4.25 Land capability class of Teesta (LP) watershed

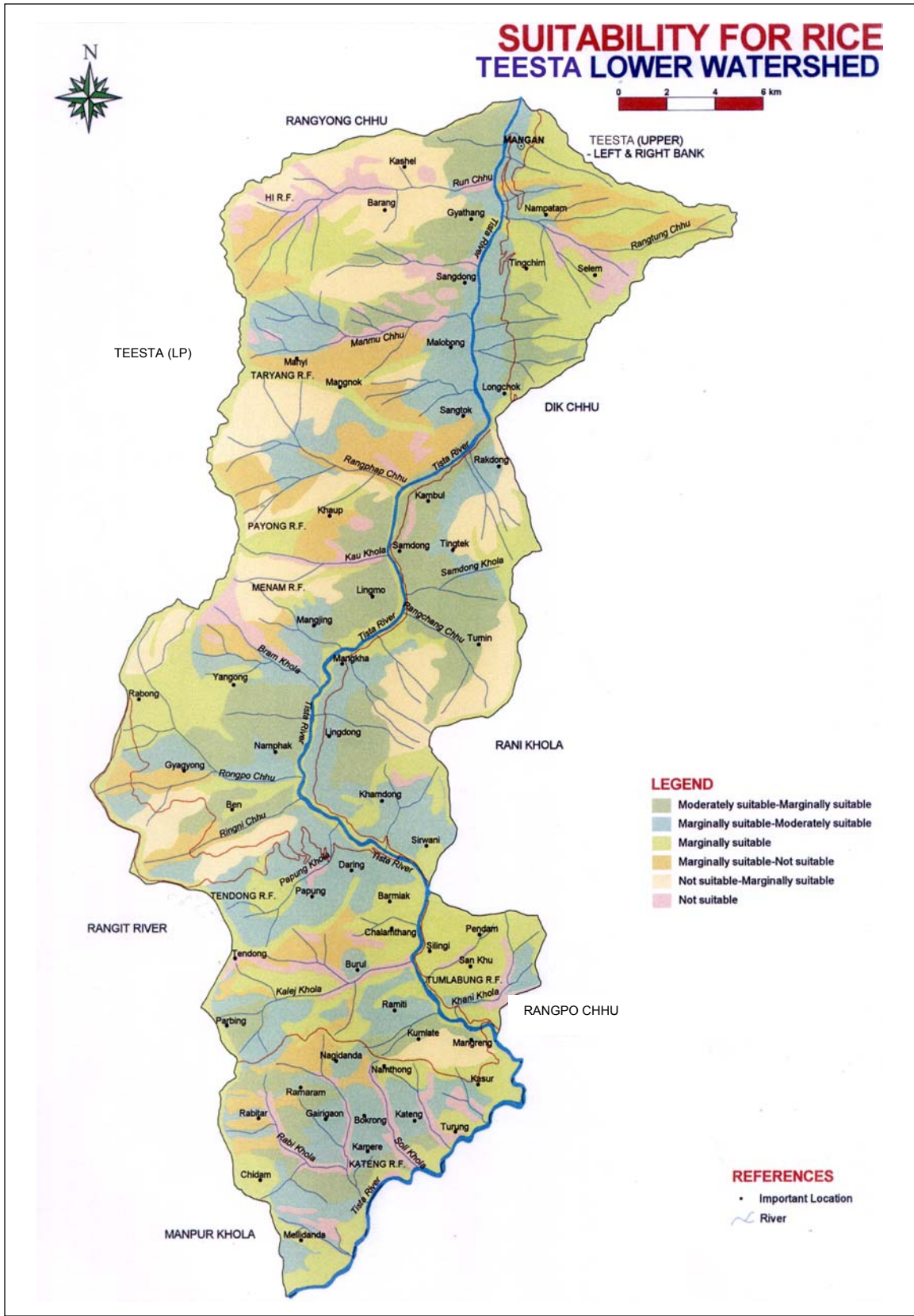


Fig. 4.26 Soil-site suitability for rice in Teesta (LP) watershed

4.3.9 Soil-site suitability for maize

Soil-site suitability for maize in this watershed shows that it is only moderately suitable (S2) in 30,294.7 ha in Teesta Lower Part watershed areas and only marginally suitable in 700.3 ha (Table 4.24 and Fig. 4.27). It is moderately suitable to marginally suitable (S2-S3) in 10,543.2 ha area representing narrow valley, mid and high mountain slopes and marginally suitable to moderately suitable (S3-S2) in 12,525.0 ha area of the watershed. Almost unsuitability alone and in combination with other (S2) occupy 5,797 ha area.

Table 4.24 Soil-site suitability for maize of Teesta (Lower Part) watershed

Sl.No.	Suitability class	Map unit nos.	Area (ha)
1.	S2	1,12,14,18,22,24,28,30,32,34,36,38	30294.7
2.	S2-S3	15,20,26,42,44	10543.2
3.	S3-S2	8,10,11,13	12525.0
4.	S3	5	700.3
5.	N-S2	46	2164.0
6.	N	3,6,7	3633.0
	Miscellaneous		0.8
Total			59861.0

4.4 DIK CHHU WATERSHED

4.4.1 Landforms

Eight broad landform regions have been identified in the watershed through visual interpretation of satellite imagery (IRS 1C LISS-III),

interpretation of toposheet and thorough traversing, which were again subdivided into 24 landform units based on the variations in tone, texture, shadow, shape, pattern of the photo elements in the satellite imagery reflecting different type of land use in the landform units (Fig. 4.28).

4.4.2 Soils

The soils of the Dik Chhu watershed comprising 39 soil series were mapped into 24 soil mapping units at the level of soil series association (Table 4.25 and Fig. 4.28). The soil mapping unit 42 comprising Damthang –Chongrang – Rock out crop association covers maximum area of 2,356.4 ha (9.8%) while the soil mapping unit 6 representing landslide zone and comprising Karporang – Hilley soil series association occupies least area of 79.7 ha (0.3%). Major area of the watershed is occupied by the soils of high mountain (32.2%) followed by mid mountain (30.4%). The dominant soil series in the watershed are Maling, Jorpul, Maniram, Samdur, Yumthang, etc.

Table 4.25 Soils of Dik Chhu watershed

Soil Unit	Soil Series Association	Area (In ha)	% of Watershed
1	Maling-Rayong	2045.0	8.5
3	Rock outcrops – Jorpul	2289.8	9.5
6	Karporang – Hilley	79.7	0.3
10	Chalumthang – Rorethang – Bhasme	255.4	1.1
16	Tumin –Phong – Chautare	294.7	1.2
22	Chongrang – Legship – Singgyang	175.9	0.7

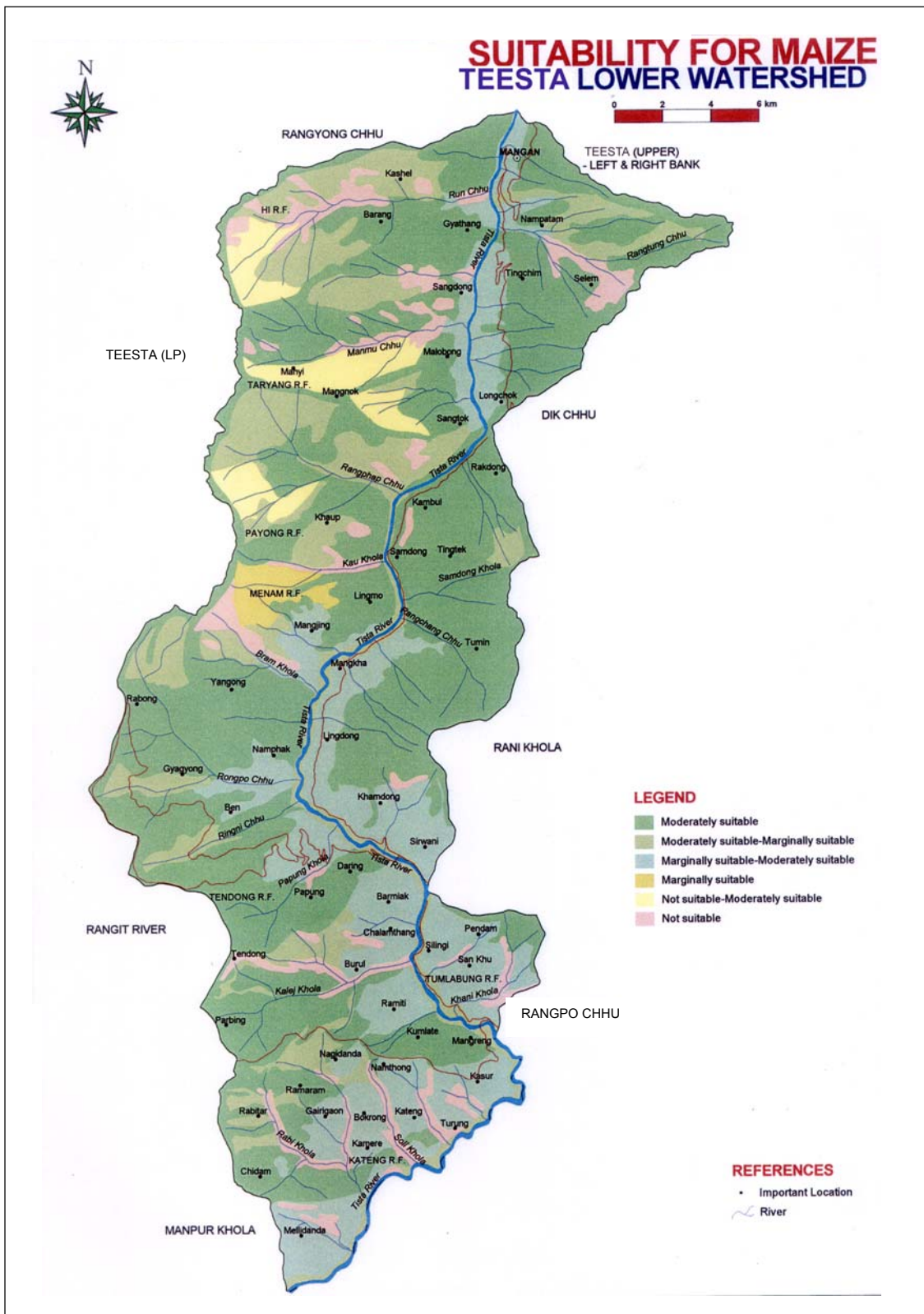


Fig. 4.27 Soil-site suitability for maize in Teesta (LP) watershed

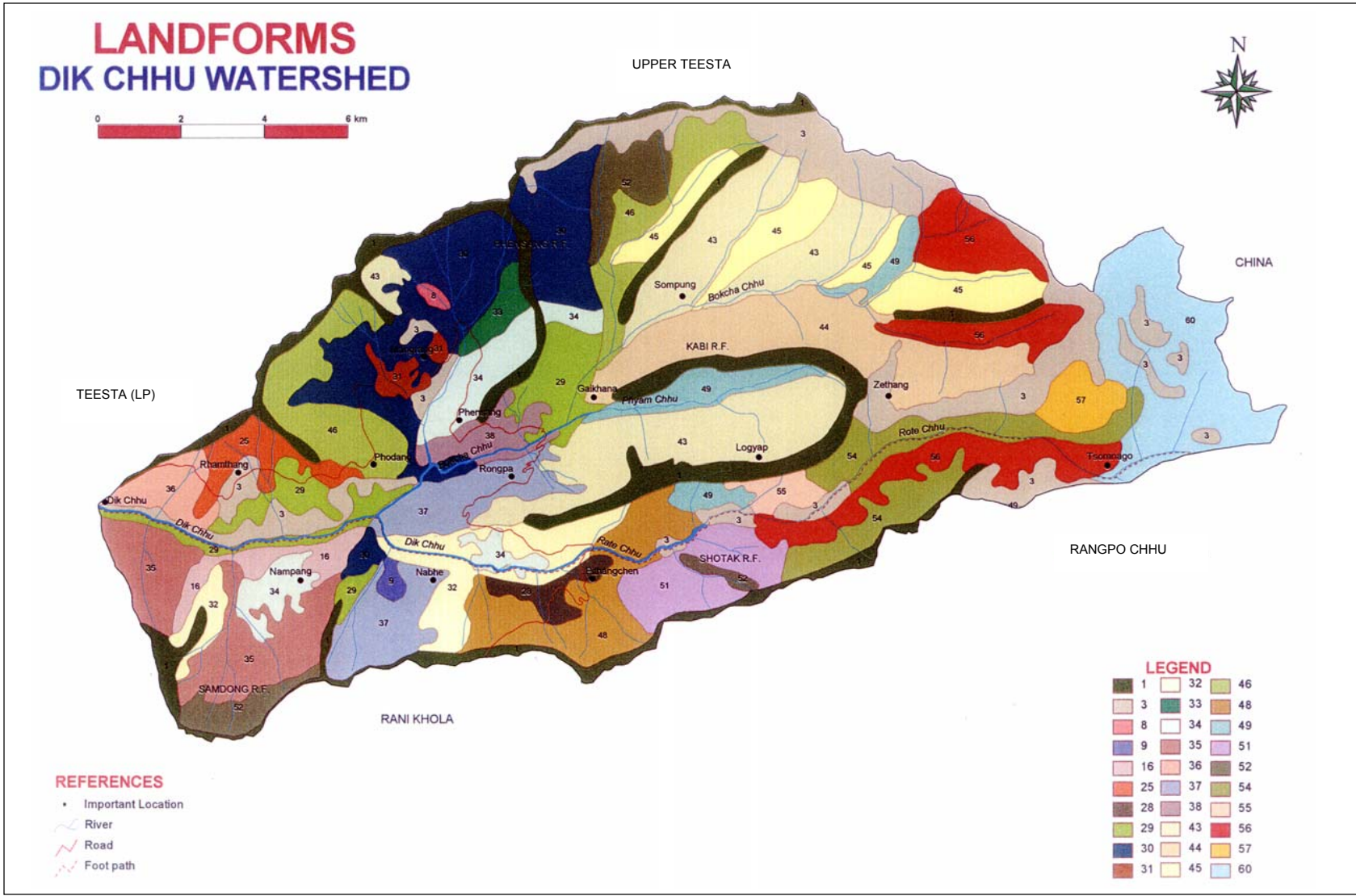


Fig. 4.28 Landforms of Dik Chhu watershed

24	Doling – Khedi	868.8	3.6
26	Dikling – Hilley	1751.6	7.3
28	Samdur – Khedi – Bhusuk	262.1	1.1
30	Rumtek – Tumin	779.2	3.2
32	Bhusuk – Pirik – Namchi	1014.3	4.2
34	Namchi– Synggyang	989.6	4.1
36	Doling – Samdur – Rock outcrop	921.5	3.8
38	Rumtek – Pirik – Mangjing	279.5	1.2
42	Damthang – Chongrang – Rock outcrop	2356.4	9.8
44	Singgyang – Maniram – Damthang	1295.4	5.4
46	Maniram-Damthang – Jorpul	2081.7	8.6
48	Martam – Tarnu – Sajong	834.8	3.5
50	Sajong –Tarnu	533.8	2.2
54	Rongnek – Sajong	545.5	2.3
56	Khedi – Dikling	581.3	2.4
60	Lachung- Puchikongma – Byuma	1014.7	4.2
61	Yumthang – Thangu – Kalep	1562.0	6.5
63	Thangu – Rock outcrop	1282.6	5.3
	Miscellaneous	0.7	0.0
	Total	24096.0	100.0

4.4.3 Soil depth

Total five soil depth classes *viz.* deep, moderately deep, moderately shallow, shallow and very shallow were identified in this watershed and were mapped into nine mapping units at the level of association of soil depth classes (Table 4.26 and Fig. 4.29). The mapping unit 1 comprising deep – moderately deep soil occupies largest area of 9,144.2 ha (37.9%) while mapping unit 5 comprising only moderately shallow depth class

occupies least area of 79.7 ha (0.3%). Rock in association with moderately shallow (mapping unit 7) and very shallow (mapping unit 8) soils in this watershed should be protected through afforestation or other soil conservation measure.

Table 4.26 Soil depth of Dik Chhu watershed

Map unit	Description	Soil Map units	Area (In ha)	% of watershed
1	Deep-mod.deep	24,28,34,38,44,46,48,22,42	9144.2	37.9
2	Deep-mod.shallow	26,30,36	3452.3	14.3
3	Deep-very shallow	61	1562.0	6.5
4	Mod.deep-deep	1,56,10	2881.7	12.0
5	Mod. shallow	6	79.7	0.3
6	Mod. shallow-deep	32,50,16	1842.8	7.6
7	Mod. shallow-Rock	63	1282.6	5.3
8	Rock-very shallow	3	2289.8	9.5
9	Shallow-mod.deep	54,60	1560.2	6.5
		Miscellaneous	1.1	0.1

4.4.4 Surface texture

Nine surface soil texture *viz.* gravelly sandy loam, silt loam, loam, sandy loam, loamy sand, clay loam, gravelly silt loam, sandy clay loam and silty clay loam were identified in the soils of the watershed and were mapped into 14 mapping units at the level of association of surface textural classes. The maximum area of 3,377.1 ha (14.0%) were occupied by the surface textural class association of sandy loam – gravelly silt loam (mapping unit 7) while least area of 79.7 ha (0.1%)

were occupied by the mapping unit 4 comprising loamy sand – loam association. The dominant textural classes occurring in this watershed were sandy loam, silt loam, loam and silty clay loam (Table 4.27 and Fig. 4.31).

Table 4.27 Surface texture of Dik Chhu watershed

Map unit	Description	Soil Map units	Area (In ha)	% of watershed
1	gsl-sil	32	1014.3	4.2
2	I-R	63	1282.6	5.3
3	I-sl	28,34	1251.7	5.2
4	Ls-l	6	79.7	0.3
5	R-l	3	2289.8	9.5
6	Sl-cl	48	834.8	3.5
7	Sl-gsil	44,46	3377.1	14.0
8	Sl-ls	60	1014.7	4.2
9	Sl-scl	61	1562.0	6.5
10	Sl-sicl	1,56	2626.3	10.8
11	sicl-l	26	1751.6	7.3
12	sil-cl	16	294.7	1.2
13	sil-l	30,36,38,10,42	4592.0	19.1
14	sil-sl	24,50,54,22	2124.0	8.8
		Miscellaneous	0.7	0.1

4.4.5 Soil erosion

Three types of soil erosion class viz. very severe, severe and moderate erosion were identified in the soils of the watershed and

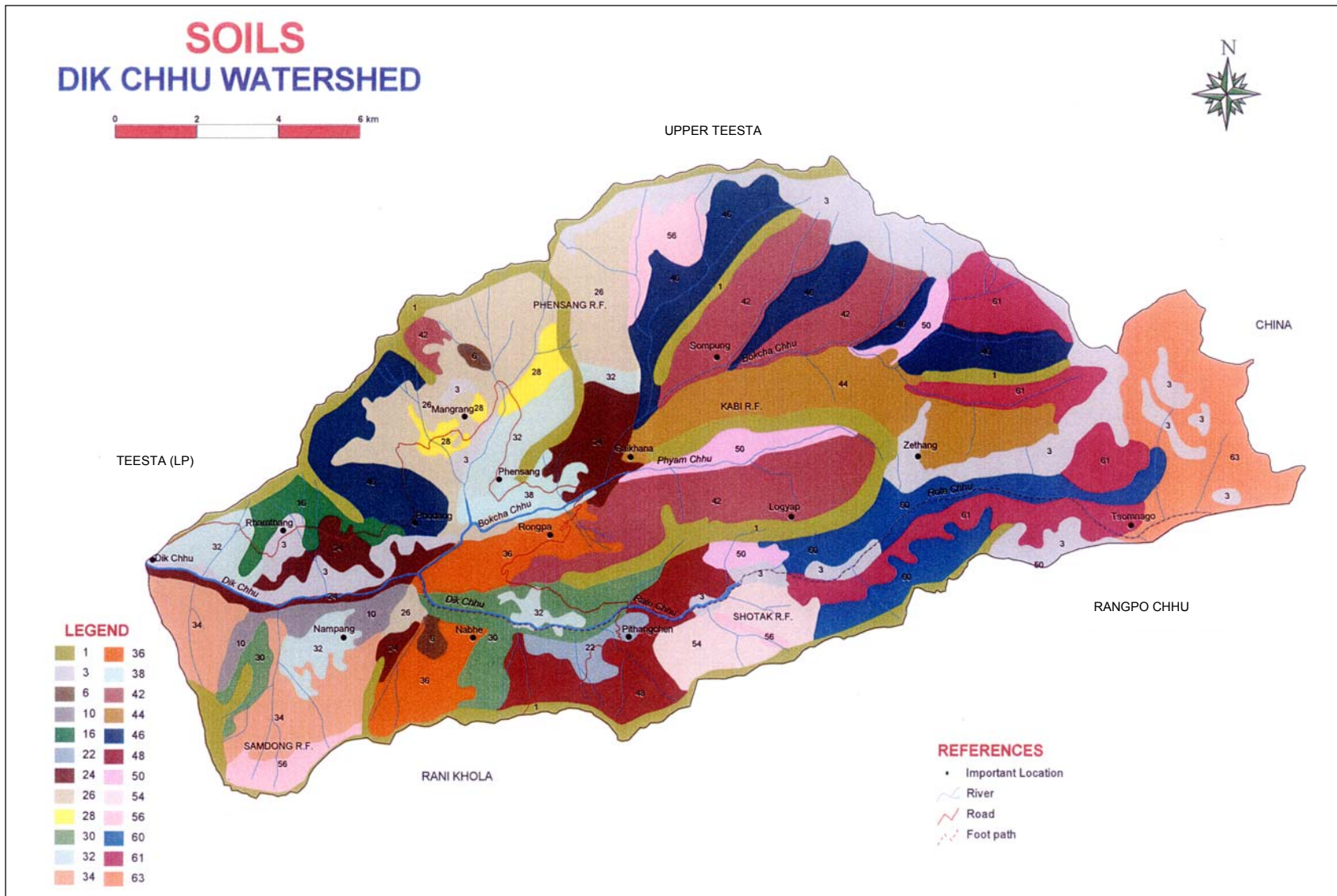


Fig. 4.29 Soil of Dik Chhu watershed

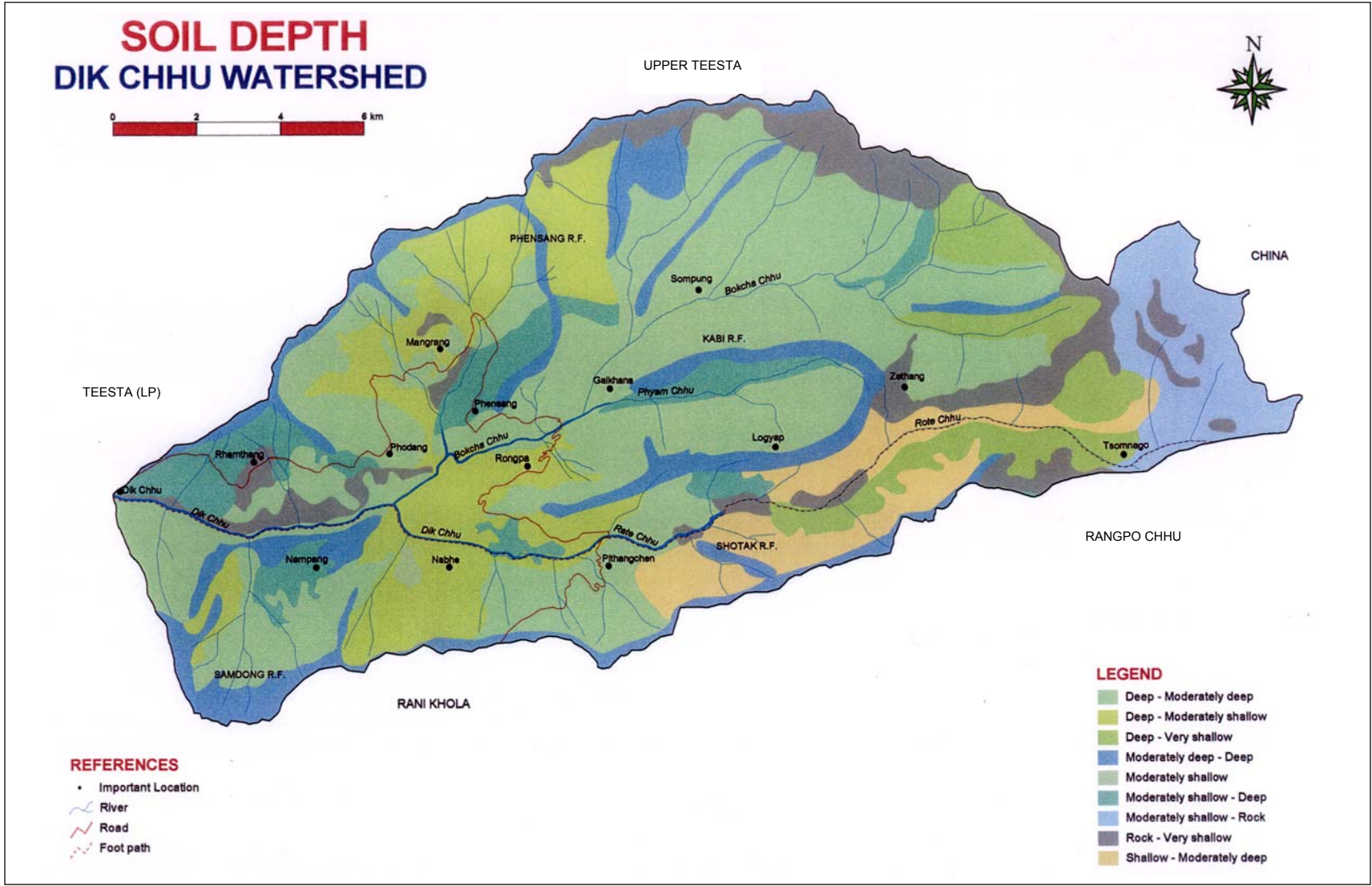


Fig. 4.30 Soil depth class of Dik Chhu watershed

mapped into seven mapping units at the level of association of erosion classes (Table 4.28 and Fig. 4.32). The mapping unit 7 comprising the association of very severe – severe erosion classes occupying 2,285.0 ha (9.5%) area is very susceptible to landslide or mass movement. Hence, soil conservation measure is of utmost important for this area to protect the natural resource. Rock in association with moderate erosion (mapping unit 2) and very severe erosion (mapping unit 4) occupies 1,282.6 ha (5.3%) and 2,289.8 ha (9.5%) respectively. Severe erosion (mapping unit 5) alone is active mostly in the part of high and very high mountain, occupies 3,641.9 ha (15.1%) while moderate erosion alone (mapping unit 1) occupies the largest area of 1,036.0 ha (13.0%) mostly in the part of ridge, mid and very high mountain.

Table 4.28 Soil erosion of Dik Chhu watershed

Map Unit	Description	Soil Map Units	Area (In ha)	% of Watershed
1	M	1,24,26,28,30,32,36,38,56,16,61	10360.0	43.0
2	M-R	63	1282.6	5.3
3	M-S	48,50,10,22,42	4156.3	17.2
4	R- VS	3	2289.8	9.5
5	S	46,54,60	3641.9	15.1
6	S-M	6	79.7	0.3
7	VS-S	34,44	2285.0	9.5
		Miscellaneous	0.7	0.1

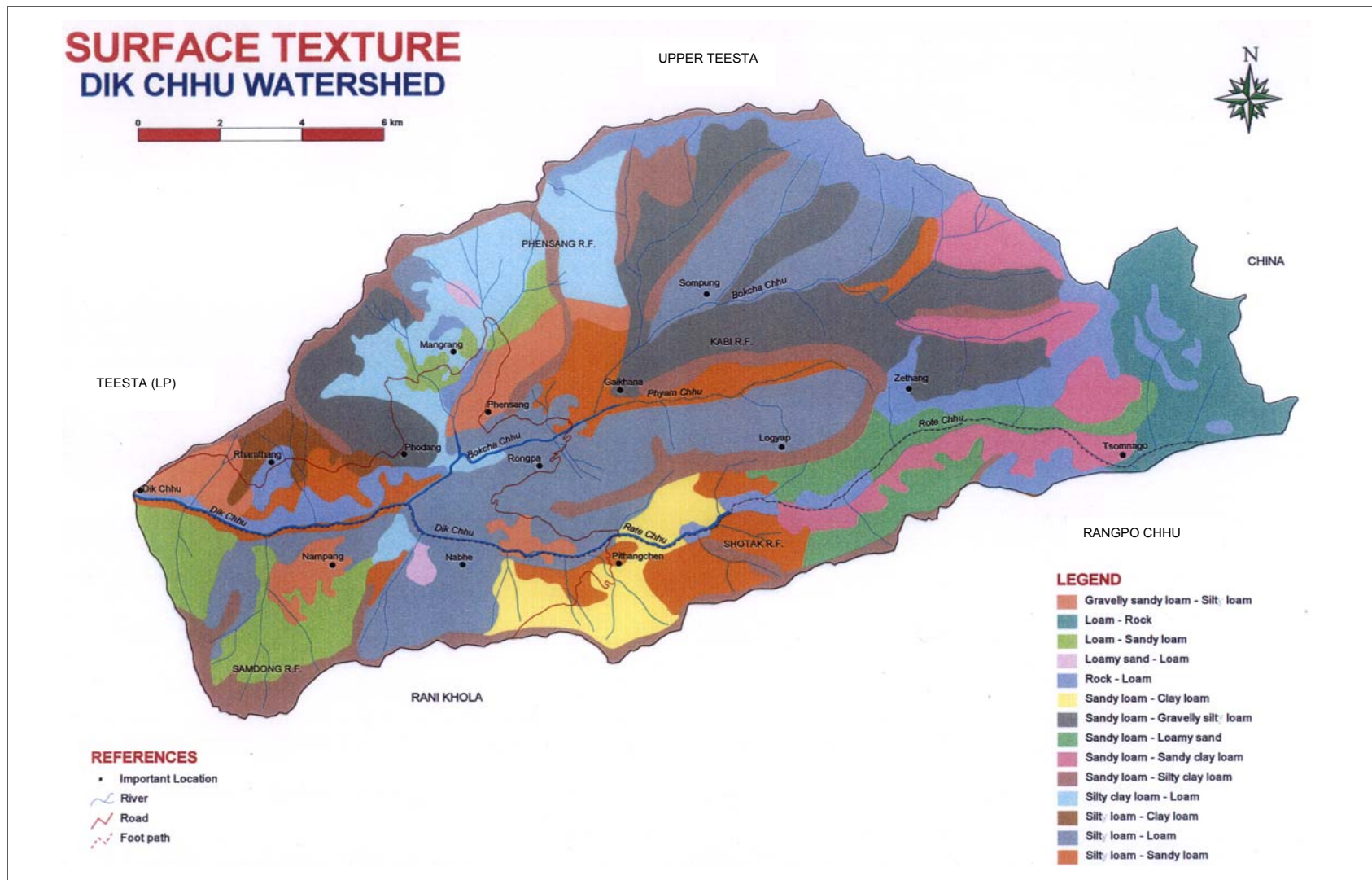


Fig. 4.31 Surface texture class of Dik Chhu watershed

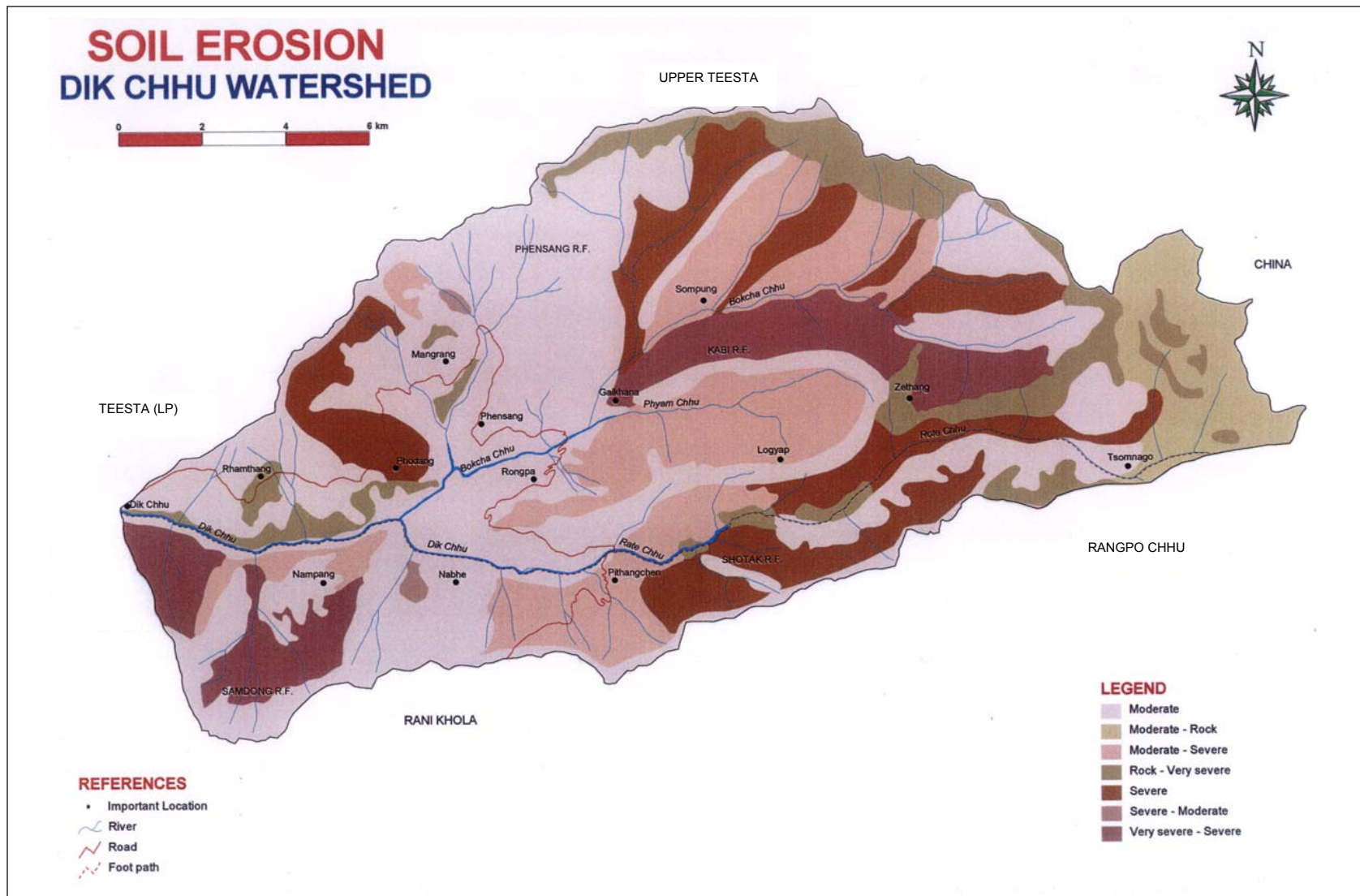


Fig. 4.32 Soil erosion class of Dik Chhu watershed

4.4.6 Soil reaction

Five soil reaction classes *viz.* extremely acidic, very strongly acidic, strongly acidic, moderately acidic and slightly acidic were identified in this watershed and were mapped into twelve mapping units at the level of association of soil reaction classes (Table 4.29 and Fig. 4.33).

Table 4.29 Soil reaction of Dik Chhu watershed

Map Unit	Description	Soil Map Units	Area (In ha)	% of Watershed
1	EX-S	24,30,36,46,50,54,22,42	8262.8	34.3
2	EX-VS	38,16	574.2	2.4
3	M-VS	48	834.8	3.5
5	R-S	3	2289.8	9.5
6	SL-VS	10	255.4	1.1
7	S-EX	1	2045.0	8.4
8	S-R	63	1282.6	5.3
9	S-VS	6,56	661.0	2.7
10	VS	60	1014.7	4.2
11	VS-M	61	1562.0	6.5
12	VS-S	26,28,32,34,44	5313.0	22.0
		Miscellaneous	0.7	0.1

About 34.3 per cent area of the watershed is occupied by the association of extremely acidic and strongly acidic reaction class mapping unit 1) followed by very strongly and strongly acidic reaction class (mapping unit 12) occupying 22.0 per cent area. Very strongly

acidic reaction class dominates in this watershed either alone or in combination with other reaction classes.

4.4.7 Land capability class (LCC)

Five land capability classes *viz.* III, IV, VI, VII and VIII and seven land capability sub-classes were identified in this watershed based on the type and degree of limitations for sustained use (Table 4.30 and Fig. 4.34). The land capability sub-class VIe2s was found (mapping unit 4) to occur in major areas (34.9%) followed by VIIe2s, VIe2 and VIIIe4s occupying 23.7%, 18.8% and 9.5% area respectively. The mapping unit 6 comprising landslide zone and mid mountain (>50% slope) is under severe erosion and hence placed under land capability sub-class VIIe3. Only rocky cliff (mapping unit 7) areas possess very severe limitation of erosion and soil and hence placed under land capability sub-class VIIIe4s.

Table 4.30 Land capability of Dik Chhu watershed

Map unit	Description	Soil Map units	Area (In ha)	% of watershed
1	IIIe2	1	2045.0	8.5
2	IVe2	38,10	534.9	2.2
3	VIe2	24,26,34,36	4531.5	18.8
4	VIe2s	28,30,32,48,50,54,56,60,61,63	8410.3	34.9
5	VIIe2s	44,46,42	5733.5	23.7
6	VIIe3	6,16,22	550.3	2.3
7	VIIIe4s	3	2289.8	9.5
		Miscellaneous	0.7	0.1

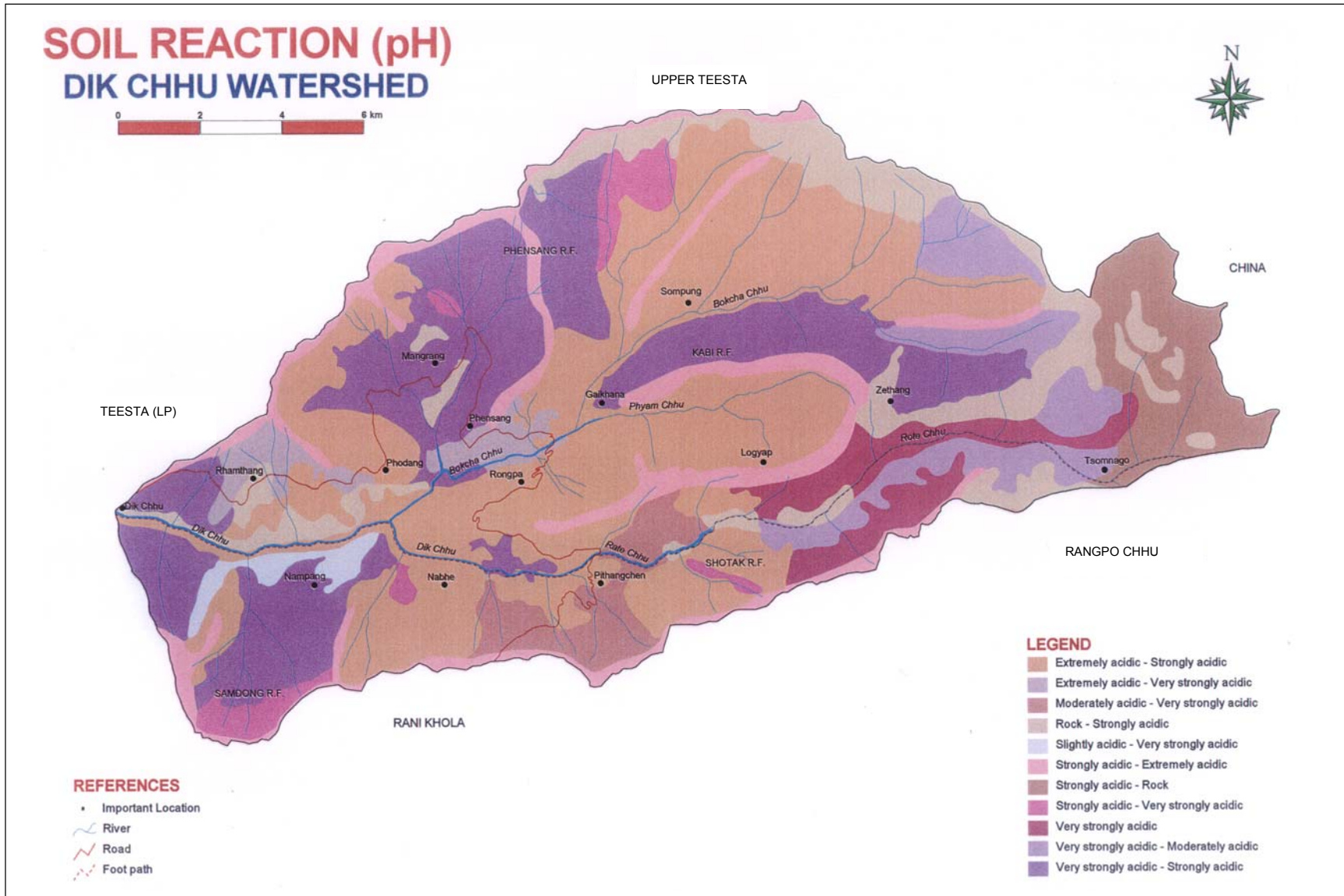


Fig. 4.33 Soil reaction class of Dik Chhu watershed

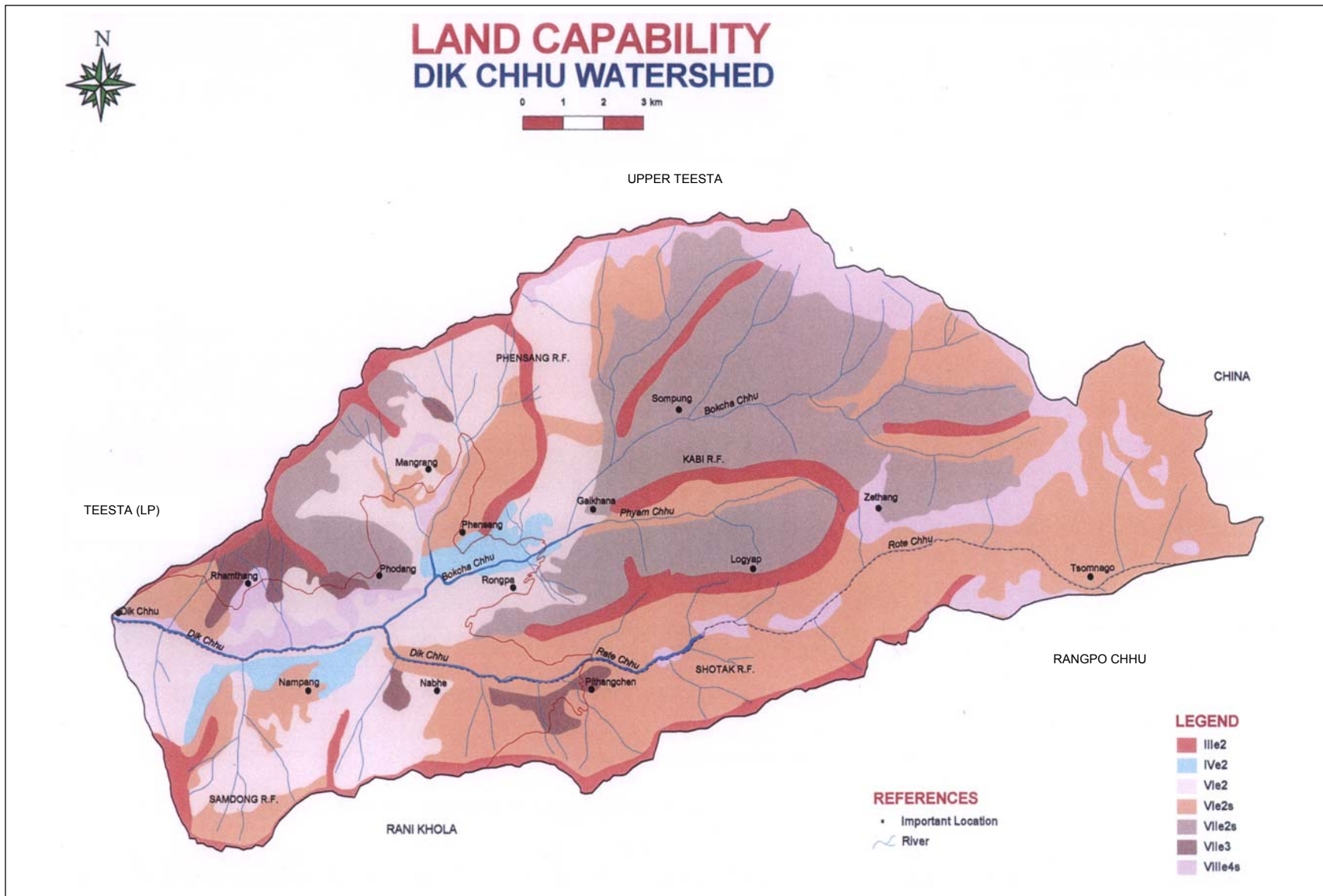


Fig. 4.34 Land capability class of Dik Chhu watershed

4.4.8 Soil-site suitability for rice

In Dik Chhu watershed areas 1,058.7 ha has been found to be moderately to marginally suitable (S2-S3) for rice cultivation and marginally to moderately suitable (S3-S2) in 1,014.3 ha areas (Table 4.31 and represented in Fig. 4.35). It is only marginally suitable in 6,405.4 ha areas due to severe limitation of topography, drainage and soil fertility. About 6,762.6 ha area of the watershed mostly from rocky cliff, landslide zone, high mountain, very high and extremely high mountain was found to be unsuitable for rice due to very severe limitation of topography and soil.

Table 4.31 Soil-site suitability for rice of Dik Chhu watershed

Sl.No.	Suitability class	Map unit nos.	Area (ha)
1.	S2-S3	30,38	1058.7
2.	S3-S2	32	1014.3
3.	S3	1,10,22,24,28,36,44,56	6405.4
4.	S3-N	26,46,48,54	5213.6
5.	N-S3	16,34,42	3640.7
6.	N	3,6,50,60,61,63	6762.6
	Miscellaneous		0.7
Total			24096.0

4.4.9 Soil-site suitability for maize

Maize is found to be only moderately suitable (S2) in 8,170.7 ha in the Dik Chhu watershed areas. It is moderately to marginally suitable (S2-S3) in 5,403.4 ha and marginally to moderately suitable (S3-S2) in

1,083.9 ha area of the watershed (Table 4.32 and Fig. 4.36). The unsuitable alone and in combination occupies 9,437.3 ha areas of the watershed due to severe to very severe limitation of topography and soil.

Table 4.32 Soil-site suitability for maize of Dik Chhu watershed

Sl.No.	Suitability class	Map unit nos.	Area (ha)
1.	S2	1,22,24,28,30,32,34,36,38,48	8170.7
2.	S2-S3	26,42,44	5403.4
3.	S3-S2	10,16,50	1083.9
4.	N-S2	46,54,56	3208.5
5.	N	3,6,60,61,63	6228.8
	Miscellaneous		0.7
Total			24096.0

4.5 TEESTA UPPER LEFT BANK WATERSHED

4.5.1 Landforms

Nine broad landform regions *viz.* ridge, rocky cliff, landslide zone, morainic zone, low mountain, mid. mountain, high mountain, very high mountain and extremely high mountain and twenty seven landform units were identified in the watershed and mapped (Fig. 4.37). In this watershed, very high mountain covers maximum area (28.4%) followed by extremely high mountain (22.0%), high mountain (16.9%), rocky cliff (16.3%), mid mountain (12.5%), ridge (0.4%), morainic zone (0.4%) and landslide zone (0.1%).

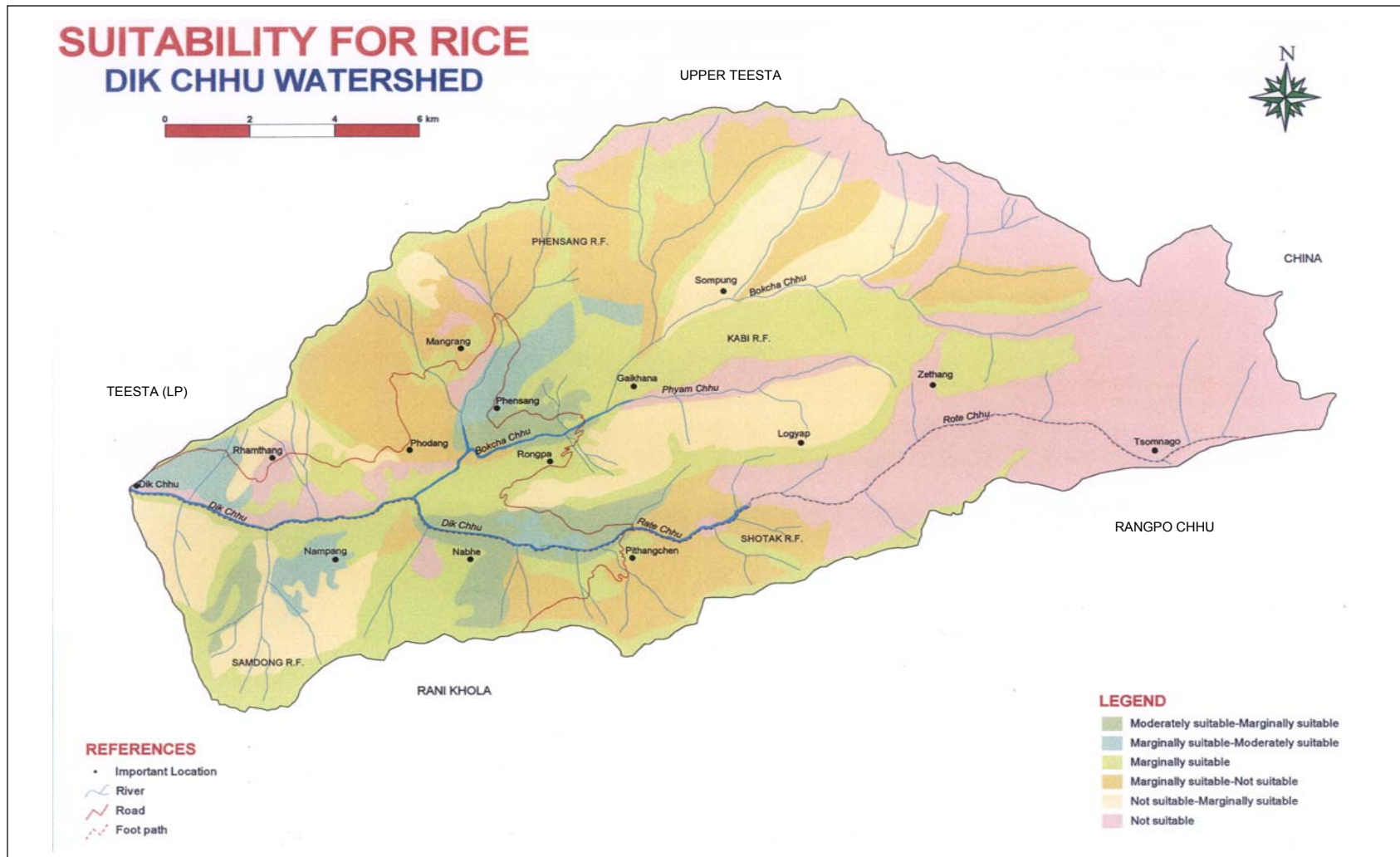


Fig. 4.35 Soil site suitability for in Dik Chhu watershed

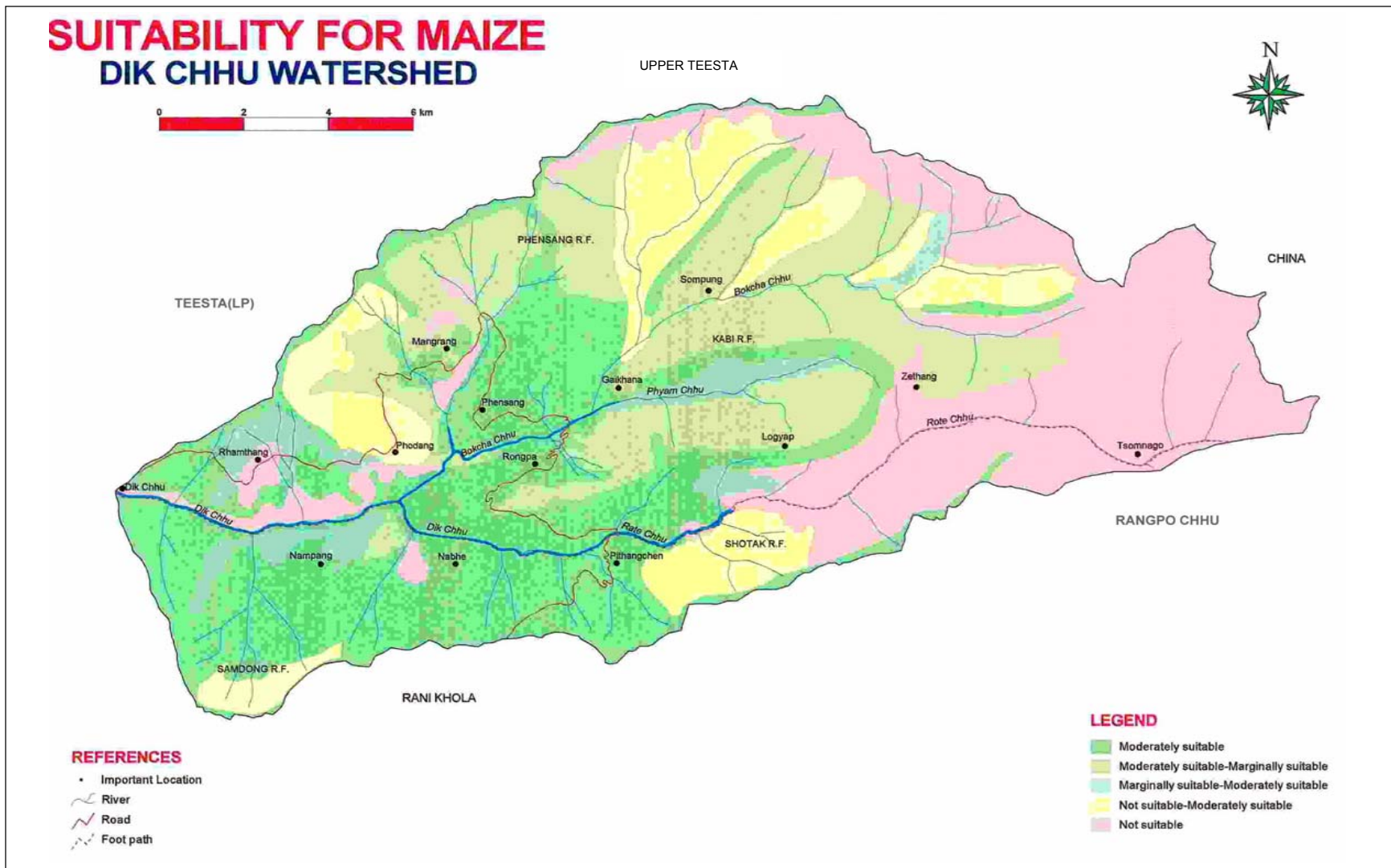


Fig. 4.36 Soil site suitability for maize in Dik Chhu watershed

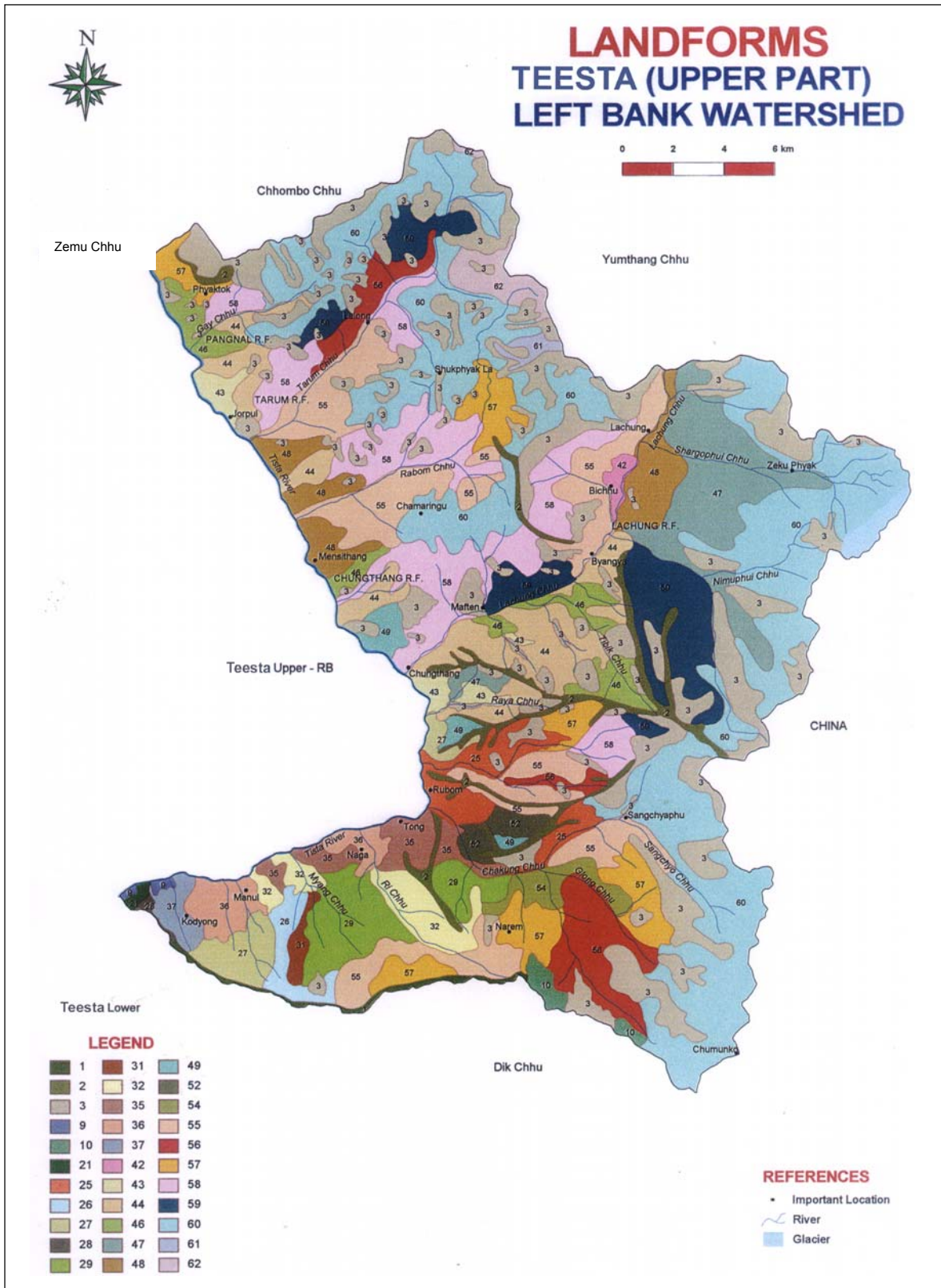


Fig. 4.37 Landforms of Teesta (Upper-LB) watershed

4.5.2 Soils

Total thirty one soil series were identified in this watershed and were mapped into twenty seven mapping units at the level of association of soil series (Table 4.33 and Fig. 4.38). In this watershed, Thangu – Rockout crop association (mapping unit 63) of extremely high mountain occupies highest area of 13,323.6 ha (22.0%) followed by Lachung – Puchi kongma – Byuma association (mapping unit 60) of very high mountain and Rockout crop – Jorpul association (mapping unit 3) of rocky cliff occupying 17.0 and 16.3 per cent area of the watershed. The major soil series occurring in this watershed are Thangu, Lachung, Yumthang, Ship, Chatten, etc. Within the hill slopes of high mountain, Chatten – Lema – Tibik association (mapping unit 45) occupies 6.8 per cent area while in the hill slopes of mid. mountain, Gyer – Manul – Lema association (mapping unit 25) occupies 2.6 per cent area of the watershed.

Table 4.33 Soils of Teesta Left Bank watershed

Soil Unit	Soil Series Association	Area (In ha)	% of watershed
1	Maling-Rayong	252.0	0.4
2	Rubam – Salem	1520.4	2.5
3	Rock outcrops – Jorpul	9844.8	16.3
6	Karporang – Hilley	67.5	0.1
7	Kalep – Rock outcrop	264.1	0.4
13	Mangjing – Dharamdin	60.8	0.1
17	Chatten-Theng	1144.6	1.9

19	Pakel – Tibik – Rock outcrop	478.3	0.8
21	Singhik – Tibik – Lingthem	776.5	1.3
23	Singhik – Ruglo – Rapung	50.7	0.1
25	Gyer – Manul – Lema	1577.4	2.6
29	Lingthem – Lema – Singhik	192.9	0.3
31	Bitchu – Ruglo – Pakel	1032.9	1.7
33	Manul – Gyer – Rock outcrop	854.3	1.4
35	Ruglo – Lingthem – Theng	927.3	1.5
37	Singhik- Pakel	363.1	0.6
41	Mensithang – Lema – Bitchu	171.5	0.3
43	Tibik-Byuma – Mensithang	579.8	1.0
45	Chatten-Lema – Tibik	2941.2	4.9
47	Ship – Theng – Pakel	4158.3	6.9
49	Rapung – Mensithang – Rock outcrop	1702.3	2.8
51	Tibik – Bitchu – Rock outcrop	432.0	0.7
57	Byuma-Ship	378.3	0.6
60	Lachung- Puchikongma – Byuma	10291.5	17.0
61	Yumthang – Thangu – Kalep	4350.2	7.2
62	Maltin – Lachen – Rock outcrop	2552.9	4.2
63	Thangu – Rock outcrop	13323.6	22.0
	Miscellaneous	235.3	0.4
Total		60525.5	100.0

4.5.3 Soil depth

Five depth classes *viz.* deep, moderately deep, moderately shallow, shallow and very shallow, have been found to occur in the soils of this watershed and were mapped at the level of association of soil depth classes into ten mapping units (Table 4.34 and Fig. 4.39).

Table 4.34 Soil depth of Teesta Left Bank watershed

Map Unit	Description	Soil Map Units	Area (In ha)	% of Watershed
1	Deep-mod.deep	13	60.8	0.1
2	Deep-very shallow	45,61	7291.4	12.1
3	Mod.deep-deep	1,23,29,35	1423.9	2.3
4	Mod.deep-shallow	21,25,33,37,62	6124.2	10.1
5	Mod. Shallow	6	67.5	0.1
6	Mod.shallow-Rock	7,63	13587.7	22.4
7	Mod.shallow.very shallow	19,43,49,51,57	3570.7	5.9
8	Rock-very shallow	3	9844.8	16.3
9	Shallow-mod.deep	60	10291.5	17.0
10	Very shallow-mod.deep	2,17,31,47,41	8027.7	13.3
		Miscellaneous	235.2	0.4

Moderately shallow – rock association (mapping unit 6) of morainic zone and hill slope of the extremely high mountain occupies 13,587.7 ha (22.4%) followed by shallow – moderately deep association (mapping unit 9) of hill slope of very high mountain occupying 10,291.5 ha (17.0%) and Rock – very shallow association (mapping unit 3) of rocky cliff occupying 9,844.8 ha (16.3%) area of the watershed. Deep and moderately deep soils in association occurs mostly on ridges and hill slope of the mid. mountain (30-50% slope and above) occupying 4.3 per cent area of the watershed.

4.5.4 Surface texture

Six surface soil textural classes *viz.* loam (l), loamy sand (ls), sandy clay loam (scl), sandy loam (sl), clay loam (cl) and silty clay loam (sicl) have been identified in the soils of the watershed and were

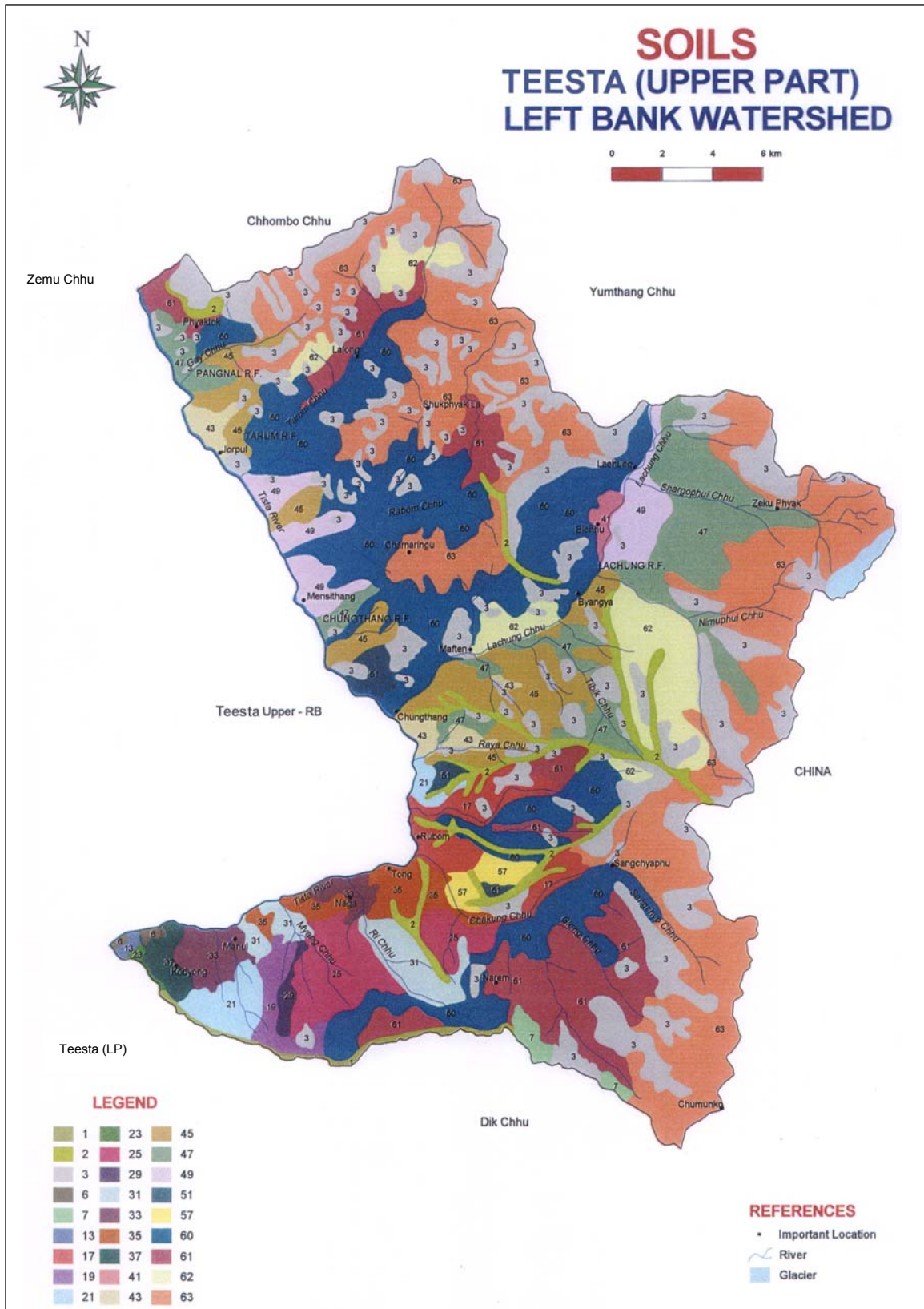


Fig. 4.38 Soils of Teesta (Upper-LB) watershed

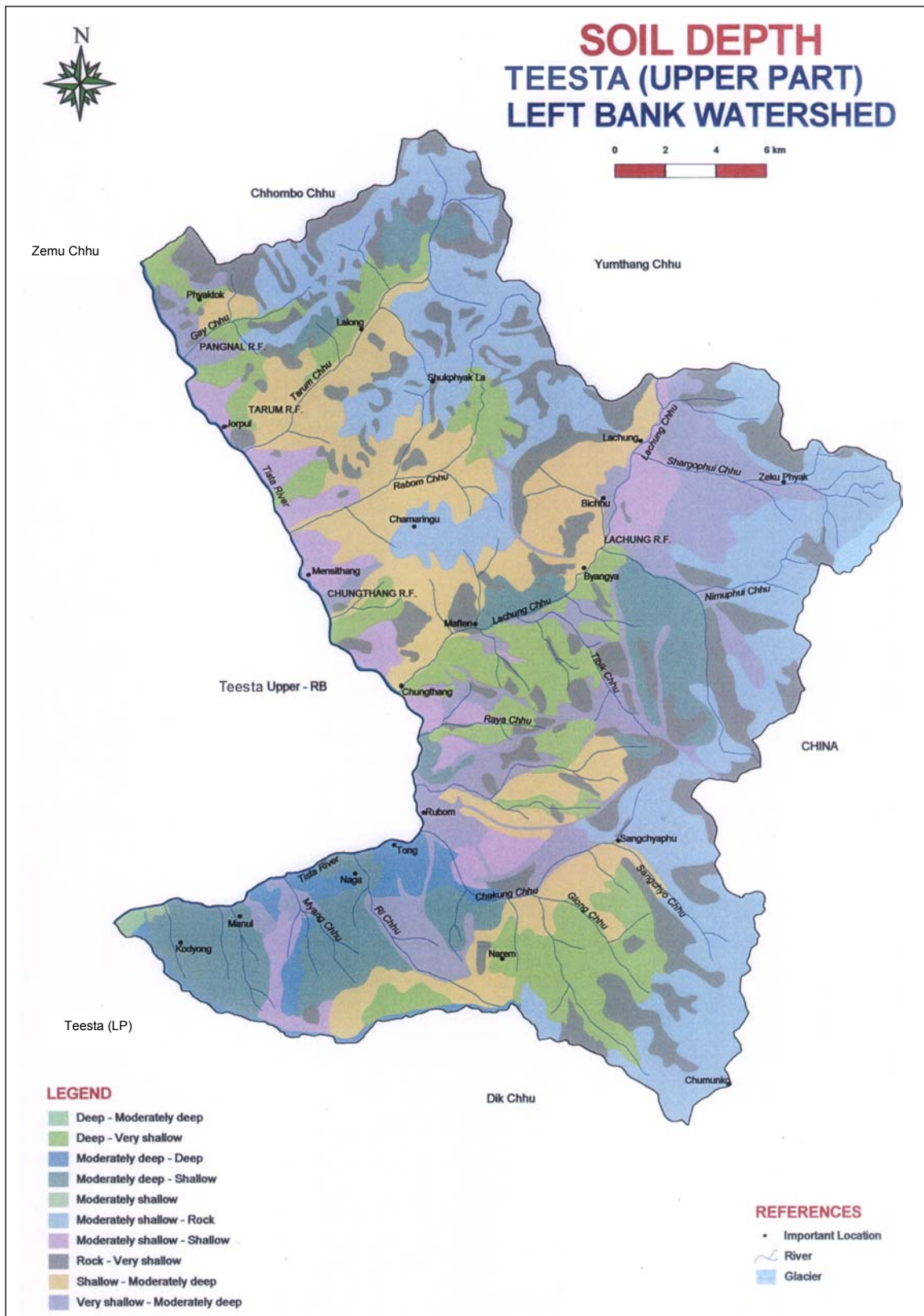


Fig. 4.39 Soil depth class of Teesta (Upper-LB) watershed

mapped into eleven mapping units at the level of association of surface soil textural class (Table 4.35 and Fig. 4.40). In this watershed, sandy clay loam – sandy loam association (mapping unit 6) mostly occurs in ridges, hill slopes of mid and high mountain (30-50% slope and above) occupies an area of 14,585.4 ha (24.1%) while sandy loam – loamy sand association (mapping unit 8) occurs mostly in the hill slopes of mid, high and very high mountain and occupies 16,698.1 ha (27.6%) area of the watershed. Loam – rock association (mapping unit 63) from hill slope of extremely high mountain occupies 13,323.6 ha (222.0%) area of the watershed.

Table 4.35 Surface texture of Teesta Left Bank watershed

Map unit	Description	Soil Map Units	Area (In ha)	% of watershed
1	I	29	192.9	0.3
2	I-R	63	13323.6	22.0
3	Is	19,41	649.8	1.1
4	Is-I	6	67.5	0.1
5	R-I	3	9844.8	16.3
6	scl-sl	2,17,23,25,31,35,45,47,33,57	14585.4	24.1
7	sl-cl	13	60.8	0.1
8	sl-Is	21,43,49,60,37,51,62	16698.1	27.6
9	sl-R	7	264.1	0.4
10	sl-scl	61	4350.2	7.2
11	sl-sicl	1	253.0	0.4
		Miscellaneous	235.2	0.4

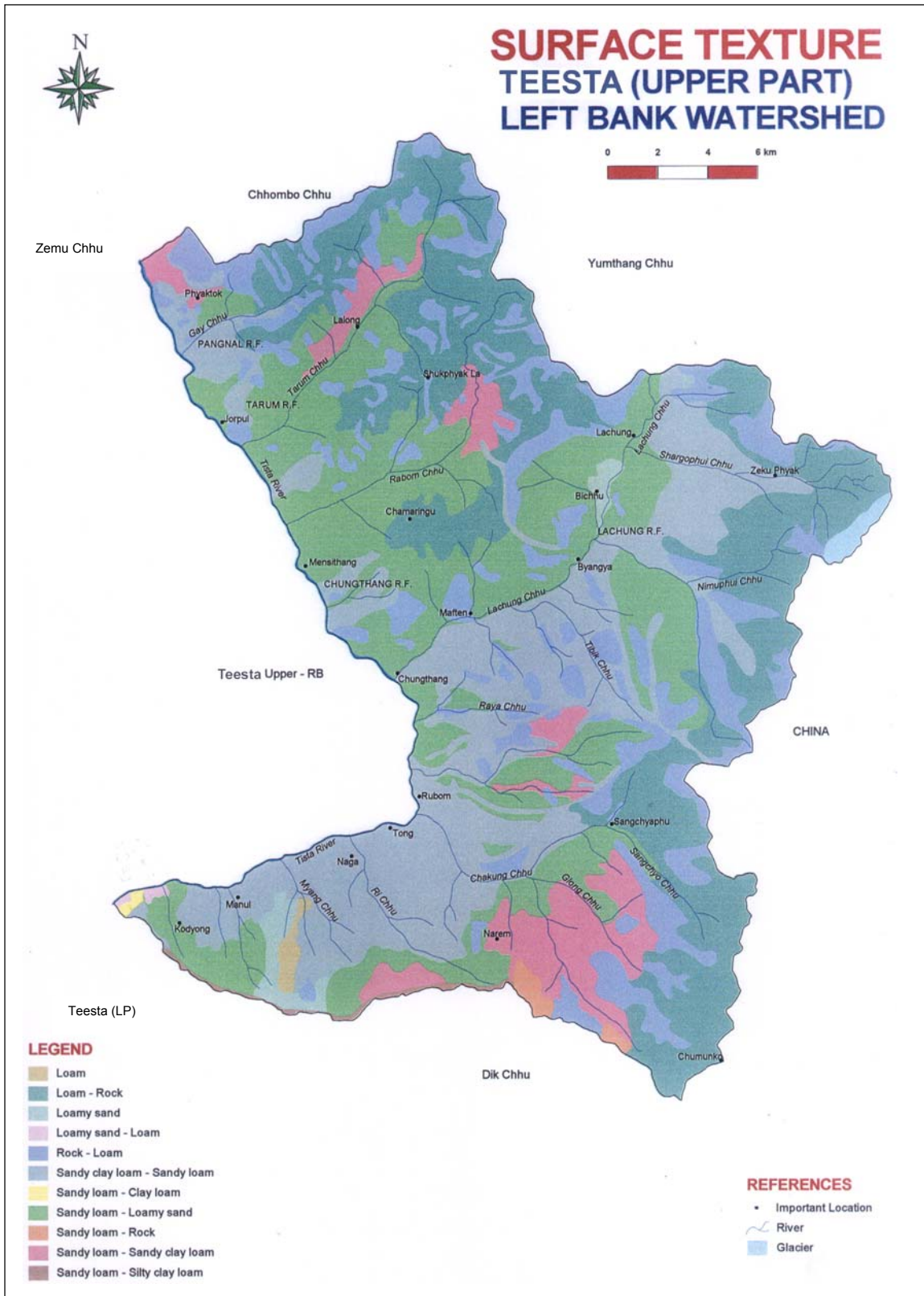


Fig. 4.40 Surface texture class of Teesta (Upper-LB) watershed

4.5.5 Soil erosion

Very severe, severe and moderate erosion classes have been identified in the soils of this watershed and were mapped into seven mapping units at the level of association of soil erosion classes (Table 4.36 and Fig. 4.41). About 22.5 per cent area of the watershed from the morainic zone and hill slope of the extremely high mountain is represented by the association of moderate erosion and rock outcrop (mapping unit 2) while very severe – severe association (mapping unit 7) and association of Rock out crop – very severe erosion of the rocky cliff area occupies 16.8 and 16.3 per cent area of the watershed. Severe erosion alone (mapping unit 4) from the hill slope of very high mountain occupies 17.0 per cent area of the watershed.

Table 4.36 Soil erosion of Teesta Left Bank watershed

Map Unit	Description	Soil Map Units	Area (In ha)	% of watershed
1	M	1,23,29,35,61,13	5834.9	9.6
2	M-R	7,63	13587.7	22.5
3	R-VS	3	9844.8	16.3
4	S	60	10291.5	17.0
5	S-M	21,31,49,6,37,41,62	6666.7	11.0
6	VS-M	43,45,57	3899.3	6.4
7	VS-S	2,17,19,25,47,33,51	10165.3	16.8
		Miscellaneous	235.2	0.4

4.5.6 Soil reaction

Four soil reaction classes viz. extremely acidic, very strongly acidic, strongly acidic and moderately acidic were identified in the soils of this watershed and were mapped into twelve mapping units at the level of association of soil reaction classes (Table 4.37 and Fig. 4.42).

Table 4.37 Soil reaction of Teesta Left Bank watershed

Map Unit	Description	Soil Map Units	Area (In ha)	% of Watershed
1	EX-M	23,29,31,35	2203.8	3.7
2	EX-R	7	264.1	0.4
3	EX-S	13	60.8	0.1
5	M	2,41	1691.9	2.8
6	R-S	3	9844.8	16.3
7	S-EX	1	253.0	0.4
8	S-M	17,25,43,45,47,33,37,62	14171.6	23.4
9	S-R	63	13323.6	22.0
10	S-VS	19,21,6,51,57	2132.6	3.5
11	VS	60	10291.5	17.0
12	VS-M	49,61	6052.5	10.0
		Miscellaneous	235.2	0.4

In this watershed, extremely acidic reaction class is dominant mostly in the morainic zone, hill slopes of mid. mountain while strongly acidic reaction class is dominant mostly in the ridges, hill slopes of the mid mountain, high mountain and extremely high mountain. Very strongly acidic reaction class is dominant mostly in the hill slopes of the

high and very high mountain. Moderately acidic reaction class alone (mapping unit 5) and very strongly acidic reaction class alone (mapping unit 11) occupies 2.8 and 17.0 per cent area of the watershed.

4.5.7 Land capability class (LCC)

Five land capability classes *viz.* III, IV, VI, VII and VIII and six land capability sub-classes *viz.* IIIe2, IVe2, VIe2s, VIIe2s, VIIIe3 and VIIIe4s were identified in this watershed based on the major limitations for sustained use and mapped into six mapping units (Table 4.38 and Fig. 4.43). The study indicates that land capability sub-class VIe2s (mapping unit 3) mostly occurring in the morainic zone and hill slopes of mid., high, very high and extremely high mountain, occupies largest area of 35,623.6 ha (58.9%) while the land capability sub-class VIIIe4s (mapping unit 6) occurring on the rocky cliff areas occupies 9,844.8 ha (16.3%) area of the watershed. About 13.6 per cent area of the watershed is represented by the land capability sub-classes VIIe2s (mapping unit 4) mostly belong to the hill slope of mid mountain and high mountain with more than 50 per cent slope.

Table 4.38 Land capability of Teesta Left Bank watershed

Map unit	Description	Soil Map units	Area (In ha)	% of watershed
1	IIIe2	1,13	313.8	0.5
2	IVe2	2,19,21,23,29,31,35,33,37	6196.4	10.2
3	Vie2s	7,25,43,49,60,61,63,41,51, 57,62	35623.6	58.9

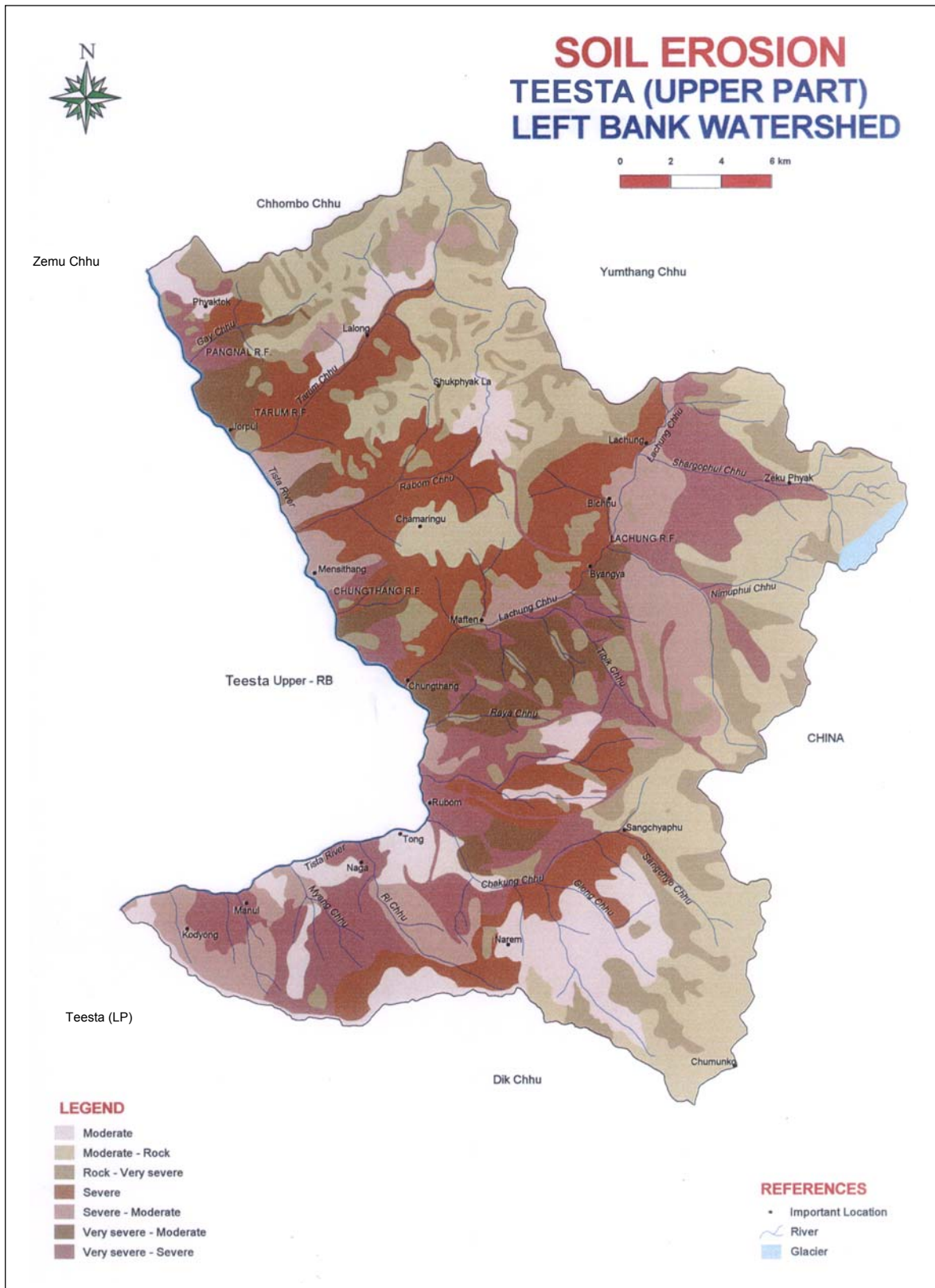


Fig. 4.41 Soil erosion class of Teesta (Upper-LB) watershed

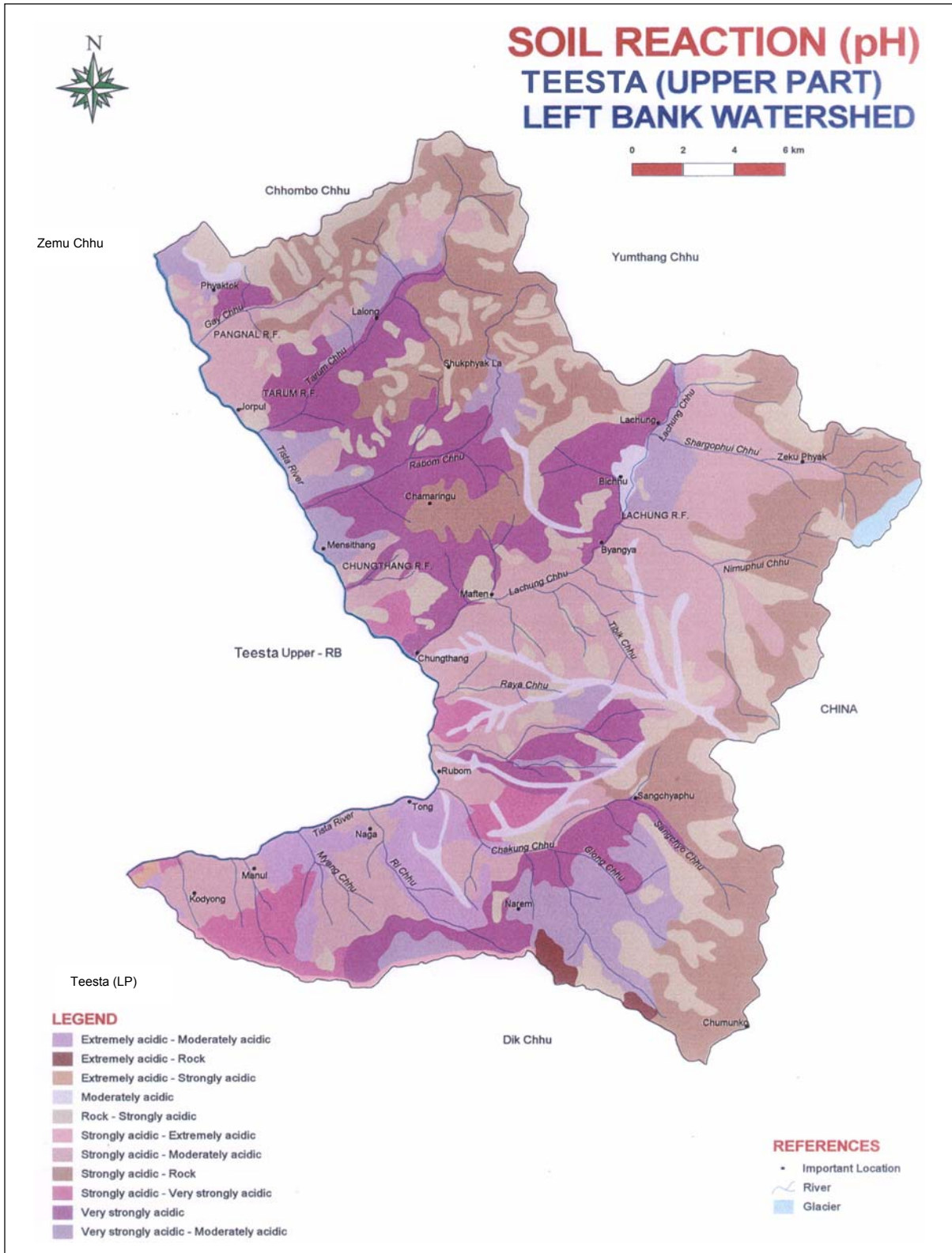


Fig. 4.42 Soil reaction class of Teesta (Upper-LB) watershed

4	VIIe2s	17,45,47	8244.1	13.6
5	VIIe3	6	67.5	0.1
6	VIIIe4s	3	9844.8	16.3
	Miscellaneous		235.2	0.4

4.6 YUMTHANG CHHU WATERSHED

4.6.1 Landforms

Five broad landform regions *viz.* rocky cliff, morainic zone, high mountain, very high mountain and extremely high mountain, and seven landform units were identified in this watershed through the interpretation of satellite imagery, toposheet and traversing the area. In this watershed, extremely high mountain occupies maximum area (52.1%) followed by very high mountain, rocky cliff, morainic zone occupying 9.0, 8.4, 5.7 per cent area respectively (Fig. 4.44).

4.6.2 Soils

Twelve soil series were identified in this watershed and were mapped into seven soil mapping units at the level of soil series association (Table 4.39 and Fig. 4.45). The dominant soil series occupying in this watershed are Thangu, Yumthang, Jorpul, Kalep. The Thangu – rockout crop association (mapping unit 63) occupies largest area of 29,864.7 ha (52.1%) while least area of 0.2 per cent is occupied by ship – Theng – Pakel association (mapping unit 47) and Rapung –

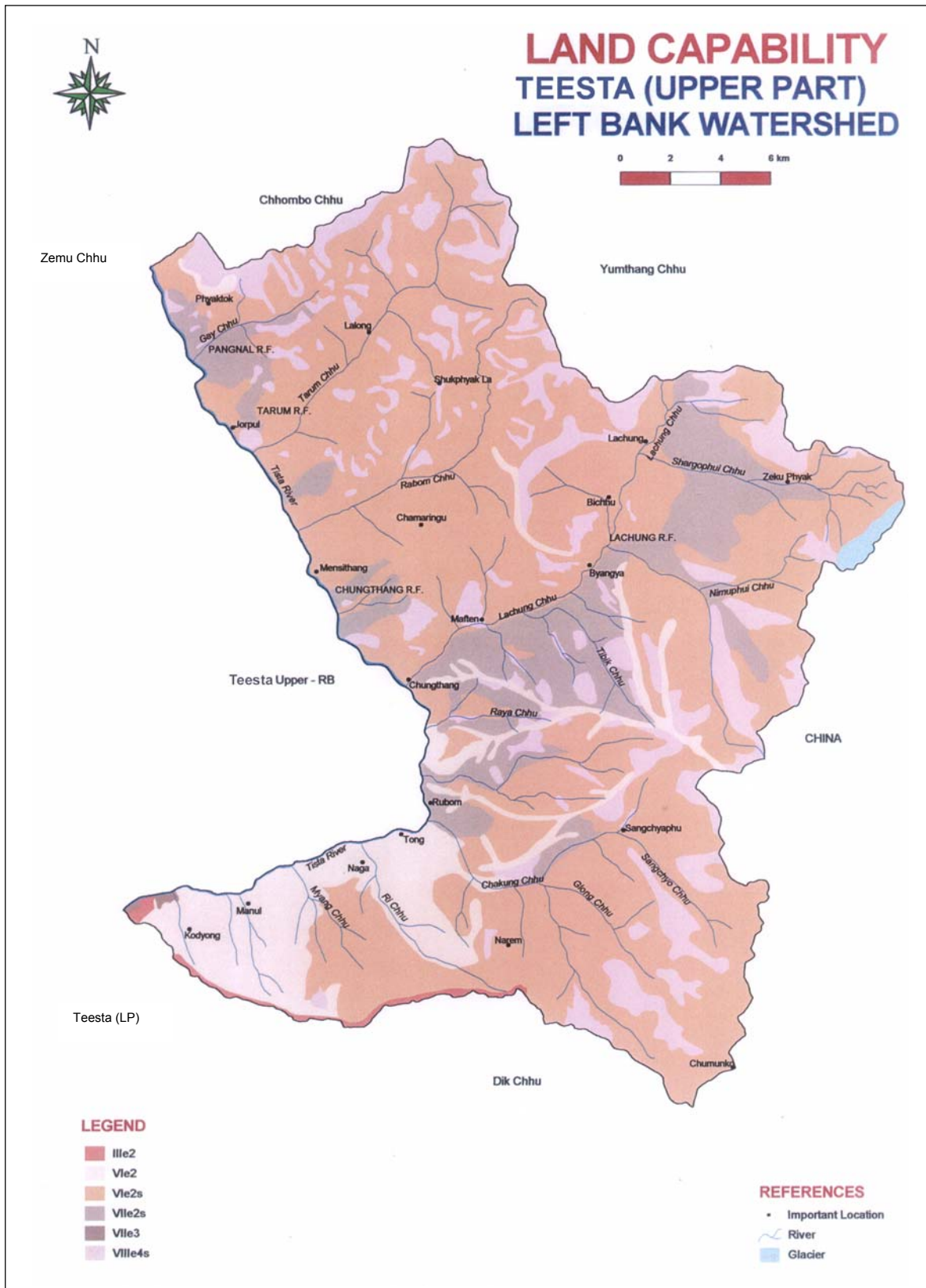


Fig. 4.43 Land capability class of Teesta (Upper-LB) watershed

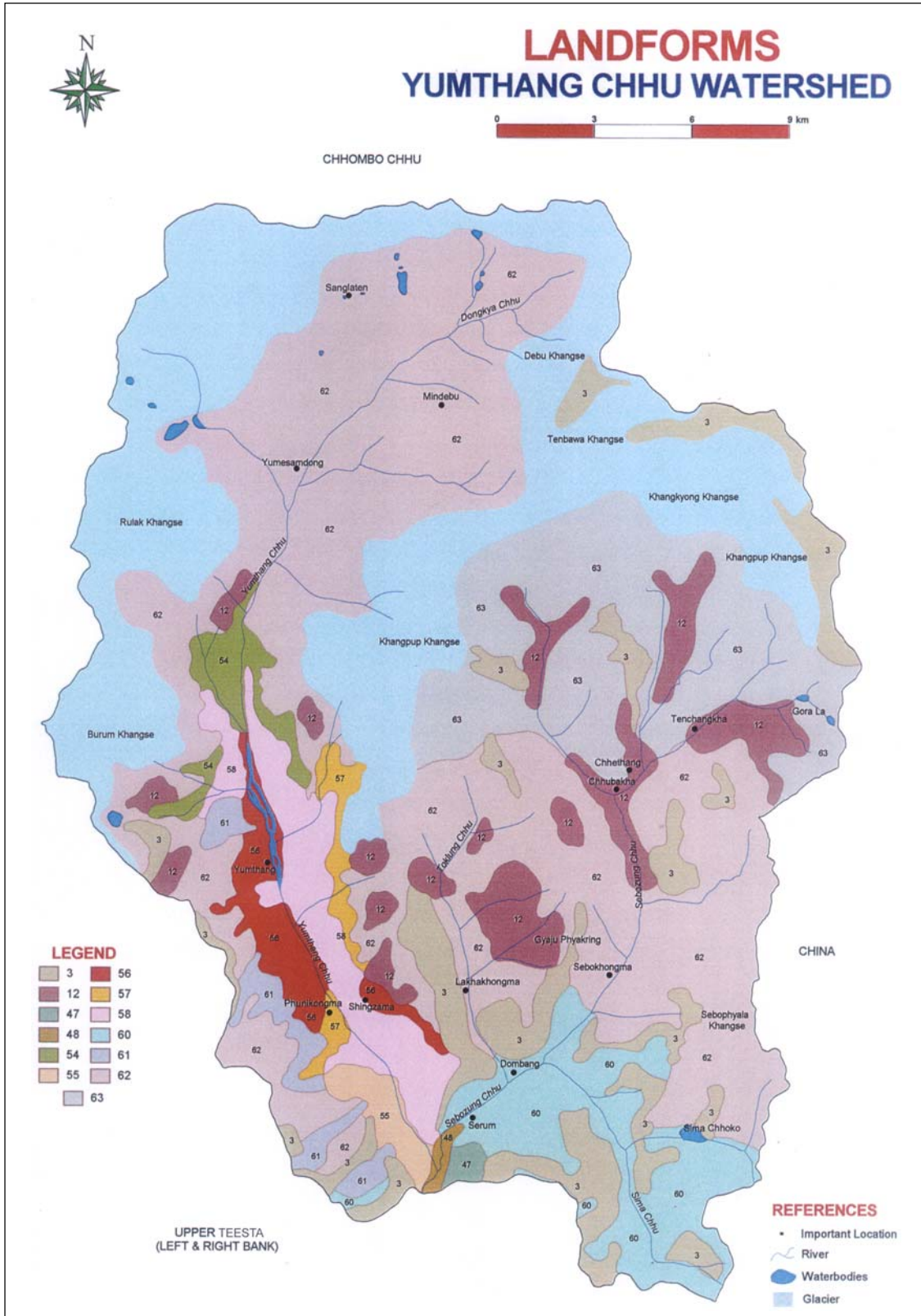


Fig. 4.44 Landforms of Yumthang Chhu watershed

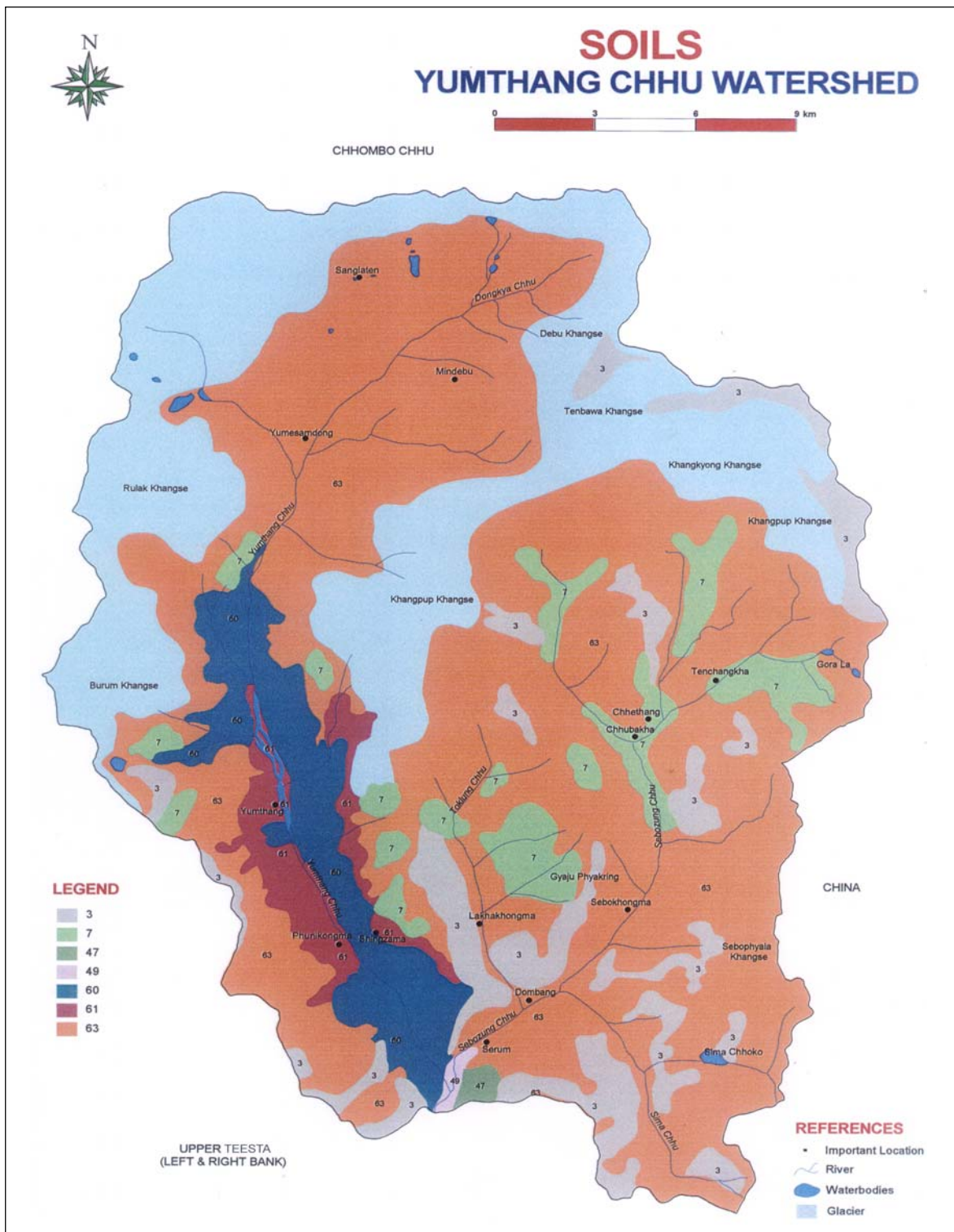


Fig. 4.45 Soils of Yumthang Chhu watershed

Meusithang – Rock out crop association (mapping unit 49) of high mountain.

Table 4.39 Soils of Yumthang Chhu watershed

Soil unit	Soil Series Association	Area (In ha)	% of watershed
3	Rock outcrops – Jorpul	4833.0	8.4
7	Kalep – Rock outcrop	3276.5	5.7
47	Ship – Theng – Pakel	127.1	0.2
49	Rapung – Mensithang – Rock outcrop	108.1	0.2
60	Lachung- Puchikongma - Byuma	3496.8	6.1
61	Yumthang – Thangu – Kalep	1623.2	2.8
63	Thangu – Rock outcrop	29864.7	51.9
	Miscellaneous	13950.1	24.2
	Total	57279.5	99.5

4.6.3 Soil depth

Five soil depth classes *viz.* deep, moderately deep, moderately shallow, shallow and very shallow were identified in the watershed and were mapped at the level of association of soil depth classes into six mapping units (Table 4.40 and Fig. 4.46). Moderately shallow – rock association (mapping unit 2) occupies largest area of 33,141.2 ha (57.9%) while moderately shallow – shallow association (mapping unit 2) and very shallow – moderately deep association (mapping unit 6) occupies least area (0.2%). Rock in combination with very shallow

(mapping unit 4) and moderately shallow (mapping unit 2) occupies 8.4 and 57.9 per cent area respectively.

Table 4.40 Soil depth of Yumthang Chhu watershed

Map Unit	Description	Soil Map units	Area (In ha)	% of watershed
1	Deep-very shallow	61	1623.2	2.8
2	Mod.shallow-Rock	7,63	33141.2	57.9
3	Mod.shallow-Shallow	49	108.1	0.2
4	Rock-very shallow	3	4833.0	8.4
5	Shallow-mod.deep	60	3496.8	6.1
6	Very shallow- mod.deep	47	127.1	0.2
		Miscellaneous	13950.1	24.4

4.6.4 Surface texture

Four surface soil textural class viz. loam (l), sandy clay loam (scl), sandy loam (sl) and loamy sand (ls) were identified in the watershed and were mapped as the association of surface soil textural class into six mapping units (Table 4.41 and Fig. 4.47). In this watershed, loam – rock association (mapping unit 1) of extremely high mountain occupies largest area of 29,864.7 ha (52.1%) while sandy clay loam – sandy loam association (mapping unit 3) occupies least area of 127.1 ha (0.2%). The sandy loam – loamy sand association (mapping unit 4) from high to very high mountain occupies 3,604.9 ha (6.3%) which is very susceptible to landslide or mass movement.

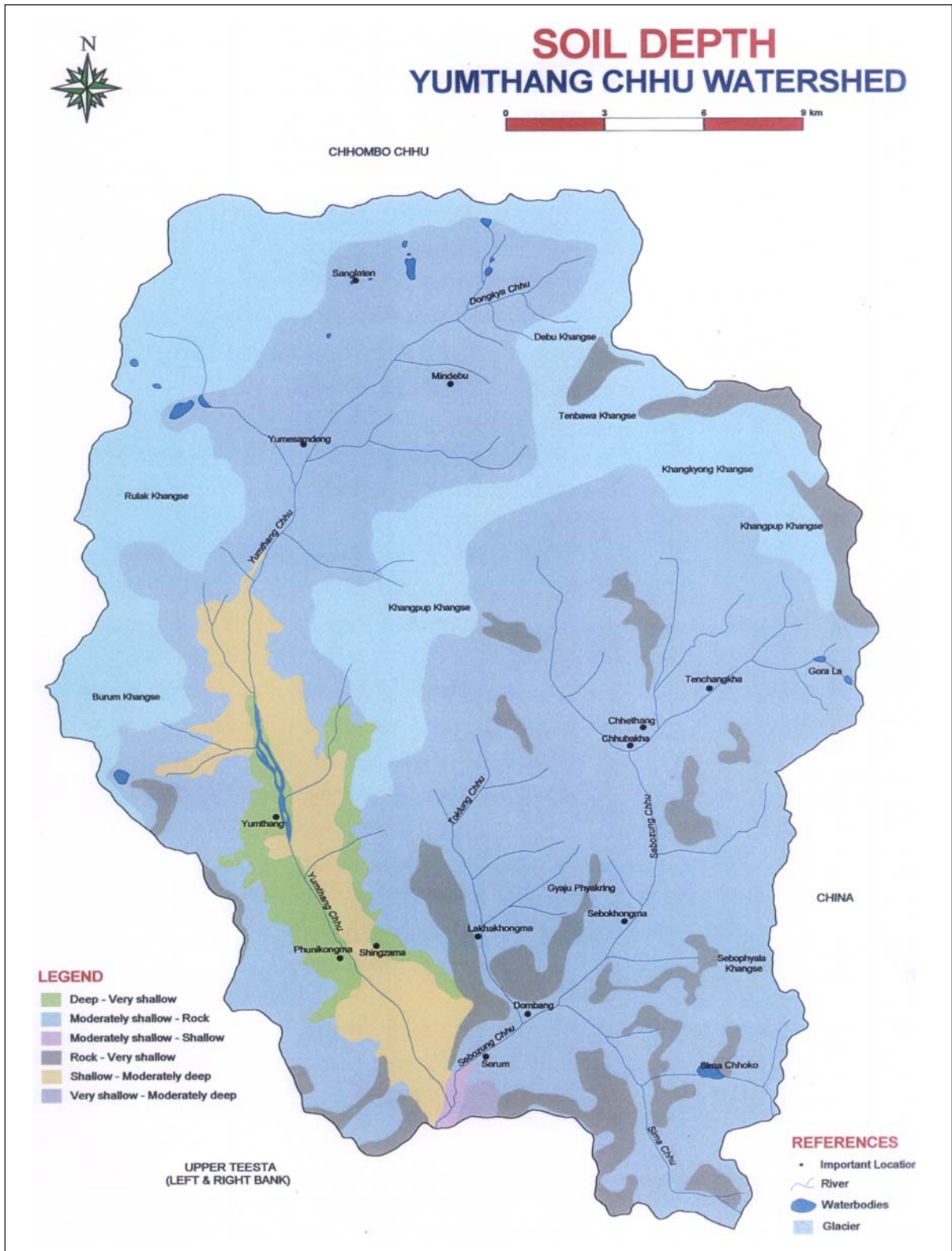


Fig. 4.46 Soil depth class of Yumthang Chhu watershed

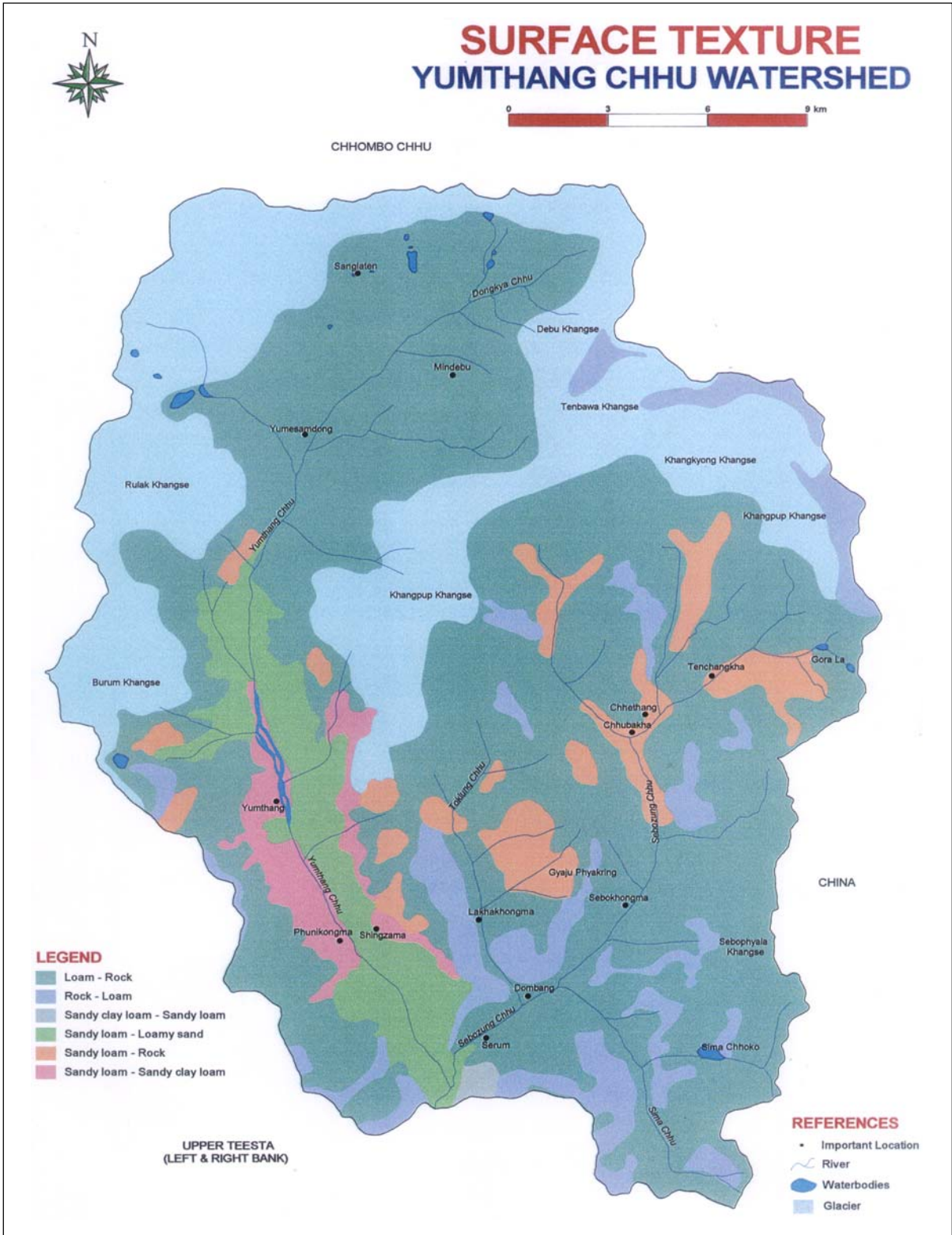


Fig. 4.47 Surface texture class of Yumthang Chhu watershed

Table 4.41 Surface texture of Yumthang Chhu watershed

Map unit	Description	Soil Map units	Area (In ha)	% of watershed
1	I-R	63	29864.7	52.1
2	R-I	3	4833.0	8.5
3	scl-sl	47	127.1	0.2
4	sl-ls	49,60	3604.9	6.3
5	sl-R	7	3276.5	5.7
6	sl-scl	61	1623.2	2.8
		Miscellaneous	13950.1	24.4

4.6.5 Soil erosion

Three erosion classes *viz.* moderate, severe and very severe were identified in the watershed and mapped into six mapping units at the level of association of erosion classes (Table 4.42 and Fig. 4.48). The very severe – severe association (mapping unit 6) is a problematic area of the watershed occupying 127.1 ha (0.2%) area which require soil conservation measure to protect the natural resource. Moderate erosion alone (mapping unit 1) and severe erosion alone (mapping unit 4) occupies 2.8 and 6.1 per cent area of the watershed.

Table 4.42 Soil erosion of Yumthang Chhu watershed

Map unit	Description	Soil Map units	Area (In ha)	% of watershed
1	M	61	1623.2	2.8

2	M-R	7,63	33141.2	57.9
3	R-VS	3	4833.0	8.4
4	S	60	3496.8	6.1
5	S-M	49	108.1	0.2
6	VS-S	47	127.1	0.2
	Miscellaneous		13950.1	24.4

4.6.6 Soil reaction

Four soil reaction classes *viz.* extremely acidic, very strongly acidic, strongly acidic and moderately acidic, were identified in the watershed and were mapped into seven mapping units at the level of association of soil reaction classes (Table 4.43 and Fig. 4.49). Strongly acidic – rock association (mapping unit 5) of extremely high mountain occupies largest area of 29,864.7 ha (52.1%) followed by very strongly acidic class alone (mapping unit 6) of very high mountain occupying 3,496.8 ha (6.1%). Rock in association with strongly acidic class occurs in rocky cliff (mapping unit 2) and extremely high mountain (mapping unit 5) occupies 8.5 and 52.1 per cent area of the watershed.

Table 4.43 Soil reaction of Yumthang Chhu watershed

Map Unit	Description	Soil Map Units	Area (In ha)	% of Watershed
1	EX-R	7	3276.5	5.7
2	R-S	3	4833.0	8.5
3	S-M	47	127.1	0.2
5	S-R	63	29864.7	52.1

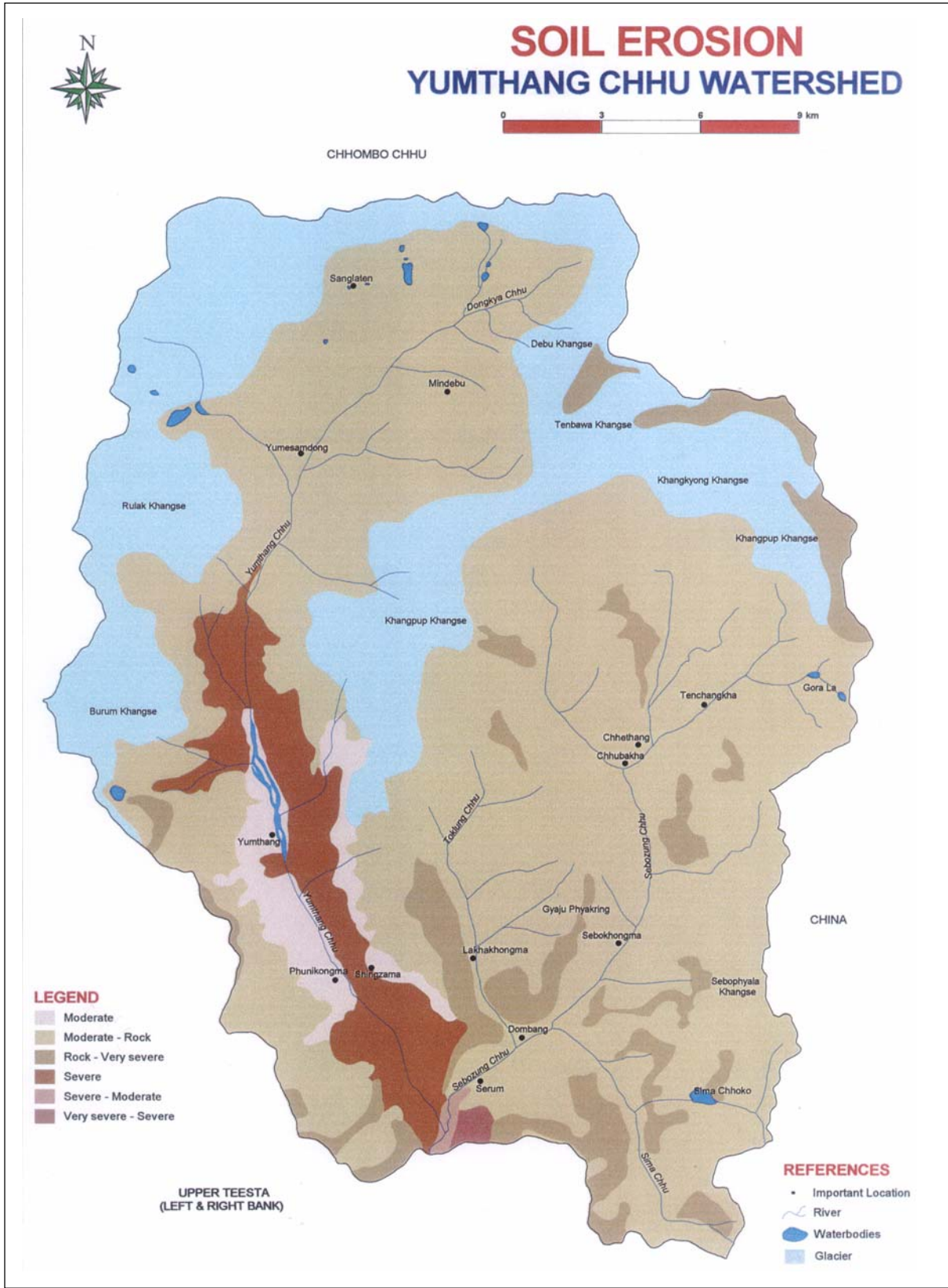


Fig. 4.48 Soil erosion class of Yumthang Chhu watershed

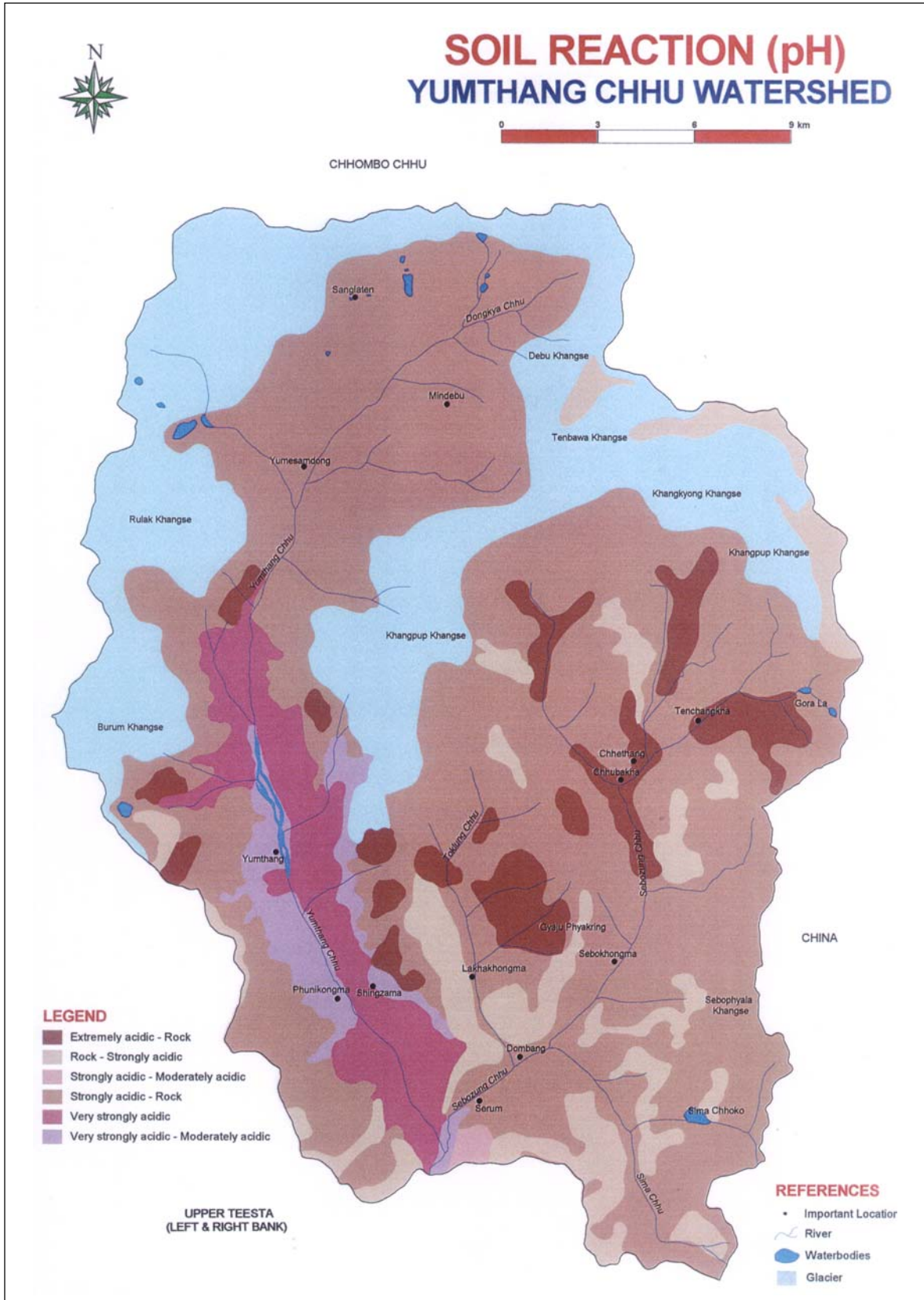


Fig. 4.49 Soil reaction class of Yumthang Chhu watershed

6	VS	60	3496.8	6.1
7	VS-M	49,61	1731.3	3.0
		Miscellaneous	13950.1	24.4

4.6.7 Land capability class (LCC)

Three land capability classes *viz.* VI, VII and VIII and three land capability sub-classes *viz.* VIe2s, VIIe2s and VIIle4s were identified in this watershed and mapped (Table 4.44 and Fig. 4.50). The result indicates that land capability subclass VIe2s occurs mostly in morainic zone and high to extremely high mountain and occupies largest area of 38,369.3 ha (67.0%). The rocky cliff area represented by land capability sub-class VIIle4s occupies 4,833.0 ha (8.4%) area of the watershed.

Table 4.44 Land capability of Yumthang Chhu watershed

Map Unit	Description	Soil Map Units	Area (In ha)	% of Watershed
1	VIe2s	7,48,60,61,63	38369.3	67.0
2	VIIe2s	47	127.1	0.2
3	VIIIle4s	3	4833.0	8.4
		Miscellaneous	13950.1	24.4

4.7 CHHOMBO CHHU WATERSHED

4.7.1 Landforms

Four broad landform regions *viz.* rocky cliff, morainic zone, very high mountain and extremely high mountain and five landform units

were identified in this watershed through the interpretation of satellite imagery, toposheet and through field traverse (Fig. 4.52.). The study revealed that very high mountain occupy major area (59.3%) followed by rocky cliff (7.2%), high mountain (10.5%) and morainic zone (3.7%) (see Fig. 4.51).

4.7.2 Soils

Seven soil series *viz.* Jorpul, Kalep, Lachung, Puchikongma, Byuma, Yumthang and Thangu were identified in the watershed and were mapped into five mapping units at the level of soil series association (Table 4.45 and Fig. 4.52). The mapping unit 63 of extremely high mountain comprising Thangu and Rock out crop occupies major area of 41,539.2 ha (59.3%). The soils of very high mountain (mapping unit 60 and 61) comprising Lachung – Puchikongma – Byuma and Yumthang – Thangu – Kalep soil series association occupy an area of 7,297 ha (10.5%). Soils of morainic zone (mapping unit 7) comprising Kalep – Rock out crop occupies 1,100.1 ha (1.6%) area of the watershed.

Table 4.45 Soils of Chhombu Chhu watershed

Soil unit	Soil Series Association	Area (In ha)	% of watershed
3	Rock outcrops – Jorpul	5048.1	7.2
7	Kalep – Rock outcrop	1100.1	1.6
60	Lachung- Puchikongma – Byuma	2561.5	3.7
61	Yumthang – Thangu – Kalep	4735.5	6.8

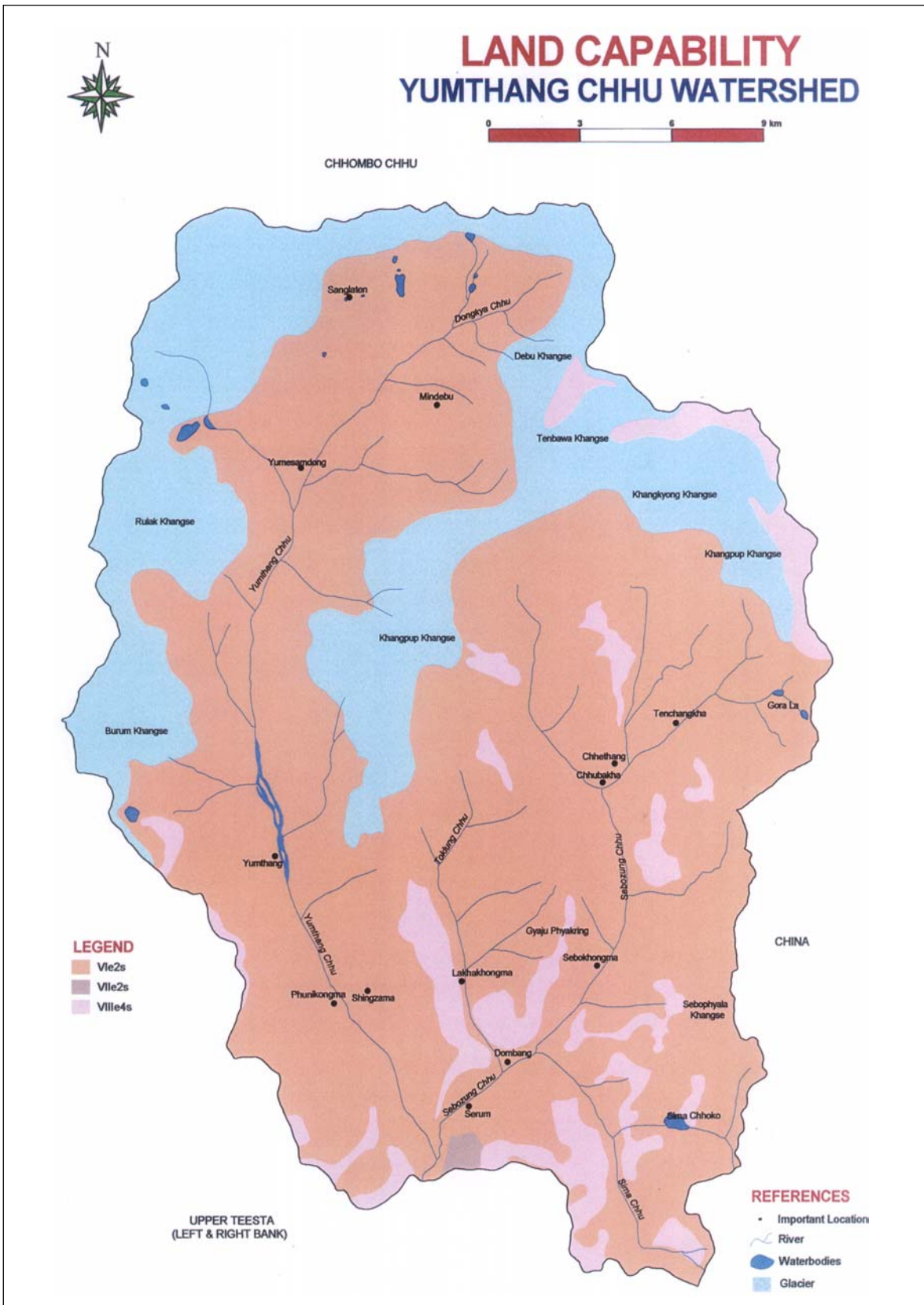


Fig. 4.50 Land capability class of Yumthang Chhu watershed

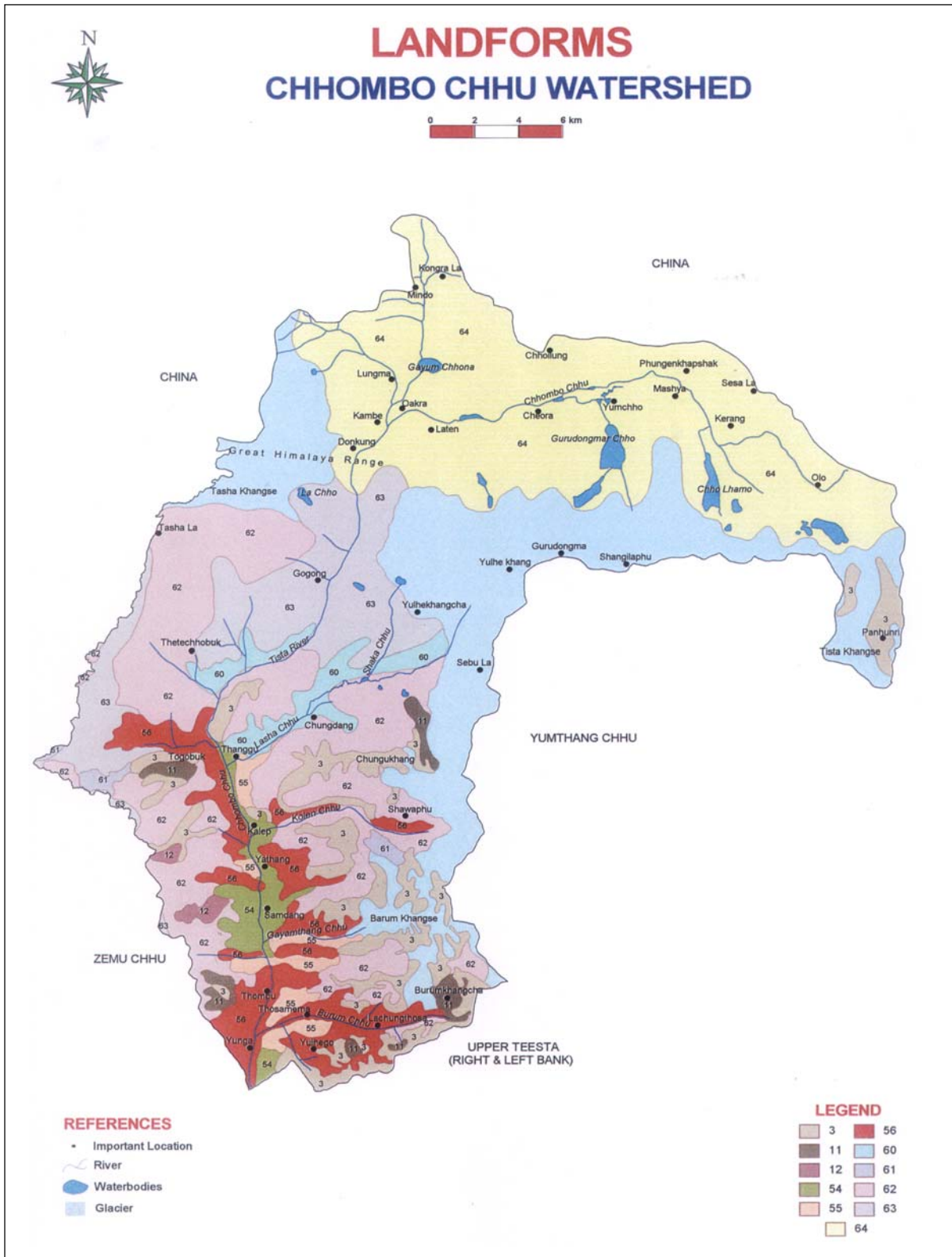


Fig. 4.51 Landforms of Chhombu Chhu watershed

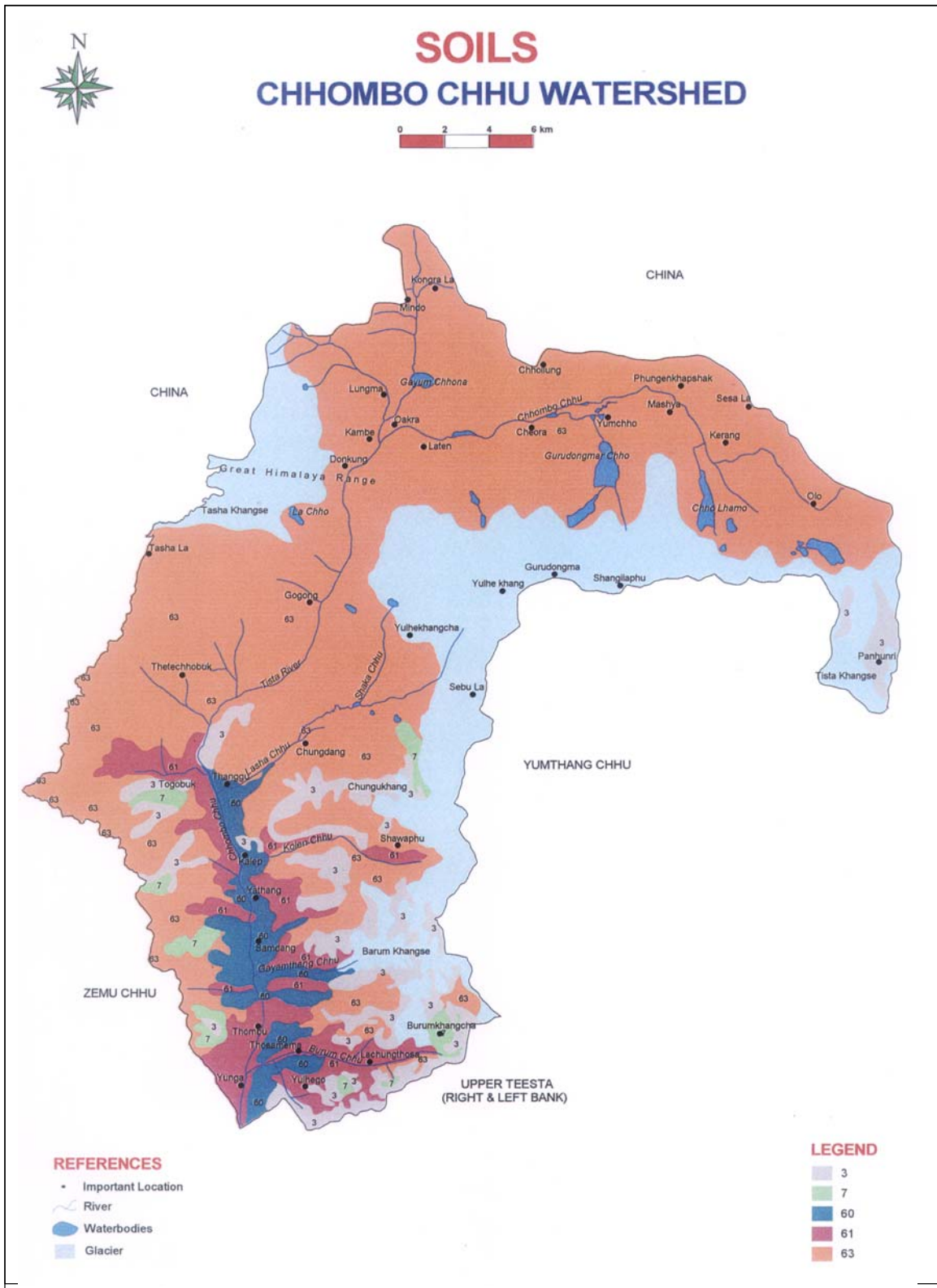


Fig. 4.52 Soils of Chhombu Chhu watershed

63	Thangu – Rock outcrop	41539.2	59.3
	Miscellaneous	15014.4	21.4
	Total	69998.2	100.0

4.7.3 Soil depth

Five soil depth classes *viz.* deep, moderately deep, moderately shallow, shallow and very shallow were identified in the watershed and were mapped into four mapping units at the level of association of soil depth classes (Table 4.46 and Fig. 4.53). Mapping unit 2 comprising moderately shallow – Rock association occupies largest area of 42,639.3 ha (60.9%) followed by rock – very shallow association (mapping unit 3), deep – very shallow association (mapping unit 1) and shallow – moderately deep association (mapping unit 4) occupying 7.2, 6.8 and 3.7 per cent area respectively.

Table 4.46 Soil depth of Chhombu Chhu watershed

Map unit	Description	Soil Map units	Area (In ha)	% of watershed
1	Deep-very shallow	61	4735.5	6.8
2	Mod.shallow-Rock	7,63	42639.3	60.9
3	Rock-very shallow	3	5048.1	7.2
4	Shallow-mod.deep	60	2561.5	3.7
	Miscellaneous		15014.1	21.4

4.7.4 Surface texture

Four surface textural class *viz.* loam (l), sandy loam (sl), loamy sand (ls) and sandy clay loam (scl) were identified in the watershed and were mapped into five mapping units at the level of association of surface textural class (Table 4.47 and Fig. 4.54). The study indicates that loam and sandy loam are the dominant textural class in the watershed. Rock in association with loam (mapping unit 1 & 2) and sandy loam (mapping unit 4) occupies 66.5 and 1.6 per cent area of the watershed. The mapping unit 3 comprising sandy loam – loamy sand association occupies 3.7 per cent area of the watershed and are most susceptible to erosion which should be protected through soil conservation measure.

Table 4.47 Surface texture of Chhombu Chhu watershed

Map unit	Description	Soil Map units	Area (In ha)	% of watershed
1	I-R	63	41539.2	59.3
2	R-I	3	5048.1	7.2
3	sl-ls	60	2561.5	3.7
4	sl-R	7	1100.1	1.6
5	sl-scl	61	4735.5	6.8
		Miscellaneous	15014.1	21.4

4.7.5 Soil erosion

Three soil erosion classes *viz.* very severe, severe and moderate were identified in this watershed and were mapped into four mapping

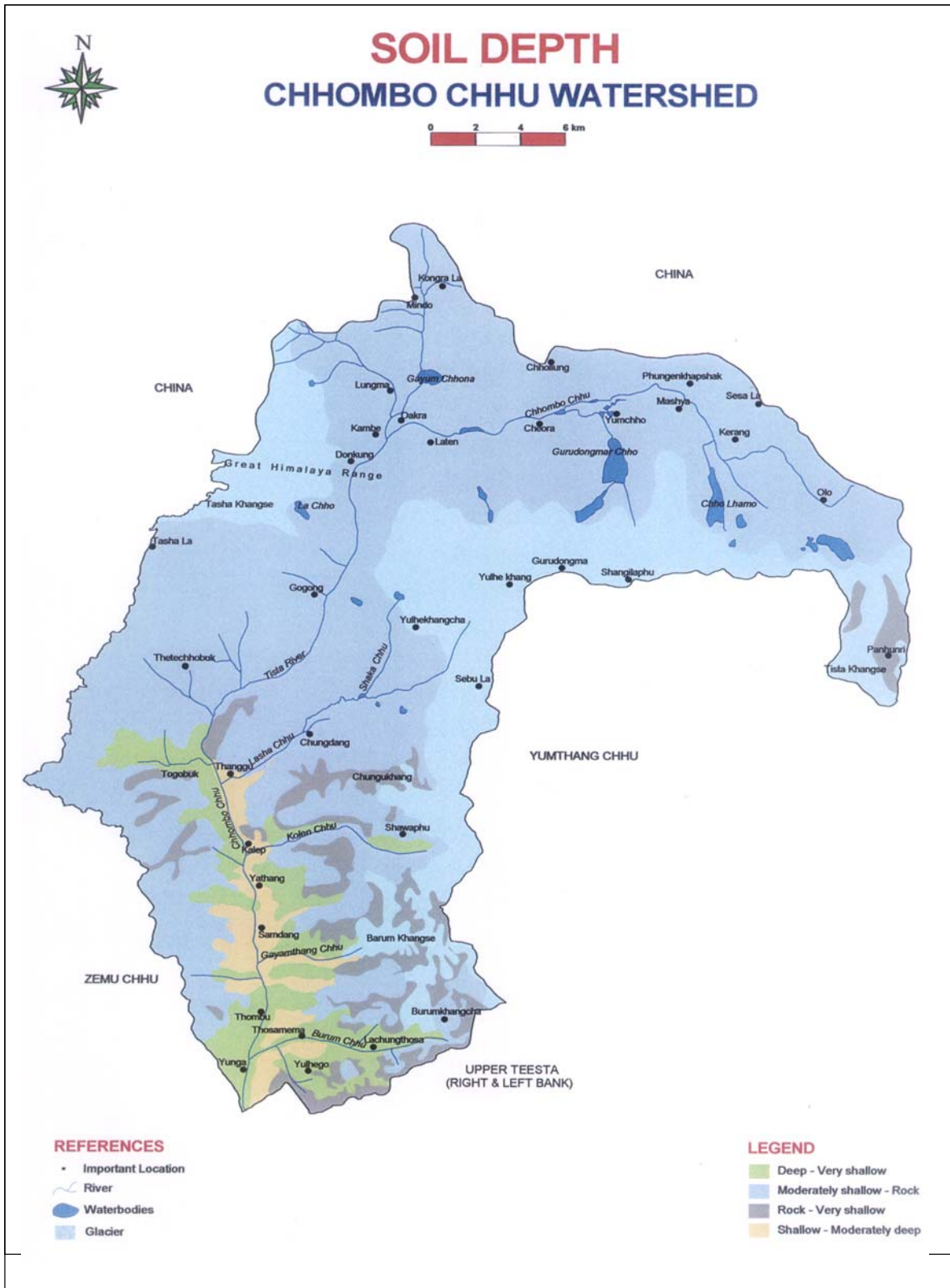


Fig. 4.53 Soil depth class of Chhombu Chhu watershed

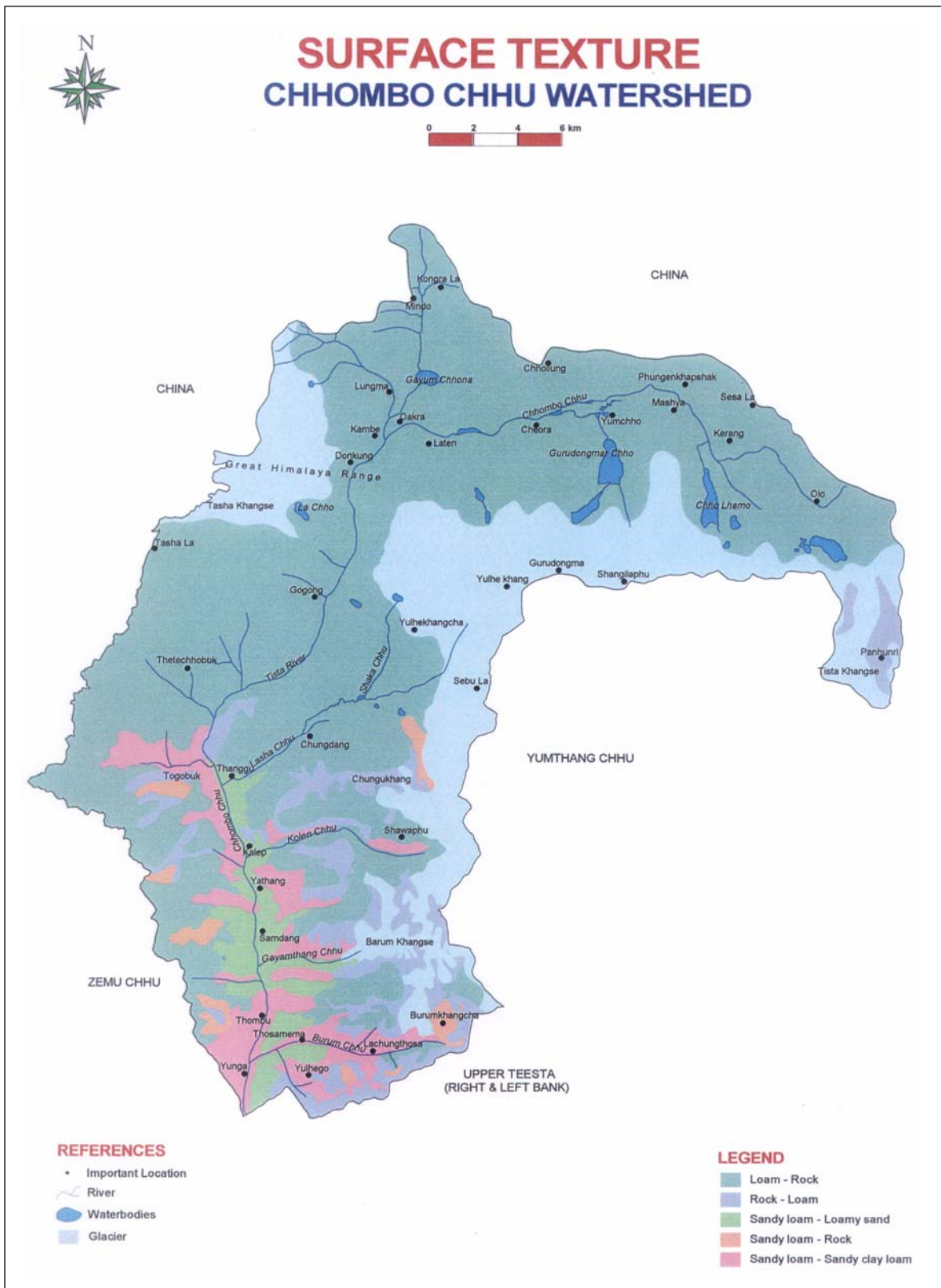


Fig. 4.54 Surface texture class of Chhombu Chhu watershed

units at the level of association of soil erosion classes (Table 4.48 and Fig. 4.55). The most problematic area (mapping unit 3) comprising Rock – very severe erosion association occupies 5,048.1 ha (7.2%) area which should be protected through soil conservation measure. Only severe erosion alone (mapping unit 4) in the very high mountain (30-50% slope) occupies 3.7 per cent area of the watershed. Rock in combination with moderate erosion (mapping unit 2) and very severe erosion (mapping unit 3) occupies 60.9 and 7.2 per cent area respectively.

Table 4.48 Soil erosion of Chhombu Chhu watershed

Map Unit	Description	Soil Map Units	Area (In ha)	% of Watershed
1	M	61	4735.5	6.8
2	M-R	7,63	42639.3	60.9
3	R-VS	3	5048.1	7.2
4	S	60	2561.5	3.7
		Miscellaneous	15014.1	21.4

4.7.6 Soil reaction

Four soil reaction classes *viz.* extremely acidic, very strongly acidic, strongly acidic and moderately acidic were identified in this watershed and were mapped as association of soil reaction classes into six mapping units (Table 4.49 and Fig. 4.56). Strongly acidic – rock association (mapping unit 3) occupies largest area of 41,539.2 ha (59.3%) while extremely acidic – rock association (mapping unit 1)

occupies least area of 1,100.1 ha (1.6%). Very strongly acidic reaction class alone (mapping unit 5) occupies 2,561.5 ha (3.7%) area of the watershed.

Table 4.49 Soil reaction of Chhombu Chhu watershed

Map Unit	Description	Soil Map units	Area (In ha)	% of watershed
1	EX-R	7	1100.1	1.6
2	R-S	3	5048.1	7.2
3	S-R	63	41539.2	59.3
5	VS	60	2561.5	3.7
6	VS-M	61	4735.5	6.8
		Miscellaneous	15014.1	21.4

4.7.7 Land capability class (LCC)

Only two land capability class *viz.* VI and VIII and two land capability sub-classes were identified in the watershed and mapped (Table 4.50 and Fig. 4.57). The land capability sub-class VIe2s mostly occurring in morainic zone and very high to extremely high mountain occupies larger area of 49,936.3 ha (71.4%) while the rocky cliff represented by land capability sub-class VIIIe4s occupies 5,048.1 ha (7.2%) area of the watershed.

Table 4.50 Land capability of Chhombu Chhu watershed

Map Unit	Description	Soil Map Units	Area (In ha)	% of Watershed
1	VIe2s	7,60,61,63	49936.3	71.4



Fig. 4.55 Soil erosion class of Chhombu Chhu watershed

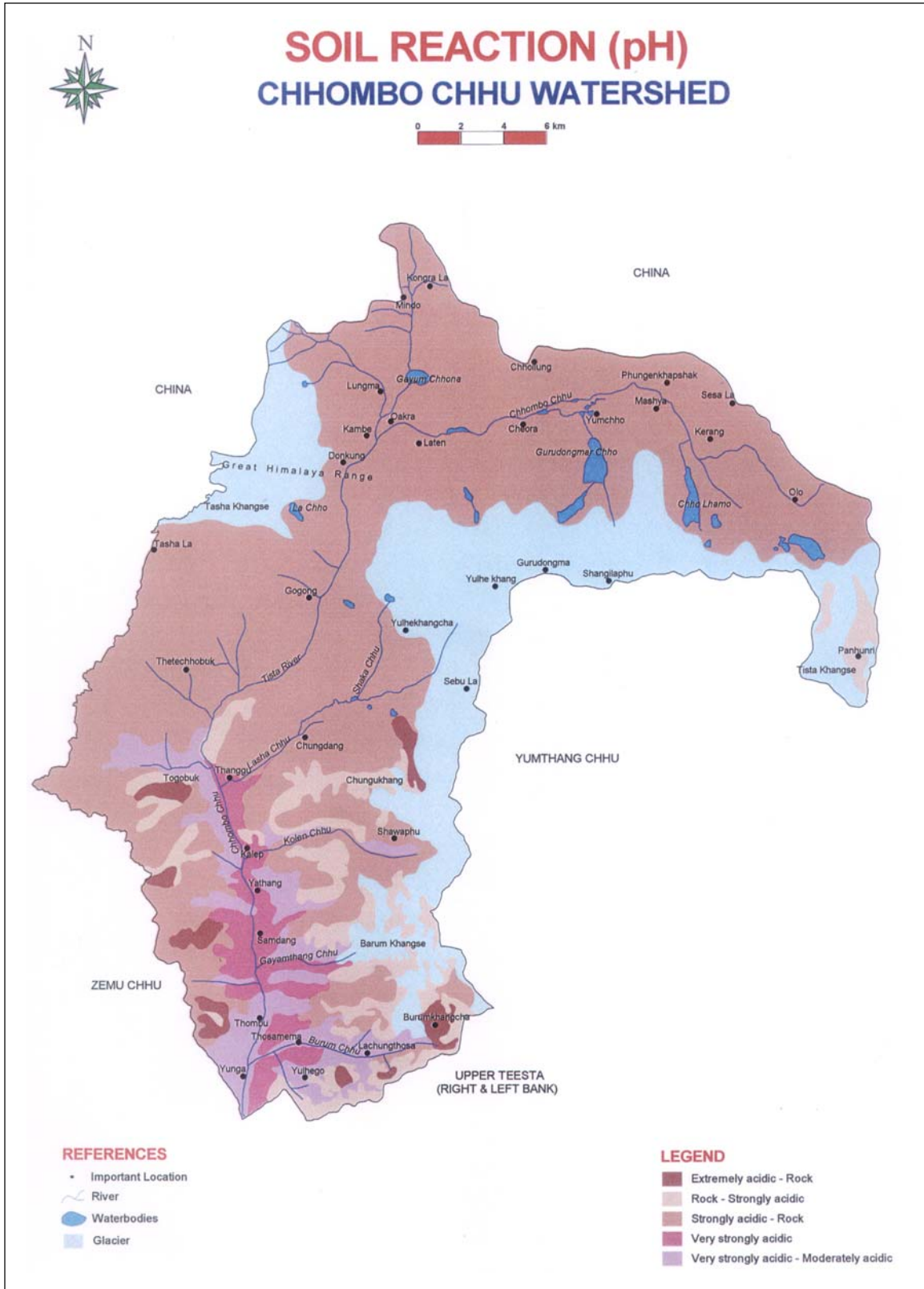


Fig. 4.56 Soil reaction class of Chhombu Chhu watershed

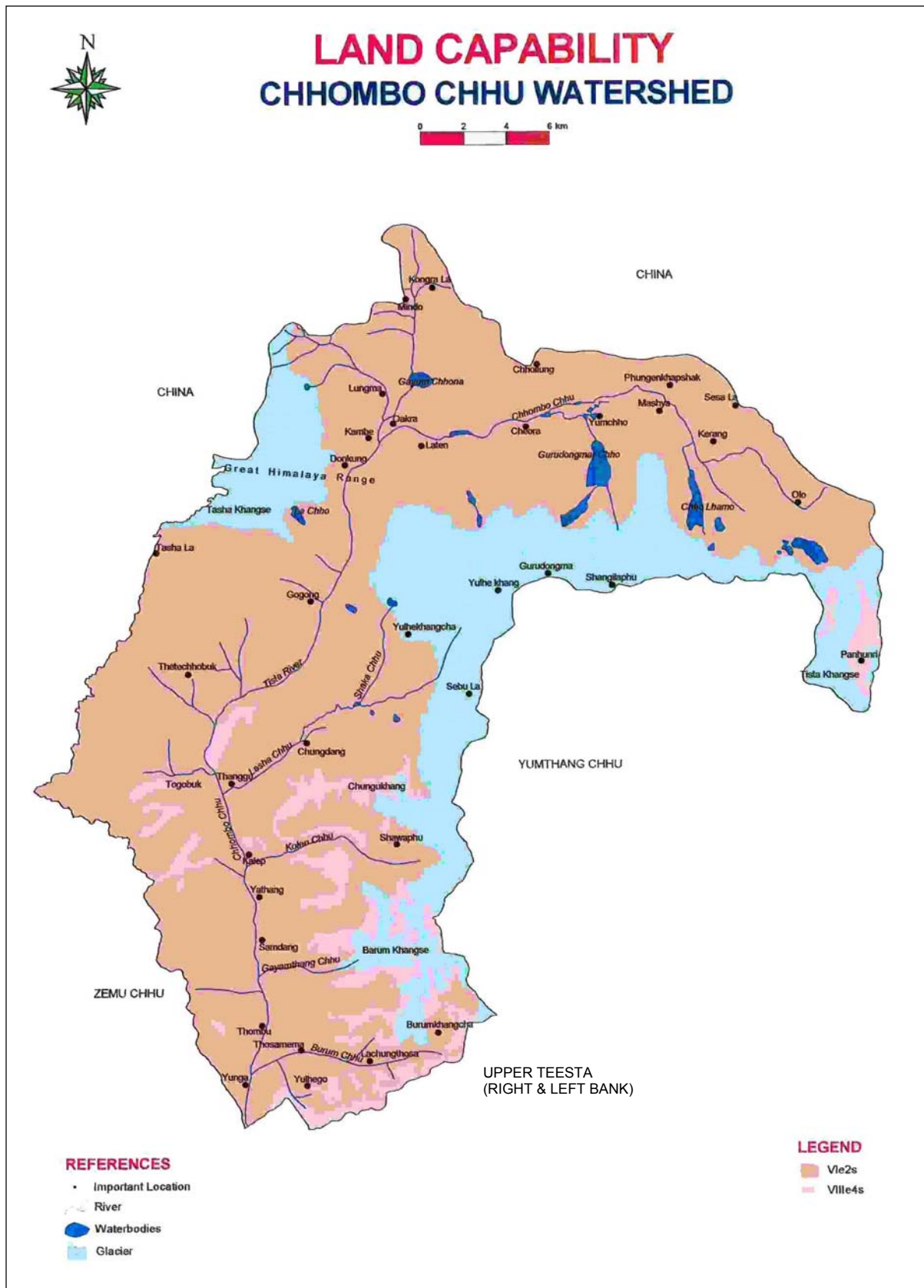


Fig. 4.57 Land capability class of Chhombo Chhu watershed

2	Ville4s	3	5048.1	7.2
		Miscellaneous	15014.1	21.4

4.8 ZEMU CHHU WATERSHED

4.8.1 Landforms

Four broad landform regions viz. rocky cliff, morainic zone, very high mountain and extremely high mountain were identified in this watershed through the interpretation of satellite imagery, toposheet and through traversing the area (Fig. 4.58). In this watershed highest area (41.2%) is covered by extremely high mountain followed by rocky cliff (0.9%), very high mountain (0.4%) and morainic zone (0.2%).

4.8.2 Soils

Eight soil series were found to occur in the soils of the watershed and were mapped into five mapping units at the level of soil series association (Table 4.51 and Fig. 4.59). Thangu – rockout crop association of extremely high mountain (mapping unit 63) occupies major area of 40,808.6 ha (41.2%), while Rockout crop – Jorpul association of rocky cliff (mapping unit 3) occupies the area of 938.7 ha (0.9%). The very high mountain soil represented by Lachung – PuchiKongma – Byuma and Yumthang – Thangu – Kalep association occupies 0.4 per cent area of the watershed. A considerable portion of this watershed remains covered with glacier/ snow cover in most of the period.

Table 4.51 Soils of Zemu Chhu watershed

Soil Unit	Soil Series Association	Area (In ha)	% of Watershed
3	Rock outcrops – Jorpul	938.7	0.9
7	Kalep – Rock outcrop	186.3	0.2
60	Lachung- Puchikongma - Byuma	38.9	0.0
61	Yumthang – Thangu - Kalep	334.1	0.3
63	Thangu – Rock outcrop	40808.6	41.2
	Miscellaneous	56801.6	57.3
	Total	99107.2	100.0

4.8.3 Soil depth

Five soil depth classes *viz.* deep, moderately deep, moderately shallow, shallow and very shallow, have been identified in this watershed and were mapped into four mapping units at the level of association of soil depth classes (Table 4.52 and Fig. 4.60). Moderately shallow – rock association (mapping unit 2) representing morainic zone and extremely high mountain occupy 4,099.4 ha (41.4%) area followed by Rock – very shallow association (mapping unit 3) of rocky cliff occupying 938.6 ha (0.9%) area.

Table 4.52 Soil depth of Zemu Chhu watershed

Map unit	Description	Soil Map units	Area (In ha)	% of watershed
1	Deep –very shallow	61	335.0	0.3
2	Moderately shallow – Rock	7,63	40994.3	41.4

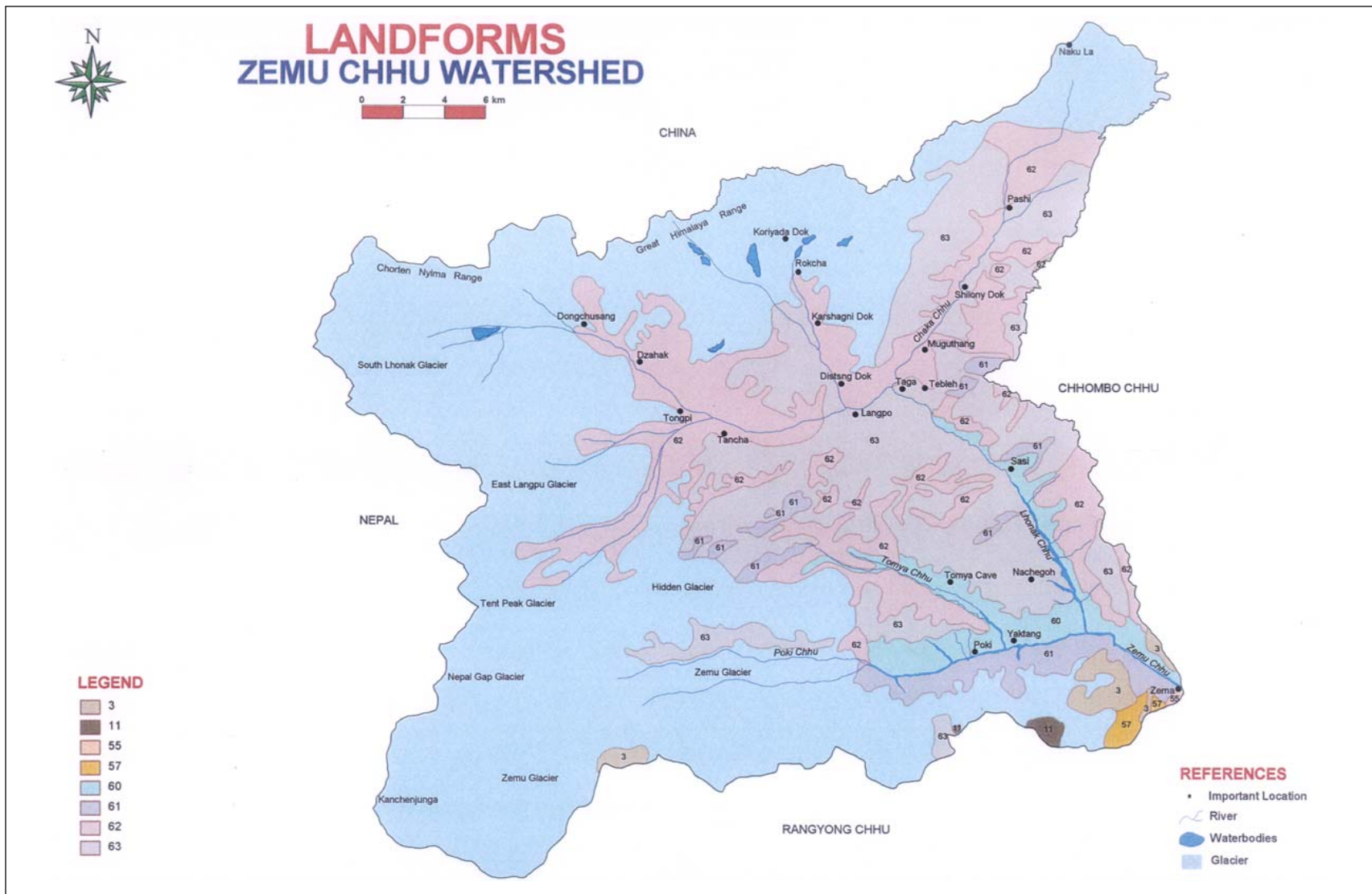


Fig. 4.58 Landforms of Zemu Chhu watershed

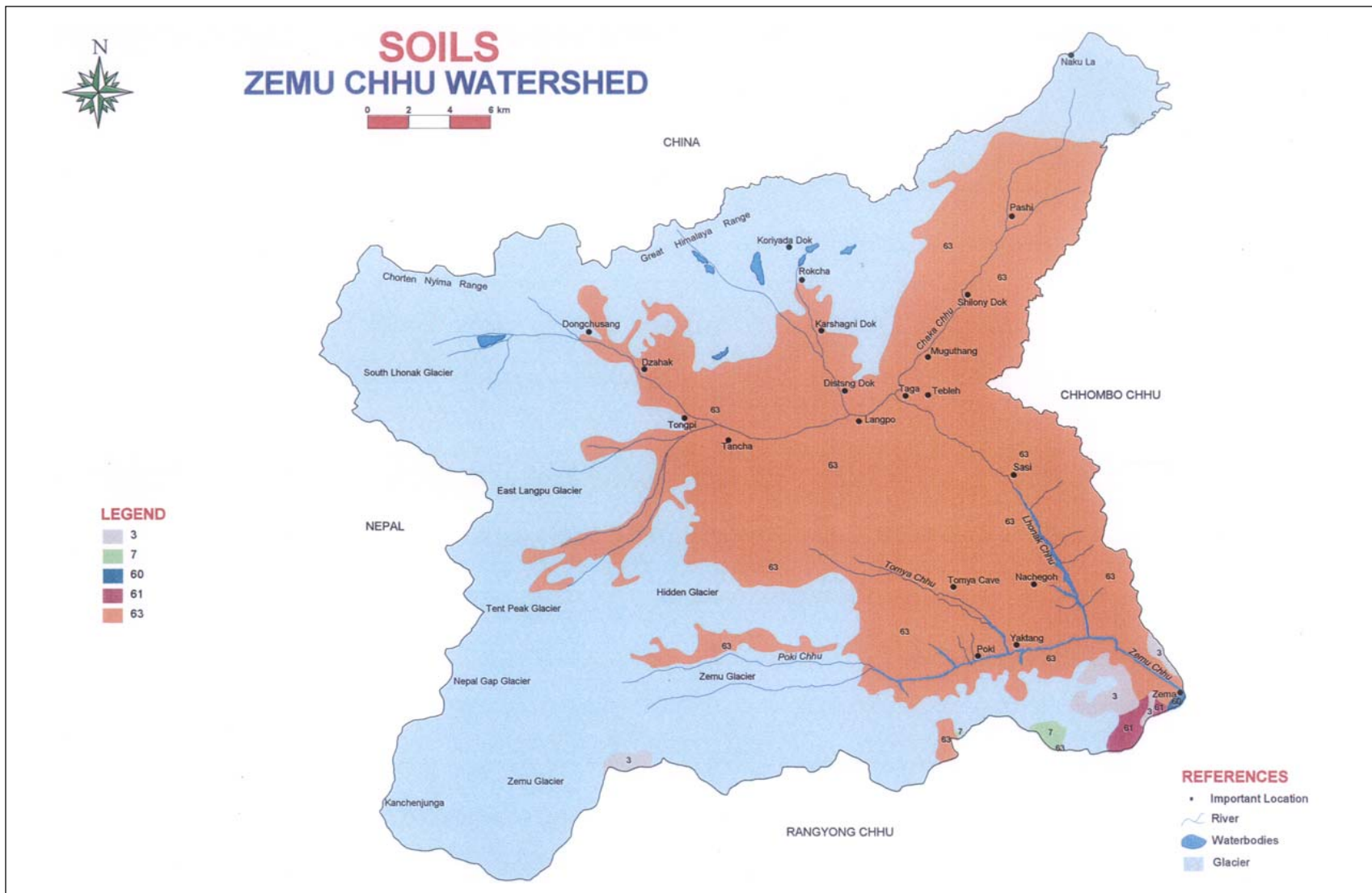


Fig. 4.59 Soils of Zemu Chhu watershed

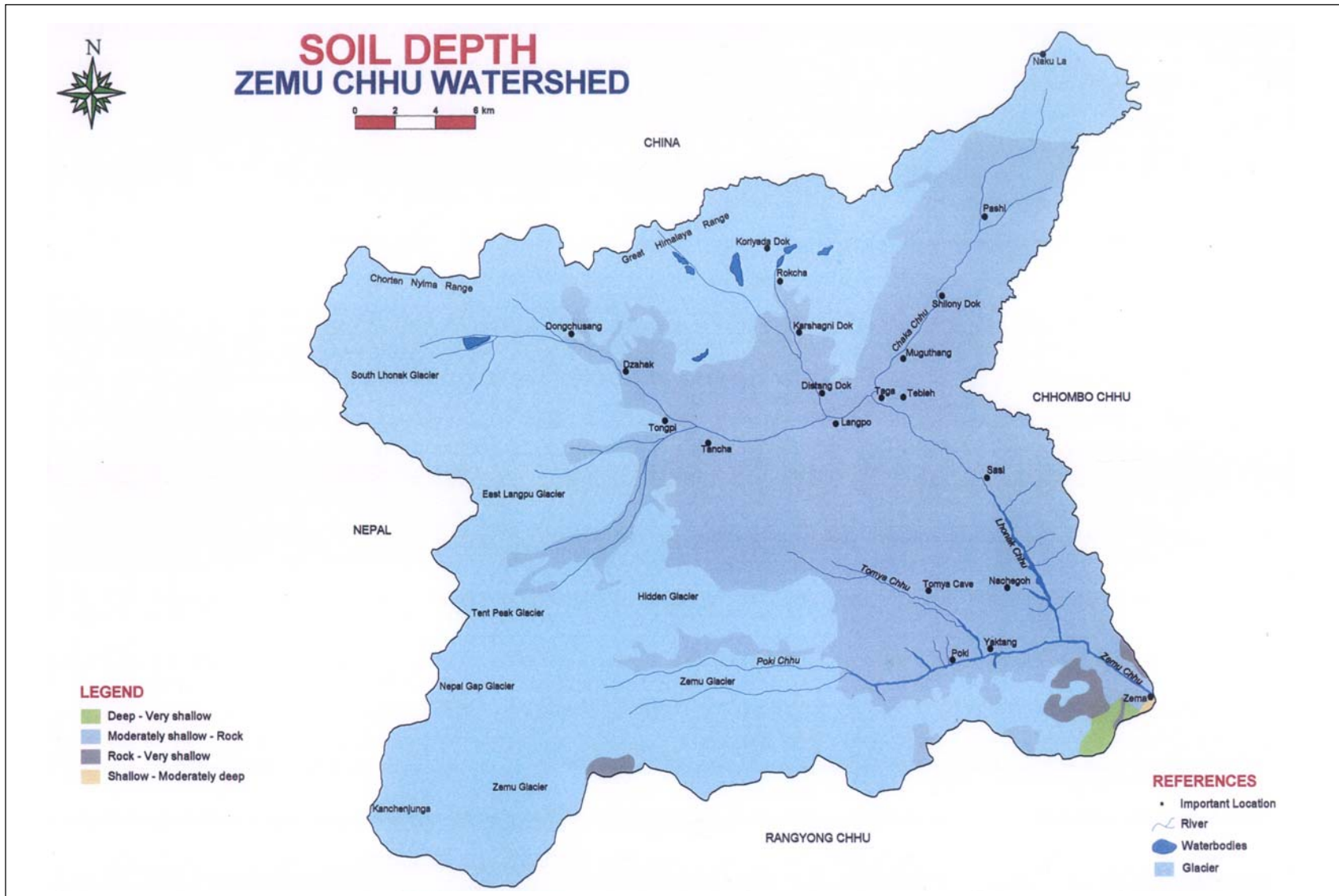


Fig. 4.60 Soil depth class of Zemu Chhu watershed

3	Rock – very shallow	3	938.6	0.9
4	Shallow – moderately deep	60	38.5	0.1
	Miscellaneous		56801.4	57.3

4.8.4 Surface texture

Four surface soil textural classes *viz.* loam (l), sandy loam (sl), loamy sand (ls) and sandy clay loam (scl) have been identified in this watershed and were mapped into five mapping units at the level of association of surface soil textural class (Table 4.53 and Fig. 4.61). Loam – rock outcrop association (mapping unit 5) of extremely high mountain occupies major area of 40,808.2 ha (41.2%). Sandy loam – sandy clay loam association (mapping unit 4) and sandy loam – loamy sand association (mapping unit 2) of very high mountain occupies 0.3 and 0.1 per cent area of the watershed.

Table 4.53 Surface texture of Zemu Chhu watershed

Map Unit	Description	Soil Map units	Area (In ha)	% of watershed
1	R-l	3	938.6	0.9
2	sl-ls	60	38.5	0.1
3	sl-R	7	186.1	0.2
4	sl-scl	61	335.0	0.3
5	l-R	63	40808.2	41.2
	Miscellaneous		56801.4	57.3

4.8.5 Soil erosion

Three soil erosion classes viz. moderate, severe and very severe have been identified in this watershed and mapped into four mapping units at the level of association of soil erosion classes (Table 4.54 and Fig. 4.62). In this watershed, moderate – rock outcrop association (mapping unit 2) occupies highest area of 40,994.3 ha (41.4%) while Rock outcrop – very severe association (mapping unit 3) of rocky cliff occupies 938.6 ha (0.9%) area of the watershed. Moderate and severe erosion class alone occupies 0.3 and 0.1 per cent area of the watershed representing very high mountain.

Table 4.54 Soil erosion of Zemu Chhu watershed

Map Unit	Description	Soil Map units	Area (In ha)	% of watershed
1	M	61	335.0	0.3
2	M-R	7,63	40994.3	41.4
3	R-VS	3	938.6	0.9
4	S	60	38.5	0.1
		Miscellaneous	56801.4	57.3

4.8.6 Soil reaction

Four soil reaction classes viz. extremely acidic, very strongly acidic, strongly acidic and moderately acidic were found to occur in the soils of the watershed and were mapped into six mapping units at the level of association of soil reaction classes (Table 4.55 and Fig. 4.63). Soils of extremely high mountain representing the association of strongly

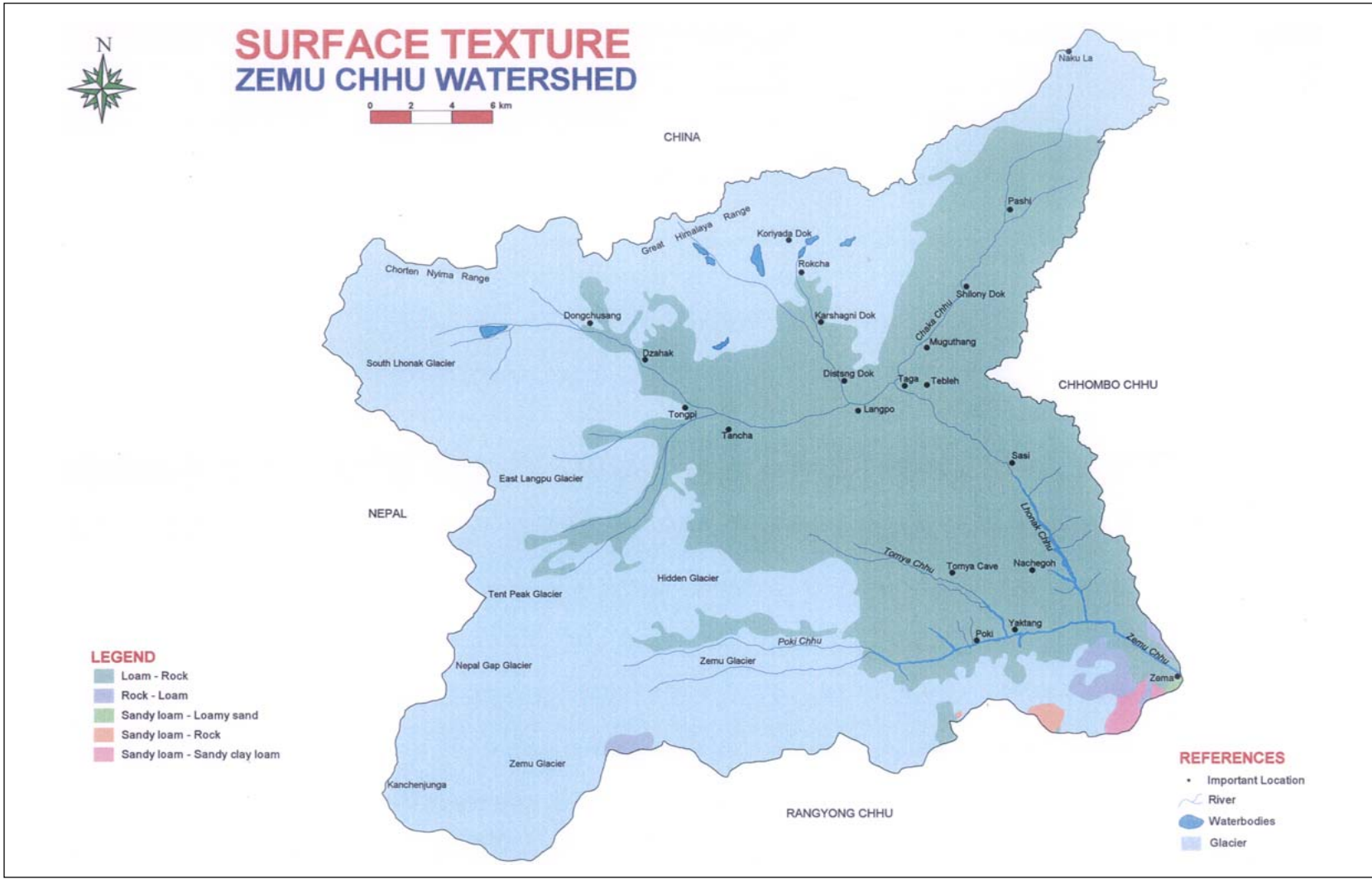


Fig. 4.61 Surface texture class of Zemu Chhu watershed

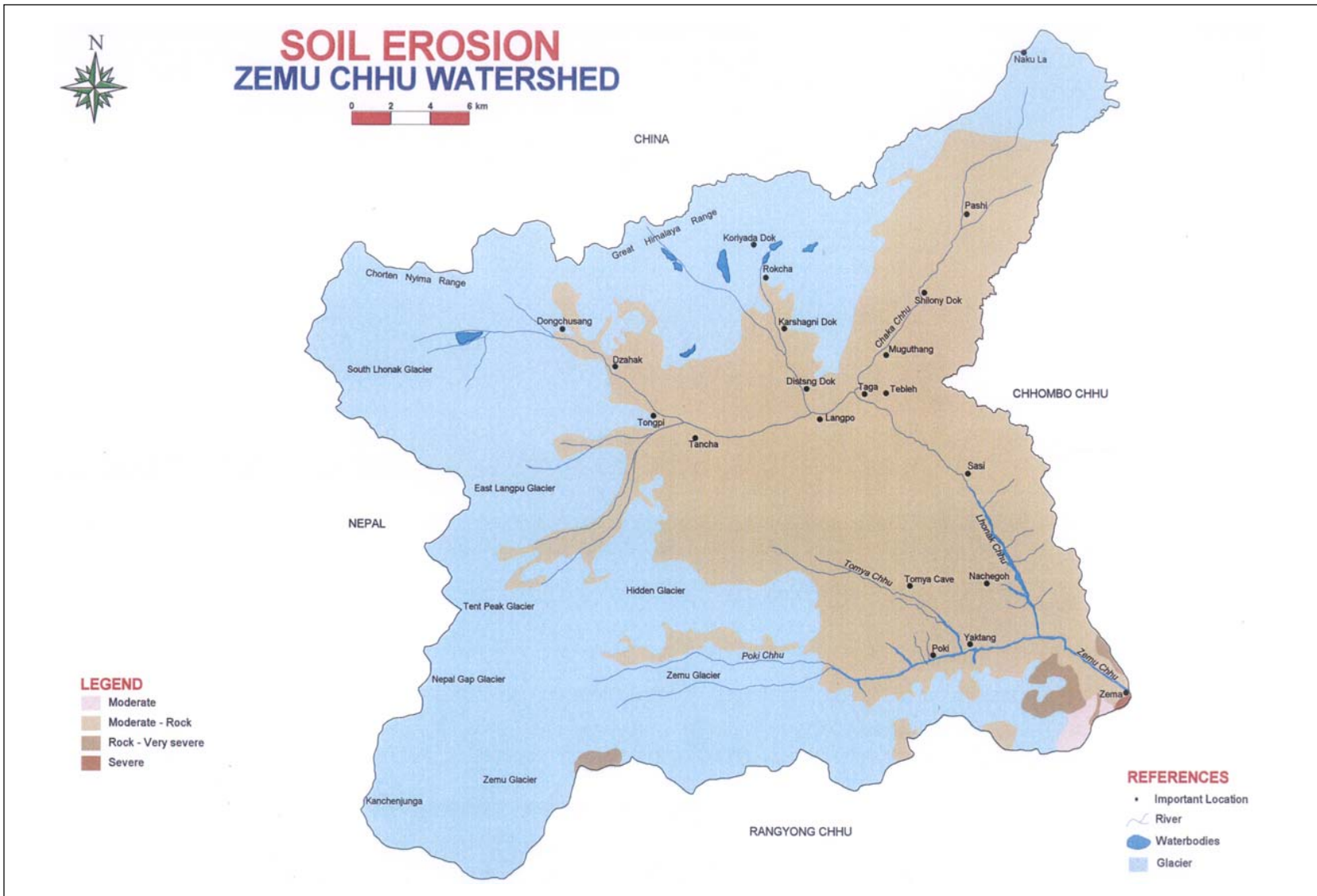


Fig. 4.62 Soil erosion class of Zemu Chhu watershed

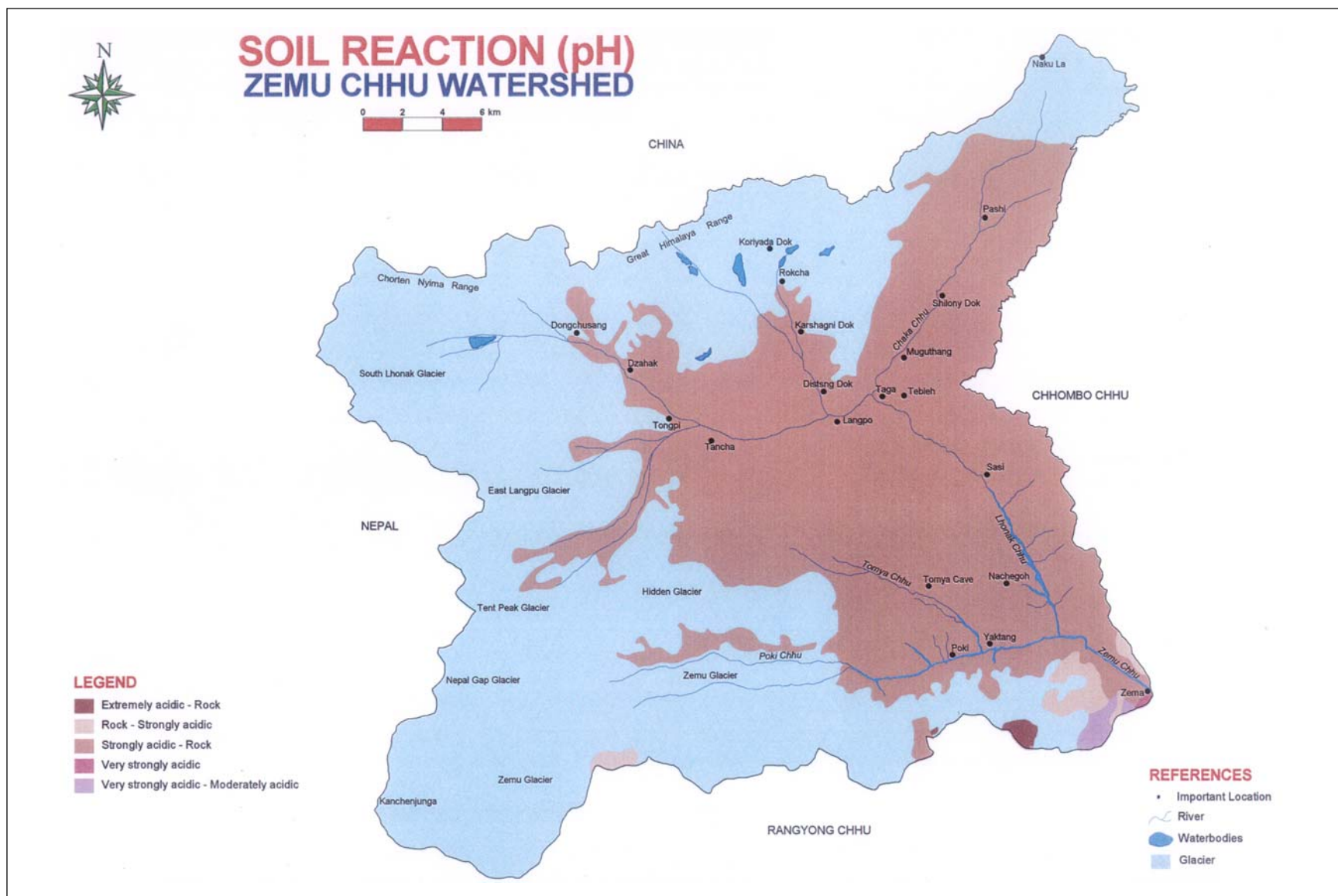


Fig. 4.63 Soil reaction class of Zemu Chhu watershed

acidic – rock outcrop occupies major area 40808.2 ha (41.2%) of the watershed. Very high mountain soil represented by mapping units 5 and 6 occupies 0.4 per cent area of the watershed. Strongly and very strongly acidic soil dominates in the watershed.

Table 4.55 Soil reaction of Zemu Chhu watershed

Map Unit	Description	Soil Map Units	Area (In ha)	% of Watershed
1	EX-R	7	186.1	0.2
2	R-S	3	938.6	0.9
3	S-R	63	40808.2	41.2
5	VS	60	38.5	0.1
6	VS-M	61	335.0	0.3
		Miscellaneous	56801.4	57.3

4.8.7 Land capability class (LCC)

Two land capability classes VI and VIII and two land capability sub-classes VIe2s and VIIIe4s have been identified in this watershed and mapped (Table 4.56 and Fig. 4.64). In this watershed, land capability sub-class VIe2s representing morainic zone, very high and extremely high mountain occupies 41.8 per cent area followed by the rocky cliff areas representing land capability sub-class VIIIe4s and occupies 0.9 per cent area of the watershed.

Table 4.56 Land capability of Zemu Chhu watershed

Map Unit	Description	Soil Map units	Area (In ha)	% of watershed
2	VIe2s	7,60,61,63	41367.8	41.8
5	VIIIe4s	3	938.6	0.9
		Miscellaneous	56801.4	57.3

4.9 RANGYONG CHHU WATERSHED

4.9.1 Landforms

Eight broad landform regions viz. ridge, rocky cliff, escarpment, morainic zone, mid mountain, high mountain, very high mountain, extremely high mountain and twenty four landform units were identified in this watershed through the interpretation of satellite imagery, toposheet and field traverse. In this watershed, high mountain covers largest area (16.5%) followed by rocky cliff, very high mountain, extremely high mountain and mid mountain covering 16.0, 13.2, 11.3 and 7.7 per cent area respectively (Fig. 4.65). A large area of this watershed remains covered with glacier/ snow cover.

4.9.2 Soils

Total thirty one soil series were identified in this watershed and mapped into 24 soil mapping units at the level of soil series association (Table 4.57 and Fig. 4.66). From this study, it is found that Rock outcrop – Jorpul association (mapping unit 3) occupies largest area of 13,111.9 ha (16.0%) followed by Thangu – Rock outcrop association (mapping unit 63) of extremely high mountain (11.3%), Yumthang – Thangu – Kalep association (mapping unit 61) of very high mountain (7.1%) of the watershed. The dominant soil series found in this watershed were Thangu, Yumthang, Ship, Singhik, etc.

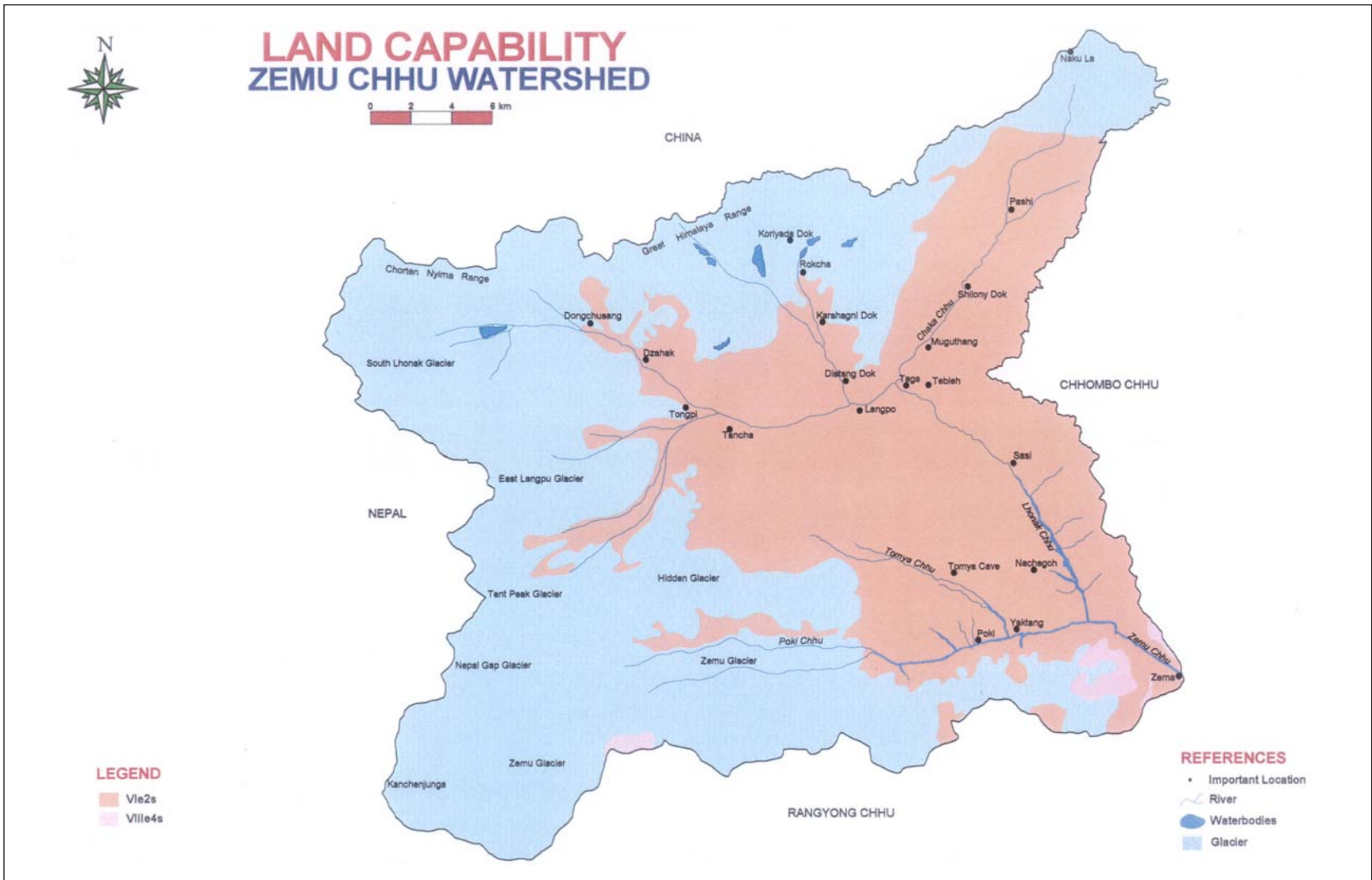


Fig. 4.64 Land capability class of Zemu Chhu watershed

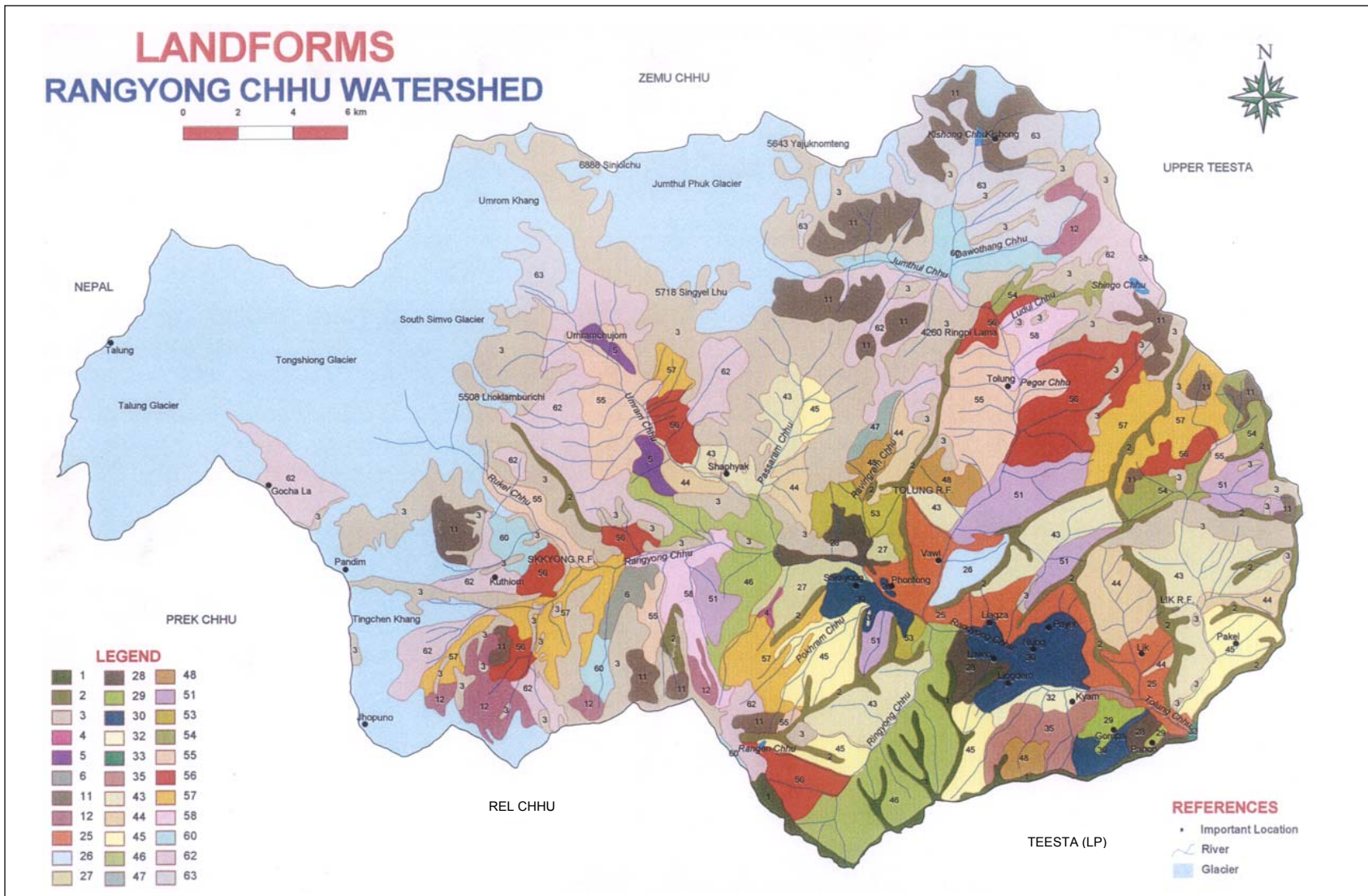


Fig. 4.65 Landforms of Rangyong Chhu watershed

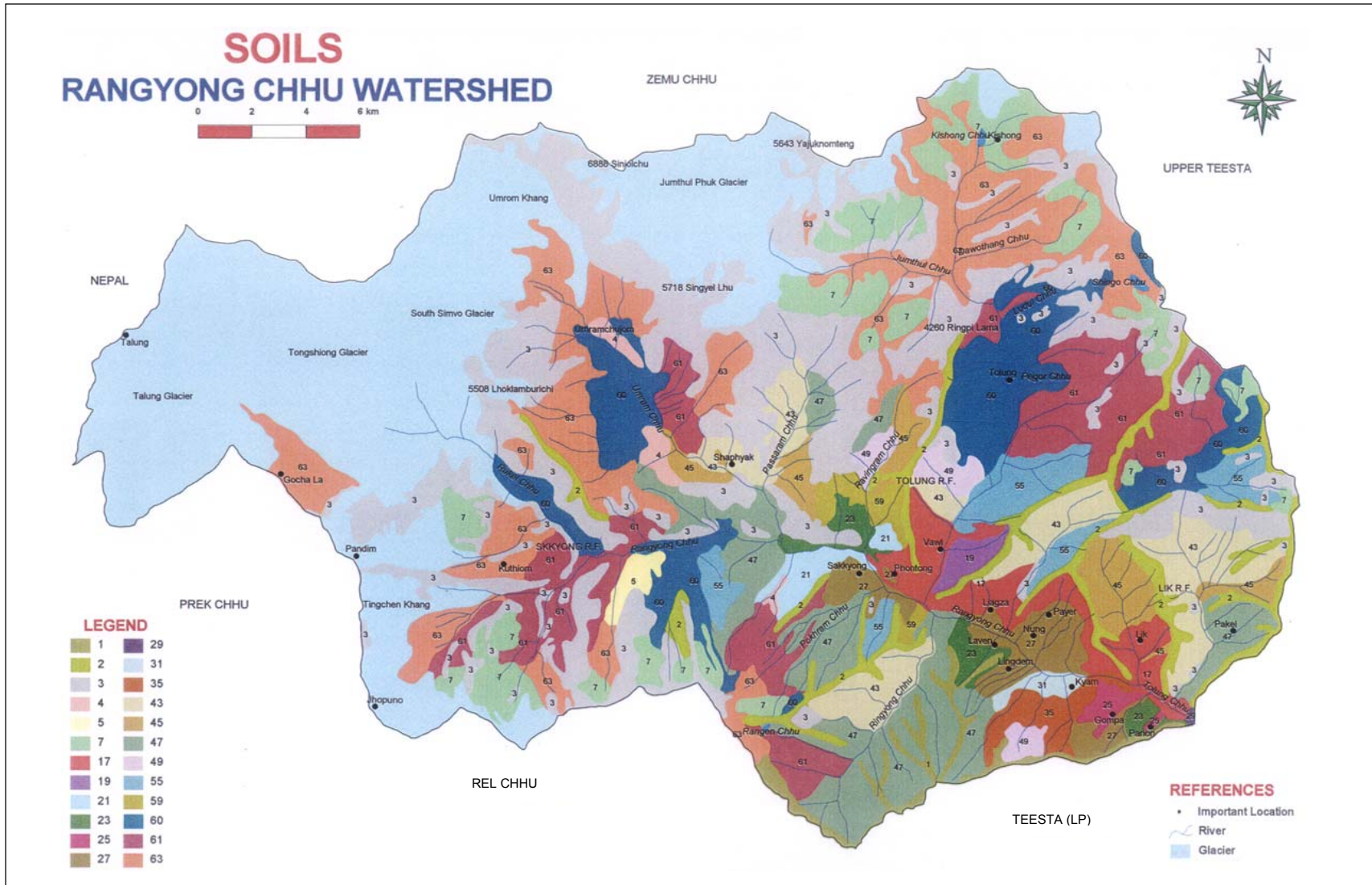


Fig. 4.66 Soils of Rangyong Chhu watershed

Table 4.57 Soils of Rangyong Chhu watershed

Soil unit	Soil Series Association	Area (In ha)	% of watershed
1	Maling-Rayong	825.7	1.0
2	Rubam – Salem	2380.8	2.9
3	Rock outcrops – Jorpul	13111.9	16.0
4	Hilley-Singrep – Chatten	331.9	0.4
5	Bhusuk- Karporang – Tibik	253.6	0.3
7	Kalep – Rock outcrop	4414.8	5.4
17	Chatten-Theng	1938.5	2.4
19	Pakel – Tibik – Rock outcrop	311.7	0.4
21	Singhik – Tibik – Lingthem	491.6	0.6
23	Singhik – Ruglo – Rapung	711.6	0.9
25	Gyer – Manul – Lema	239.2	0.3
27	Nung – Lingthem	1068.7	1.3
29	Lingthem – Lema – Singhik	20.5	0.0
31	Bitchu – Ruglo – Pakel	222.6	0.3
35	Ruglo – Lingthem – Theng	685.7	0.8
43	Tibik-Byuma – Mensithang	3513.1	4.3
45	Chatten-Lema – Tibik	1791.1	2.2
47	Ship – Theng – Pakel	5052.1	6.2
49	Rapung – Mensithang – Rock outcrop	691.1	0.8
55	Ship – Lingthem – Rock outcrop	1922.6	2.3
59	Yumthang – Bitchu	566.3	0.7
60	Lachung- Puchikongma – Byuma	5041.1	6.1
61	Yumthang – Thangu – Kalep	5853.9	7.1
63	Thangu – Rock outcrop	9299.3	11.3
	Miscellaneous	20775.5	25.3
	Total	82054.6	99.3

4.9.3 Soil depth

Five soil depth classes starting from very shallow to deep were found in this watershed and were mapped into thirteen mapping units at the level of association of soil depth classes (Table 4.58 and Fig. 4.67).

Table 4.58 Soil depth of Rangyong Chhu watershed

Map unit	Description	Soil Map units	Area (In ha)	% of watershed
1	Deep	27	1608.7	1.9
2	Deep-mod.deep	4	331.9	0.4
3	Deep-mod.shallow	59	566.3	0.7
4	Deep-very shallow	45,61	7645.0	9.3
5	Mod.deep-deep	1,23,29,35	2243.2	2.7
6	Mod.deep-shallow	21,25	730.8	0.9
7	Mod. Shallow	5	253.6	0.3
8	Mod.shallow-Rock	7,63	13714.1	16.7
9	Mod.shallow-shallow	19,43,49	4515.9	5.5
10	Rock – very shallow	3	13111.9	16.0
11	Shallow-mod.shallow	60	5041.1	6.1
12	Very shallow-deep	55	1922.6	2.3
13	Very shallow-deep	2,17,31,47	9594.0	11.7
		Miscellaneous	20775.5	25.3

Deep soils only (mapping unit 1) occupy 1,608.7 ha (1.9%) area while moderately shallow soils only (mapping unit 7) occupy 253.6 ha (0.3%) area of the watershed. Very shallow soils mostly occur in rocky cliff, high mountain (30-50% slope and above), ridge, mid and high

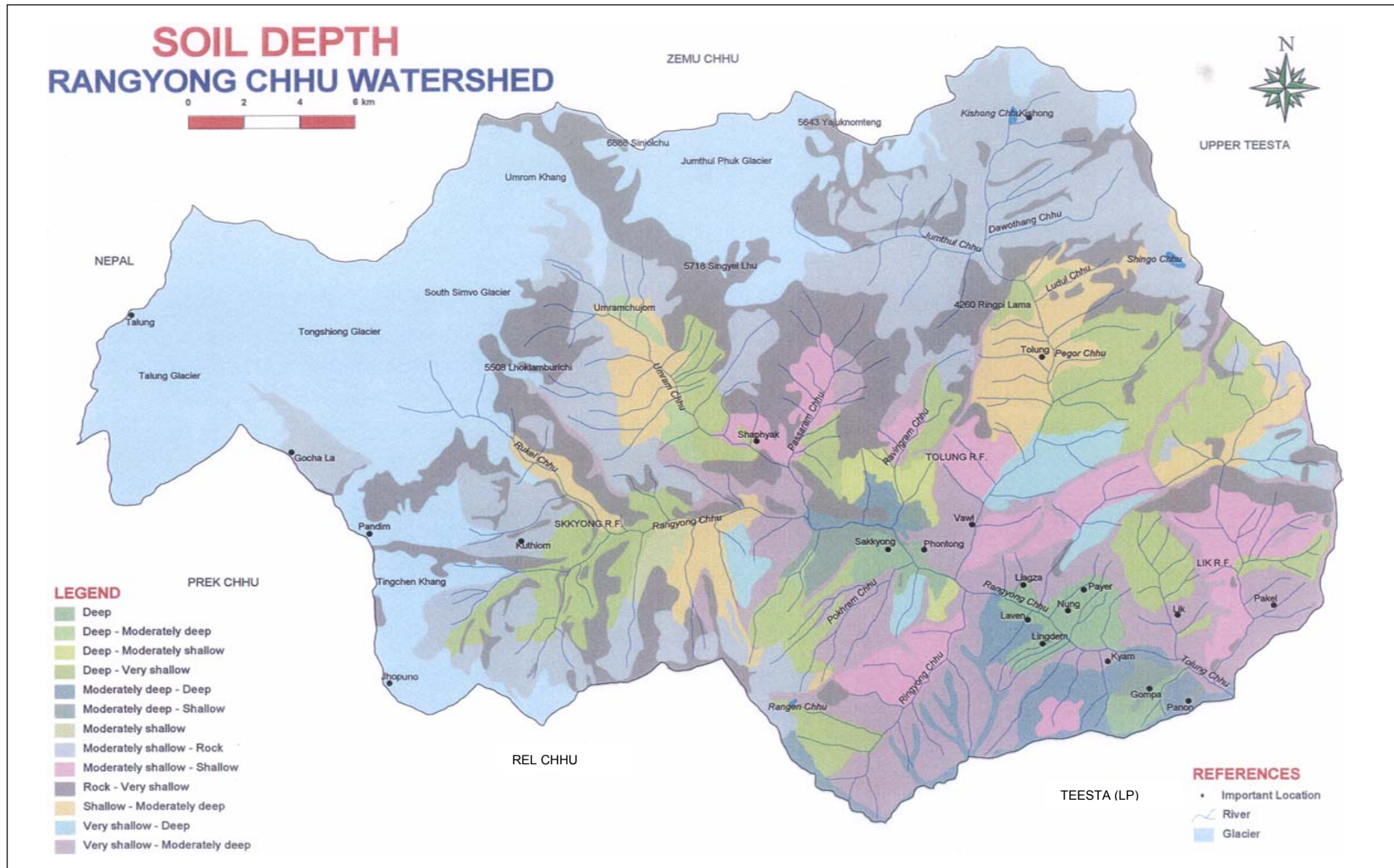


Fig. 4.67 Soil depth class of Rangyong Chhu watershed

mountain (>50% slope) in combination with rock and deep soils in mapping unit 7, 12 and 13.

4.9.4 Surface texture

Seven surface soil textural classes viz. gravelly sandy loam (gsl), loamy sand (ls), loam (l), sandy loam (sl), sandy clay loam (scl) silt loam (sil) and silty clay loam (sicl), were found to occur in the soils of the watershed and were mapped into thirteen mapping units at the level of association of surface textural classes (Table 4.59 and Fig. 4.68).

In this watershed, largest area 13,111.9 ha (16.0%) is occupied by rock – loam association (mapping unit 6) in the rocky cliff followed by sandy clay loam – sandy loam association (mapping unit 7) occupying 13,021.3 ha (15.9%) area under ridge, mid mountain and high mountain (30-50% slope and above). The sandy loam – loamy sand association (mapping unit 9) occurring on hill slopes of mid, high and very high mountain (30-50% slope and above) is very susceptible to landslide or mass movement and should be protected through afforestation or other soil conservation measure.

Table 4.59 Surface texture of Rangyong Chhu watershed

Map unit	Description	Soil Map units	Area (In ha)	% of watershed
1	gsl-ls	5	253.6	0.3
2	L	29	20.5	0.1
3	l-R	63	9299.3	11.3
4	l-sl	4	331.9	0.4

5	Ls	19	311.7	0.4
6	R-I	3	13111.9	16.0
7	Scl-sl	2,17,23,25,31,35,45,47	13021.3	15.9
8	Scl-sil	27,55	3531.3	4.3
9	sl-ls	21,43,49,60	9736.9	11.8
10	sl-R	7	4414.8	5.4
11	sl-scl	61	5853.9	7.1
12	sl-sicl	1	825.7	1.0
13	sil-sl	59	566.3	0.7
		Miscellaneous	20775.5	25.3

4.9.5 Soil erosion

Moderate severe and very severe erosion classes were identified in this watershed and were mapped into nine mapping units at the level of association of soil erosion classes (Table 4.60 and Fig. 4.69).

Moderate erosion alone (mapping unit 1) occupies 9,705.8 ha (11.8%), while severe erosion alone (mapping unit 5) and very severe erosion alone (mapping unit 7) occupies 6.2 and 2.3 per cent area of the watershed respectively. The mapping unit 9 comprising very severe – severe erosion class association occupies 12.1 per cent area of the watershed which is very susceptible to landslide or mass movement.

Table 4.60 Soil erosion of Rangyong Chhu watershed

Map unit	Description	Soil Map units	Area (In ha)	% of watershed
1	M	1,23,27,29,35,61	9705.8	11.8
2	M-R	7,63	13714.1	16.7
3	M-S	4,5,59	1151.8	1.4
4	R-VS	3	13111.9	16.0

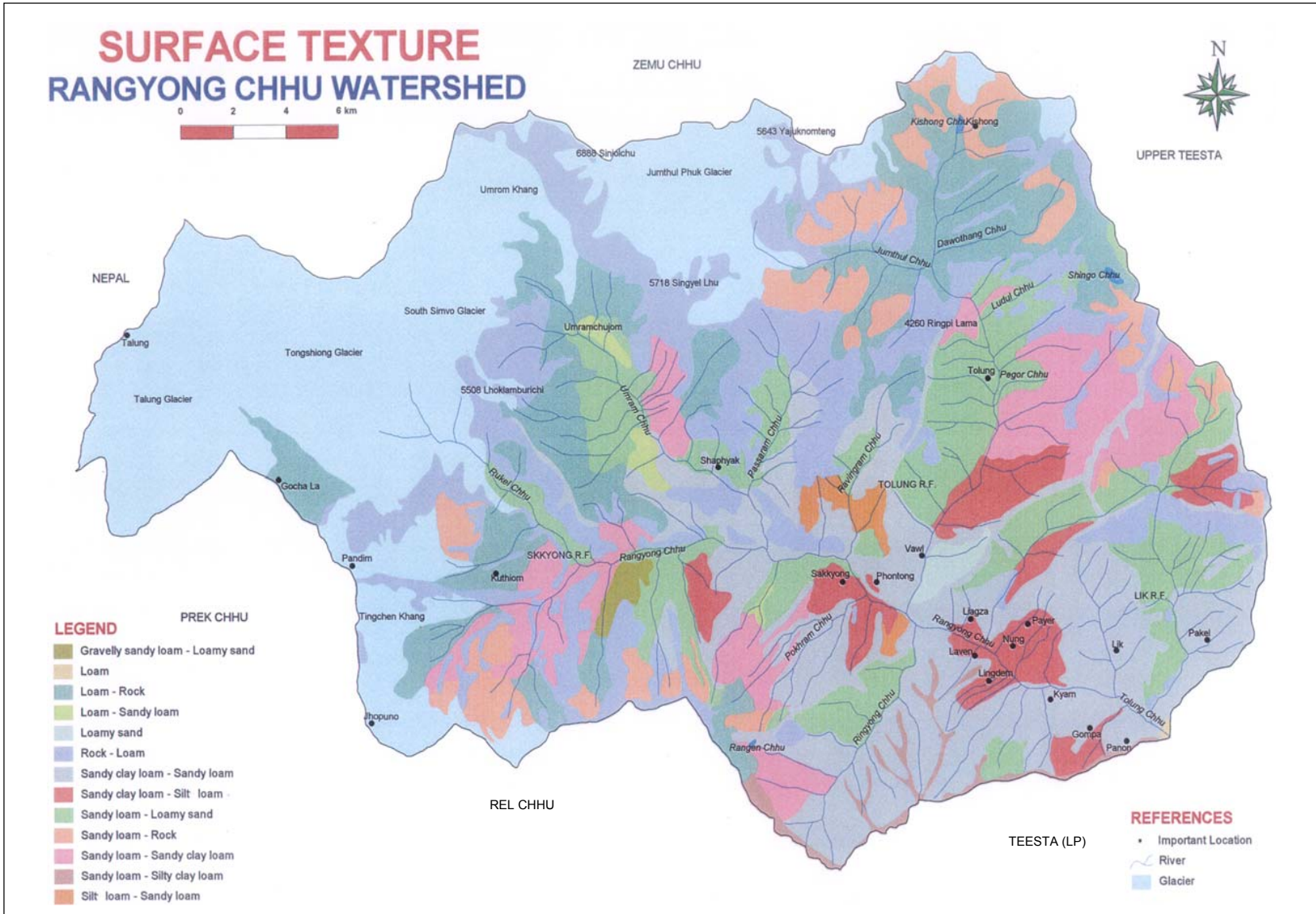


Fig. 4.68 Surface texture class of Rangyong Chhu watershed

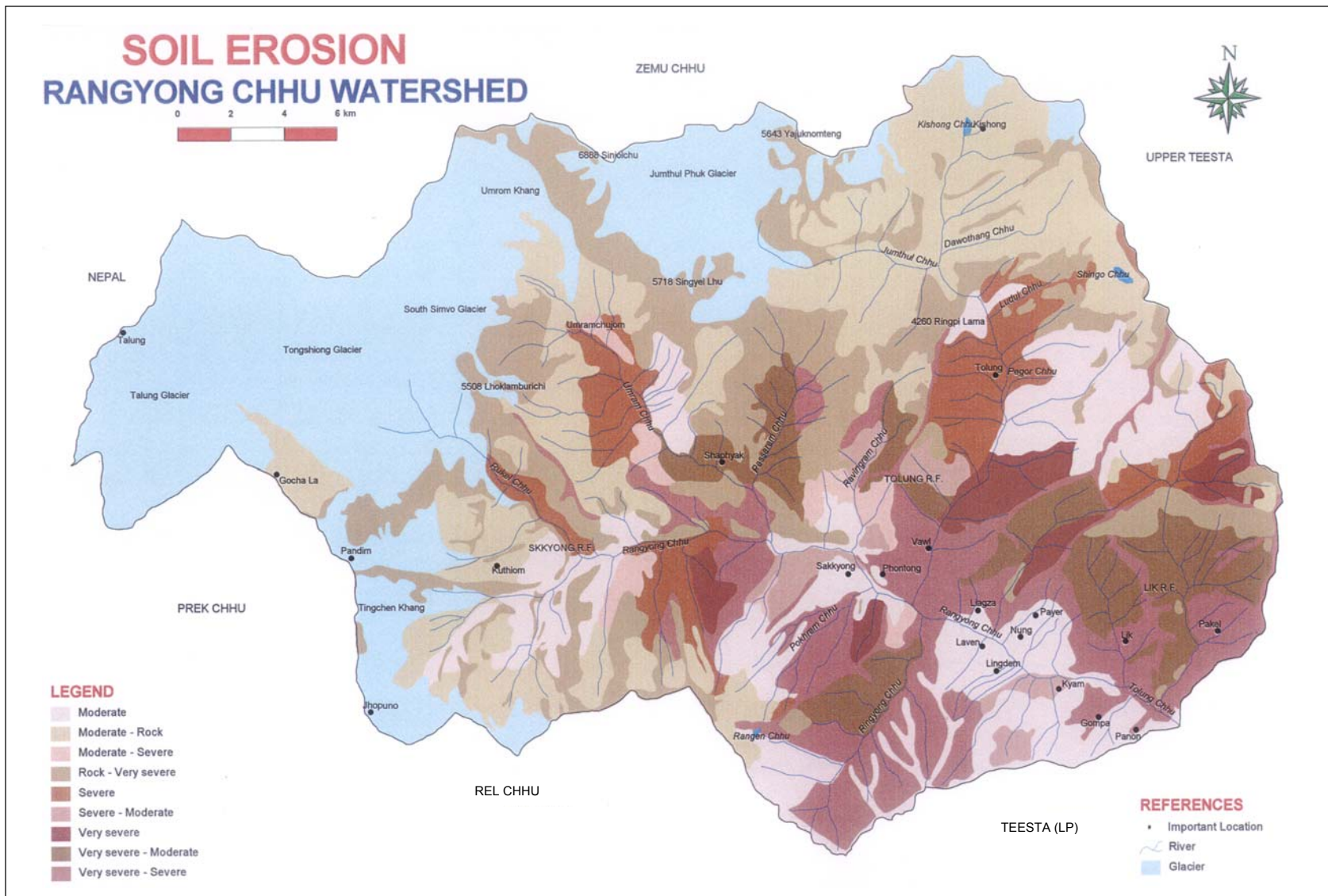


Fig. 4.69 Soil erosion class of Rangyong Chhu watershed

5	S	60	5041.1	6.2
6	S-M	21,31,49	1405.3	1.7
7	VS	55	1922.6	2.3
8	VS-M	43,45	5304.2	6.5
9	VS-S	2,17,19,25,47	9922.3	12.1
		Miscellaneous	20775.5	25.3

4.9.6 Soil reaction

Five soil reaction classes *viz.* extremely acidic, very strongly acidic, strongly acidic, moderately acidic and slightly acidic, were identified in this watershed and were mapped into fourteen mapping units at the level of association of soil reaction classes (Table 4.61 and Fig. 4.70).

Very strongly acidic reaction class alone (mapping unit 11) occupies 5,607.4 ha (6.8%) area while only moderate soil reaction class (mapping unit 3) occupies 2,380.8 ha (2.9%) area of the watershed. The mapping units 11 and 14 represents association of very strongly acidic and strongly acidic reaction classes, mostly on the escarpments and hill slope of mid mountain (>50% slope), are very problematic soils so far as the soil acidity is concerned and should be managed efficiently through growing acid tolerant crops.

Table 4.61 Soil reaction of Rangyong Chhu watershed

Map unit	Description	Soil Map units	Area (In ha)	% of watershed
1	EX-M	23,29,31,35	1640.1	2.0

2	EX-R	7	4414.8	5.4
3	M	2	2380.8	2.9
5	R-S	3	13111.9	16.0
6	SI-EX	55	1922.6	2.3
7	S-EX	1	825.7	1.0
8	S-M	17,25,43,45,47	12534.0	15.3
9	S-R	63	9299.3	11.3
10	S-VS	19,21	803.3	1.0
11	VS	59,60	5607.4	6.8
12	VS-EX	27	1608.7	2.0
13	VS-M	49,61	6545.0	8.0
14	VS-S	4,5	585.5	0.7
		Miscellaneous	20775.5	25.3

4.9.7 Land capability class (LCC)

Five land capability classes *viz.* III, IV, VI, VII and VIII and six land capability sub-classes were identified in this watershed and were mapped into six mapping units (Table 4.62 and Fig. 4.71). The result revealed that the land capability sub-class Vie2s (mapping unit 3) covers maximum area of 29,618.8 ha (36.1%) and land capability sub-class VIIe3 covers least area of 585.5 ha (0.7%). The extreme land capability subclass VIIIe4s was found on rocky cliff area (mapping unit 6) occupying 16.0 per cent area of the watershed.

Table 4.62 Land capability of Rangyong Chhu watershed

Map Unit	Description	Soil Map Units	Area (In ha)	% of Watershed
1	IIIe2	1	825.7	1.0

2	Ive2	2,19,21,23,27,29,31,35	6432.9	7.8
3	Vie2s	7,25,43,49,59,60,61,63	29618.8	36.1
4	Vlle2s	17,45,47,55	10704.3	13.1
5	Vlle3	4,5	585.5	0.7
6	Vllle4s	3	13111.9	16.0
		Miscellaneous	20775.5	25.3

4.10 TEESTA UPPER RIGHT BANK WATERSHED

4.10.1 Landforms

Eight broad landform regions *viz.* ridge, rocky cliff, escarpment, morainic zone, low mountain, mid mountain, high mountain and very high mountain were identified in this watershed and mapped (Fig. 4.72). In this watershed, major area (38.6%) is occupied by high mountain followed by rocky cliff (15.7%), mid mountain (9.5%) and very high mountain (7.5%).

4.10.2 Soils

Twenty six soil series were identified in this watershed and the soil map of the watershed was prepared with seventeen mapping units using soil series association as the mapping unit (Table 4.63 and Fig. 4.73). From the soil map, it is observed that Chatten – Lema – Tibik association (mapping unit 45) of high mountain (>50% slope) occupies an area of 2,088 ha (12.7%) while Lachung – Puchikongma – Byuma (mapping unit 60) association of very high mountain occupies 2,547.8 ha (15.6%) area. The dominant soil series occurring in this watershed are Lachung, Chatten, Tibik, Jorpul, Yumthang.

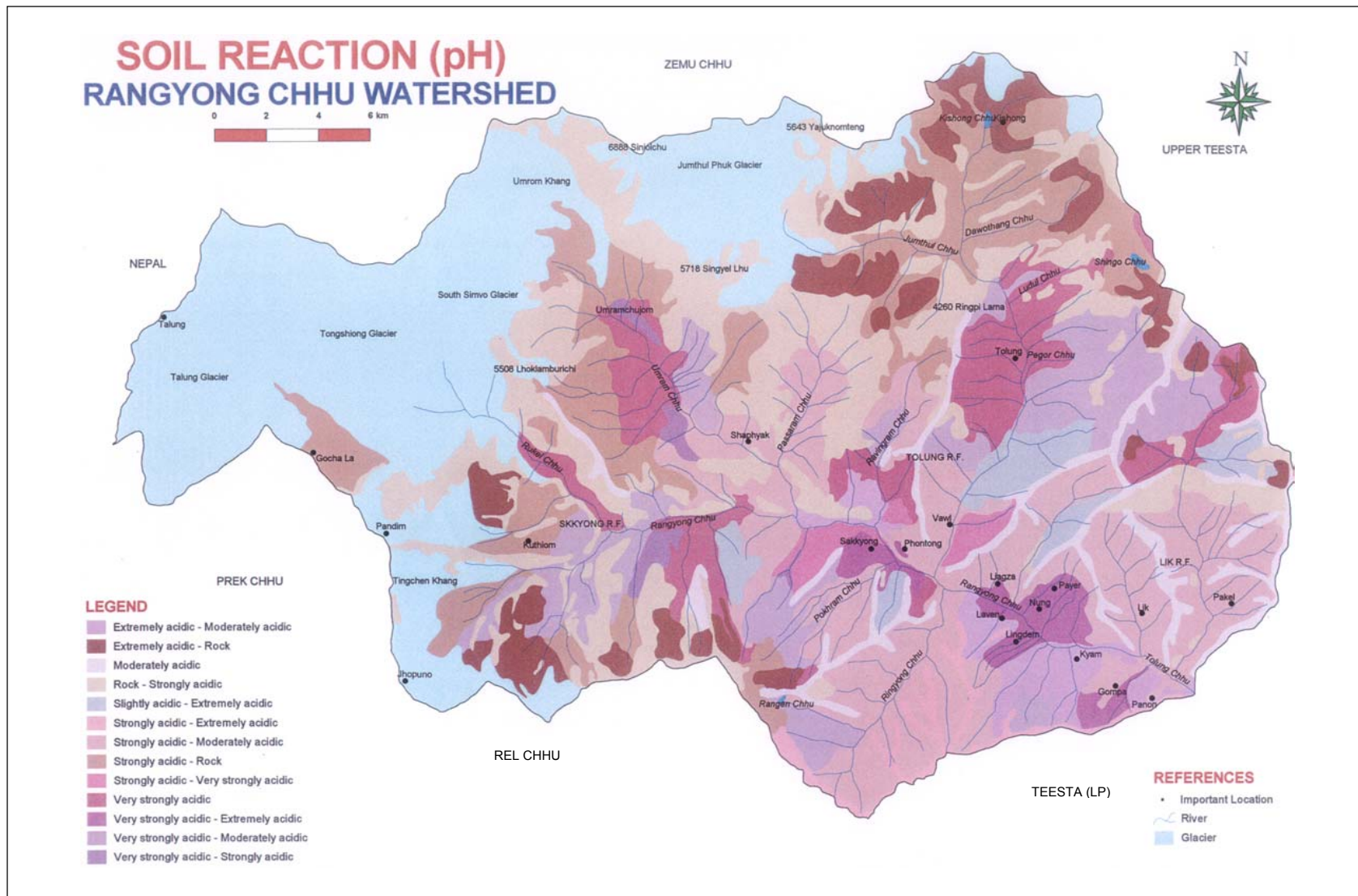


Fig. 4.70 Soil reaction class of Rangyong Chhu watershed

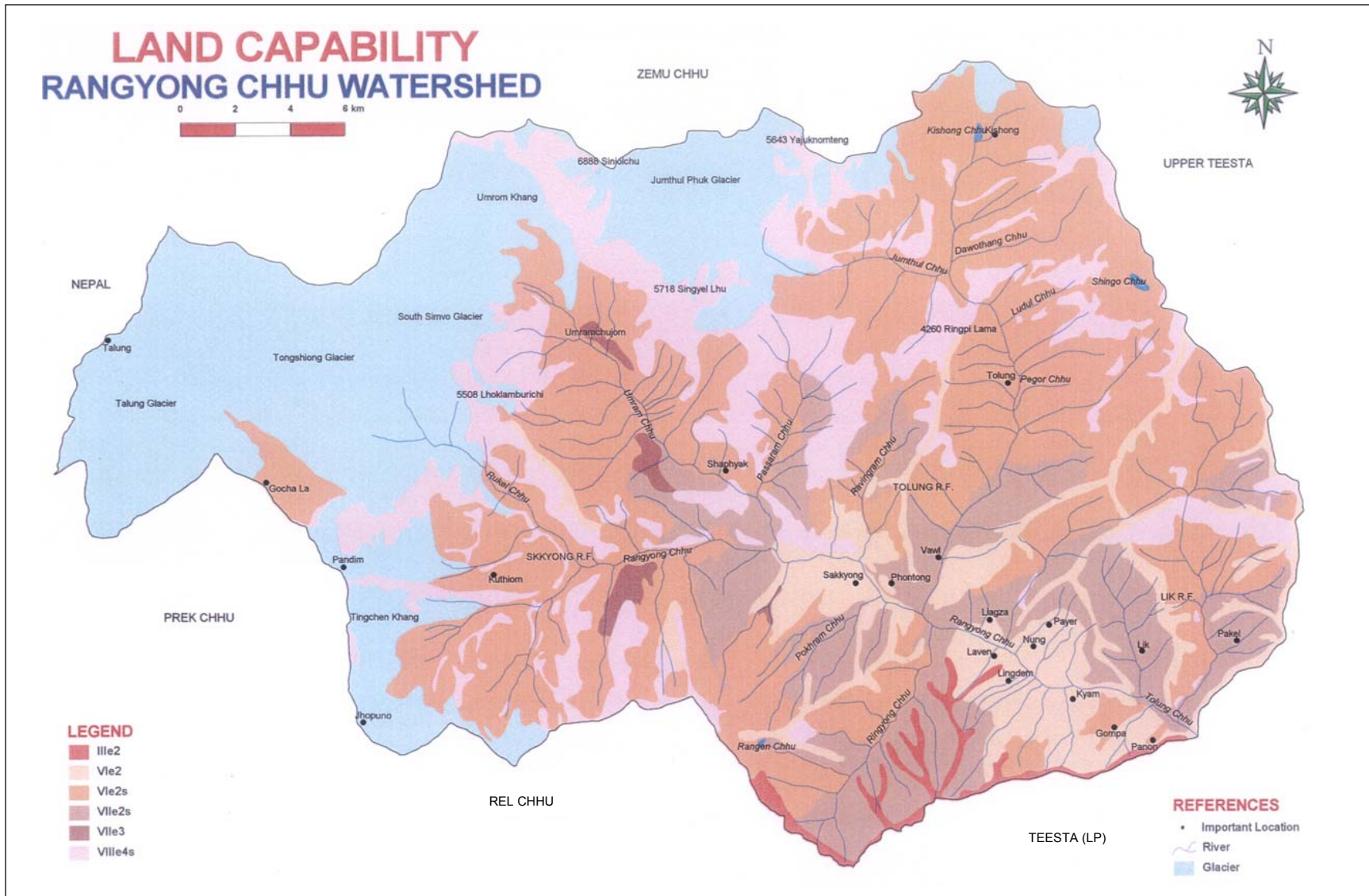


Fig. 4.71 Land capability class of Rangyong Chhu watershed

Table 4.63 Soils of Teesta Right Bank watershed

Soil Unit	Soil Series Association	Area (In ha)	% of watershed
2	Rubam – Salem	810.6	5.0
3	Rock outcrops – Jorpul	2570.0	15.7
5	Bhusuk- Karporang - Tibik	46.4	0.3
7	Kalep – Rock outcrop	280.6	1.7
9	Singhik - Lingthem	425.3	2.6
21	Singhik – Tibik - Lingthem	572.1	3.5
23	Singhik – Ruglo – Rapung	213.1	1.3
25	Gyer – Manul - Lema	270.0	1.7
29	Lingthem – Lema - Singhik	561.7	3.4
33	Manul – Gyer – Rock outcrop	505.4	3.1
43	Tibik-Byuma - Mensithang	1639.7	10.0
45	Chatten-Lema - Tibik	20.0	0.1
47	Ship – Theng – Pakel	1923.5	11.8
49	Rapung – Mensithang – Rock outcrop	446.1	2.7
53	Bitchu – Lachen - Chatten	230.3	1.4
60	Lachung- Puchikongma - Byuma	2547.8	15.6
61	Yumthang – Thangu - Kalep	1104.1	6.8
	Miscellaneous	106.4	0.7
	Total	16344.1	87.3

4.10.3 Soil depth

Five soil depth classes viz. deep, moderately deep, moderately shallow, shallow and very shallow were identified in the watershed and were mapped into nine mapping units at the level of association of soil depth class (Table 4.64 and Fig. 4.74). It is observed that deep – very shallow association (mapping unit 1) occupies major area of 3,192.1 ha (19.5%) followed by very shallow – moderately deep association (mapping unit 9), rock – very shallow association (mapping unit 7),

shallow – moderately deep association (mapping unit 8) occupying 16.7, 15.7 and 15.6 per cent area of the watershed. The best type of soil in terms of its depth is represented by the moderately deep – deep association (mapping unit 2) and occupies 1,200.1 ha (7.3%) area of the watershed.

Table 4.64 Soil depth of Teesta Right Bank watershed

Map unit	Description	Soil Map units	Area (In ha)	% of watershed
1	Deep-very shallow	45,61	3192.1	19.5
2	Mod.deep-deep	23,29,9	1200.1	7.3
3	Mod.deep-shallow	21,25,33	1350.5	8.3
4	Mod. Shallow	5	46.4	0.3
5	Mod.shallow-Rock	7	280.6	1.7
6	Mod.shallow-shallow	43,49,53	2316.1	14.2
7	Rock-very shallow	3	2570.0	15.7
8	Shallow-mod.deep	60	2547.8	15.6
9	Very shallow-mod.deep	2,47	2734.1	16.7
		Miscellaneous	106.4	0.7

4.10.4 Surface texture

Five surface soil textural class viz. gravelly sandy loam (gsl), loamy sand (ls), loam (l), sandy clay loam (scl) and sandy loam (sl) were identified in this watershed and were mapped at the level of association of soil depth classes into seven mapping units (Table 4.65 and Fig. 4.75). In this watershed, sandy loam – loamy sand association occupies

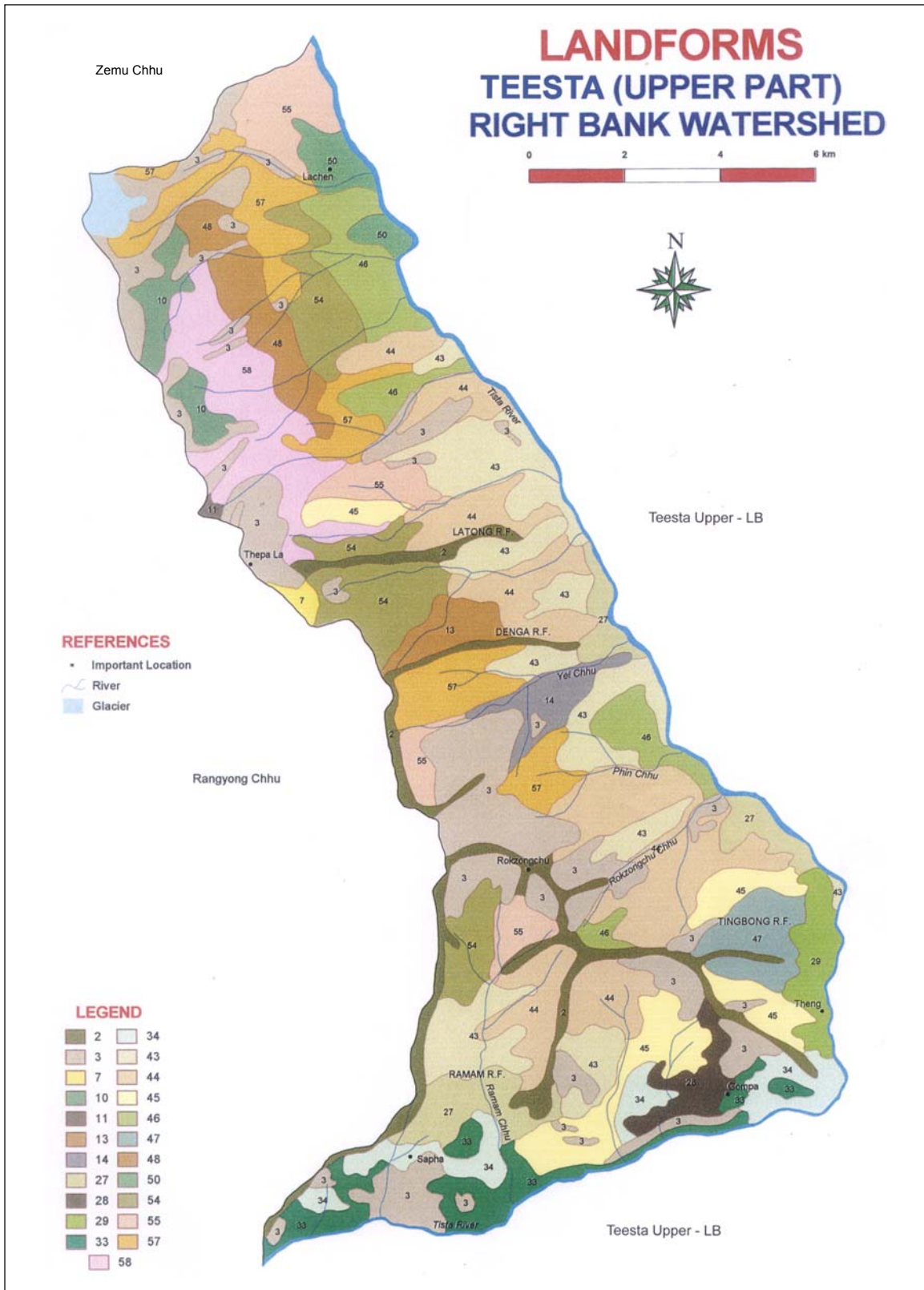


Fig. 4.72 Landforms of Teesta (Upper – RB) watershed

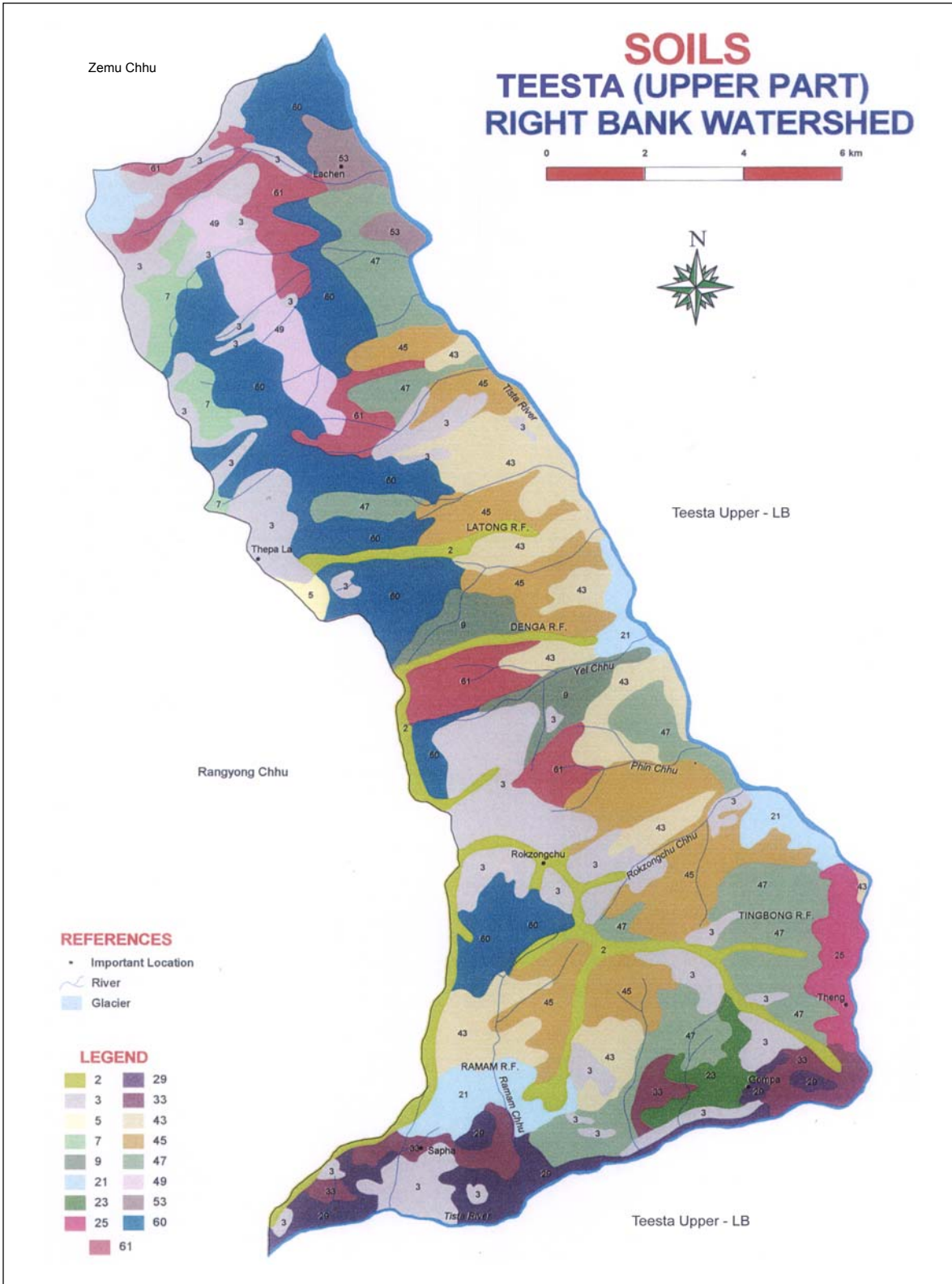


Fig. 4.73 Soils of Teesta (Upper – RB) watershed

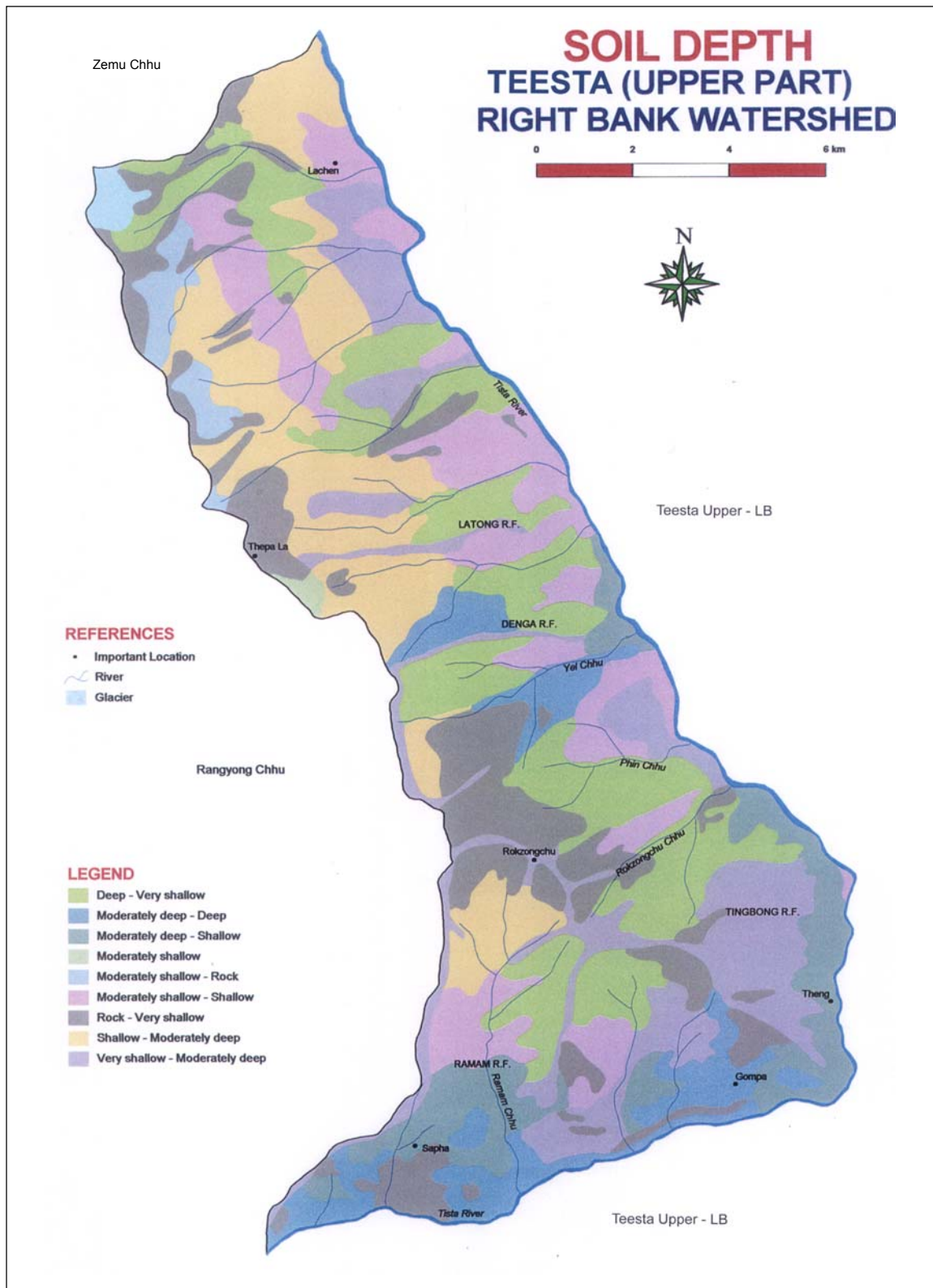


Fig. 4.74 Soil depth class of Teesta (Upper – RB) watershed

an area of 5,436.0 ha (33.2%) which is very susceptible to landslide or mass movement. Maximum area of the watershed (38.2%) is occupied by the sandy clay loam – sandy loam association (mapping unit 4). Gravelly sandy loam – loamy sand association (mapping unit 1) of escarpment occupies least area of 46.4 ha (0.3%).

Table 4.65 Surface texture of Teesta Right Bank watershed

Map unit	Description	Soil Map units	Area (In ha)	% of watershed
1	gsl-ls	5	46.4	0.3
2	l	29	561.7	3.4
3	R-l	3	2570.0	15.7
4	scl-sl	2,23,25,45,47,9,33	6238.9	38.2
5	sl-ls	21,43,49,60,53	5436.0	33.2
6	sl-R	7	280.6	1.7
7	sl-scl	61	1104.1	6.8
		Miscellaneous	106.4	0.7

4.10.5 Soil erosion

Three soil erosion classes viz. very severe, severe and moderate were identified in the watershed and were mapped into eight mapping units at the level of association of soil erosion classes (Table 4.66 and Fig. 4.76). Moderate erosion class alone (mapping unit 1) and severe erosion alone (mapping unit 5) occupies 2,304.2 ha (14.1%) and 2,547.8 ha (15.6%) area of the watershed. Very severe – severe association (mapping unit 8) occupying 3,512.5 ha (21.5%) area, mostly belong to the

ridge, hill slope of mid and high mountain (30-50% slope). Rock in association with moderate erosion (mapping unit 2) and very severe erosion (mapping unit 4) occurs in 280.6 ha (1.7%) and 2,570 ha (15.7%) area of the watershed.

Table 4.66 Soil erosion of Teesta Right Bank watershed

Map unit	Description	Soil Map units	Area (In ha)	% of watershed
1	M	23,29,61,9	2304.2	14.1
2	M-R	7	280.6	1.7
3	M-S	5	46.4	0.3
4	R-VS	3	2570.0	15.7
5	S	60	2547.8	15.6
6	S-M	21,49,53	1248.5	7.6
7	VS-M	43,45	3727.7	22.8
8	VS-S	2,25,47,33	3512.5	21.5
		Miscellaneous	106.4	0.7

4.10.6 Soil reaction

Three soil reaction classes viz. extremely acidic, very strongly acidic and strongly acidic were identified in the soils of this watershed and were mapped into ten mapping units at the level of association of soil reaction classes (Table 4.67 and Fig. 4.77). In this watershed, maximum area of 6,429.6 ha (39.3%) is occupied by the mapping unit 6 represented by the association of strongly acidic – moderately acidic reaction class, mostly belong to the hill slope of mid and high mountain.

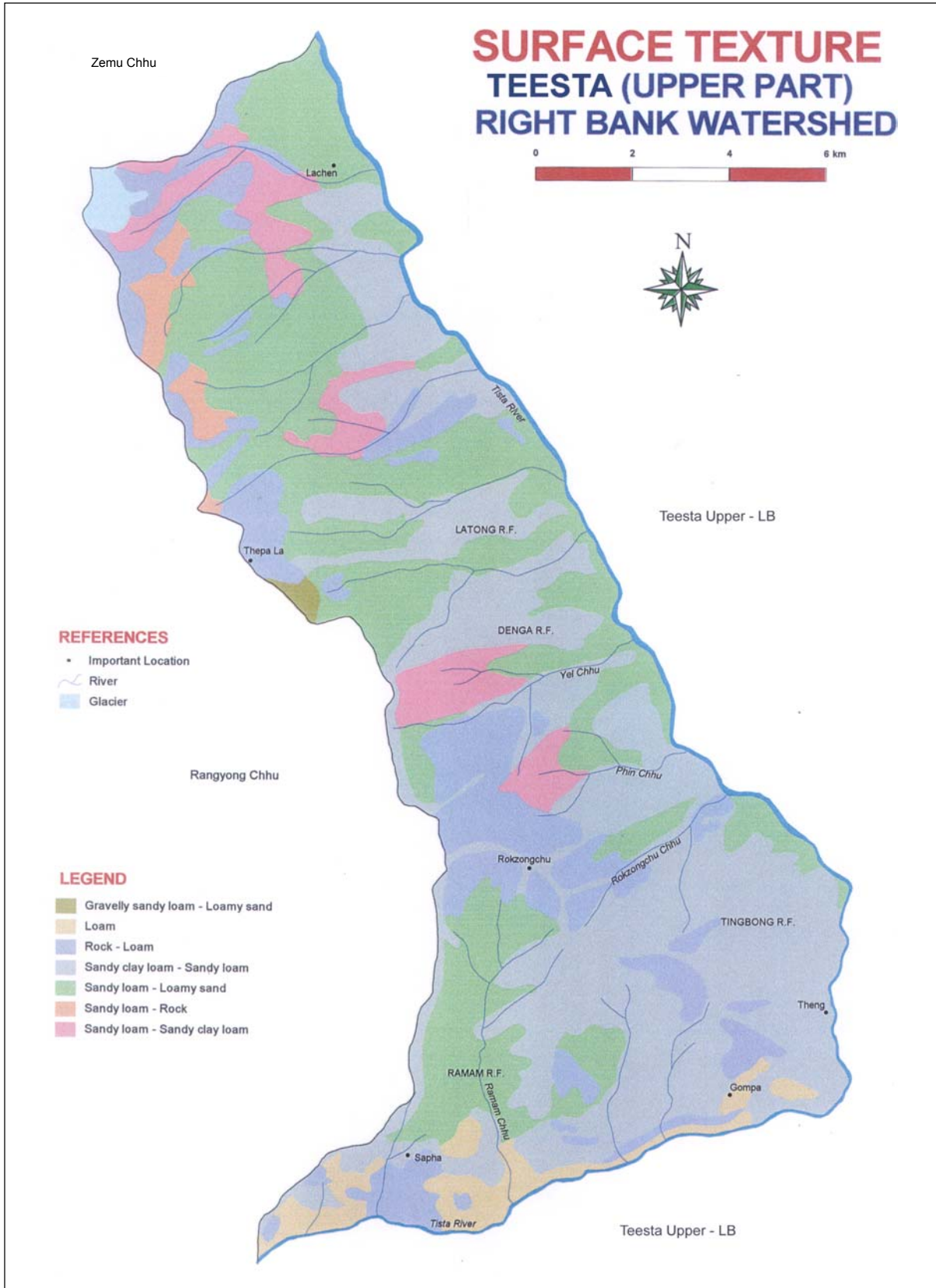


Fig. 4.75 Surface texture class of Teesta (Upper – RB) watershed

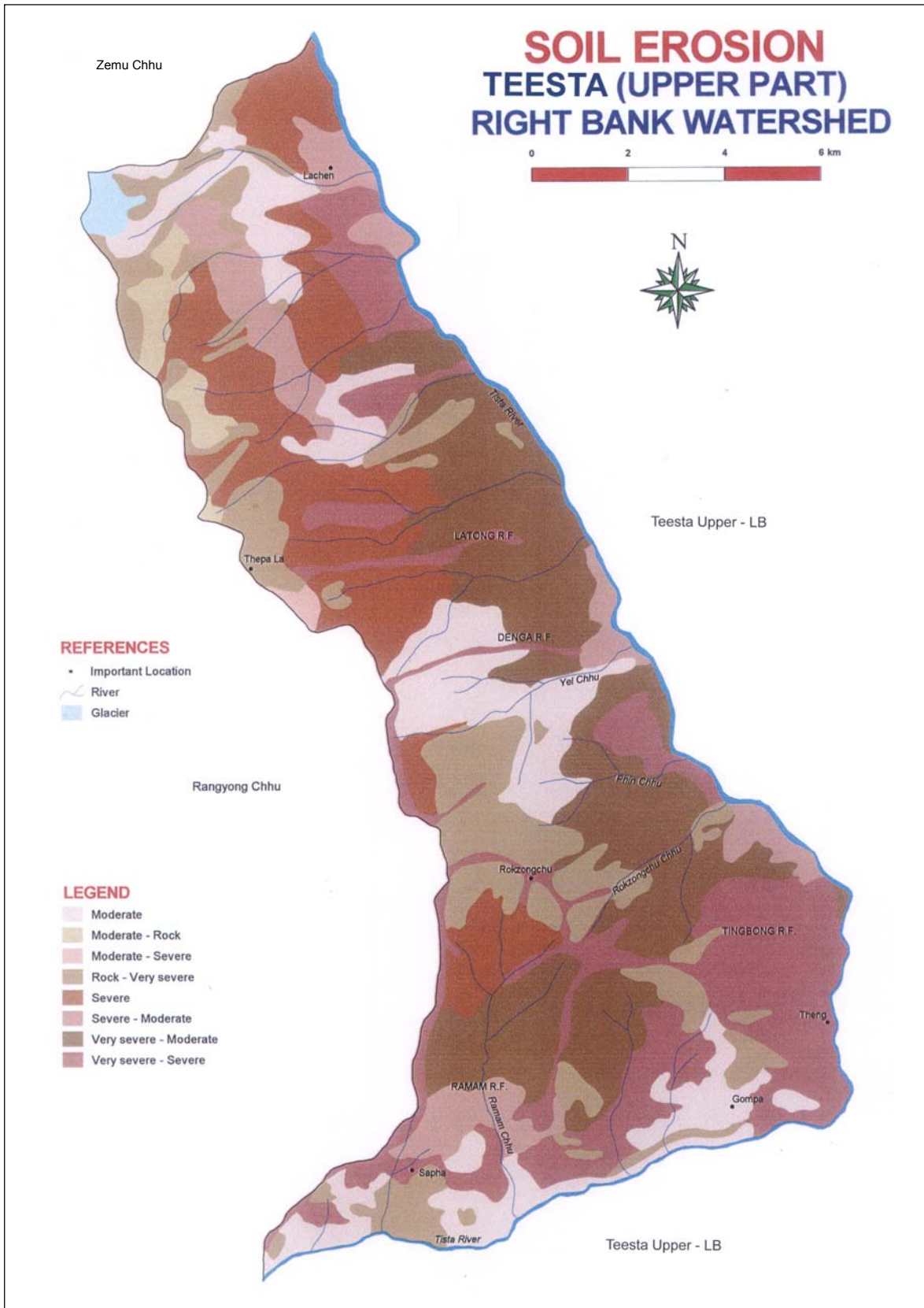


Fig. 4.76 Soil erosion class of Teesta (Upper – RB) watershed

The morainic zone (mapping unit 2) represented by the association extremely acidic – Rock occupies 280.6 ha (1.7%) area of the watershed. The rocky cliff area (mapping unit 5) representing the association Rock – strongly acidic class occupies 15.7 per cent area of the watershed.

Table 4.67 Soil reaction of Teesta Right Bank watershed

Map unit	Description	Soil Map units	Area (In ha)	% of watershed
1	EX-M	23,29,9	1200.1	7.3
2	EX-R	7	280.6	1.7
3	M	2	810.6	5.0
5	R-S	3	2570.0	15.7
6	S-M	25,43,45,47,33	6429.6	39.3
7	S-VS	21,53	802.4	4.9
8	VS	60	2547.8	15.6
9	VS-M	49,61	1550.2	9.5
10	VS-S	5	46.4	0.3
		Miscellaneous	106.4	0.7

4.10.7 Land capability class (LCC)

Four land capability classes and five land capability sub-classes viz. IVe2, VIe2s, VIIe2s, VIIe3 and VIIIe4s were identified in this watershed and mapped (Table 4.68 and Fig. 4.78). The maximum area 6,716.6 ha (41.1%) of the watershed is represented by the land capability sub-class VIe2s (mapping unit 2) while the least were 46.4 ha (0.3%) and is represented by the land capability sub-class VIIIe3

(mapping unit 4). The rocky cliff area is represented by the land capability sub-class VIIIe4s (mapping unit 5) and covers only 2,570 ha (15.7%) area of the watershed.

Table 4.68 Land capability of Teesta Right Bank watershed

Map unit	Description	Soil Map units	Area (In ha)	% of watershed
1	IVe2	2,21,23,29,33,53	2893.2	17.7
2	Vle2s	7,25,43,49,60,61,9	6716.6	41.1
3	VIIe2s	45,47	4011.5	24.5
4	VIIe3	5	46.4	0.3
5	VIIIe4s	3	2570.0	15.7
		Miscellaneous	106.4	0.7

4.11 PREK CHHU WATERSHED

4.11.1 Landforms

Six broad landform regions viz. ridge, rocky cliff, escarpment, morainic zone, very high mountain and extremely high mountain and seven landform units were identified in this watershed through visual interpretation of satellite imagery, toposheet and traversing throughout the area. In this watershed extremely high mountain covers largest area (40.8%) followed by escarpments (23.9%) and rocky cliff (6.5%). About 2.2 per cent area of this watershed represents the morainic zone (Fig. 4.79). A large portion of the watershed particularly the high altitude area remains covered with glacier/ snow covered.

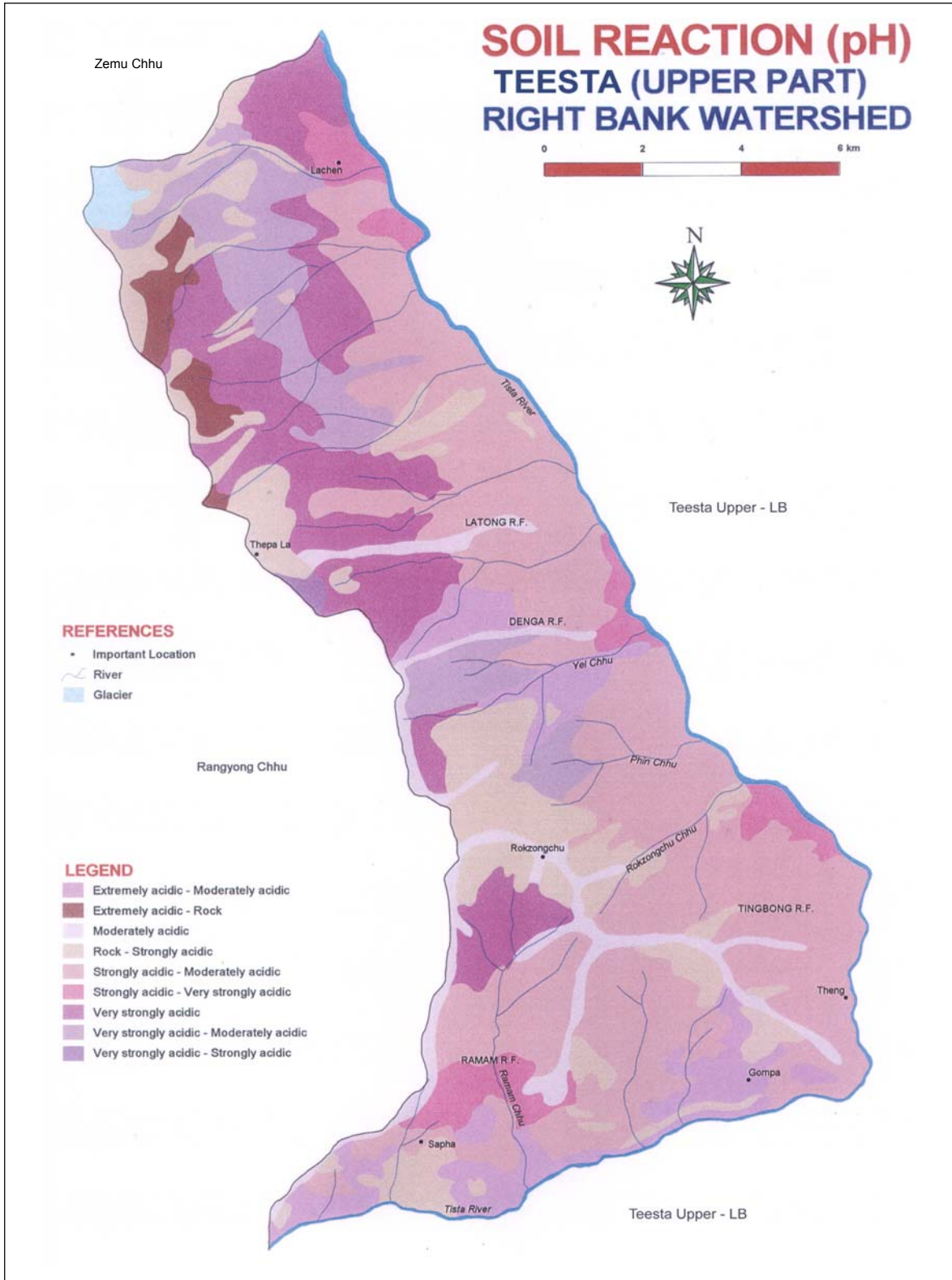


Fig. 4.77 Soil reaction class of Teesta (Upper – RB) watershed

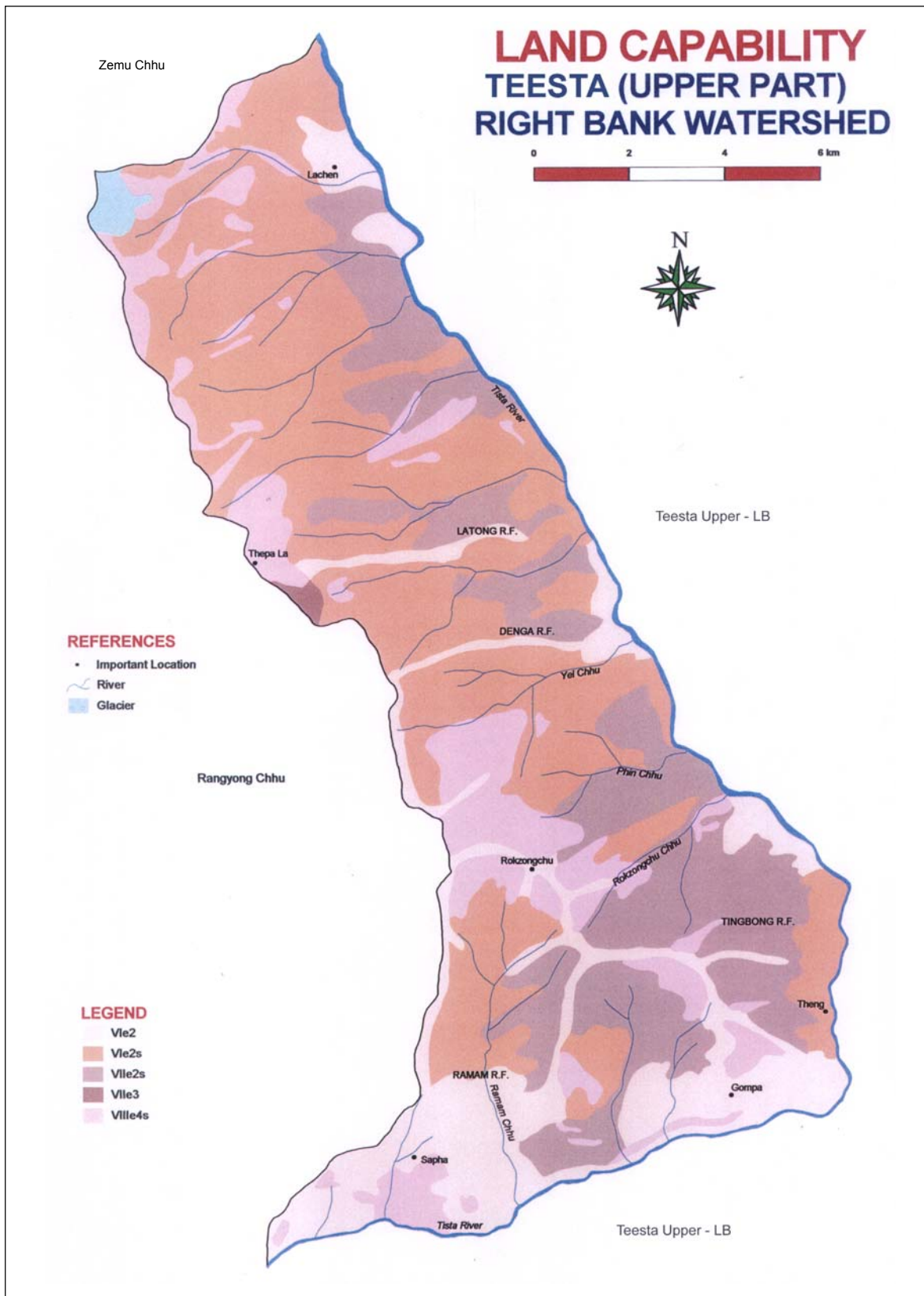


Fig. 4.78 Land capability class of Teesta (Upper – RB) watershed

4.11.2 Soils

Fourteen soil series were identified in this watershed and were mapped into seven soil mapping units at the level of soil series association (Table 4.69 and Fig. 4.80). Thangu – rock outcrop association of extremely high mountain occupies 12,792.2 ha (40.8%) area of the watershed. Escarpment is represented by mapping unit 4 and 5 comprising Hilley – Singrep – Chatten and Bhusuk – Karporang – Tibik association and occupies 23.9 per cent area. Morainic zone (mapping unit 7) represented by the association of Kalep – rock outcrop occupies least area of 688.8 ha (2.2%). The dominant soil series in this watershed are Thangu, Lachung, Hilley, Singrep, Rubam.

Table 4.69 Soils of Prek Chhu watershed

Soil unit	Soil Series Association	Area (In ha)	% of watershed
2	Rubam – Salem	420.2	1.3
3	Rock outcrops – Jorpul	2023.9	6.5
4	Hilley-Singrep – Chatten	5905.6	18.8
5	Bhusuk- Karporang – Tibik	1605.7	5.1
7	Kalep – Rock outcrop	688.8	2.2
60	Lachung- Puchikongma - Byuma	1092.5	3.5
63	Thangu – Rock outcrop	12792.2	40.8
	Miscellaneous	6818.7	21.8
	Total	31346.6	100.0

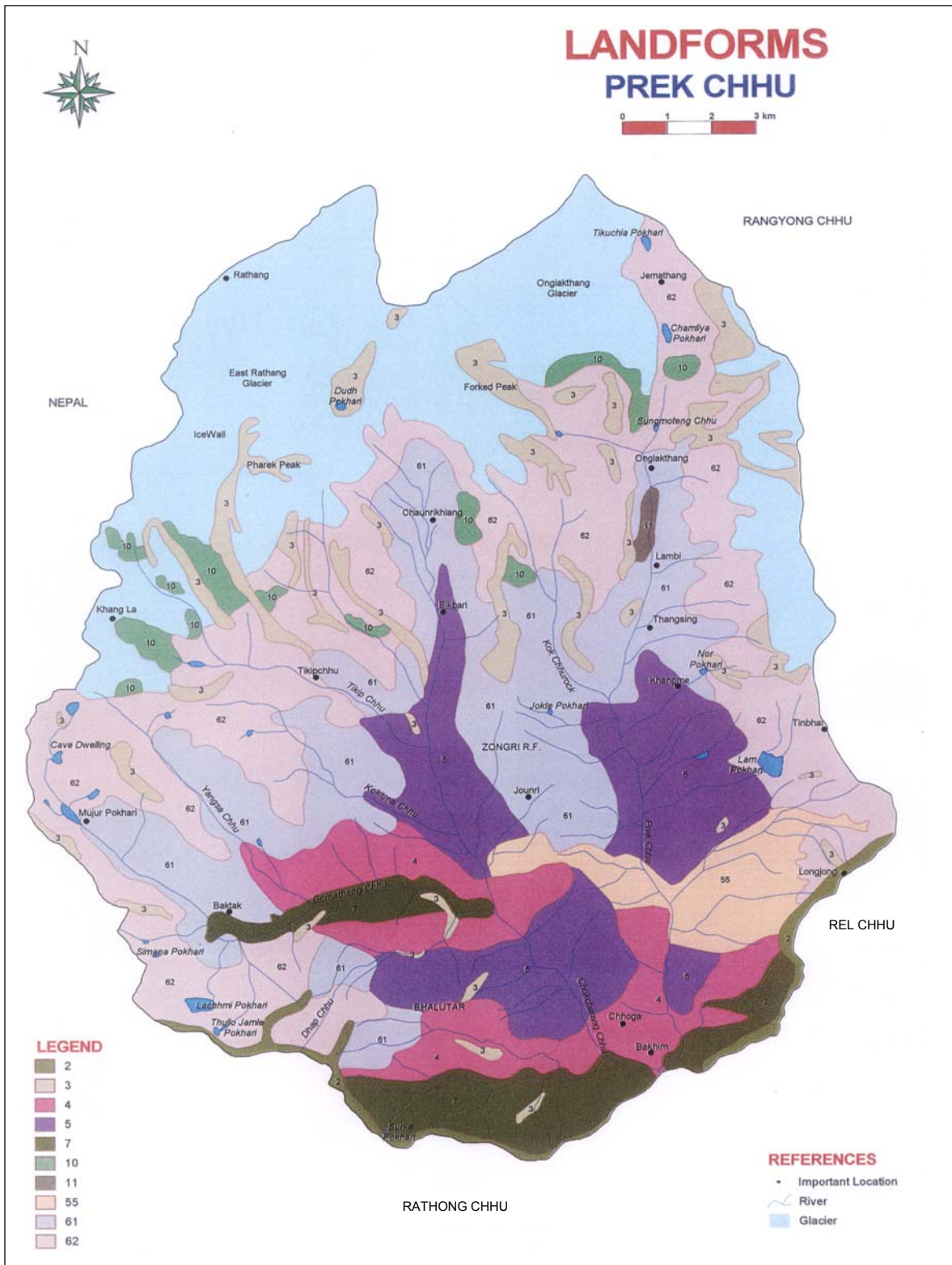


Fig. 4.79 Landforms of Prek Chhu watershed

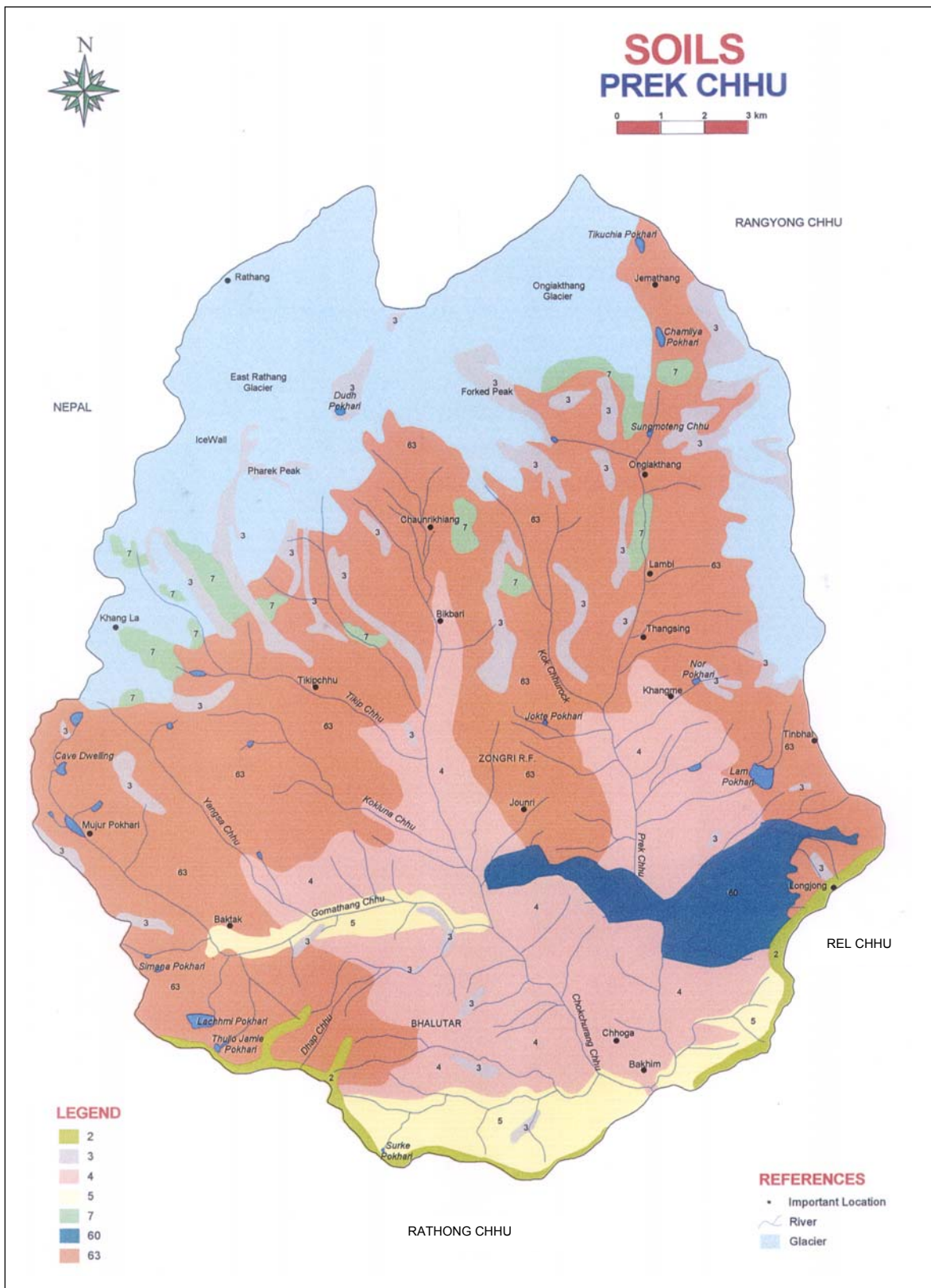


Fig. 4.80 Soils of Prek Chhu watershed

4.11.3 Soil depth

Five soil depth classes viz. deep, moderately deep, moderately shallow, shallow and very shallow were identified in the soils of the watershed and mapped into six mapping units at the level of association of soil depth class (Table 4.70 and Fig. 4.81). From the result, it is observed that moderately shallow – rock association (mapping unit 3) occupies largest area of 13,480.4 ha (43.0%) while very shallow – moderately deep association (mapping unit 6) occupies least area of 420.5 ha (1.3%). Deep – moderately deep association (mapping unit 1) representing the good soil so far as the soil depth is concerned, occupies 5,905.4 ha (18.8%).

Table 4.70 Soil depth of Prek Chhu watershed

Map unit	Description	Soil Map units	Area (In ha)	% of watershed
1	Deep-mod.deep	4	5905.4	18.8
2	Mod. – shallow	5	1605.1	5.1
3	Mod.shallow-Rock	7,63	13480.4	43.0
4	Rock-very shallow	3	2023.8	6.5
5	Shallow-very deep	60	1092.5	3.5
6	Very shallow-mod.deep	2	420.5	1.3
		Miscellaneous	6818.9	21.8

4.11.4 Surface texture

Five surface soil textural classes viz. gravelly sandy loam (gsl), loamy sand (ls), loam (l), sandy clay loam (scl) and sandy loam (sl) were identified in the soils of this watershed and were mapped into seven mapping units at the level of association of surface textural classes (Table 4.71 and Fig. 4.82). Loam – rock association (mapping unit 2) occupies largest area of 12,792.1 ha (40.8%) followed by loam – sandy loam association (mapping unit 3), rock-loam association (mapping unit 4), gravelly sandy loam – loamy sand association (mapping unit 1) occupying 18.8, 6.5 and 5.1 per cent area of the watershed. Sandy loam – loamy sand association (mapping unit 6) mostly from very high mountain is very susceptible to landslide or mass movement and hence implementation of soil conservation measure is utmost important in this area.

Table 4.71 Surface texture of Prek Chhu watershed

Map unit	Description	Soil Map units	Area (In ha)	% of watershed
1	gsl-ls	5	1605.1	5.1
2	l-R	63	12792.1	40.8
3	l-sl	4	5905.4	18.8
4	R-l	3	2023.8	6.5
5	scl-sl	2	420.5	1.3
6	sl-ls	60	1092.5	3.5
7	sl-R	7	688.3	2.2
		Miscellaneous	6818.9	21.8

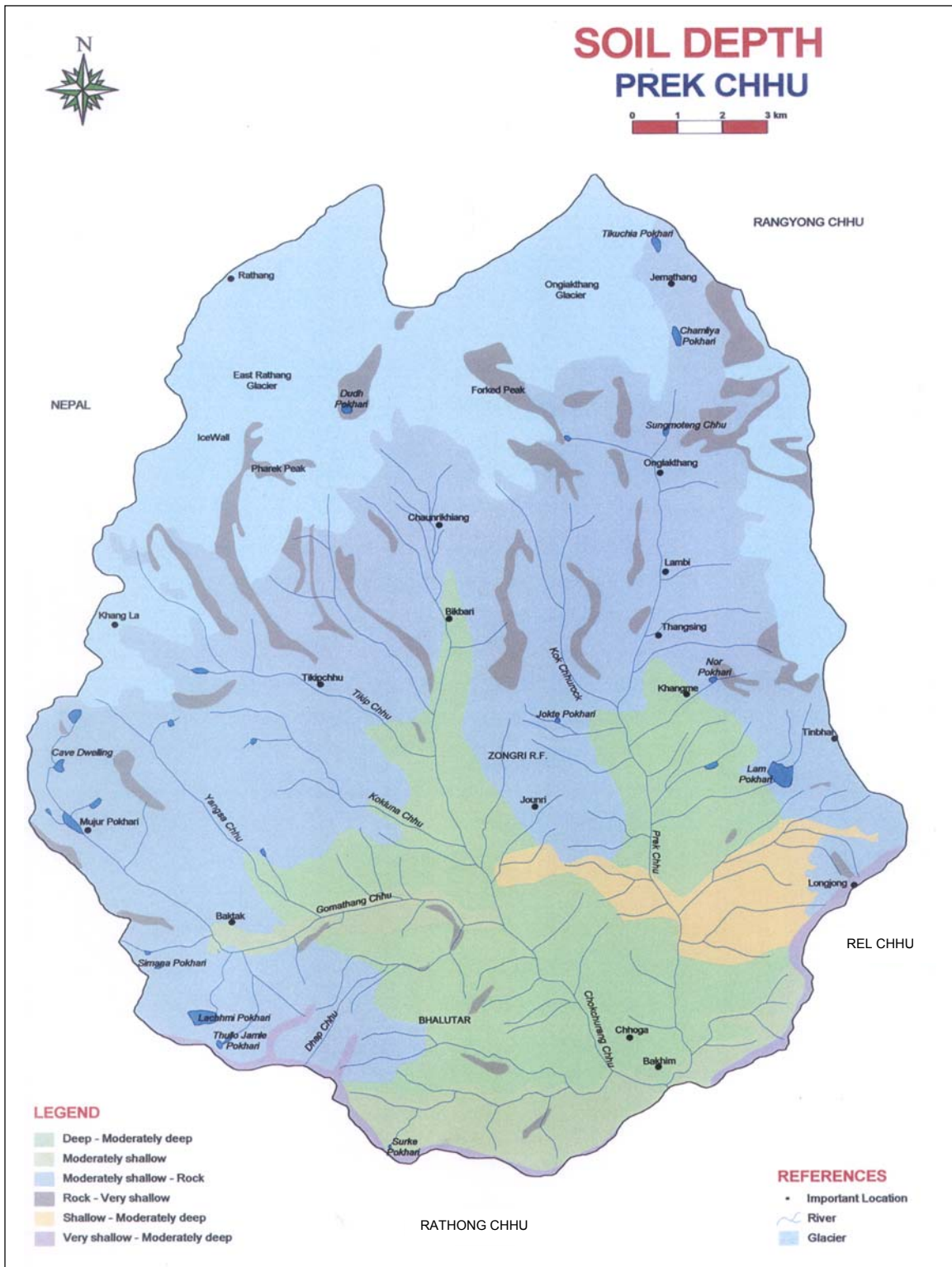


Fig. 4.81 Soil depth class of Prek Chhu watershed

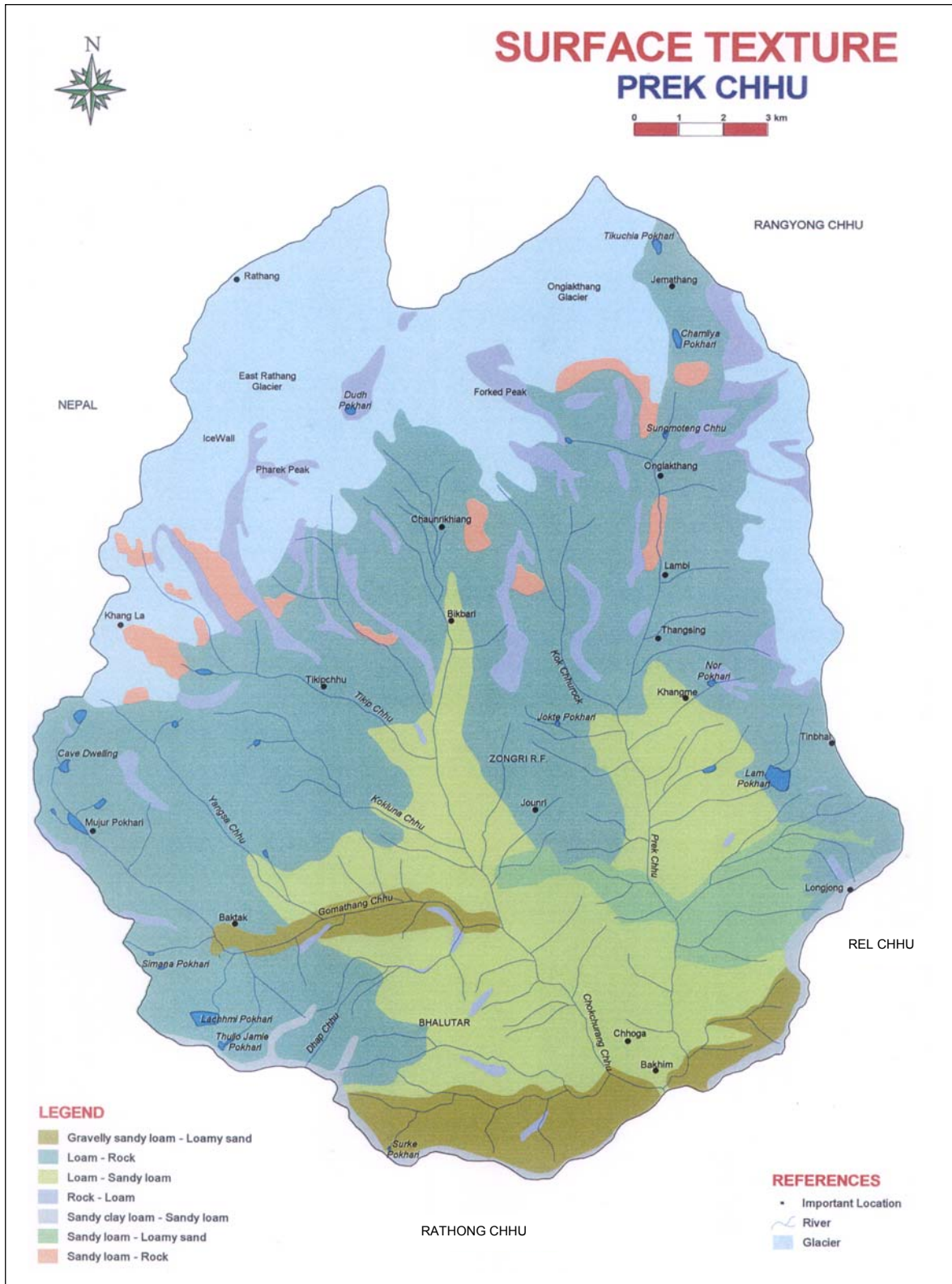


Fig. 4.82 Surface texture class of Prek Chhu watershed

4.11.5 Soil erosion

Moderate, severe and very severe soil erosion class have been identified in this watershed and were mapped into five mapping units at the level of association of soil erosion class (Table 4.72 and Fig. 4.83). Moderate erosion – rock association (mapping unit 1) occupies largest area of 13,480.4 ha (43.0%) while very severe – severe association (mapping unit 5) occupies least area of 420.5 ha (1.3%). Rock in association with moderate (mapping unit 1) and very severe erosion (mapping unit 3) occupies 43.0 and 6.5 per cent area of the watershed.

Table 4.72 Soil erosion of Prek Chhu watershed

Map unit	Description	Soil Map units	Area (In ha)	% of watershed
1	M-R	7,63	13480.4	43.0
2	M-S	4,5	7510.5	23.9
3	R-VS	3	2023.8	6.5
4	S	60	1092.5	3.5
5	VS-S	2	420.5	1.3
		Miscellaneous	6818.9	21.8

4.11.6 Soil reaction

Four soil reaction classes viz. extremely acidic, very strongly acidic, strongly acidic and moderately acidic were identified this watershed and were mapped into seven mapping units at the level of association of soil reaction classes (Table 4.73 and Fig. 4.84). The

major area of 12,792.1 ha (40.8%) were occupied by strongly acidic – rock association (mapping unit 5) while least area of 420.5 ha (1.3%) is occupied by the moderately acidic class alone (mapping unit 2). The very strongly – strongly acidic reaction class association (mapping unit 7) of the escarpment occupies 7,510.5 ha (23.9%) area of the watershed.

Table 4.73 Soil reaction of Prek Chhu watershed

Map Unit	Description	Soil Map units	Area (In ha)	% of watershed
1	EX-R	7	688.3	2.2
2	M	2	420.5	1.3
3	R-S	3	2023.8	6.5
5	S-R	63	12792.1	40.8
6	VS	60	1092.5	3.5
7	VS-S	4,5	7510.5	23.9
		Miscellaneous	6818.9	21.8

4.11.7 Land capability class (LCC)

Three land capability classes viz. VI, VII and VIII and four land capability sub-classes viz. VIe2, VIe2s, VIIe3 and VIIle4s were identified in this watershed and were mapped (Table 4.74 and Fig. 4.85). The study revealed that about 14,572.9 ha (46.5%) area of the watershed representing morainic zone, very high and extremely high mountain is occupied by the land capability subclass VIe2s (mapping unit 2) and 7,510.5 ha (23.9%) area of the watershed representing escarpments is

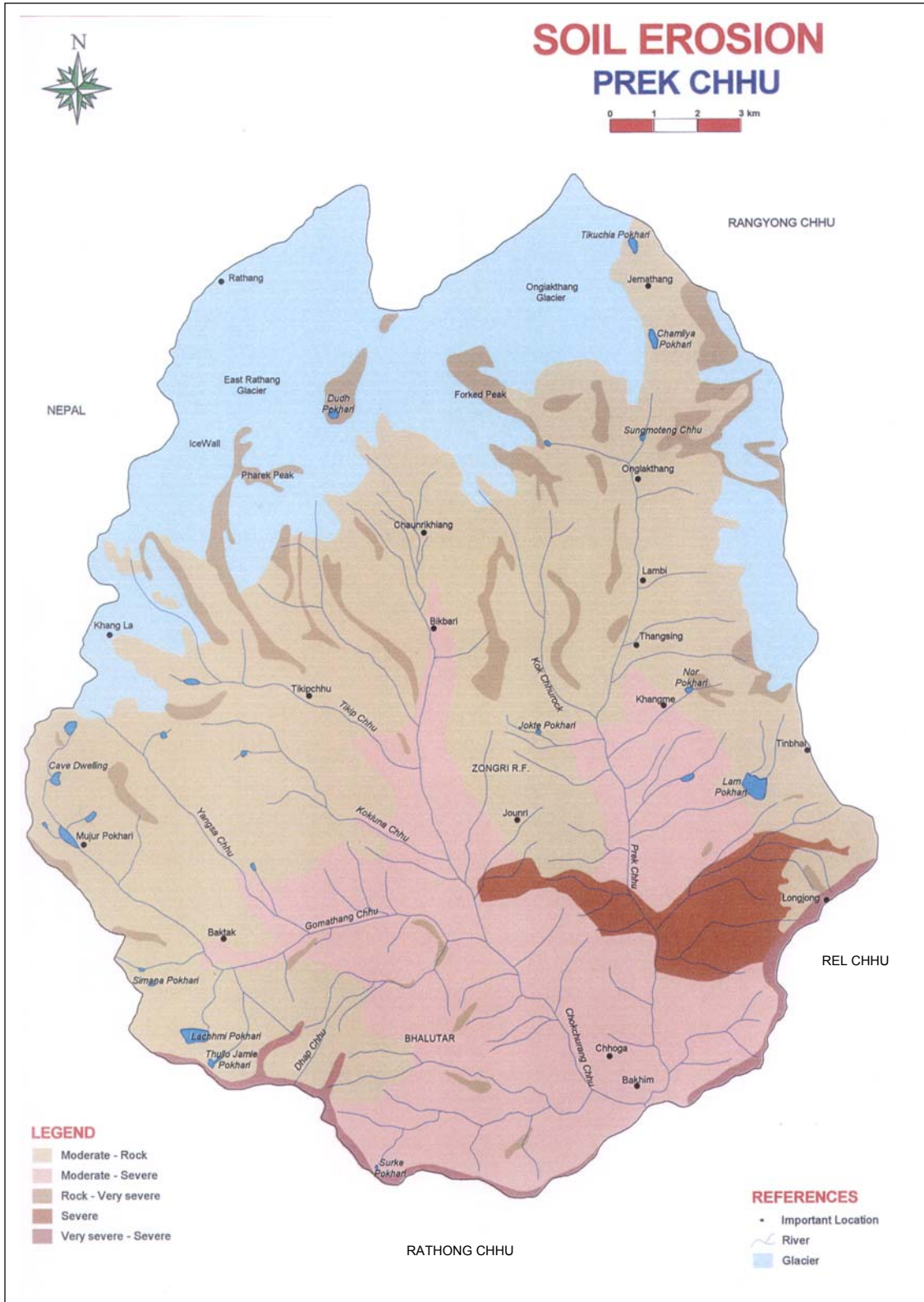


Fig. 4.83 Soil erosion class of Prek Chhu watershed

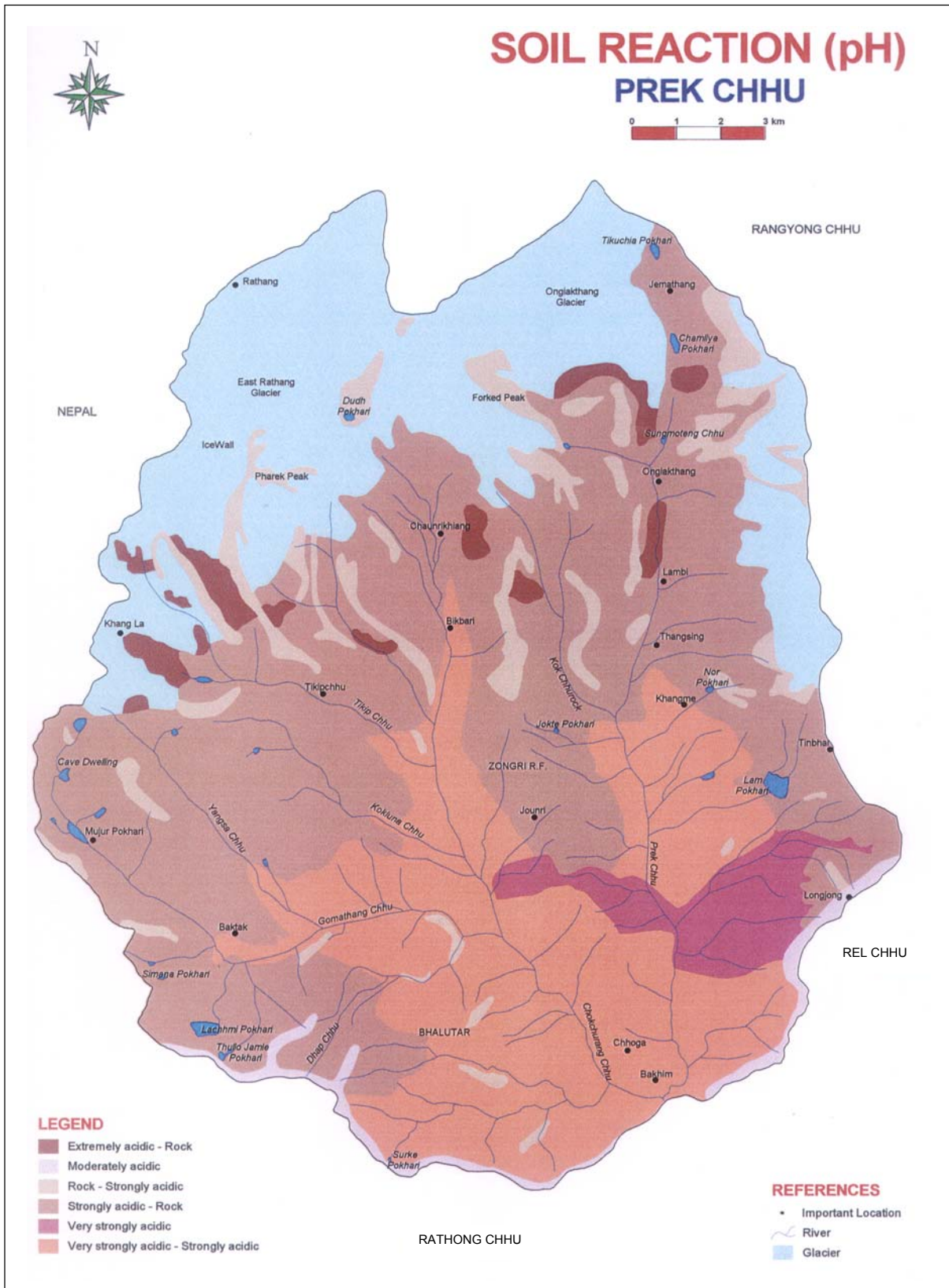


Fig. 4.84 Soil reaction class of Prek Chhu watershed

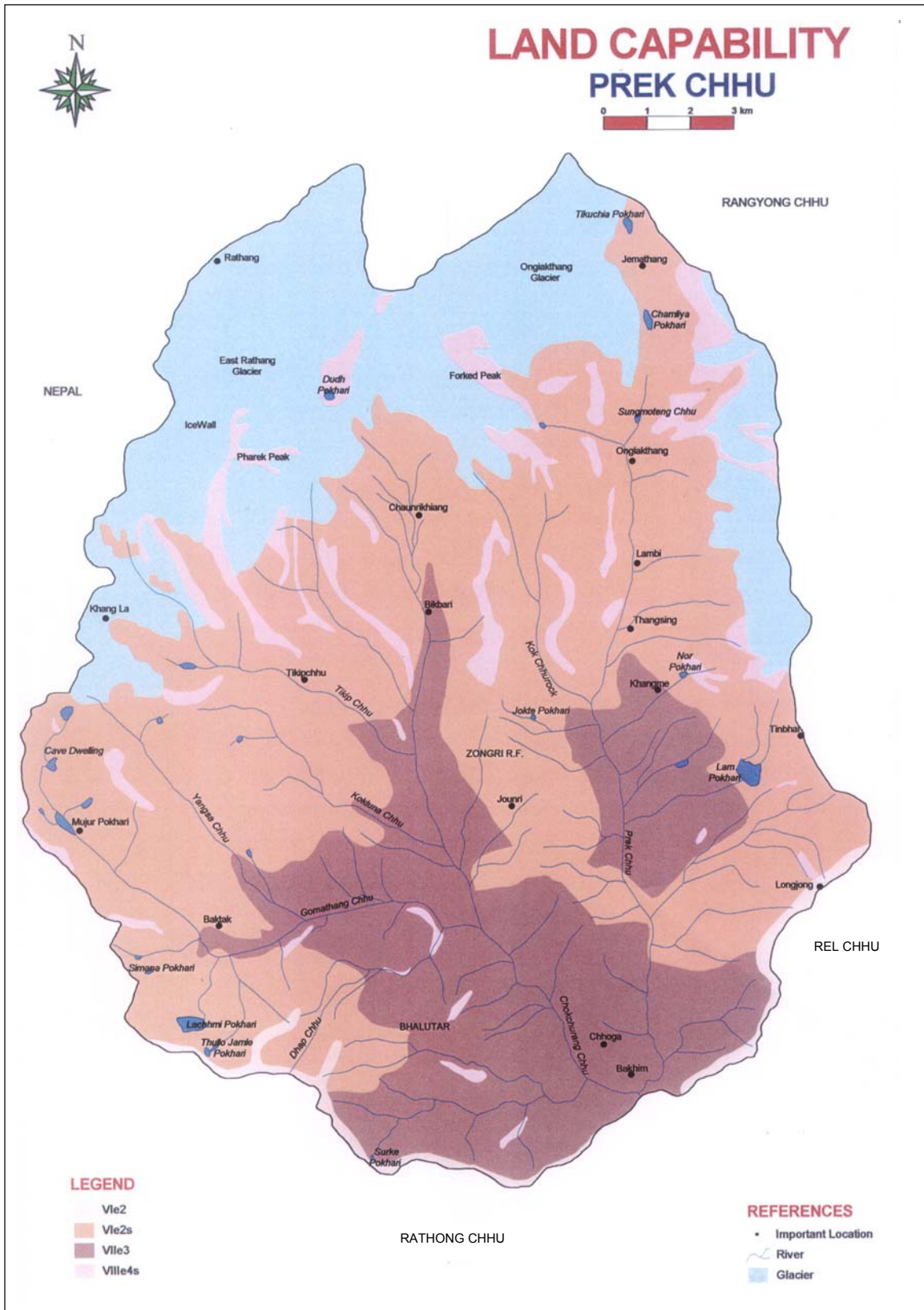


Fig. 4.85 Land capability class of Prek Chhu watershed

occupied by the land capability sub-class VIIe3 (mapping unit 3). The rocky cliff area (mapping unit 4) is represented by the land capability sub-class VIIIe4s showing very severe limitation of soil erosion and soil depth.

Table 4.74 Land capability of Prek Chhu watershed

Map unit	Description	Soil Map units	Area (In ha)	% of watershed
1	Vle2	2	420.5	1.3
2	Vle2s	7,60,63	14572.9	46.5
3	VIIe3	4,5	7510.5	23.9
4	VIIIe4s	3	2023.8	6.5
		Miscellaneous	6818.9	21.8

4.12 REL CHHU WATERSHED

4.12.1 Landforms

Total ten broad landform regions viz. ridge, rocky cliff, escarpment, landslide zone, morainic zone, low mountain, mid mountain, high mountain, very high mountain and twenty six landform units were identified in this watershed through the interpretation of satellite imagery, toposheet and through traversing (Fig. 4.86). In this watershed maximum area (36%) is occupied by high mountain following by mid mountain (16%), rocky cliff (12.5%), very high mountain (11.2%), ridge (7.8%), extremely high mountain (7.4%). A significant area of this watershed is covered with glacier/ snow cover.

4.12.2 Soils

Thirty seven soil series were identified in the watershed and were mapped into twenty six mapping units at the level of association of soil series (Table 4.75 and Fig. 4.87). The maximum area of 4,1319 ha (13.5%) is occupied by the Maniram – Damthang – Jorpul association from high mountain (>50% slope) followed by Rockout crop – Jorpul association in the rocky cliff area (12.5%). The ridge soils comprising Mailing – Rayong and Rubam – Salem association (mapping unit 1 & 2) occupies 6.8 per cent area of the watershed. The dominant soil series occurring in this watershed are Maniram, Lachung, Thangu, Rongnek, Damthang, etc.

Table 4.75 Soils of Rel Chhu watershed

Soil unit	Soil Series Association	Area (In ha)	% of watershed
1	Maling-Rayong	1713.4	5.6
2	Rubam – Salem	363.4	1.2
3	Rock outcrops – Jorpul	3847.6	12.5
4	Hilley-Singrep – Chatten	466.7	1.5
5	Bhusuk- Karporang – Tibik	842.6	2.7
6	Karporang – Hilley	226.8	0.7
7	Kalep – Rock outcrop	603.0	2.0
10	Chalumthang – Rorethang - Bhasme	24.1	0.1
16	Tumin –Phong - Chautare	650.6	2.1
18	Phong – Khedi - Maniram	662.0	2.2
24	Doling - Khedi	916.1	3.0
26	Dikling – Hilley	368.4	1.2

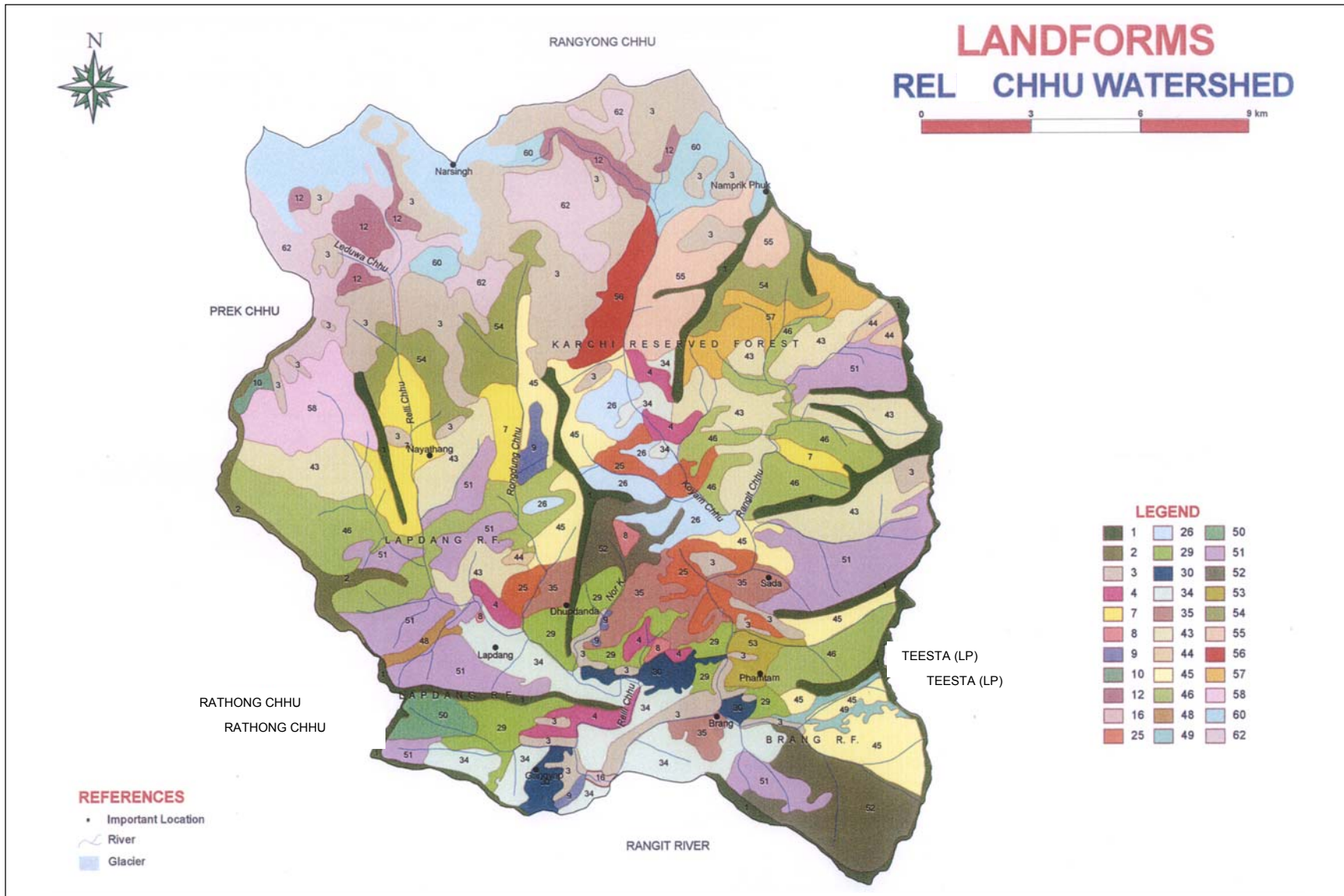


Fig. 4.86 Landform of Rel Chhu watershed

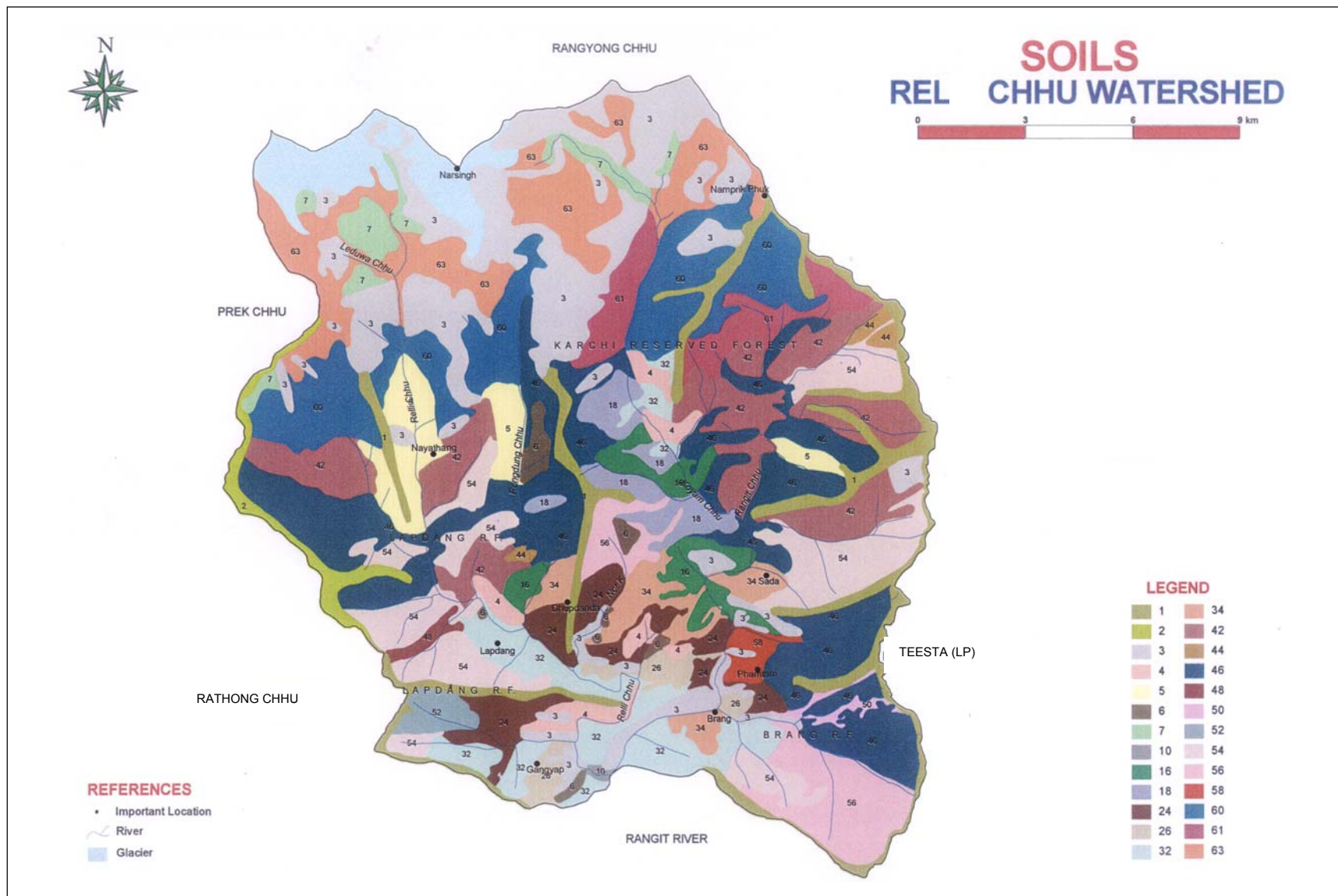


Fig. 4.87 Soils of Rel Chhu watershed

32	Bhusuk – Pirik - Namchi	1523.4	5.0
34	Namchi– Synggyang	770.6	2.5
42	Damthang – Chongrang – Rock outcrop	2425.0	7.9
44	Singgyang – Maniram - Damthang	122.5	0.4
46	Maniram-Damthang - Jorpul	4131.9	13.5
48	Martam – Tarnu - Sajong	80.1	0.3
50	Sajong –Tarnu	124.3	0.4
52	Khedi – Maniram - Rongnek	221.9	0.7
54	Rongnek – Sajong	2542.6	8.3
56	Khedi – Dikling	1198.6	3.9
58	Gaucharan – Tarnu	181.8	0.6
60	Lachung- Puchikongma - Byuma	2544.8	8.3
61	Yumthang – Thangu - Kalep	905.3	2.9
63	Thangu – Rock outcrop	2285.3	7.4
	Miscellaneous	963.6	3.1
	Total	30706.4	100.0

4.12.3 Soil depth

Five soil depth classes viz. deep, moderately deep, moderately shallow, shallow and very shallow have been identified in this watershed and were mapped into the mapping units at the level of association of soil depth classes (Table 4.76 and Fig. 4.88).

Table 4.76 Soil depth of Rel Chhu watershed

Map unit	Description	Soil Map units	Area (In ha)	% of watershed
1	Deep-mod.deep	4,18,24,34,42,44,46,48,58	9756.7	31.8

2	Deep-mod.shallow	26	368.4	1.2
3	Deep-very shallow	61	905.3	2.9
4	Mod deep-deep	1,10,56,52	3158.0	10.3
5	Mod. shallow	5,6	1069.4	3.5
6	Mod.shallow-deep	16,32,50	2298.3	7.5
7	Mod.shallow-Rock	63,7	2888.3	9.4
8	Rock-very shallow	3	3847.6	12.5
9	Shallow-mod.deep	54,60	5087.4	16.6
10	Very shallow- mod.deep	2	363.4	1.2
		Miscellaneous	963.6	3.1

In this watershed, deep – moderately deep association occurs in the maximum area of 9,756.7 ha (31.8%) while shallow – moderately deep and Rockout crop – moderately deep association covers 16.6 and 12.5 per cent area of the watershed. Moderately shallow soil depth alone (mapping unit 5) occupies 2,298.3 ha (3.5%) area of the watershed.

4.12.4 Surface texture

Ten surface soil textural class viz. gravelly sandy loam (gsl), loamy sand (ls), silt loam (sil), loam (l), sandy clay (sc), sandy clay loam (scl), gravelly silt loam (gsil), silty clay loam (sicl), sandy loam (sl), clay loam (cl), were identified in the soils of the watershed and were mapped into eighteen mapping units at the level of association of surface soil textural classes (Table 4.77 and Fig. 4.89). In this watershed sandy loam – gravelly silt loam association (mapping unit 10) belonging to high

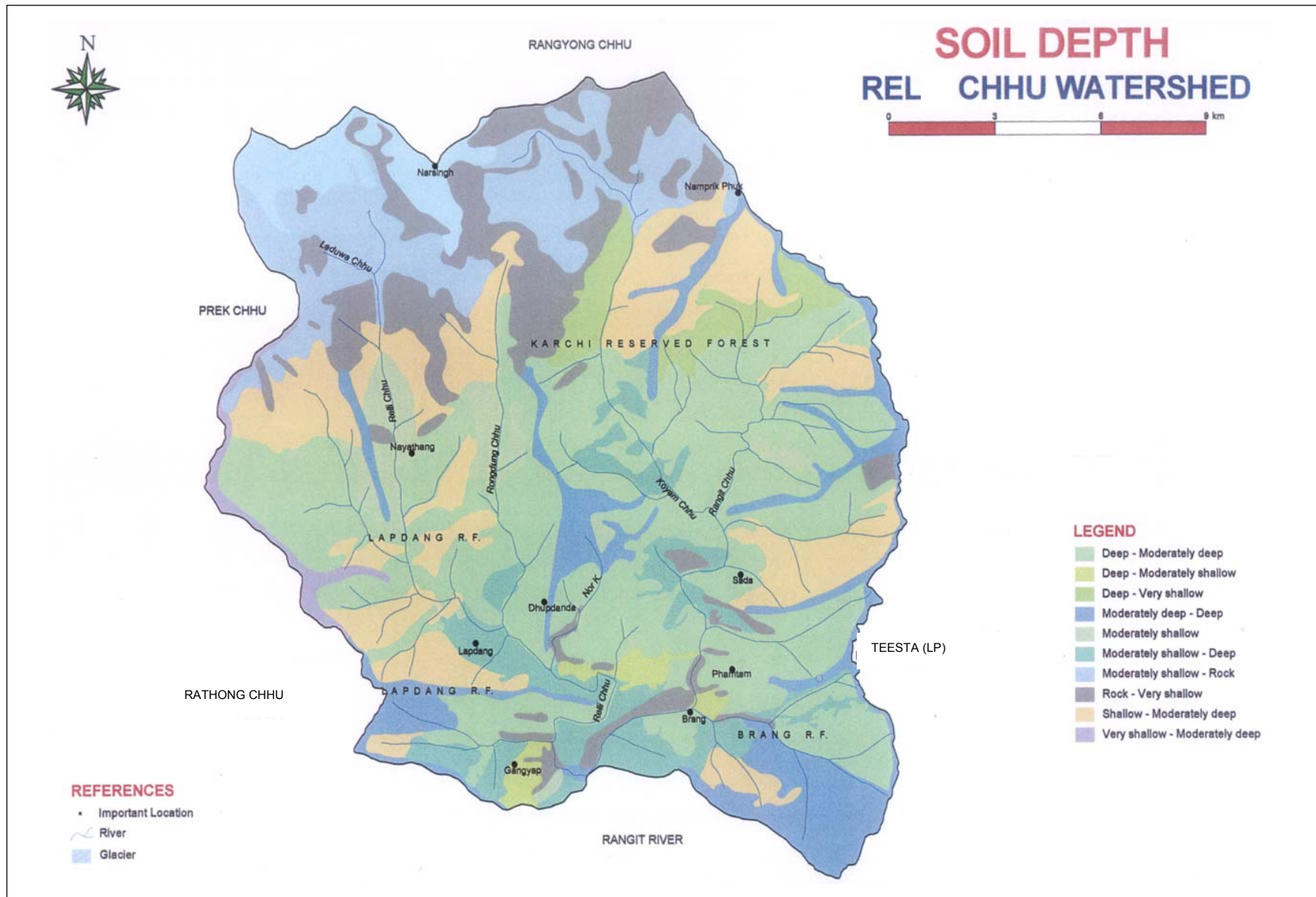


Fig. 4.88 Soils depth class of Rel Chhu watershed

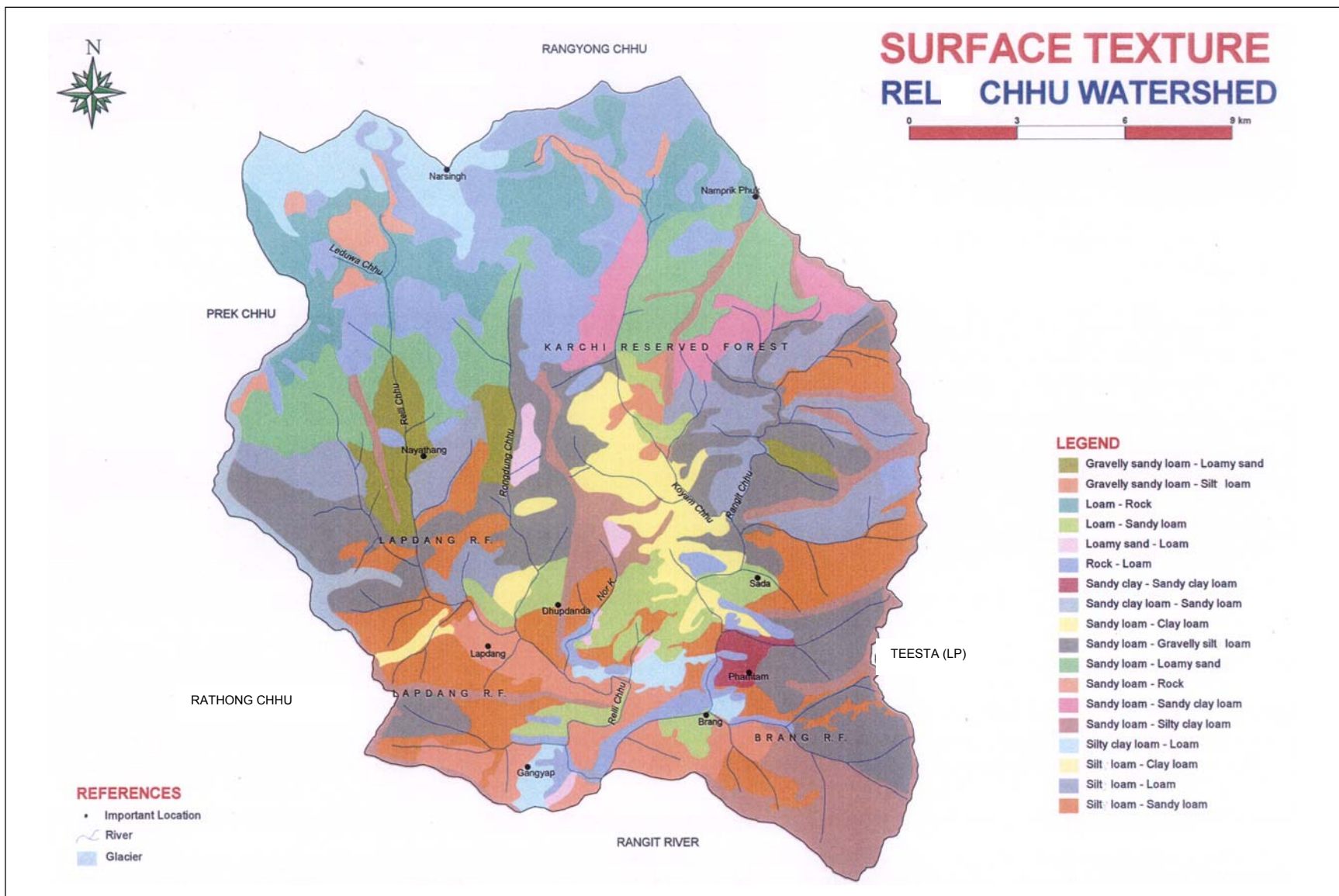


Fig. 4.89 Surface texture class of Rel Chhu watershed

mountain area (30-50% slope and above) occupies largest area of 4,476.3 ha (14.6%) while Rock outcrop - loam association (mapping unit 3) of rocky cliff occupies 3,847.6 ha (12.6%) area of the watershed. Sandy loam – loamy sand association (mapping unit 11) of the very high mountain occupies 2,544.8 ha (8.3%) area of the watershed which is very susceptible to landslide or mass movement. The gravelly sandy loam – loamy sand association (mapping unit 1) of the escarpment area is also under serious threat to landslide or mass movement and occupies 842.6 ha (2.7%) area of the watershed.

Table 4.77 Surface texture of Rel Chhu watershed

Map unit	Description	Soil Map units	Area (In ha)	% of watershed
1	gsl-ls	5	842.6	2.7
2	gsl-sil	32	1523.4	5.0
3	l-R	63	2285.3	7.4
4	l-sl	4,34	1237.3	4.0
5	ls-l	6	226.8	0.7
6	R-l	3	3847.6	12.6
7	sc-scl	58	181.8	0.6
8	scl-sl	2	363.4	1.2
9	sl-cl	18,48	742.1	2.4
10	sl-gsil	44,46,52	4476.3	14.6
11	sl-ls	60	2544.8	8.3
12	sl-R	7	603.0	2.0
13	sl-scl	61	905.3	2.9
14	sl-sicl	1,56	2912.0	9.5
15	sicl-l	26	368.4	1.2

16	sil-cl	16	650.6	2.1
17	sil-l	10,42	2449.1	8.0
18	sil-sl	24,50,54	3583.0	11.7
		Miscellaneous	963.6	3.1

4.12.5 Soil erosion

Three soil erosion classes *viz.* moderate, severe and very severe, have been identified in the soils of this watershed and were mapped into seven mapping units at the level of association of soil erosion classes (Table 4.78 and Fig. 4.90). In this watershed, moderate erosion class alone (mapping unit 1) and severe erosion class alone (mapping unit 5) occupies 7,937.8 ha (25.9%) and 9,219.3 ha (30.0%) area of the watershed, mostly belong to the ridge and hill slopes of mid mountain and high mountain. Very severe – severe association (mapping unit 7) is the real problematic zone which require immediate soil conservation measure.

Table 4.78 Soil erosion of Rel Chhu watershed

Map Unit	Description	Soil Map units	Area (In ha)	% of watershed
1	M	1,16,24,26,32,56,61,18	7937.8	25.9
2	M-R	63,7	2888.3	9.4
3	M-S	10,42,48,50,4,5,52,58	4366.5	14.3
4	R- VS	3	3847.6	12.5
5	S	46,54,60	9219.3	30.0

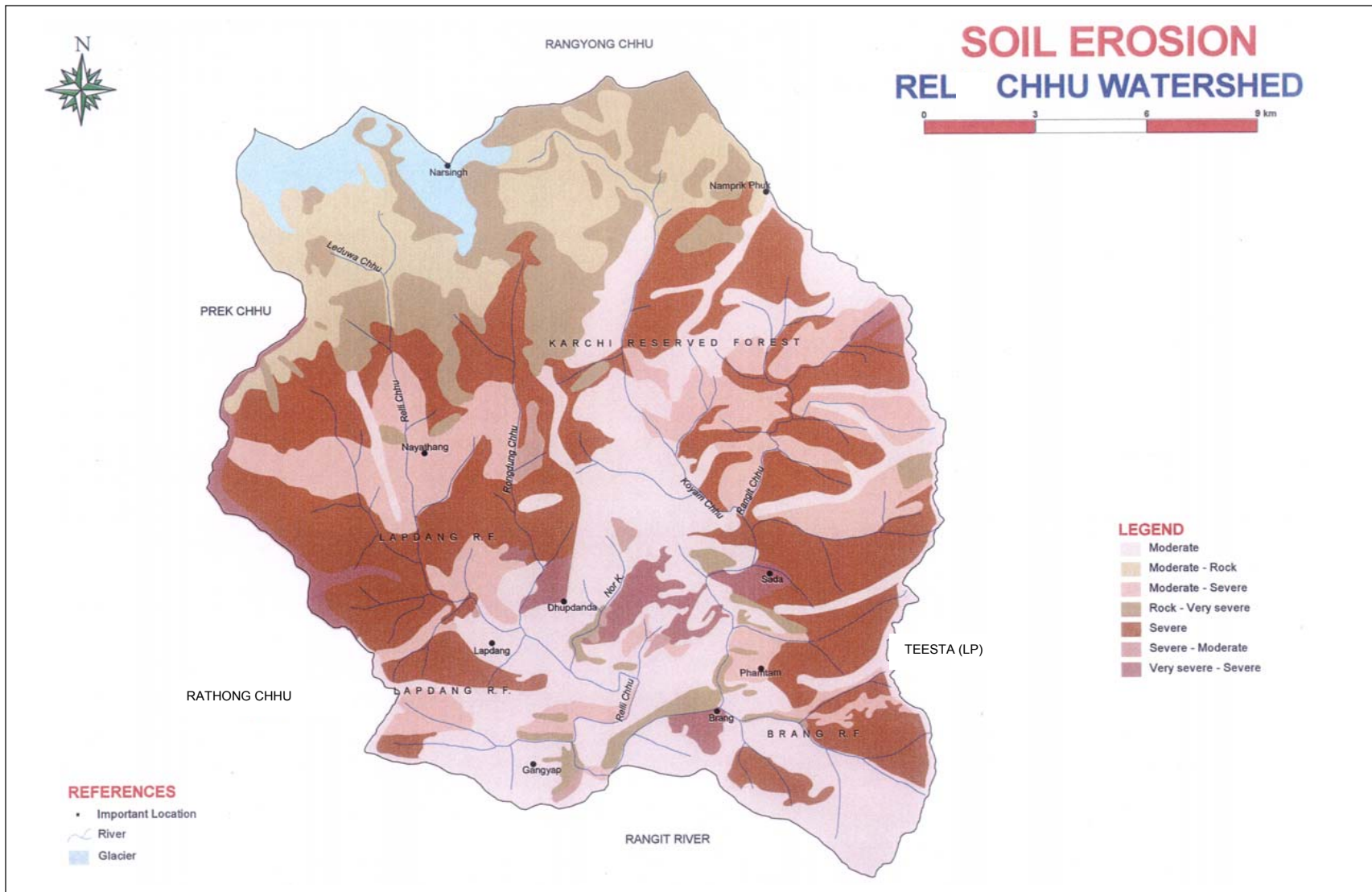


Fig. 4.90 Soil erosion class of Rel Chhu watershed

6	S-M	6	226.8	0.7
7	VS-S	34,44,2	1256.5	4.1
		Miscellaneous	963.6	3.1

4.12.6 Soil reaction

Five soil reaction classes *viz.* extremely acidic, very strongly acidic, strongly acidic, moderately acidic and slightly acidic were identified in the soil of this watershed and were mapped as association of soil reaction classes into sixteen mapping units (Table 4.79 and Fig. 4.91). Extremely acidic soils dominates mostly in the morainic zone, hill slopes of mid and high mountain while strongly acidic and very strongly acidic reaction classes dominates in the part of ridge, landslide zone, hill slopes of high, very high and extremely high mountain. However, the extremely acidic and strongly acidic association (mapping unit 2) occurs in the largest area 10,139.9 ha (33.0%) of the watershed.

Table 4.79 Soil reaction of Rel Chhu watershed

Map unit	Description	Soil Map units	Area (In ha)	% of watershed
1	EX-R	7	603.0	2.0
2	EX-S	24,42,46,50,54	10139.9	33.0
3	EX-VS	16	650.6	2.1
5	M	2	363.4	1.2
6	M-VS	48	80.1	0.3
7	M-S	58	181.8	0.6
8	R-S	3	3847.6	12.5
9	SL-VS	10	24.1	0.1

10	S-EX	1	1713.4	5.6
11	S-M	52	221.9	0.7
12	S-R	63	2285.3	7.4
13	S-VS	6,56	1425.4	4.6
14	VS	60	2544.8	8.3
15	VS-M	61	905.3	2.9
16	VS-S	26,32,34,4,5,18	4756.2	15.5
		Miscellaneous	963.6	3.1

4.12.7 Land capability class (LCC)

Five land capability classes viz. III, IV, VI, VII and VIII and seven land capability sub-classes viz. IIIe2, IVe2, Vie2, Vie2s, VIIe2s, VIIe3 and VIIIe4s were identified in this watershed and mapped (Table 4.80 and Fig. 4.92). The result revealed that land capability sub-class Vie2s occurring mostly in morainic zone, hill slopes of mid, high, very high and extremely high mountain (mapping unit 4) occupies major area of 12,029.3 ha (39.2%) of the watershed. The land capability sub-class VIIe2s occurring on the hill slopes of the high mountain (>50% slope) under mapping unit 5, occupies 6,679.4 ha (21.7%) area of the watershed. The rocky cliff area represented by the mapping unit 7 and land capability sub-class VIIIe4s is under very severe problem of soil erosion and occupies 3.1 per cent area of the watershed.

Table 4.80 Land capability of Rel Chhu watershed

Map Unit	Description	Soil Map units	Area (In ha)	% of watershed
1	IIIe2	1	1713.4	5.6

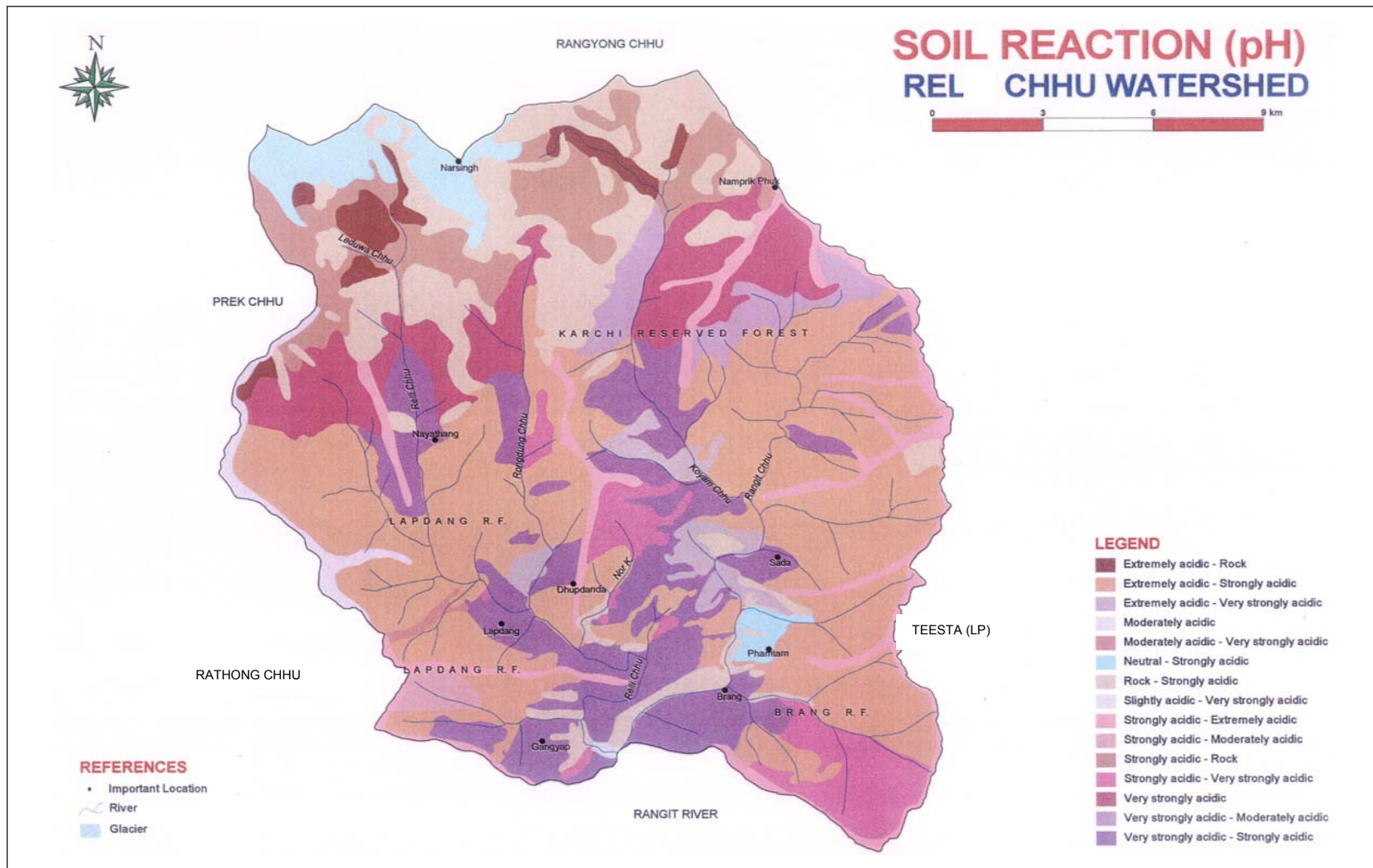


Fig. 4.91 Soil reaction class of Rel Chhu watershed

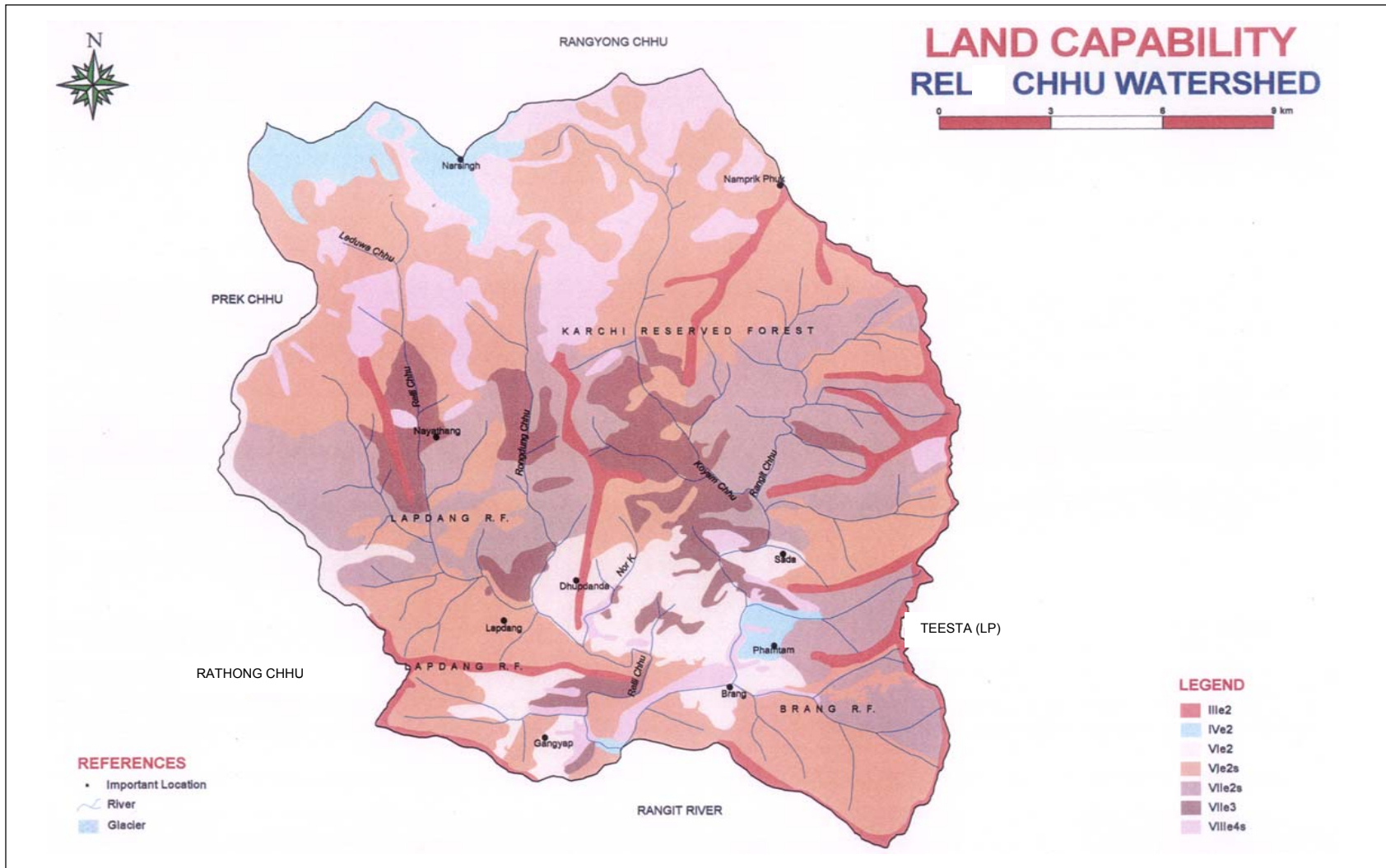


Fig. 4.92 Land capability class of Rel Chhu watershed

2	Ive2	10,58	205.9	0.7
3	Vie2	24,26,34,2	2418.5	7.9
4	Vie2s	32,48,50,54,56,60,61,63,7,52	12029.3	39.2
5	Vlle2s	42,44,46	6679.4	21.7
6	Vlle3	6,16,4,5,18	2848.7	9.3
7	Vllle4s	3	3847.6	12.5
		Miscellaneous	963.6	3.1

4.12.8 Soil-site suitability for rice

Soil-site suitability for rice in Rel Chhu Watershed showed that about 1,523.4 ha areas were found to be marginally to moderately suitable (S3-S2) and 4,858.6 ha area as marginally suitable (S3). About 10,900.5 ha area covering part of ridge, rocky cliff, landslide zone, morainic zone, very high mountain and extremely high mountain were found to be unsuitable for rice (Table 4.81 and Fig. 4.93).

Table 4.81 Soil-site suitability for rice of Rel Chhu watershed

Sl.No.	Suitability class	Map unit nos.	Area (ha)
1.	S3-S2	32	1523.4
2.	S3	24,18,1,10,44,52,56	4858.6
3.	S3-N	26,46,48,54,58	7304.8
4.	N-S3	4,5,16,34,42	5155.5
5.	N	2,3,6,7,50,60,61,63	10900.5
	Miscellaneous		963.6
		Total	30706.4

4.12.9 Soil-site suitability for maize

Maize cultivation was found to be moderately suitable (S2) in the ridges, part of mid and high mountain covering 5,847.4 ha areas while moderately suitable to marginally suitable (S2-S3) in parts of low and mid mountain covering 3,714.9 ha area of the watershed. About 1,309.3 ha area of escarpment were found to be only marginally suitable and 10,776.2 ha area of the ridge, rocky cliff, landslide zone, morainic zone and part of very high and extremely high mountain were found to be unsuitable for maize (Table 4.82 and Fig. 4.94).

Table 4.82 Soil-site suitability for maize of Rel Chhu watershed

SI.No.	Suitability class	Map unit nos.	Area (ha)
1	S2	1,18,24,32,34,48,58	5847.4
2	S2-S3	26,42,44	2915.9
3	S3-S2	10,16,50	799.0
4	S3	4,5	1309.3
5	N-S2	46,52,54,56	8095.0
6	N	2,3,6,7,60,61,63	10776.2
	Miscellaneous		963.6
		Total	30706.4

4.13 RATHONG CHHU WATERSHED

4.13.1 Landforms

Nine broad landform regions have been identified in this watershed viz. ridge, rocky cliff, escarpment, morainic zone, low

mountain, narrow valley, mid mountain, high mountain and very high mountain (Fig.4.95). In this watershed high mountain occupies largest area of 40.7 per cent followed by mid. mountain, very high mountain and ride occupying 25.9, 21.7 and 7.2 per cent area respectively.

4.13.2 Soils

Soils of Rathong Chhu watershed have been mapped into twenty five units at the level of soil series association (Table 4.83) and mapped in Fig. 4.96. Mapping unit 50 comprising of Sajong – Tarnu series association, mapping unit 60 of Lachung – Puchikongma – Byuma series association, mapping unit 42 of Damthang – Chongrang – Rock are the dominant associations which covered 3,764.9 ha (13.5%), 34,524.4 ha (12.3%) and 3,079.4 ha (11.0%) area respectively. Soil map unit 60, 61 and 62 occurs mainly in sub-alpine climatic region occupies an area of 21.7 per cent area of the watershed. The soils of high mountain occupy 40.7 per cent area while the soils of mid mountain occupy 25.9 per cent and low mountain occupy 2.2 per cent area of the watershed.

Table 4.83 Soils of Rathong Chhu watershed

Soil unit	Soil Series Association	Area (In ha)	% of watershed
1	Maling-Rayong	1179.0	4.2
2	Rubam – Salem	834.7	3.0
3	Rock outcrops - Jorpul	177.9	0.6
4	Hilley-Singrep - Chatten	23.0	0.1
5	Bhusuk- Karporang - Tibik	121.2	0.4

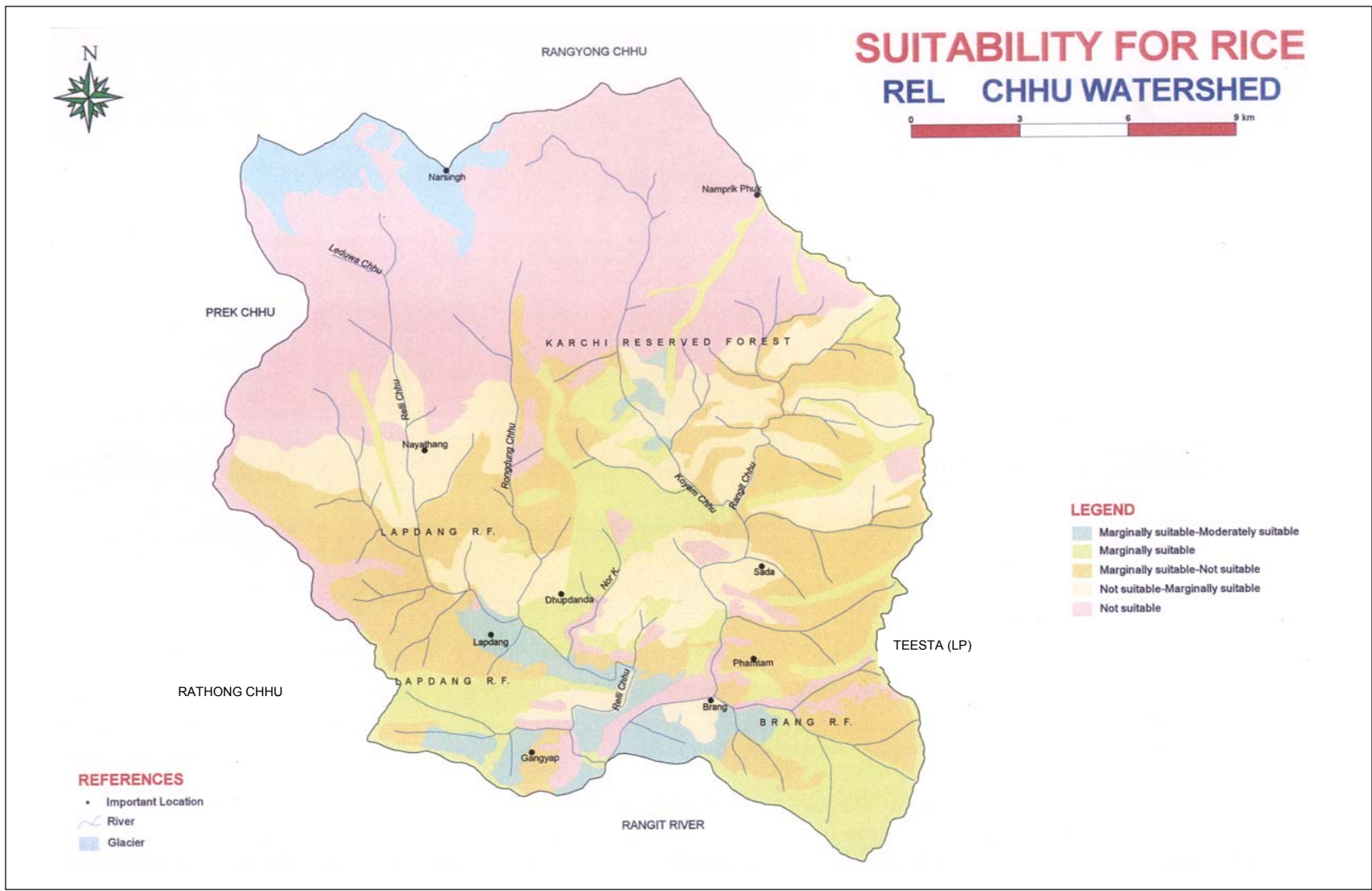


Fig. 4.93 Soil site suitability for rice in Rel Chhu watershed

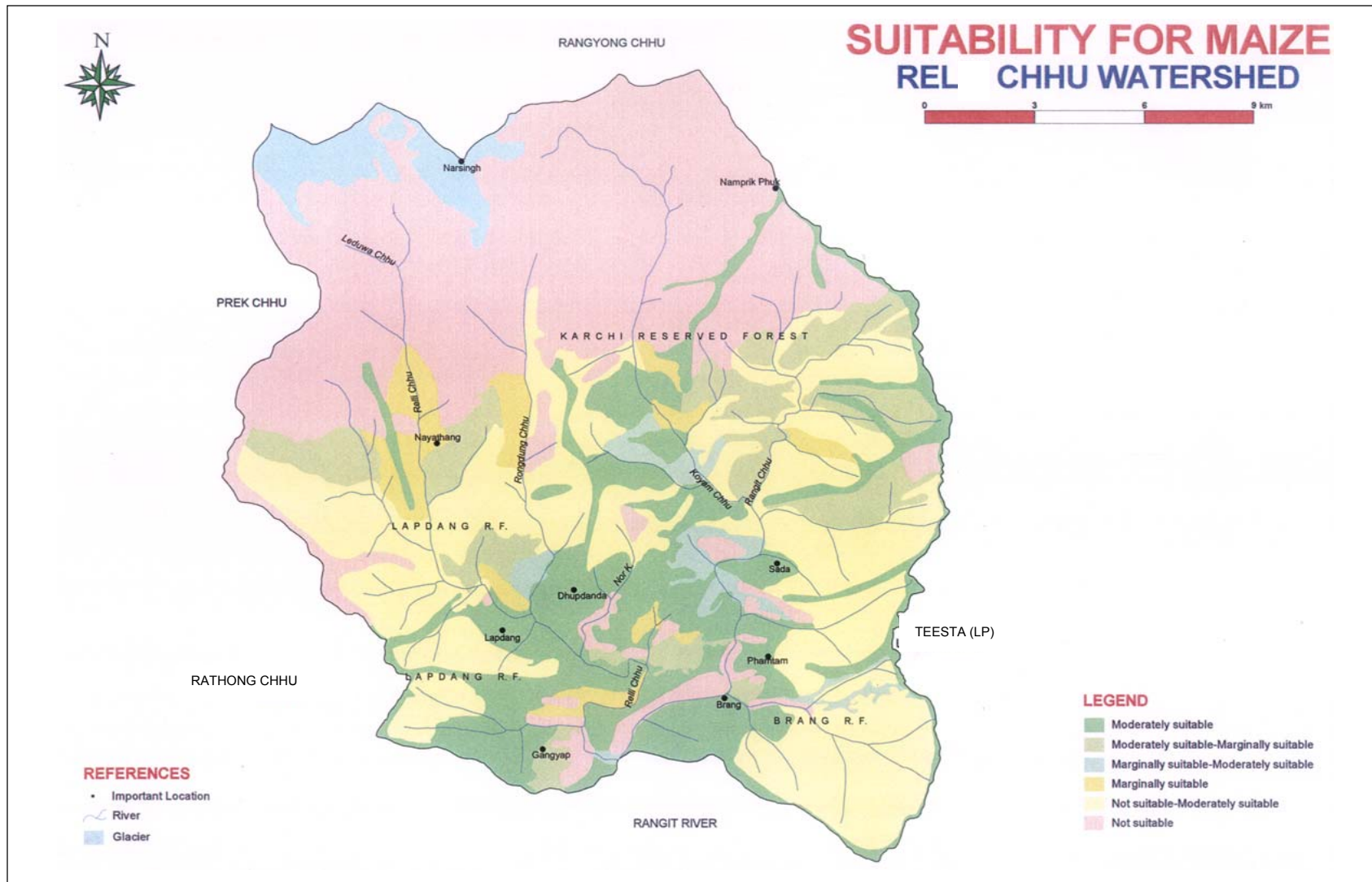


Fig. 4.94 Soil site suitability for maize in Rel Chhu watershed

7	Kalep – Rock outcrop	94.8	0.3
8	Bhasme – Chautare - Legship	373.3	1.3
10	Chalumthang – Rorethang - Bhasme	242.9	0.9
15	Mangreng – Karfacter- Mangjing	176.2	0.6
16	Tumin –Phong - Chautare	1320.4	4.7
18	Phong – Khedi - Maniram	1773.7	6.3
20	Chakung – Tumin - Sajong	856.7	3.1
22	Chongrang – Legship - Singgyang	1995.6	7.1
26	Dikling – Hilley	206.5	0.7
32	Bhusuk – Pirik - Namchi	235.8	0.8
34	Namchi– Synggyang	887.1	3.2
42	Damthang – Chongrang – Rock outcrop	3079.4	11.0
44	Singgyang – Maniram - Damthang	1762.9	6.3
46	Maniram-Damthang - Jorpul	1717.9	6.1
48	Martam – Tarnu – Sajong	588.8	2.1
50	Sajong –Tarnu	3764.9	13.5
56	Khedi – Dikling	467.7	1.7
60	Lachung- Puchikongma – Byuma	3452.4	12.3
61	Yumthang – Thangu – Kalep	2564.1	9.2
62	Maltin – Lachen – Rock outcrop	62.2	0.2
	Miscellaneous	16.0	0.1
	Total	27975.7	100.0

4.13.3 Soil depth

Five different classes of soil depth have been identified and mapped into eleven units at the level of association of soil depth classes (Table 4.84) and presented in Fig. 4.97 Map Unit 1 comprising of deep – moderately deep association covered an area of 2,004.6 ha (42.9%). Soil map unit 7 with moderately shallow – deep association covers an area of 5,694.4 ha (20.4%). Rock is distributed in soil map unit 8 & 9

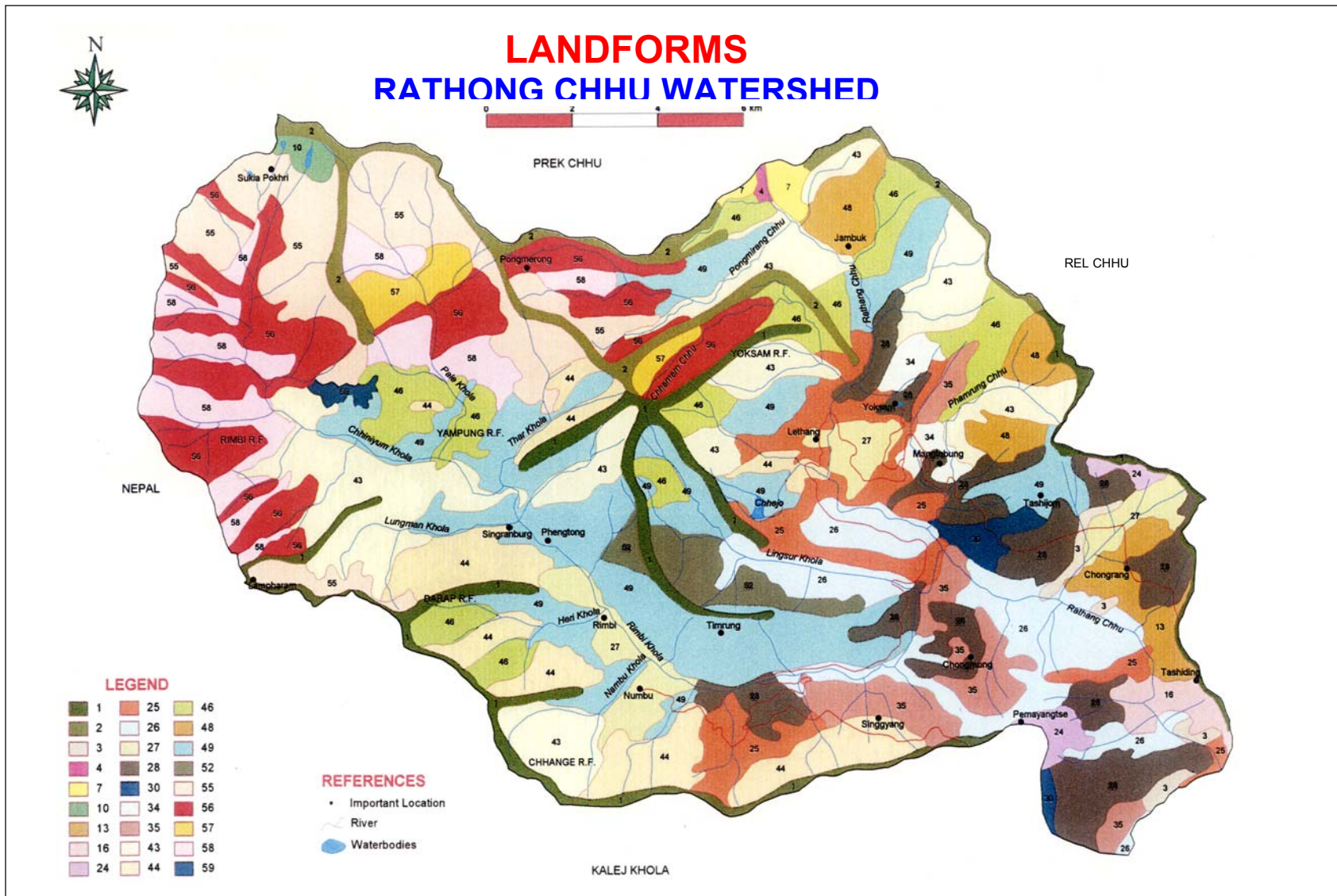


Fig. 4.95 Landform of Rathong Chhu watershed

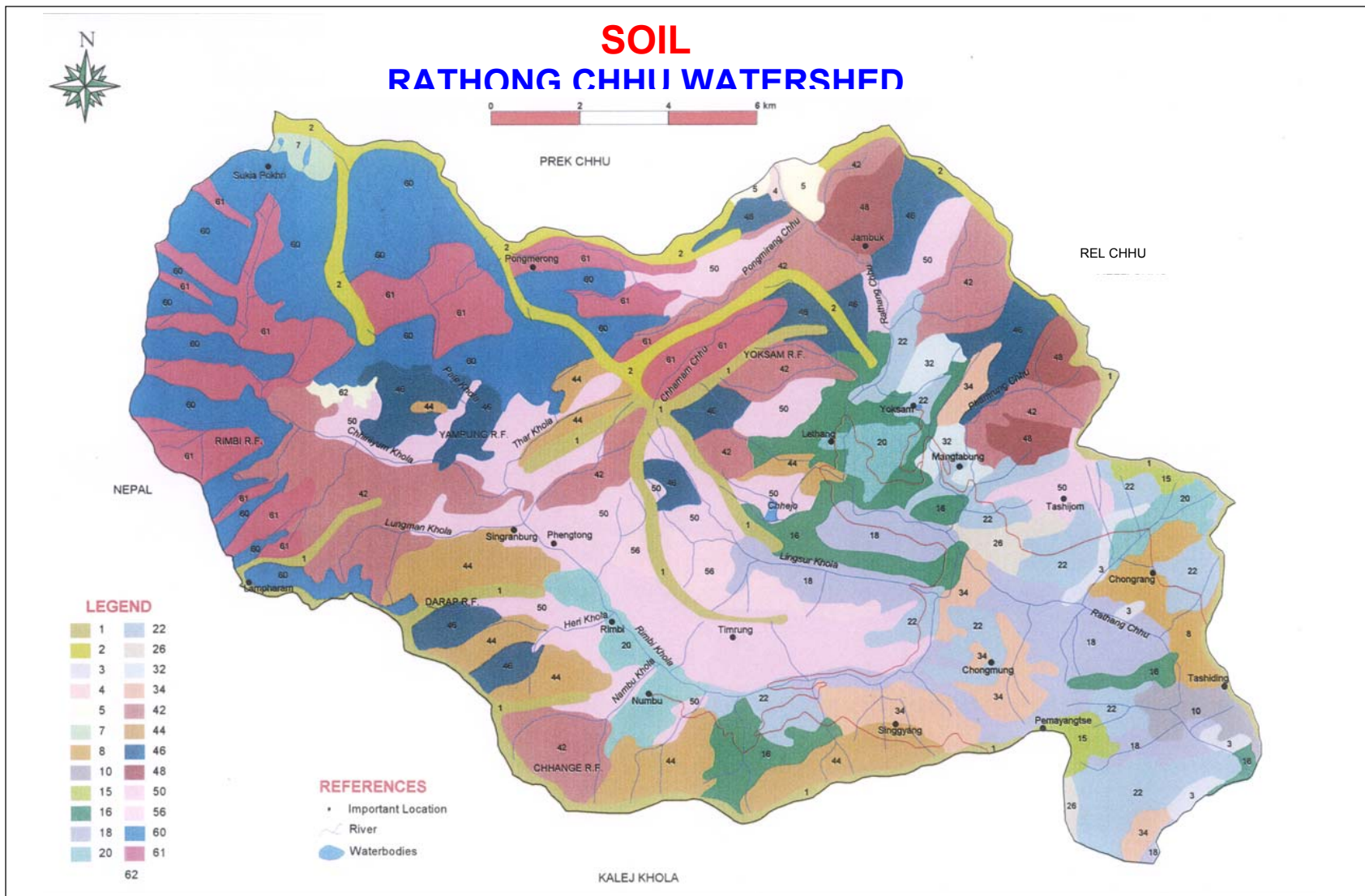


Fig. 4.96 Soils of Rathong Chhu watershed

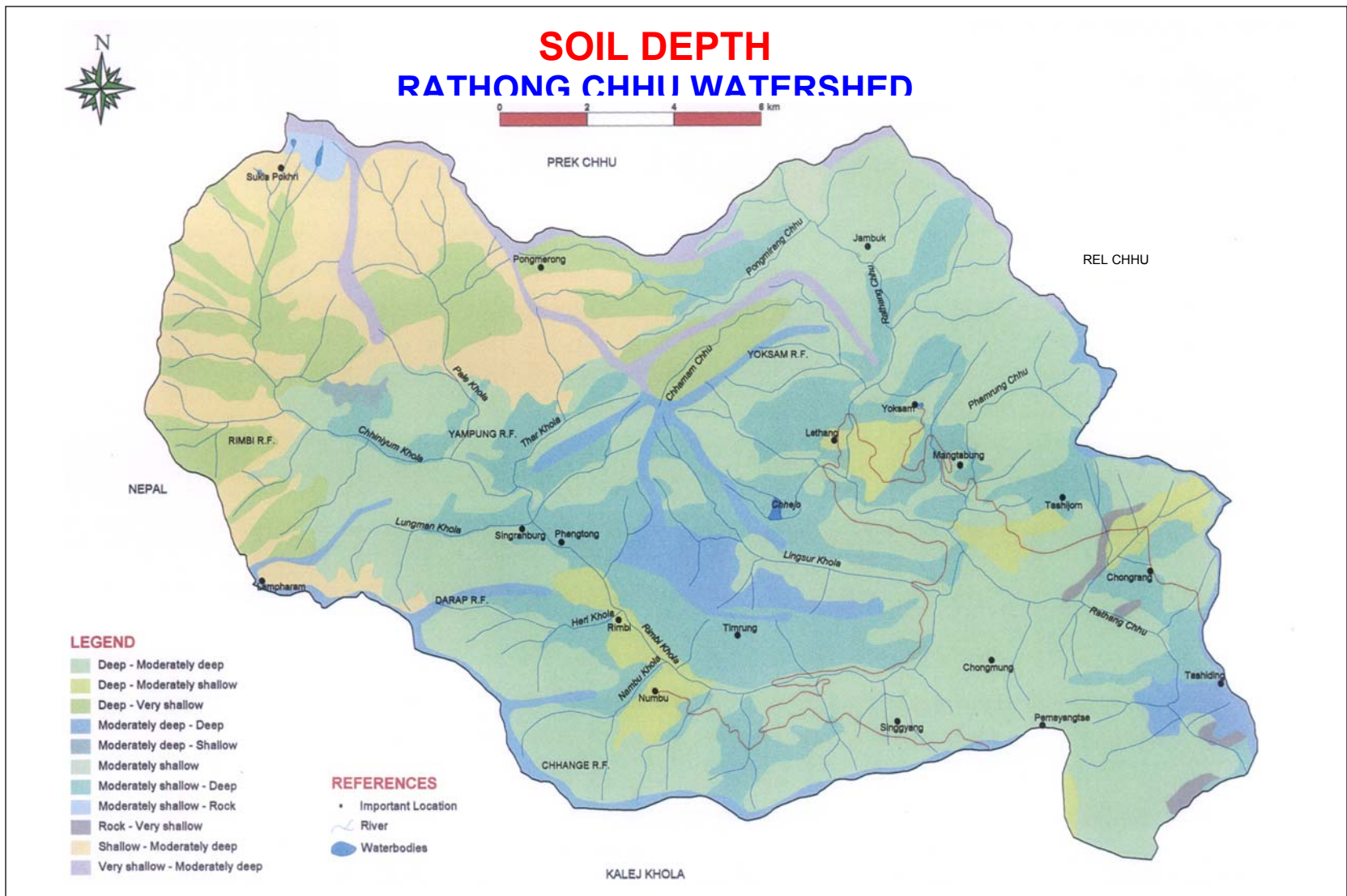


Fig. 4.97 Soils depth class of Rathong Chhu watershed

with association of moderately shallow and extremely shallow depth class respectively.

Table 4.84 Soil depth of Rathong Chhu watershed

Map unit	Description	Soil Map units	Area (In ha)	% of watershed
1	Deep-mod deep	22,4,34,42,44,46,48,15,18	2004.6	42.9
2	Deep-mod shallow	20,26	1063.2	3.8
3	Deep-very shallow	61	2564.1	9.2
4	Mod deep-deep	1,10,56	1889.6	6.8
5	Mod deep-shallow	62	62.2	0.2
6	Mod shallow	5	121.2	0.4
7	Mod shallow-deep	8,16,32,50	5694.4	20.4
8	Mod shallow-Rock	7	94.8	0.3
9	Rock-very shallow	3	177.9	0.6
10	Shallow-mod deep	60	3452.4	12.3
11	Very shallow-mod deep	2	834.7	3.0
		Miscellaneous	16.5	0.1

The mapping unit 9 comprising Rock – very shallow association is the real problematic area of the watershed covering an area of 0.6 per cent which should be protected through afforestation.

4.13.4 Surface texture

Ten surface soil textural classes have been identified in Rathong Chhu Watershed (Table 4.85 and presented in Fig. 4.98) and mapped into sixteen mapping units at the level of association of surface textural class. Silt loam (sil) and sandy loam (sl) are dominant textural class

identified in the watershed. The silt loam- sandy loam association (mapping unit 16) occupies largest area of the watershed (20.6%) followed by silt loam-loam (15%), sandy loam- loamy sand (12.6%) and sandy loam – gravelly silt loam (12.4%).

Table 4.85 Surface texture of Rathong Chhu watershed

Map unit	Description	Soil Map units	Area (In ha)	% of watershed
1	cl-l	15	176.2	0.6
2	Gsl-ls	5	121.2	0.4
3	gsl-sil	32	235.8	0.8
4	l-sl	4,8,34	1283.4	4.6
5	R-l	3	177.9	0.6
6	Scl-sl	2	834.7	3.0
7	sl-cl	18,48	2362.5	8.5
8	sl-gsil	44,46	3480.8	12.4
9	sl-ls	60,62	3514.6	12.6
10	sl-R	7	94.8	0.3
11	sl-scl	61	2564.1	9.2
12	sl-sicl	1,56	1646.7	5.9
13	sicl-l	26	206.5	0.7
14	Sil-cl	16	1320.4	4.7
15	Sil-l	10,42,20	4179.0	15.0
16	Sil-sl	22,50	5760.5	20.6
		Miscellaneous	16.5	0.1

4.13.5 Soil erosion

Moderate, severe and very severe classes of soil erosion have been identified and mapped into eight mapping units at the level of association of erosion classes (Table 4.86 and Fig. 4.99). Moderate

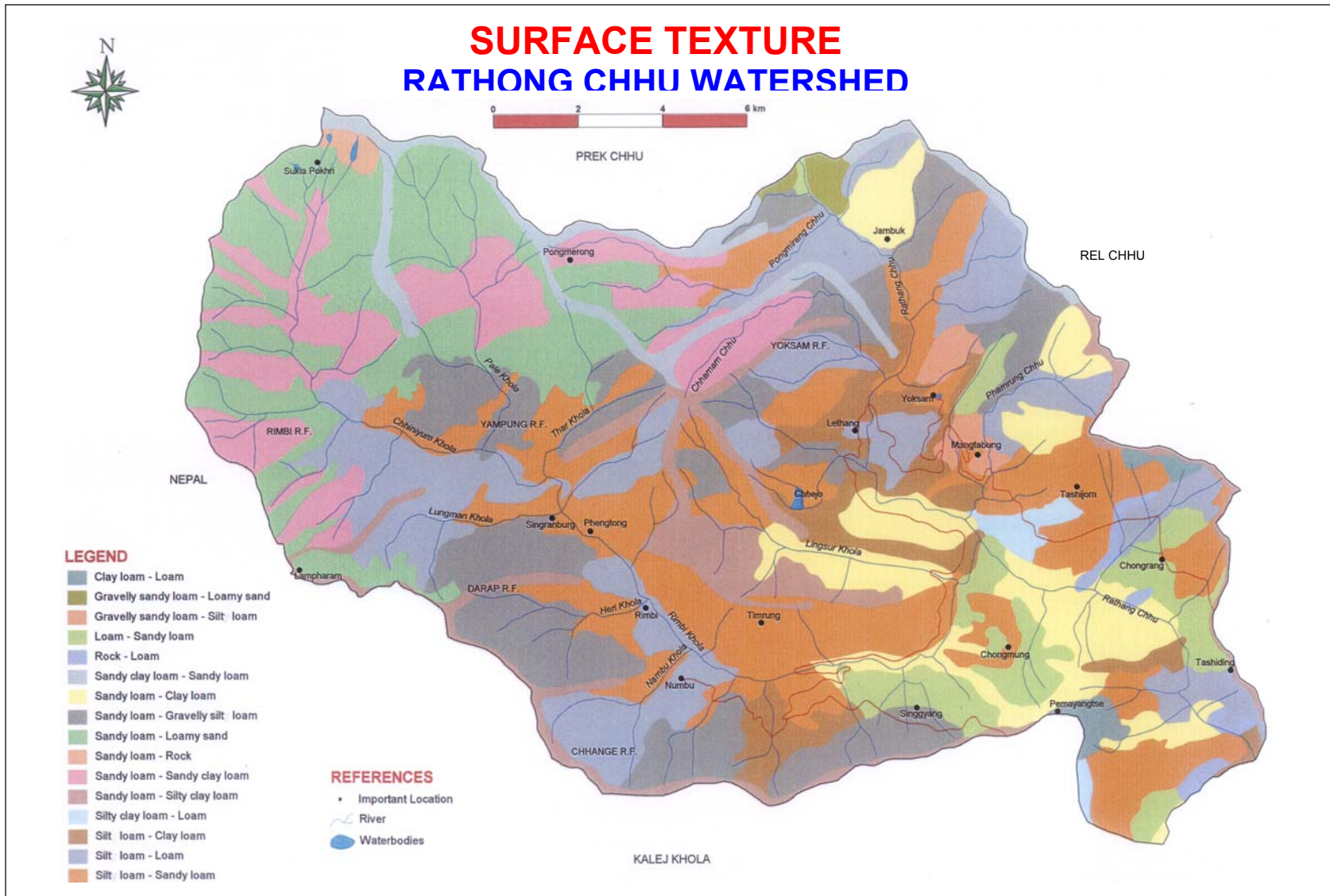


Fig. 4.98 Surface texture class of Rathong Chhu watershed

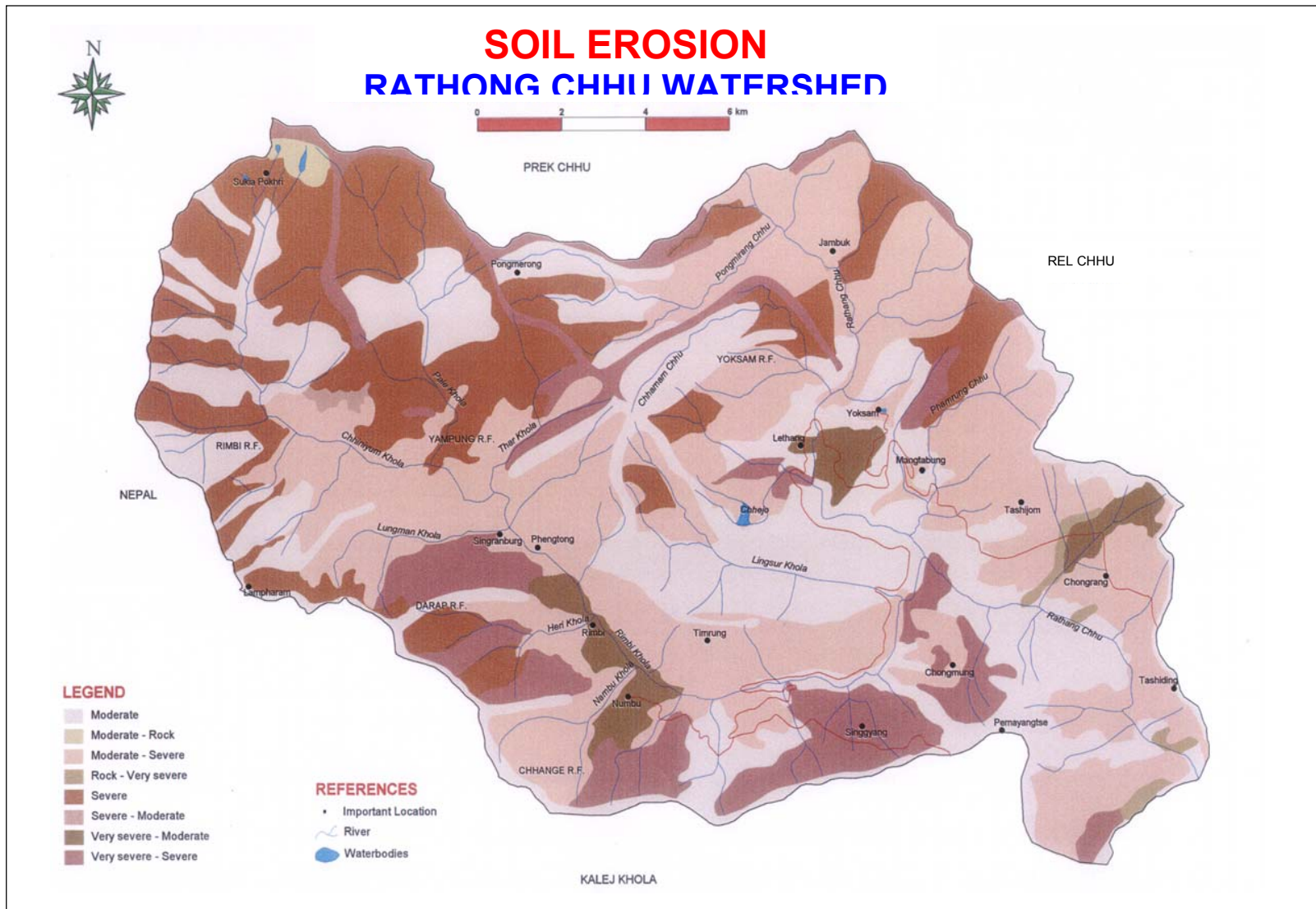


Fig. 4.99 Soil erosion class of Rathong Chhu watershed

erosion alone (mapping unit 1) covered 7,923.4 ha (28.3%) whereas severe erosion alone covered 5,170.3 ha (mapping unit 5). The largest area of 36.4 ha is occupied by the association of moderate and severe erosion (mapping unit 3) and association of very severe and severe erosion (Mapping unit 8) occupies 12.5% area of the watershed.

Table 4.86 Soil erosion of Rathong Chhu watershed

Map unit	Description	Soil Map units	Area (In ha)	% of watershed
1	M	1,16,26,32,56,61,15,18	7923.4	28.3
2	M-R	7	94.8	0.3
3	M-S	10,22,42,48,50,5,8,4	10189.1	36.4
4	R-VS	3	177.9	0.6
5	S	46,60	5170.3	18.5
6	S-M	62	62.2	0.2
7	VS-M	20	856.7	3.1
8	VS-S	34,44,2	3484.7	12.5
		Miscellaneous	16.5	0.1

4.13.6 Soil reaction

Four types of soil reaction class viz. moderately acidic, strong acidic, very strong acidic and extremely acidic have been identified in this watershed and mapped at the level of association of soil reaction classes into fourteen mapping units (Table 4.87 and Fig. 4.100).

Table 4.87 Soil reaction of Rathong Chhu watershed

Map unit	Description	Soil Map units	Area (In ha)	% of watershed
1	EX-R	7	94.8	0.3
2	EX-S	8,20,22,42,46,50	11787.8	42.2
3	EX-VS	16	1320.4	4.7
5	M	2	834.7	3.0
6	M-VS	15,48	765.0	2.7
7	R-S	3	177.9	0.6
8	SL-VS	10	242.9	0.9
9	S-EX	1	1179.0	4.2
10	S-M	62	62.2	0.2
11	S-VS	56	467.7	1.7
12	VS	60	3452.4	12.3
13	VS-M	61	2564.1	9.2
14	VS-S	5,18,26,34,32,44,4	5010.2	17.9
		Miscellaneous	16.5	0.1

Mapping unit 2 comprising extremely acidic - strongly acidic soils covered an area of 11,787.8 ha (42.1%), followed by mapping unit 12 comprising only very strongly acidic reaction class and mapping unit 14 comprising the association of very strongly – strongly acidic class which covered 3,452.4 ha (12.3%) and 5,010.2 ha (17.9%) area respectively of the watershed.

4.13.7 Land capability class (LCC)

Five Land Capability Classes and seven land capability sub-classes have been identified in this watershed (Table 4.88) and have been mapped (Fig. 4.101). Land Capability sub-class Vle2s (mapping unit 4) is

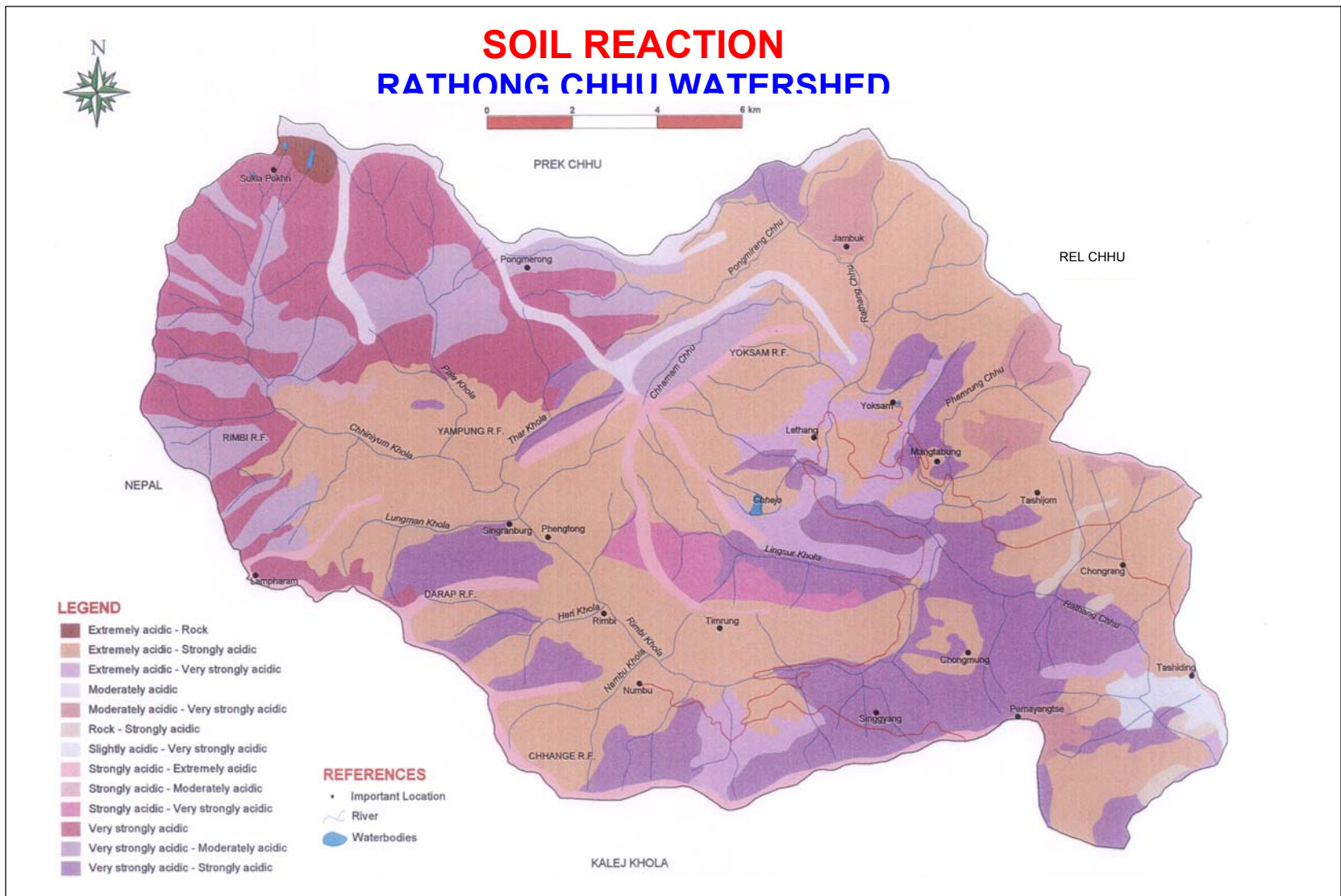


Fig. 4.100 Soil reaction class of Rathong Chhu watershed

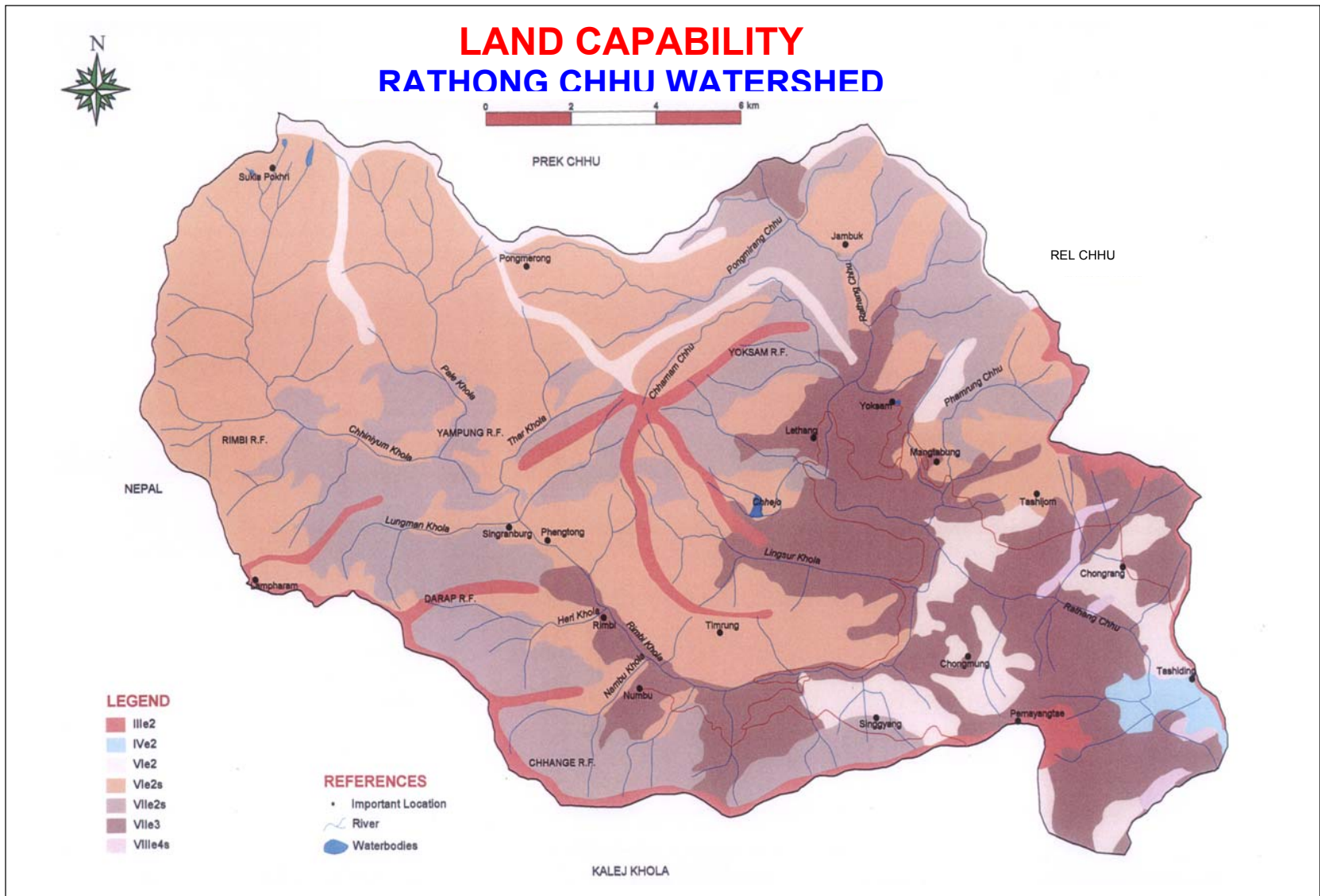


Fig. 4.101 Land capability class of Rathong Chhu watershed

most extensive in 11,230.7 ha (40.1%) area. Mapping unit 5 of land capability sub class VIIe2s and mapping unit 6 of land capability sub class VIIe3 covered 6,560.2 ha (23.4%) and 6,090.6 ha (21.8%) area respectively. The rocky cliff area (mapping unit no.7) possesses land capability sub-class VIIIe4s and occupies 0.6 per cent area of the watershed.

Table 4.88 Land capability of Rathong Chhu watershed

Map unit	Description	Soil Map units	Area (In ha)	% of watershed
1	IIIe2	1,15	1355.2	4.8
2	IVe2	10	242.9	0.9
3	VIe2	8,26,34,2	2301.6	8.2
4	VIe2s	32,48,50,56,60,61,62,7	11230.7	40.1
5	VIIe2s	42,44,46	6560.2	23.5
6	VIIe3	5,16,18,20,22,4	6090.6	21.8
7	VIIIe4s	3	177.9	0.6
		Miscellaneous	16.5	0.1

4.13.8 Soil-site suitability for rice

In Rathong Chhu watershed 235.8 ha areas (mapping unit 1) have been found to be marginally to moderately suitable (S3-S2) (Table 4.89 and Fig. 4.102) for rice cultivation and 7,971.3 ha area was found to be only marginally suitable. Almost unsuitable (N) alone and in combination with marginally suitable (S3) in mapping unit 3,4 and 5 cover 19,752.1

ha area and is mainly due to severe to very severe limitations of topography, soil fertility including soil acidity.

Table 4.89 Soil-site suitability for rice of Rathong Chhu watershed

Sl.No.	Suitability class	Map unit nos.	Area (ha)
1.	S3-S2	32	235.8
2.	S3	1,8,10,15,18,22,44,56	7971.3
3.	S3-N	20,26,46,48	3369.9
4.	N-S3	4,5,16,34,42	5431.2
5.	N	2,3,7,50,60,61,62	10951.0
	Miscellaneous		16.5
		Total	27975.7

4.13.9 Soil-site suitability for maize

Maize is found to be only moderately suitable (S2) in 6,660.0 ha (mapping unit 1) areas in Rathong Chhu watershed and only marginally suitable in 144.2 ha area (Table 4.90 and Fig. 4.103). It is moderately to marginally suitable (S2-S3) in 6,081.7 ha and marginally to moderately suitable (S3-S2) in 5,701.5 ha. Almost unsuitable (N) alone and in combination occupy 9,371.8 ha area may be due to severe to very severe limitations of topography and soil.

Table 4.90 Soil-site suitability for maize of Rathong Chhu watershed

Sl.No.	Suitability class	Map unit nos.	Area (ha)
1.	S2	1,18,22,32,34,48	6660.0
2.	S2-S3	15,20,26,42,44	6081.7

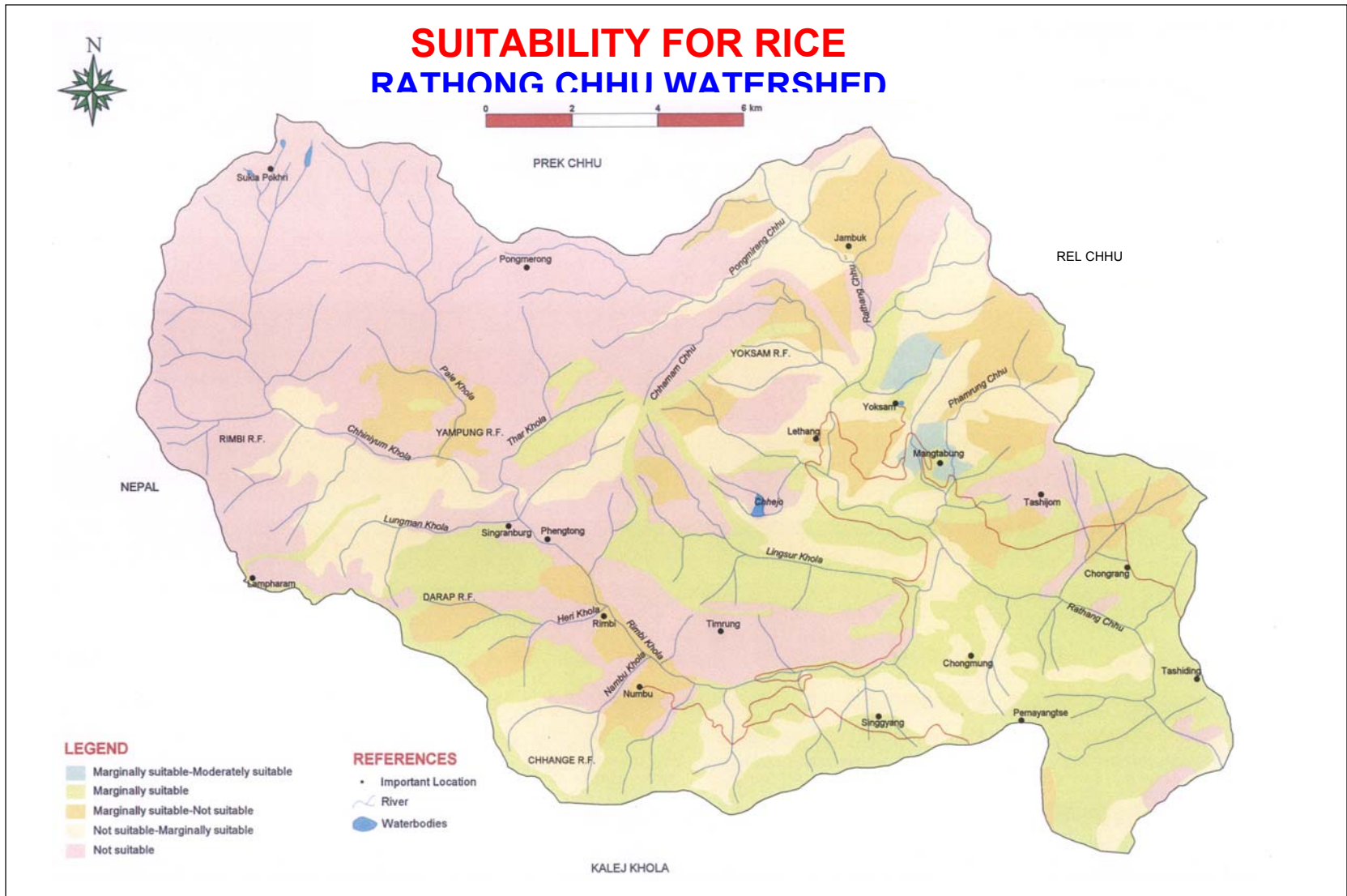


Fig. 4.102 Soil-site suitability for rice in Rathong Chhu watershed

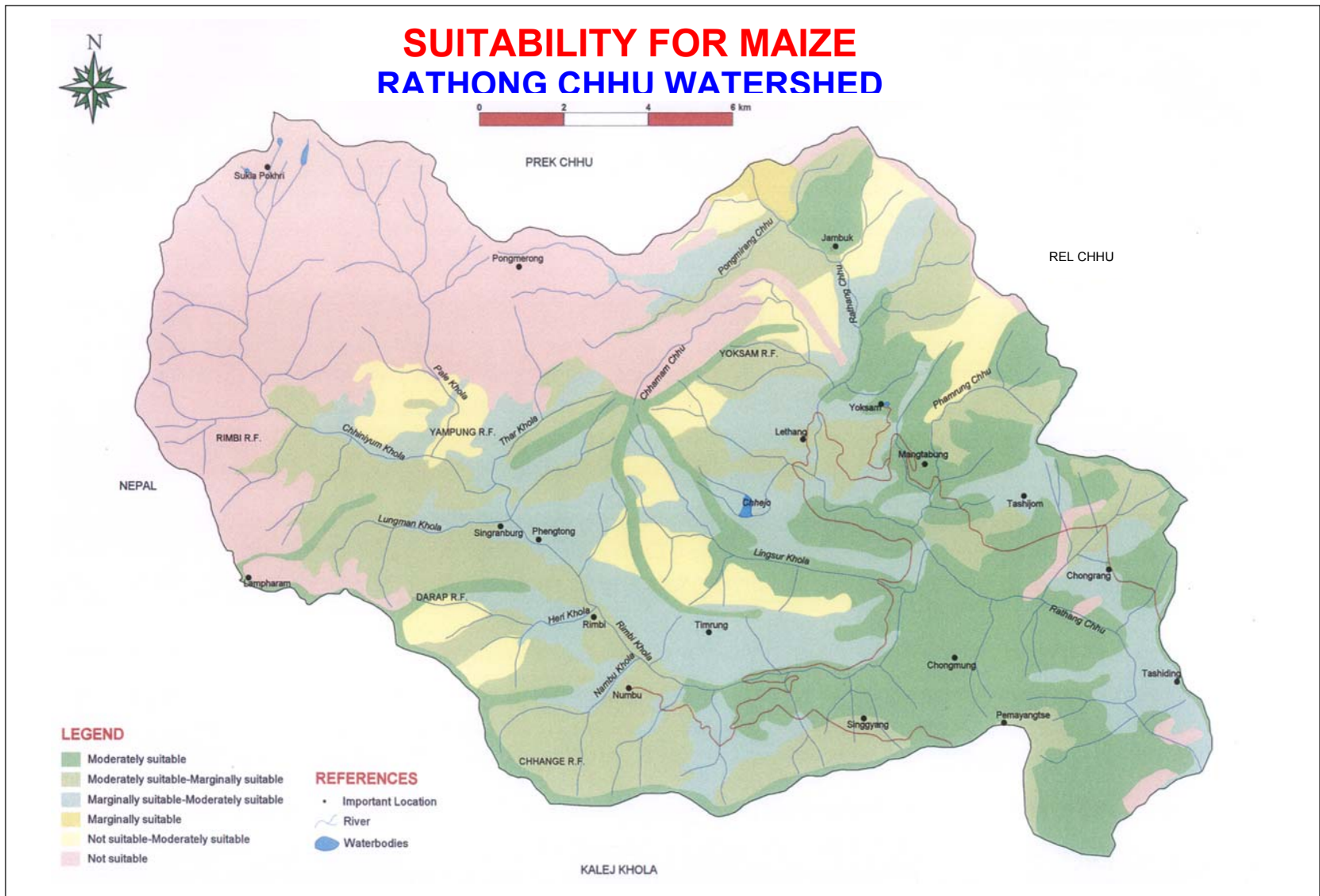


Fig. 4.103 Soil-site suitability for maize in Rathong Chhu watershed

3.	S3-S2	8,10,16,50	5701.5
4.	S3	4,5	144.2
5.	N-S2	46,56	2185.6
6.	N	2,3,7,60,61,62	7186.2
	Miscellaneous		16.5
		Total	27975.7

4.14 KALEJ KHOLA WATERSHED

4.14.1 Landforms

Six broad landform regions viz. ridge, landslide zone, low mountain, mid mountain, high mountain and very high mountain were identified in this watershed. These broad geomorphic units again subdivided into 20 landform units based on terrain features identified through satellite imagery, toposheet and field traverse (Fig. 4.104). In this watershed, 43.2 per cent area is covered by mid and high mountain while very high mountain, ridge, low mountain and landslide zone covers 5.2, 5.1, 3.0 and 0.2 per cent area respectively.

4.14.2 Soils

Soils of Kalej Khola watershed have been mapped into twenty soil mapping units at the level of soil series association (Table 4.91) and presented in Fig. 4.105. Association of Damthang and Chongrang soil series with rock out crop (soil map unit 42) covers an area of 3,512.4 ha (17.1%). Association of Rumtek and Tumin soil series of soil map unit 30

covers an area of 2,238.3 ha (10.9%). Other dominant soil map units are 22, 26 and 46. The dominant soil series found in this watershed are Damthang, Rumtek, Dikling, Bhasme, etc.

Table 4.91 Soils of Kalej Khola watershed

Soil unit	Soil Series Association	Area (In ha)	% of watershed
1	Maling-Rayong	1034.2	5.1
6	Karporang – Hilley	43.9	0.2
8	Bhasme – Chautare - Legship	177.7	0.9
11	Mangjing – Singrep - Rorethang	208.7	1.0
14	Dharamdin – Lingtse - Karfecter	220.7	1.1
16	Tumin –Phong - Chautare	61.7	0.3
20	Chakung – Tumin - Sajong	844.9	4.1
22	Chongrang – Legship - Singgyang	1788.8	8.7
24	Doling – Khedi	650.0	3.2
26	Dikling – Hilley	1745.8	8.5
28	Samdur – Khedi - Bhusuk	424.9	2.1
30	Rumtek – Tumin	2238.3	10.9
32	Bhusuk – Pirik - Namchi	515.3	2.5
39	Daragoan – Gaucharan - Dharamdin	293.8	1.4
40	Dharamdin – Martam - Karfecter	308.4	1.5
42	Damthang – Chongrang – Rock outcrop	3512.4	15.8
44	Singgyang – Maniram - Damthang	3234.1	1.6
46	Maniram-Damthang - Jorpul	1665.0	8.1
52	Khedi – Maniram - Rongnek	437.5	2.1
60	Lachung- Puchikongma - Byuma	1065.9	5.2
	Miscellaneous	1.3	0.1
	Total	20473.3	100.0

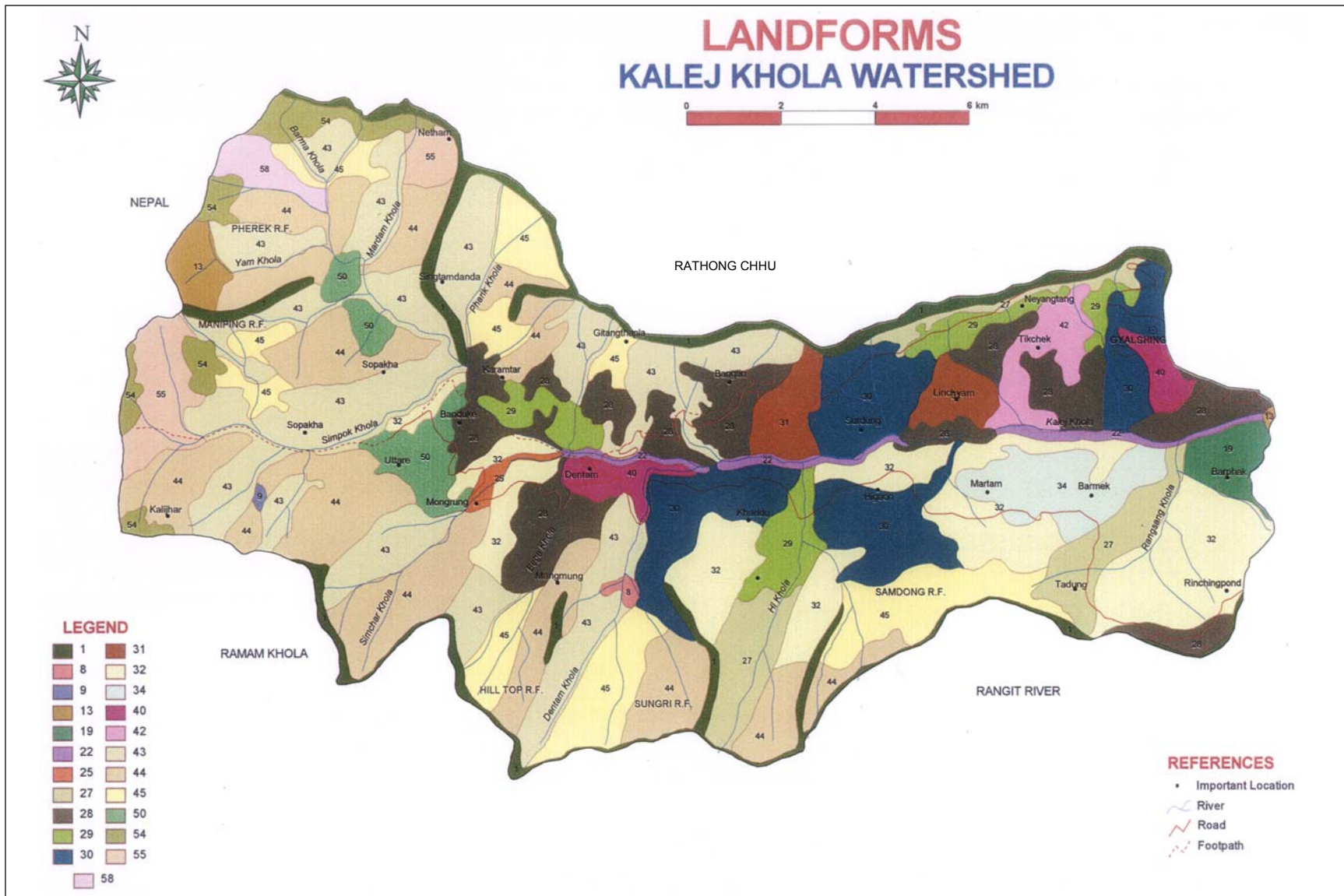


Fig. 4.104 Landforms of Kalej Khola watershed

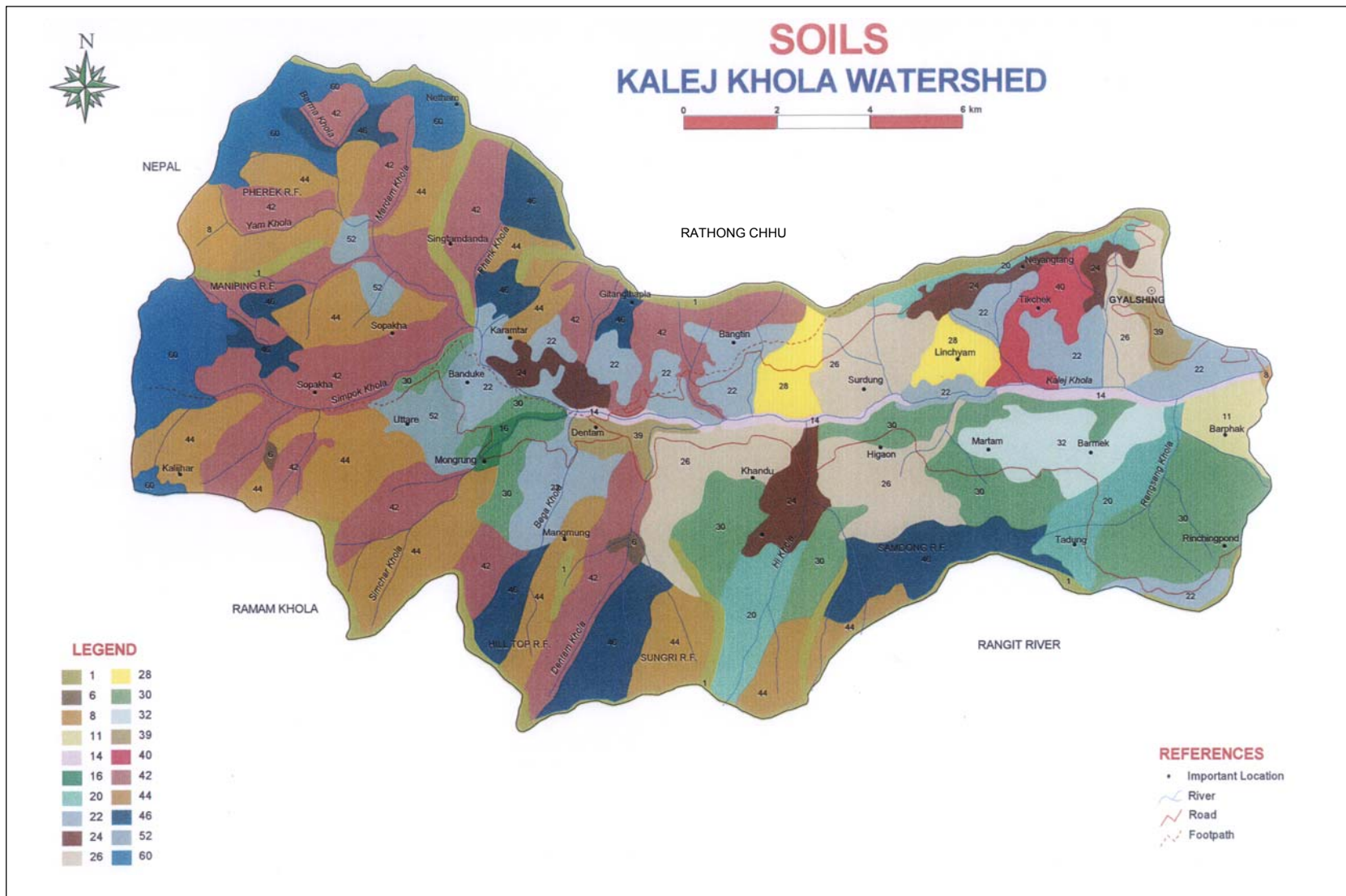


Fig. 4.105 Soils of Kalej Khola watershed

4.14.3 Soil depth

Shallow to deep soils have been identified in Kalej Khola watershed. They have been mapped into six soil mapping units at the level of association of soil depth classes (Table 4.92) and presented in Fig. 4.106. Mapping unit 1 comprising of deep and moderately deep association covers the highest area of 12,086.1 ha (59.0%) and deep and moderately shallow association (map unit 2) covers 5,049.7 ha (24.6%) area. Shallow and moderately deep association cover third largest area i.e. an area of 1,065.9 ha (5.2%). Only moderately shallow soils occupies least area of 43.9 ha (0.2%) of the watershed.

Table 4.92 Soil depth of Kalej Khola watershed

Map unit	Description	Soil Map units	Area (In ha)	% of watershed
1	Deep-mod.deep	22,24,28,39,40,44,46,42, 11	12086.1	59.0
2	Deep-mod.shallow	20,26,30,14	5049.7	24.6
3	Mod deep-deep	1,52	1471.7	7.2
4	Mod. shallow	6	43.9	0.2
5	Mod.shallow-deep	8,16,32,	754.7	3.7
6	Shallow-mod.deep	60	1065.9	5.2
		Miscellaneous	1.3	0.1

4.14.4 Surface texture

Different surface soil textural classes have been mapped into thirteen mapping units at the level of association of surface soil textural class (Table 4.93 and presented in Fig. 4.107). Mapping unit 7 & 12 comprising of sandy loam - gravelly silt loam and silt loam – loam are dominant covering 5,336.6 ha (26.1%) and 6,595.6 ha (32.2%), respectively. Clay loam and silty clay loam are distributed in map unit 1,9,10 and 11. From the Table 3.99, it is found that loamy sand and loam association (soil map unit 4) occupies least area of 43.9 ha (0.2%).

Table 4.93 Surface texture of Kalej Khola watershed

Map unit	Description	Soil Map units	Area (In ha)	% of watershed
1	cl-l	40,14	529.1	2.6
2	gsl-sil	32	515.3	2.5
3	l-sl	8,28	602.6	2.9
4	ls-l	6	43.9	0.2
5	Sc-scl	39	293.8	1.4
6	sl-gl	11	208.7	1.0
7	sl-gsil	44,46,52	5336.6	26.1
8	sl-ls	60	1065.9	5.2
9	sl-sicl	1	1034.2	5.1
10	sicl-l	26	1745.8	8.5
11	Sil-cl	16	61.7	0.3
12	Sil-l	30,42,20	6595.6	32.2
13	Sil-sl	22,24	2438.8	11.9
		Miscellaneous	1.3	0.1

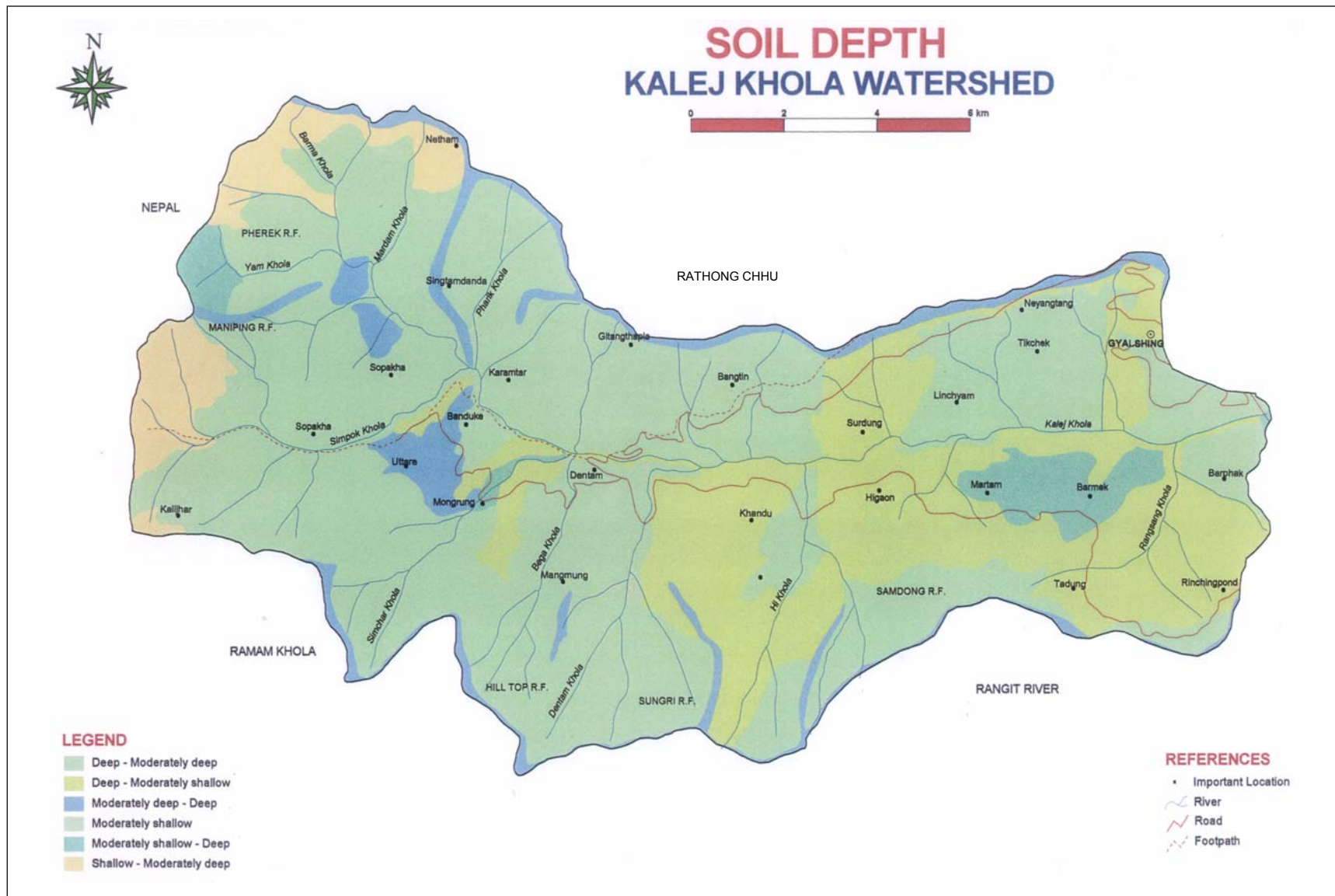


Fig. 4.106 Soil depth class of Kalej Khola watershed

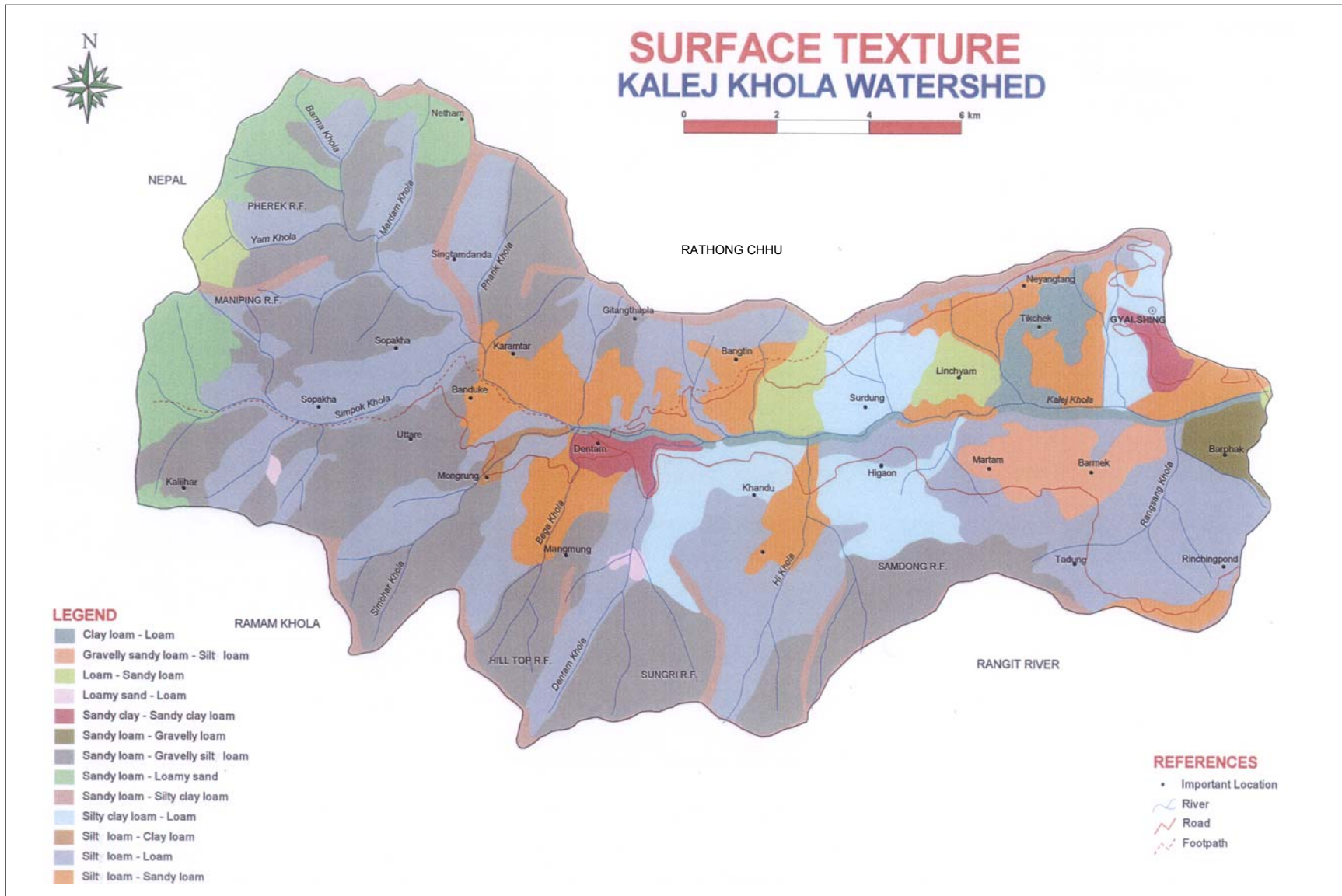


Fig. 4.107 Surface texture class of Kalej Khola watershed

4.14.5 Soil erosion

Three classes of soil erosion viz. medium, severe and very severe have been identified in this watershed (Table 4.94) and presented in Fig. 4.108. Moderate erosion alone covers 7,493.1 ha (36.6%) while severe erosion alone occupies 2,730.9 ha (13.3%). Moderate erosion in association with severe and very severe erosion covers 34.2% area of the watershed.

Table 4.94 Soil erosion of Kalej Khola watershed

Map unit	Description	Soil Map units	Area (In ha)	% of watershed
1	M	39,1,16,24,26,28,30,32,40,14	7493.1	36.6
2	M-S	22,42,8,11,52	6125.1	29.9
3	S	46,60	2730.9	13.3
4	S-M	6	43.9	0.2
5	VS-M	20	844.4	4.1
6	VS-S	44	3234.1	15.8
		Miscellaneous	1.3	0.1

4.14.6 Soil reaction

Soil reaction (pH) at the level of association of two classes have been mapped into nine mapping units (Table 4.95) and presented in Fig. 4.109. In this watershed extremely acidic – strongly acidic association (mapping unit 1) covers largest area of 10,877.1 ha (53.1%), very strongly acidic – strongly acidic association (mapping unit 9) covers an

area of 5,920.1 ha (28.9%). Extremely acidic – very strongly acidic association (mapping unit 2) occupies least area of 270.4 ha (1.3%).

Table 4.95 Soil reaction of Kalej Khola watershed

Map unit	Description	Soil Map units	Area (In ha)	% of watershed
1	EX-S	8,20,22,24,30,42,46	10877.1	53.1
2	EX-VS	11,16	270.4	1.3
3	M-VS	39	293.8	1.4
5	S-EX	1	1034.2	5.1
6	S-M	14,52	658.2	3.2
7	S-VS	6,40	352.3	1.7
8	VS	60	1065.9	5.2
9	VS-S	26,28,32,44	5920.1	28.9
		Miscellaneous	1.3	0.1

4.14.7 Land capability class (LCC)

Four Land Capability Classes and six land capability sub-classes have been identified in this watershed (Table 4.96) and presented in Fig. 4.110.

Table 4.96 Land capability of Kalej Khola watershed

Map unit	Description	Soil Map units	Area (In ha)	% of watershed
1	Ille2	1,14	1254.9	6.1

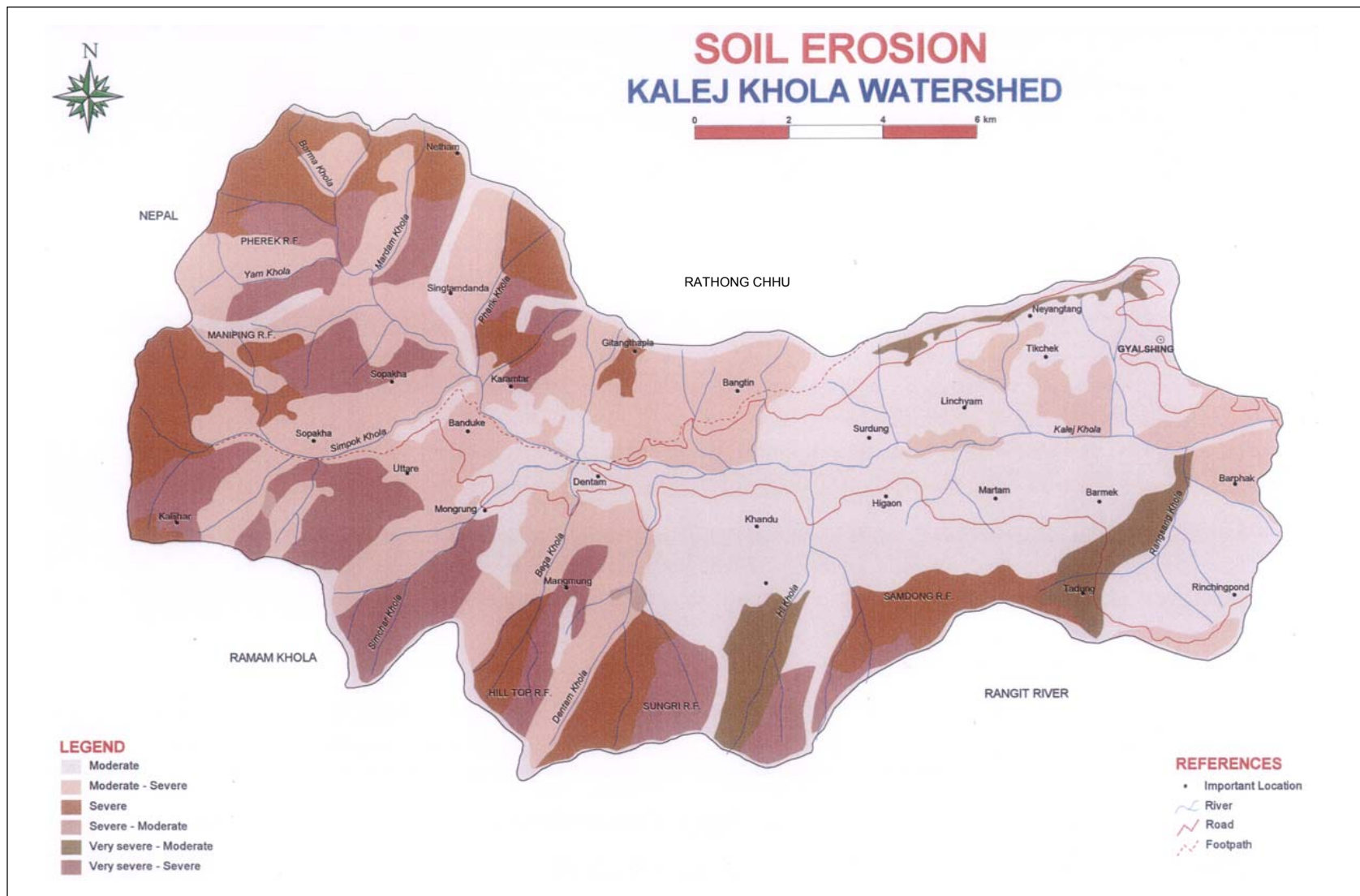


Fig. 4.108 Soil erosion class of Kalej Khola watershed

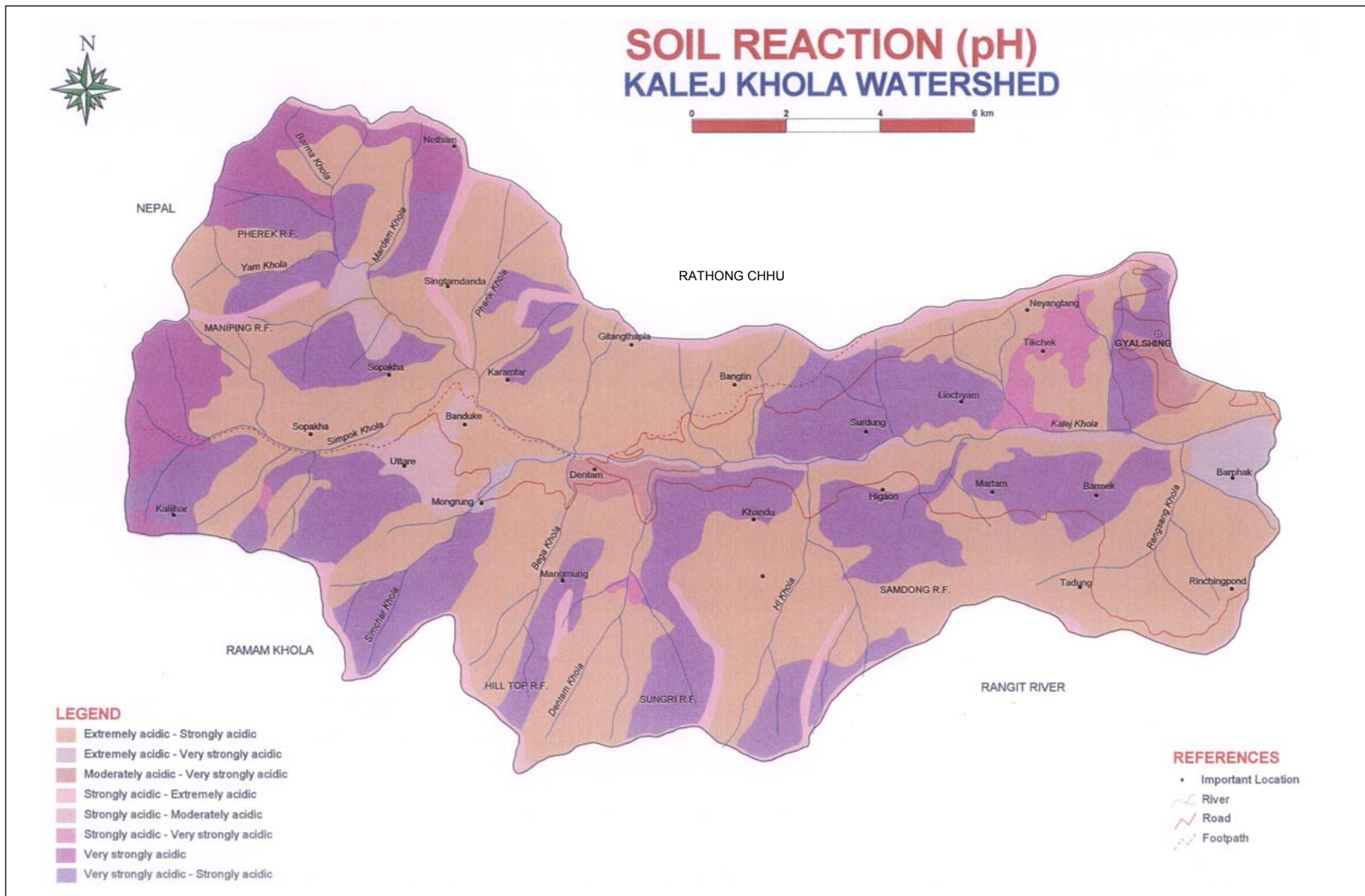


Fig. 4.109 Soil reaction class of Kalej Khola watershed

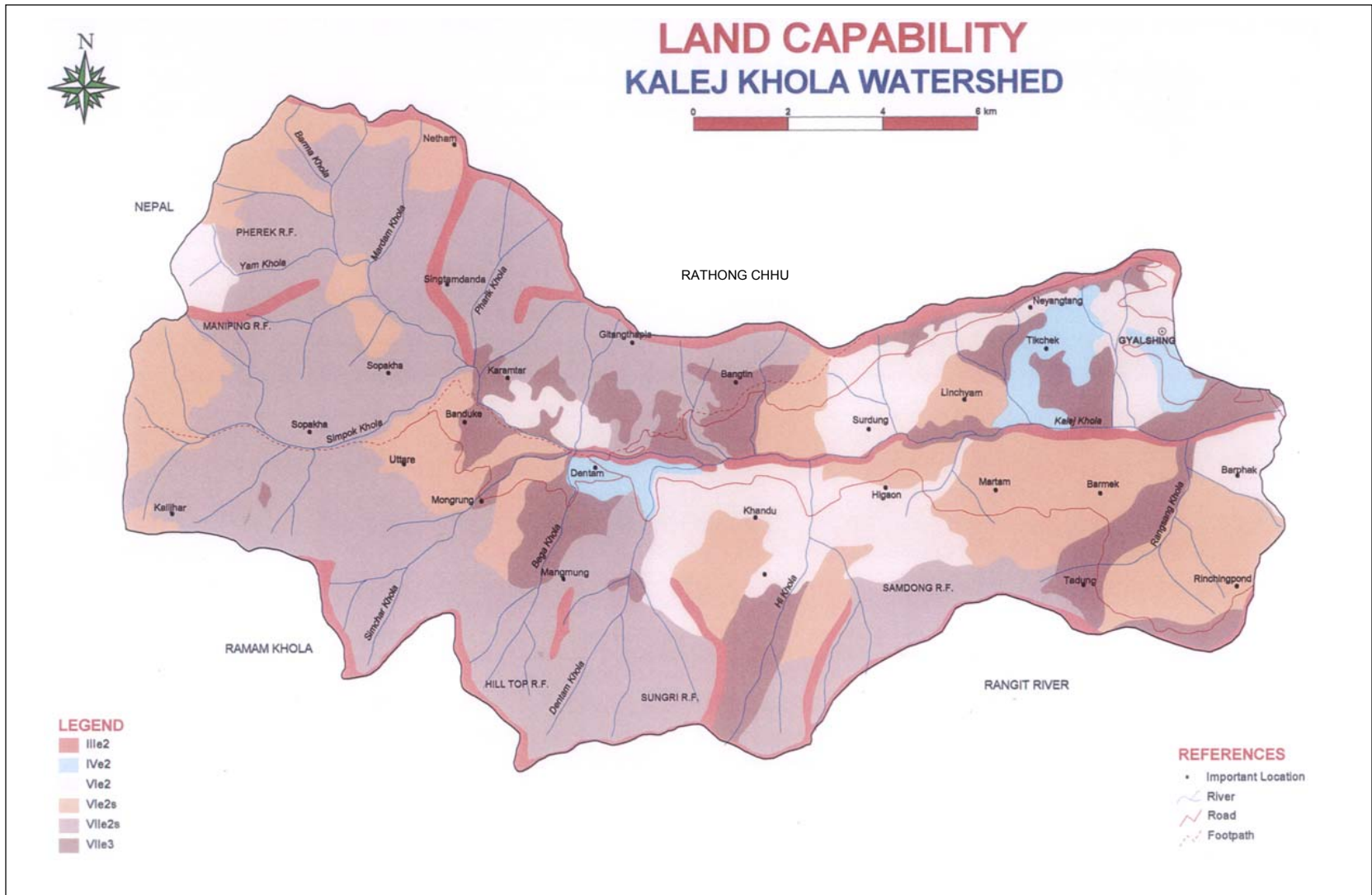


Fig. 4.110 Land capability class of Kalej Khola watershed

2	IVe2	39,40,52	1039.7	5.1
3	Vle2	24,26,8,11	2782.2	13.5
4	Vle2s	28,30,32,60	4244.4	20.7
5	Vlle2s	42,44,46	8411.5	41.1
6	Vlle3	6,16,22,20	2739.3	13.4
		Miscellaneous	1.3	0.1

The land capability sub-class Vlle2s having moderate limitation of erosion and soil (mapping unit 5) occupies largest area 8,411.5 ha (41.1%) of the watershed. Other dominant land capability sub-classes identified are Vle2S, Vle2 and Vlle3 which covers 4,244.4 ha (20.7%), 2,782.2 ha (13.5%) and 2,739.3 ha (13.4%) respectively of the watershed. The land capability sub-classes Vlle2s (mapping unit 5) and Vlle3 (mapping unit 6) occupying 41.1% and 13.4% area of the watershed should be brought under forestry.

4.14.8 Soil-site suitability for rice

Kalej Khola soils are moderately to marginally suitable (S2-S3) in 2,767.4 ha area for rice cultivation and marginally to moderately suitable (S3-S2) in 724.0 ha areas of the watershed (Table 4.97 and Fig. 4.111). It is only marginally suitable in 8041.0 ha; marginally too not suitable in 4,255.7 ha; not suitable to marginally suitable in 3,574.1 ha and not suitable alone in 1,109.8 ha due to severe to very severe limitation of topography, soil depth, soil fertility including soil acidity.

Table 4.97 Soil-site suitability for rice of Kalej Khola watershed

Sl.No.	Suitability class	Map unit nos.	Area (ha)
1.	S2-S3	14,30,40	2767.4
2.	S3-S2	11,32	724.0
3.	S3	1,8,22,24,28,39,44,52	8041.0
4.	S3-N	20,26,46	4255.7
5.	N-S3	16,42	3574.1
6.	N	60,6	1109.8
	Miscellaneous		1.3
		Total	20473.3

4.14.9 Soil-site suitability for maize

Kalej Khola soils are only moderately suitable (S2) in 7,474.4 ha areas for maize cultivation (Table 4.98 and Fig. 4.112). It is moderately to marginally suitable (S2-S3) in 9,337.2 ha and marginally to moderately suitable (S3-S2) in 448.1 ha area of the watershed. It is unsuitable to moderately suitable (N-S2) in 2,102.5 ha and not suitable (N) in 1,109.8 ha mostly belong to landslide zone and high mountain region of higher slope (> 50%).

Table 4.98 Soil-suitability for maize of Kalej Khola watershed

Sl.No.	Suitability class	Map unit nos.	Area (ha)
1.	S2	1,14,22,24,28,30,32,39,40	7474.4
2.	S2-S3	20,26,42,44	9337.2
3.	S3-S2	8,11,16	448.1
4.	N-S2	46,52	2102.5

5.	N	6,60	1109.8
	Miscellaneous		1.3
		Total	20473.3

4.15 RAMAM KHOLA WATERSHED

4.15.1 Landforms

Eight broad landform regions viz. ridge, rocky cliff, landslide zone, low mountain, narrow valley, mid mountain, high mountain and very high mountain have been identified in this watershed (Fig. 4.113).

4.15.2 Soils

Soils of Ramam Khola have been mapped into twenty seven soil mapping units at the level of soil series association (Table 4.99 and Fig. 4.114). Twenty five soil series are well distributed in this watershed with different associations. Soil map unit 60 comprising of Lachung – Puchikongma – Byuma soil series association covered the largest area of 1,841.3 ha (12.3%). Soils of ridge comprising of Maling and Rayong soil series association covered 771.1 ha (5.2%). The soil mapping unit 22 having Chongrang – Legship – Singgyang soil series association of low mountain covers the least area of 117.5 ha (0.85) in the watershed.

Table 4.99 Soils of Ramam Khola watershed

Soil Unit	Soil Series Association	Area (In ha)	% of watershed
1	Maling-Rayong	771.1	5.2

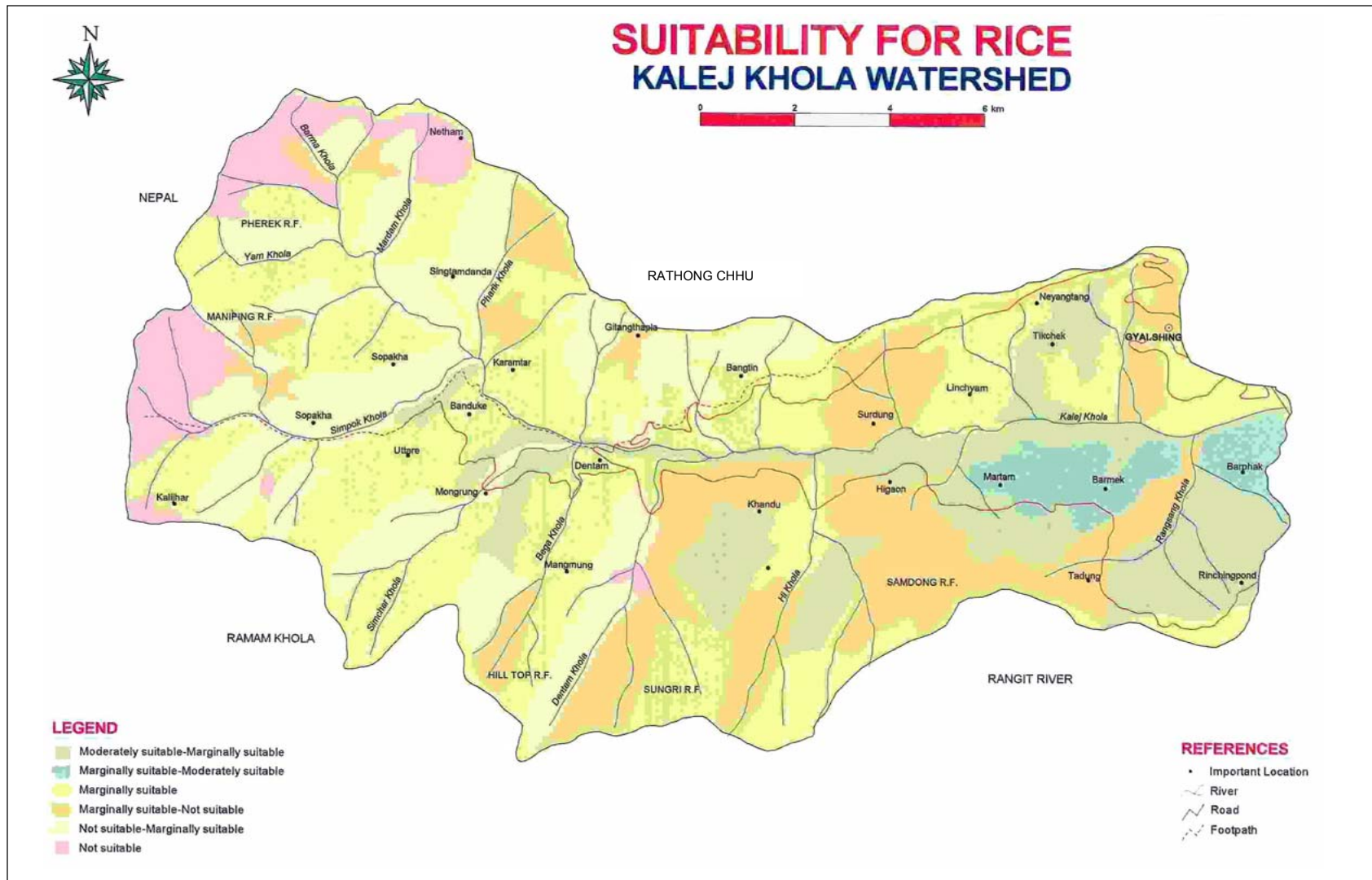


Fig. 4.111 Soil-site suitability for rice in Kalej Khola watershed

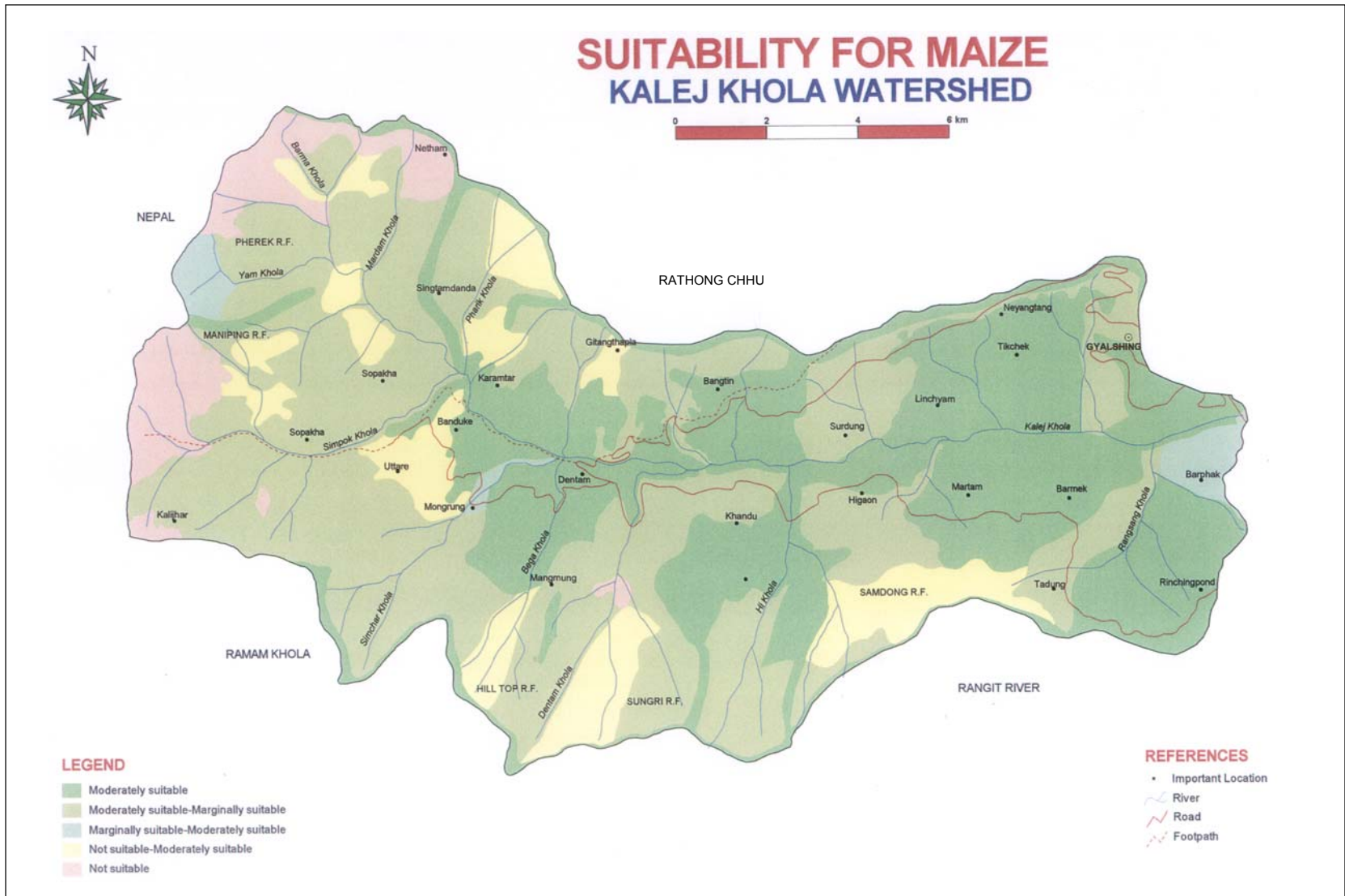


Fig. 4.112 Soil-site suitability for maize in Kalej Khola watershed

3	Rock outcrops – Jorpul	250.4	1.7
6	Karporang – Hilley	63.6	0.4
8	Bhasme – Chautare – Legship	384.6	2.5
11	Mangjing – Singrep – Rorethang	1133.6	7.5
13	Mangjing – Dharamdin	177.4	1.2
15	Mangreng – Karfacter- Mangjing	74.5	0.5
16	Tumin –Phong – Chautare	590.1	3.9
18	Phong – Khedi – Maniram	872.5	5.8
20	Chakung – Tumin – Sajong	1049.6	7.0
22	Chongrang – Legship - Singgyang	117.5	0.8
24	Doling – Khedi	607.9	4.0
26	Dikling – Hilley	313.3	2.1
28	Samdur – Khedi – Bhusuk	474.8	3.2
30	Rumtek – Tumin	223.9	1.5
32	Bhusuk – Pirik – Namchi	630.5	4.2
34	Namchi– Synggyang	265.0	1.8
36	Doling – Samdur – Rock outcrop	452.5	3.0
38	Rumtek – Pirik – Mangjing	98.6	0.7
42	Damthang – Chongrang – Rock outcrop	522.6	3.5
44	Singgyang – Maniram - Damthang	218.9	1.5
46	Maniram-Damthang – Jorpul	1161.7	7.8
48	Martam – Tarnu – Sajong	338.4	2.3
50	Sajong –Tarnu	1162.3	7.8
52	Khedi – Maniram – Rongnek	838.9	5.6
56	Khedi – Dikling	260.8	1.7
60	Lachung- Puchikongma – Byuma	1841.3	12.3
	Miscellaneous	70.7	0.5
	Total	14967.0	100.0

4.15.3 Soil depth

Five soil depth classes have been identified in this watershed and mapped at the level of association of soil depth classes (Table 4.100 and Fig. 4.115). Deep - moderately deep association (mapping unit no.1) covered an area of 6,063.5 ha (40.5%). Mapping unit 6, 5, 2 and 3 are widely distributed covering 1.7, 18.5, 13.6 and 12.5 per cent areas of the watershed. Rocks have been distributed in Mapping Unit 6 along with very shallow depth class which is not suitable for agriculture and should be protected through afforestation.

Table 4.100 Soil depth of Ramam Khola watershed

Map unit	Description	Soil Map units	Area (In ha)	% of watershed
1	Deep- mod.deep	13,15,24,28,34,38,44,46,48,11,18,42, 22	6063.5	40.5
2	Deep- mod.shallow	20,26,30,36	2039.3	13.6
3	Mod.deep- deep	1,52,56	1870.8	12.5
4	Mod. Shallow	6	63.6	0.4
5	Mod.shallow- deep	8,32,50,16	2767.5	18.5
6	Rock-very shallow	3	250.4	1.7
7	Shallow- mod.deep	60	1841.3	12.3
		Miscellaneous	70.7	0.5

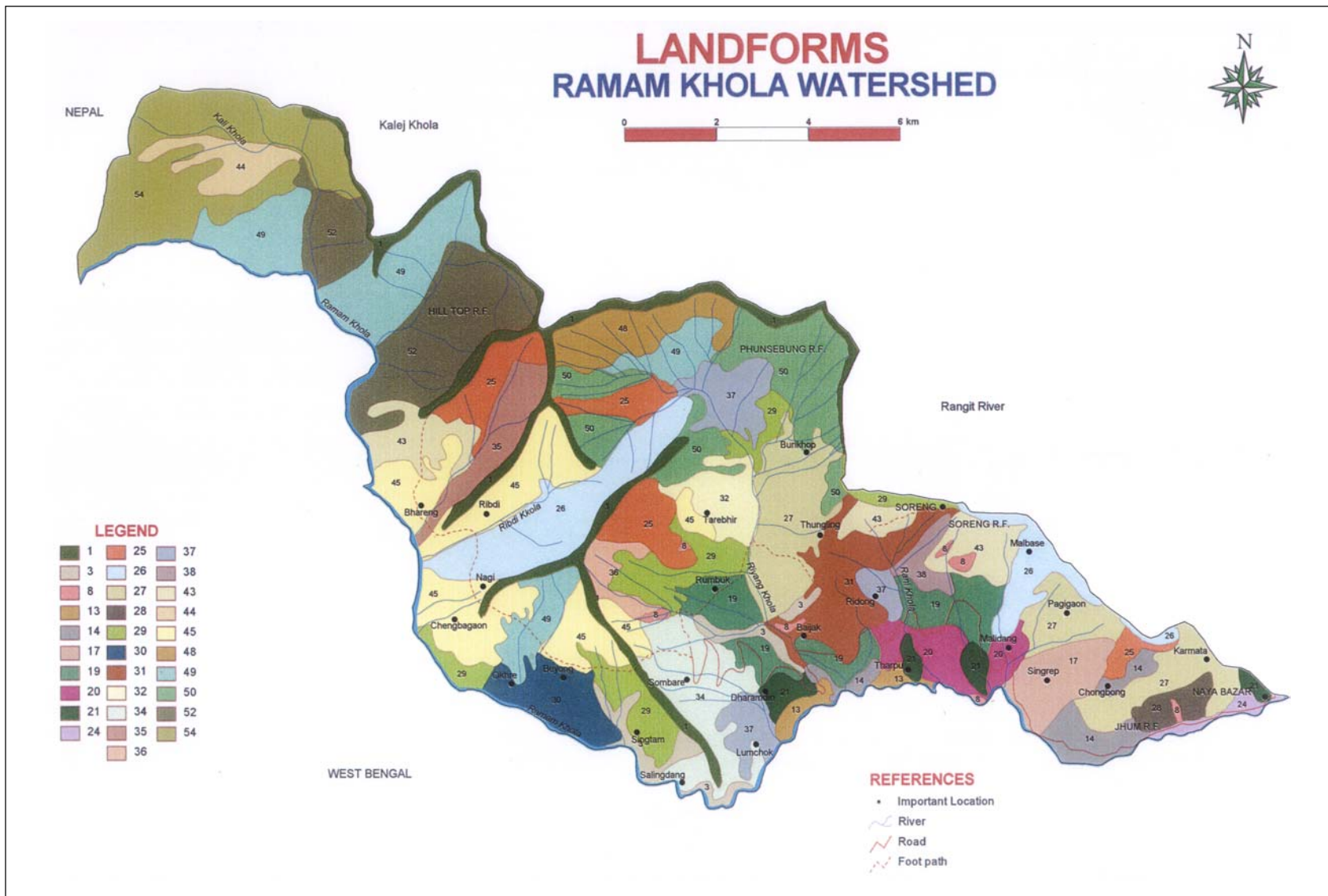


Fig. 4.113 Landform of Ramam Khola watershed

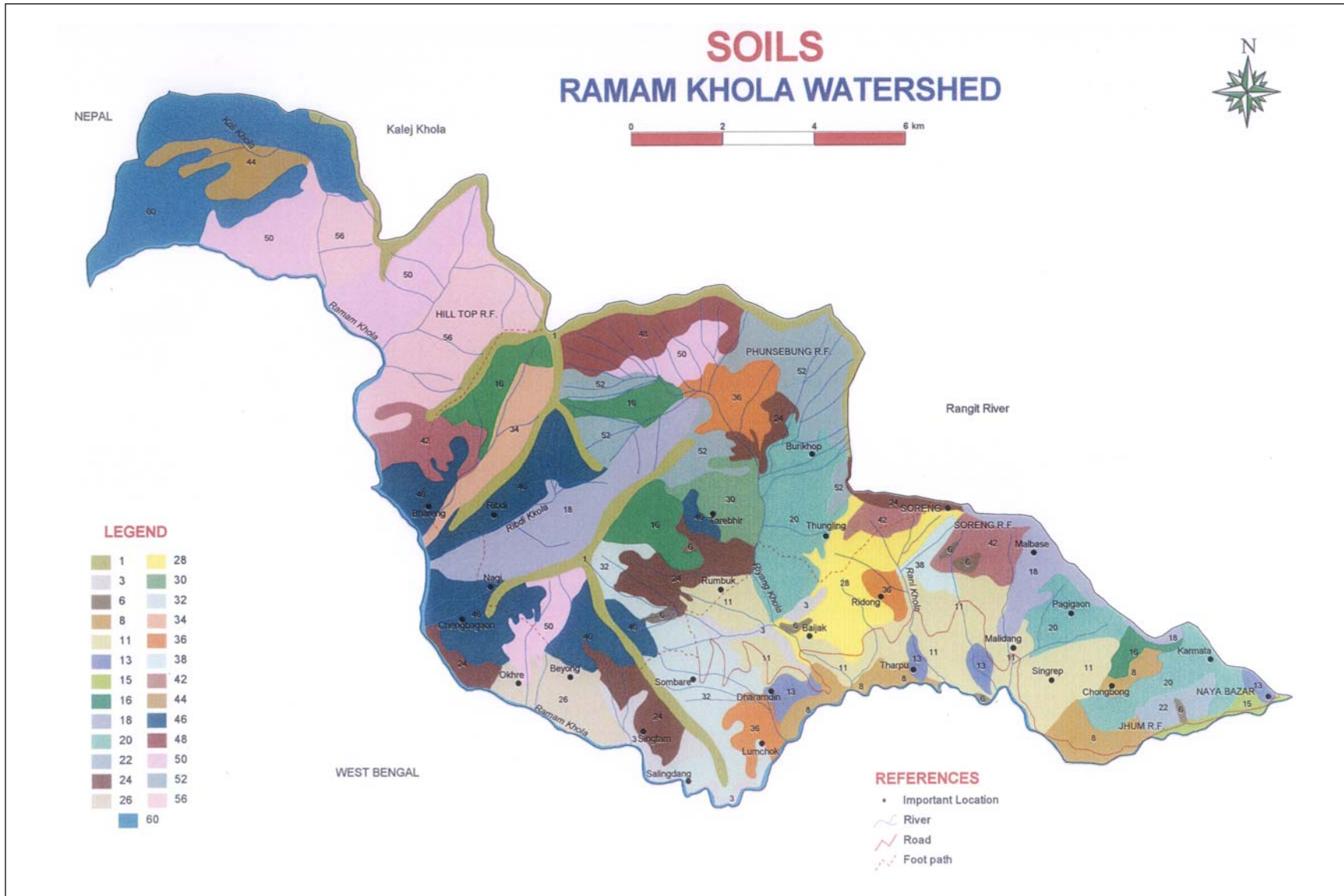


Fig. 4.114 Soils of Ramam Khola watershed

4.15.3 Surface texture

Nine textural classes have been identified and mapped into fourteen mapping units at the level of association of textural class (Table 4.101 and Fig. 4.116). Mapping unit 13 comprising of silt loam and loam (sil-I) covered largest area of 2,347.0 ha (15.7%) while mapping unit 4 comprising loamy sand and loam (ls-I) association covered least area of 65.6 ha (0.4%). The sandy loam – loamy sand association (mapping unit 9) covers an area of 1,841.3 ha (12.3%) which is very susceptible to erosion and hence should be protected through conservation measure.

Table 4.101 Surface texture of Ramam Khola watershed

Map unit	Description	Soil Map units	Area (In ha)	% of watershed
1	cl-I	15	74.5	0.5
2	Gsl-sil	32	630.5	4.2
3	l-sl	8,28,34	1124.4	7.5
4	Ls-I	6	63.6	0.4
5	R-I	3	250.4	1.7
6	Sl-cl	13,48,18	1388.3	9.3
7	Sl-gl	11	1133.6	7.6
8	sl-gsil	44,46,52	2219.5	14.8
9	Sl-ls	60	1841.3	12.3
10	sl-sicl	1,56	1031.9	6.9
11	sicl-I	26	313.3	2.1
12	Sil-cl	16	590.1	3.9
13	sil-I	20,30,36,38,42	2347.2	15.7
14	Sil-sl	24,50,22	1887.8	12.6
		Miscellaneous	70.7	0.5

Fig. 4.115 Soils depth class of Ramam Khola watershed

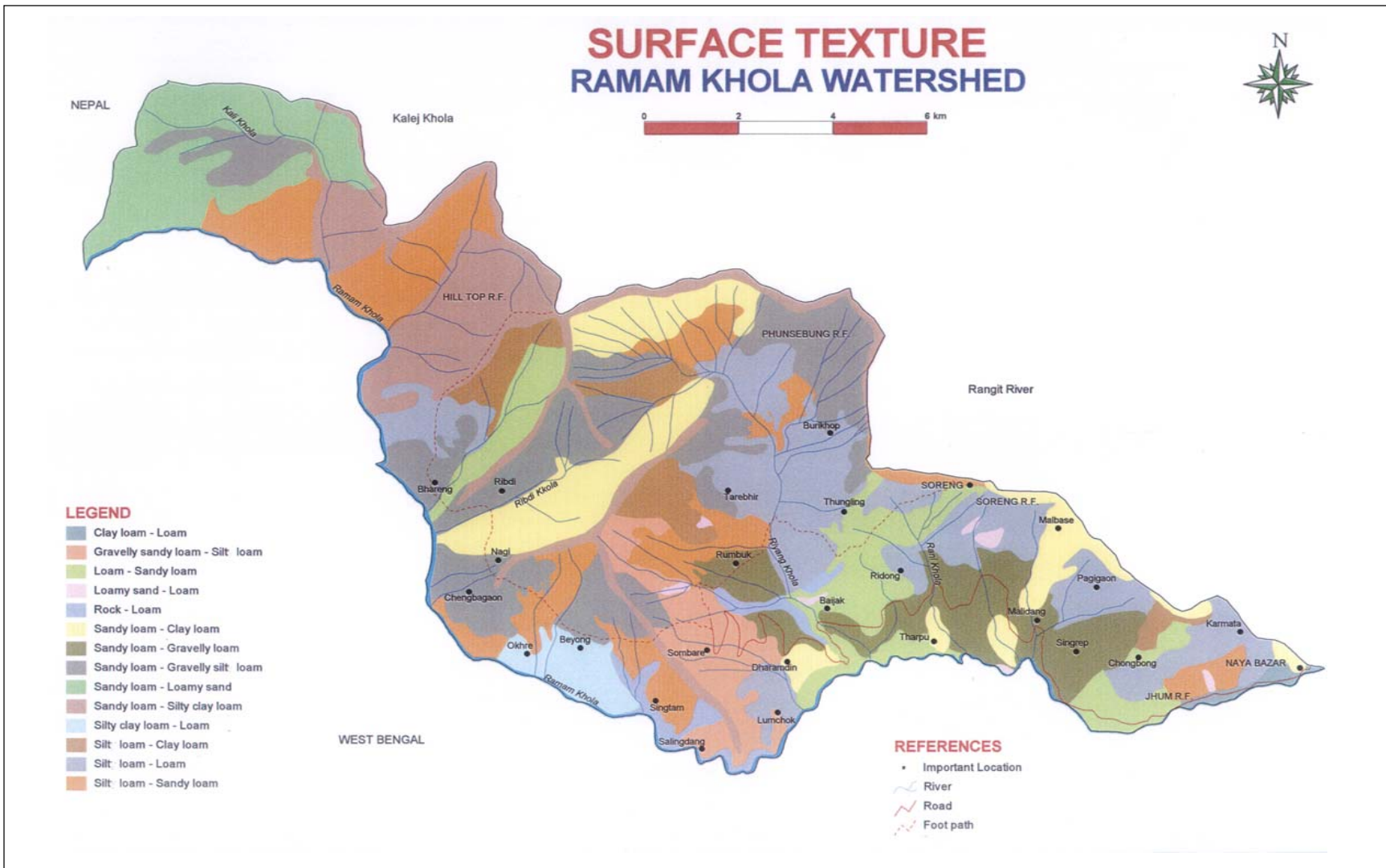


Fig. 4.116 Surface texture class of Ramam Khola watershed

4.15.4 Soil erosion

Three soil erosion classes have been identified in this watershed and mapped into six mapping units at the level of association of erosion classes (Table 4.102 and Fig. 4.117). Mapping unit 1 & 2 are most extensive and covered an area of 5,548.0 ha (37.1%) and 4,497.9 ha (30.1%) respectively. The mapping unit 7 comprising very severe – severe erosion classes mostly in the mid. and high mountain (30-50% slope and above) is the real problematic area occupying 1,535.5 ha (10.2%) which require efficient soil conservation measures.

Table 4.102 Soil erosion of Ramam Khola watershed

Map unit	Description	Soil Map units	Area (In ha)	% of watershed
1	M	1,13,15,24,26,28,30,32,36,38,56,16,18	5548.0	37.1
2	M-S	8,48,50,52,11,42,22	4497.9	30.1
3	R-VS	3	250.4	1.7
4	S	46,60	3003.0	20.0
5	S-M	6	63.6	0.4
6	VS-S	20,34,44	1533.5	10.2
		Miscellaneous	70.7	0.5

4.15.6 Soil reaction

Four types of soil reaction classes have been identified in this watershed and mapped at ten mapping units at the level of association of soil reaction classes (Table 4.103 and Fig. 4.118). The mapping unit 1

comprising extremely acidic – strongly acidic association covers largest area of 5,860.1 ha (39.1%) while Rock – strongly acidic class (mapping unit 5) occupies least area of 250.4 ha (1.7%). The mapping unit 2 comprising extremely acidic – very strongly acidic association covers an area of 1822.3 ha (12.2%) and represents highly acidic soils which can be used for growing acid tolerant crop like, tea, coffee etc.

Table 4.103 Soil reaction of Ramam Khola watershed

Map unit	Description	Soil Map units	Area (In ha)	% of watershed
1	EX-S	8,13,20,24,30,36,46,50,42,22	5860.1	39.1
2	EX-VS	38,11,16	1822.3	12.2
3	M-VS	15,48	412.9	2.9
4	R-S	3	250.4	1.7
5	S-EX	1	771.1	5.2
6	S-M	52	838.9	5.5
7	S-VS	6,56	324.4	2.2
8	VS	60	1841.3	12.3
9	VS-S	26,28,32,34,44,18	2774.3	18.6
		Miscellaneous	70.7	0.5

4.15.7 Land capability class (LCC)

Five land capability classes viz. III, IV, VI, VII and VIII and seven land capability sub-classes have been identified in the study area and mapped (Table 4.104 and Fig. 4.119). The land capability sub-class VIe2 is the most dominant one covering 18,565.8 ha (31.0%) while land capability sub-classes VIIIe4s of very steep rocky cliff geomorphic units

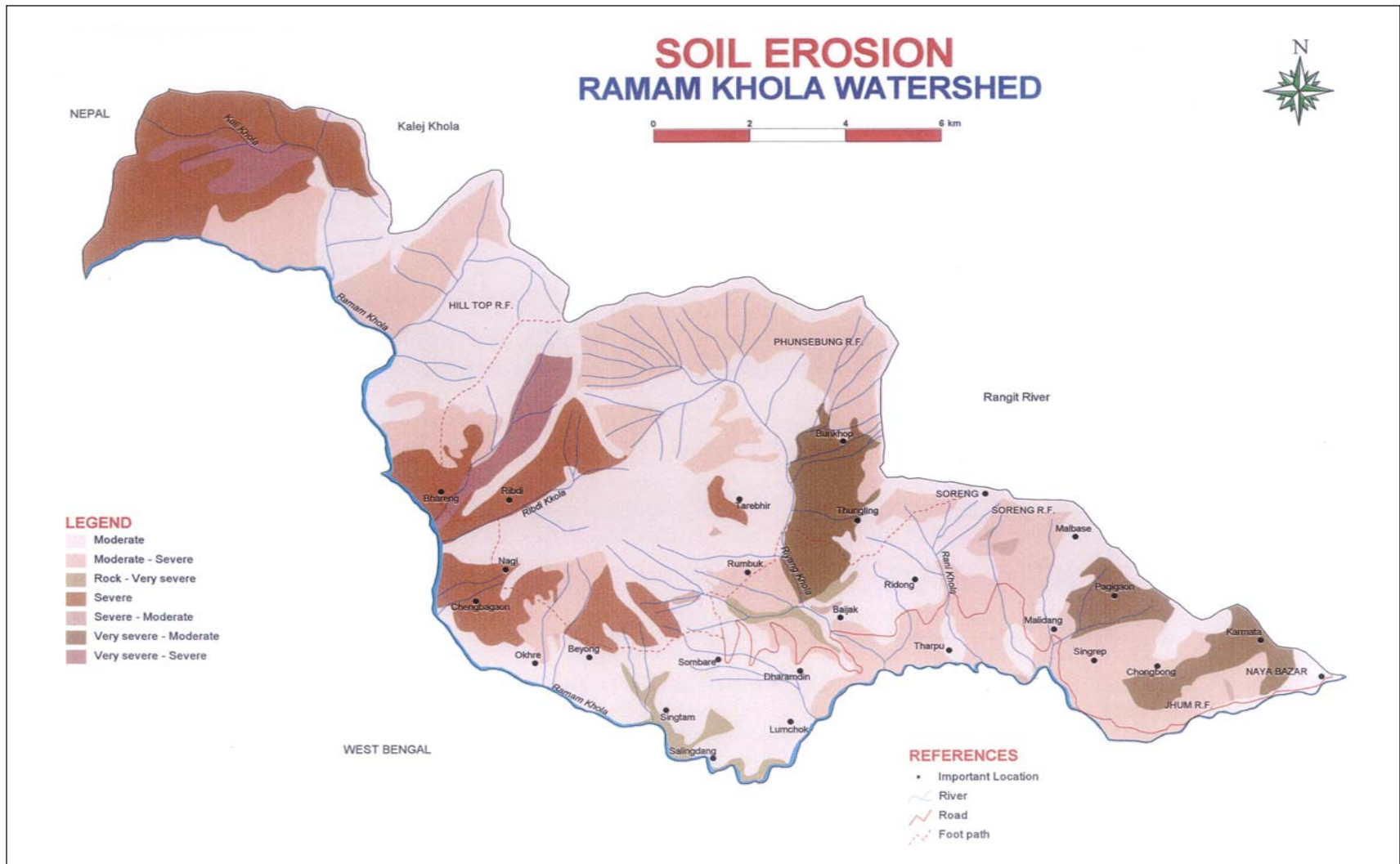


Fig. 4.117 Soil erosion class of Ramam Khola watershed

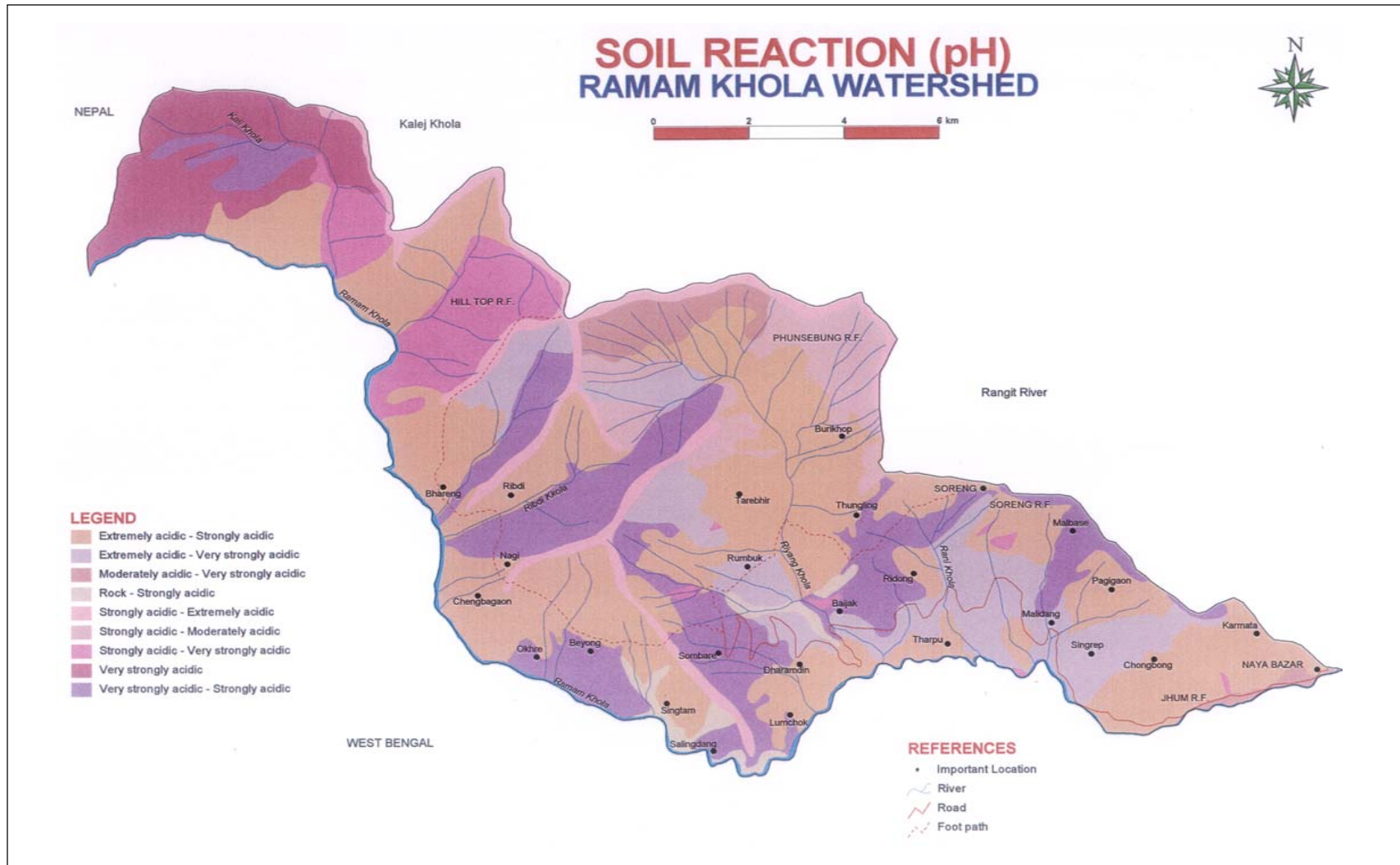


Fig. 4.118 Soil reaction class of Ramam Khola watershed

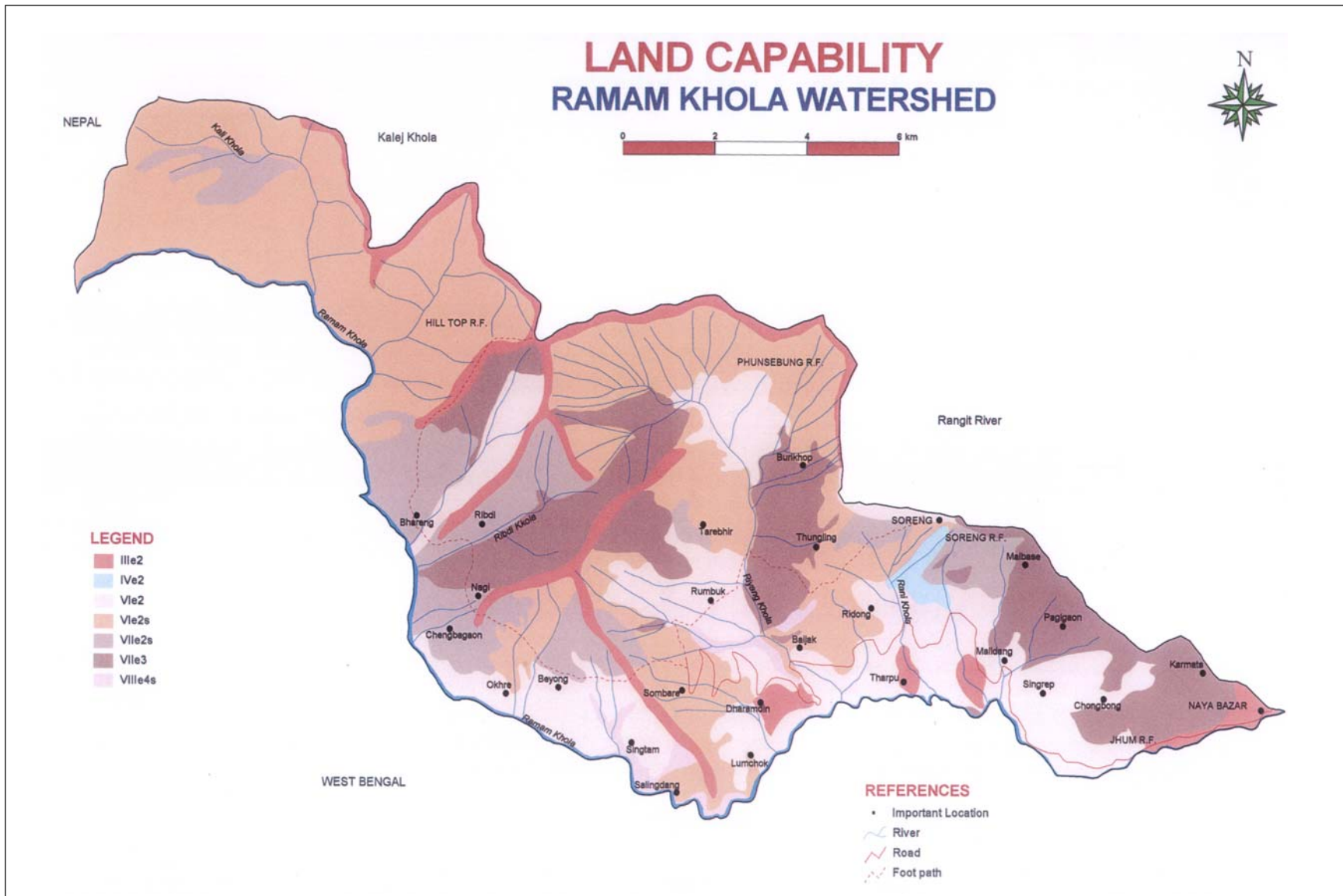


Fig. 4.119 Land capability class of Ramam Khola watershed

covers an area of 3,088.1 ha (5.2%). Land capability sub-classes Vle2s mostly from mid., high and very high mountain covers largest area of 5,770.9 ha (38.6%) and the land capability sub-class IVe2 representing mid. mountain (15-30% slope) occupies least area of 18.6 ha (0.7%).

Table 4.104 Land capability of Ramam Khola watershed

Map unit	Description	Soil Map units	Area (In ha)	% of watershed
1	IIIe2	1,13,15	102.0	6.8
2	IVe2	38	98.6	0.7
3	Vle2	8,24,26,34,36,11	3157.0	21.0
4	Vle2s	28,30,32,48,50,52,56,60	5770.9	38.6
5	VIIe2s	44,46,42	1903.2	12.7
6	VIIe3	6,20,16,18,22	2693.3	18.0
7	VIIIe4s	3	250.4	1.7
		Miscellaneous	70.7	0.5

4.15.8 Soil-site suitability for rice

The study of soil-site suitability for rice in Ramam Khola watershed (Table 4.105 and Fig. 4.120) shows that about 322.5 ha area is found to be moderately to marginally suitable (S2-S3). Rice is only marginally suitable (S3) in 5,074.0 ha while 1,941.5 ha is found to be marginally to moderately suitable (S3-S2). It is mostly unsuitable to marginally suitable in mapping units 4, 5, 6 due to severe limitations of slope, erosion and fertility status.

Table 4.105 Soil-site suitability for rice of Ramam Khola watershed

Sl.No.	Suitability class	Map unit nos.	Area (ha)
1.	S2-S3	30,38	322.5
2.	S3-S2	11,13,32	1941.5
3.	S3	1,8,15,18,22,24,28,36,44,52,56	5074.0
4.	S3-N	20,26,46,48	2863.0
5.	N-S3	16,34,42	1377.7
6.	N	3,6,50,60	3317.6
	Miscellaneous		70.7
Total			14967.0

4.15.9 Soil-site suitability for maize

The study of soil-site suitability for maize shows that it is only moderately suitable (S2) in 4,852.8 ha in the Ramam Khola watershed, moderately to marginally suitable (S2-S3) in 2,178.9 ha and marginally to moderately suitable (S3-S2) in 2,916.2 ha (Table 4.106 and Fig. 4.121). It is totally unsuitable in rocky cliff (map unit 3), landslide zone (map unit 6) and very high mountain with steep slope (map unit 60).

Table 4.106 Soil-site suitability for maize of Ramam Khola watershed

Sl.No.	Suitability class	Map unit nos.	Area (ha)
1.	S2	1,18,22,24,28,30,32,34,36,38,48	4852.8
2.	S2-S3	15,20,26,42,44	2178.9
3.	S3-S2	8,11,13,16,32	2916.2
4.	N-S2	46,52,56	2261.4
5.	N	3,6,60	2155.3

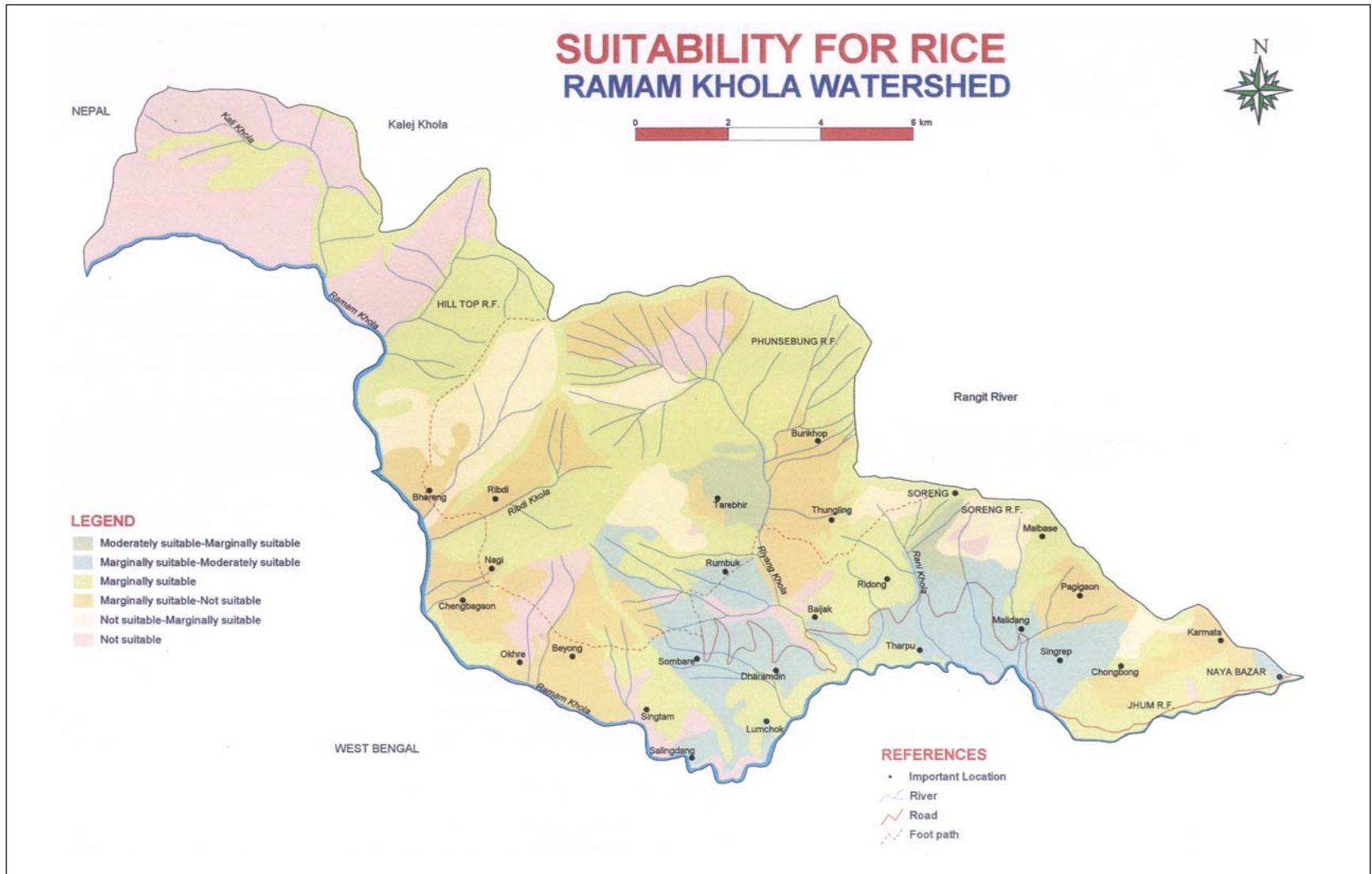


Fig. 4.120 Soil site suitability for rice in Ramam Khola watershed

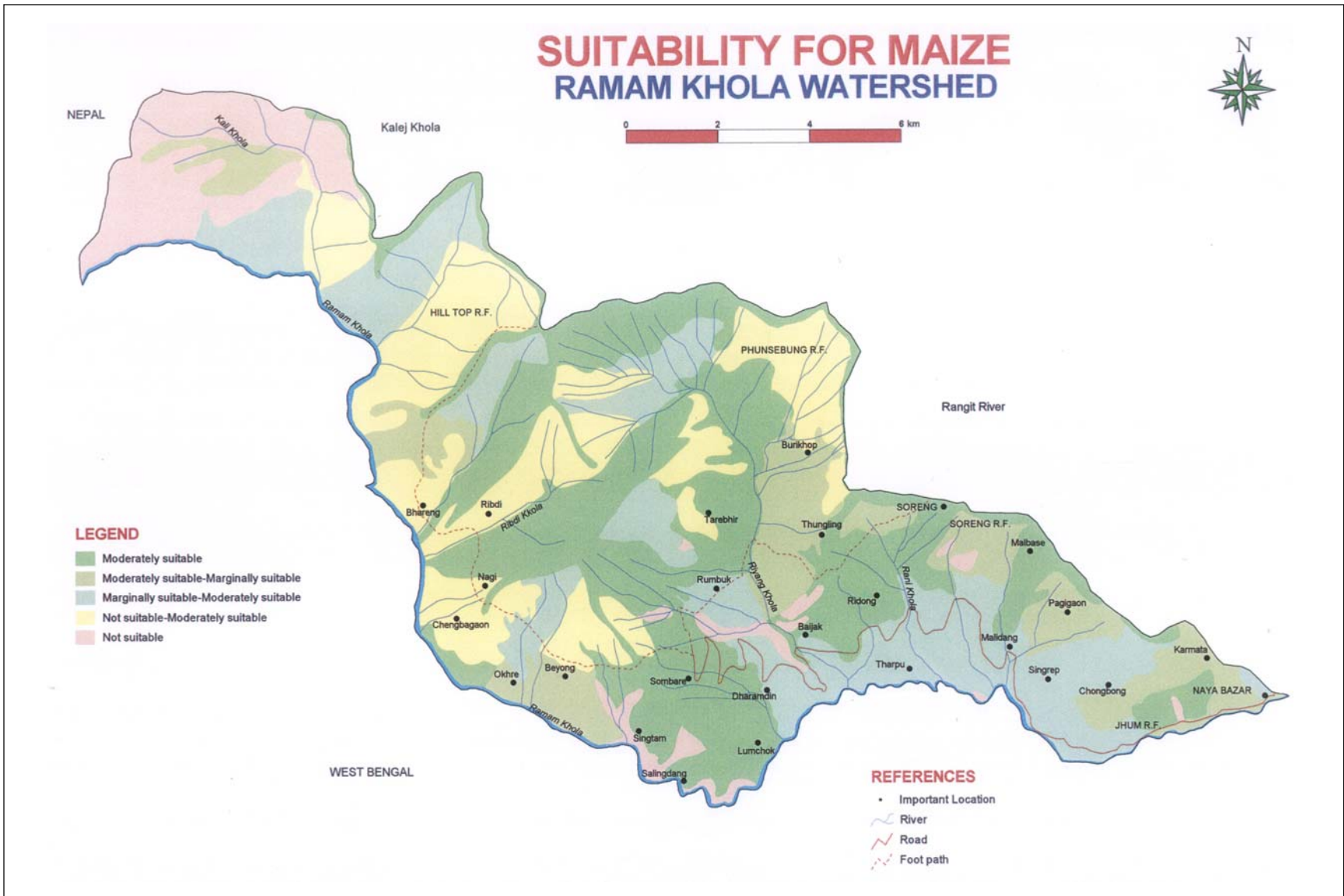


Fig. 4.121 Soil site suitability for maize in Ramam Khola watershed

Miscellaneous	70.7
Total	14967.0

4.16 RANGIT RIVER WATERSHED

4.16.1 Landforms

Seven broad landform regions viz. ridge, rocky cliff, landslide zone, low mountain, mid mountain, high mountain and narrow valley were identified in this watershed through the interpretation of satellite imagery, toposheet and traversing the area. In this watershed mid mountain covers maximum area (56.2%) followed by low mountain (21.4%) and high mountain (9.8%) (Fig. 4.122).

4.16.2 Soils

Soils of Rangit Khola have been mapped into twenty mapping units at the level of soil series association (Table 4.107) and presented in Fig. 4.123. Soil map unit 24 & 11 comprising Doling – Khedi association and Mangjing – Singhrep – Rorethang association are dominant covering 3,455.5 ha (11.9%) and 2,939.5 ha (10.1%), respectively. The low mountain soil occurring in soil mapping unit 8,11 and 13 occupies 21.4 per cent area while the mid hill soils occurring in soil mapping unit 24,26,30,34,39,40 and 42 occupies about 35.3 per cent and the high mountain soils occurring in soil mapping unit 42, 48, 54 and 56 occupies about 6.8 per cent area of the watershed.

Table 4.107 Soils of Rangit River watershed

Soil unit	Soil Series Association	Area (In ha)	% of watershed
1	Maling-Rayong	1791.5	6.2
3	Rock outcrops – Jorpul	1458.3	5.0
6	Karporang – Hilley	19.8	0.1
8	Bhasme – Chautare – Legship	2424.2	8.3
11	Mangjing – Singrep - Rorethang	2939.5	10.1
13	Mangjing – Dharamdin	885.6	3.0
15	Mangreng – Karfecter- Mangjing	306.7	1.1
16	Tumin –Phong – Chautare	2322.5	8.0
18	Phong – Khedi – Maniram	2888.6	9.9
20	Chakung – Tumin – Sajong	1757.2	6.0
24	Doling – Khedi	3455.5	11.9
26	Dikling – Hilley	2811.3	9.7
30	Rumtek – Tumin	503.0	1.7
34	Namchi– Synggyang	898.9	3.1
39	Daragoan – Gaucharan – Dharamdin	711.4	2.4
40	Dharamdin – Martam - Karfecter	1002.7	3.5
42	Damthang – Chongrang – Rock outcrop	868.0	3.0
48	Martam – Tarnu – Sajong	159.3	0.5
54	Rongnek – Sajong	592.5	2.0
56	Khedi – Dikling	1103.4	3.8
	Miscellaneous	157.1	0.5
	Total	29057.0	100.0

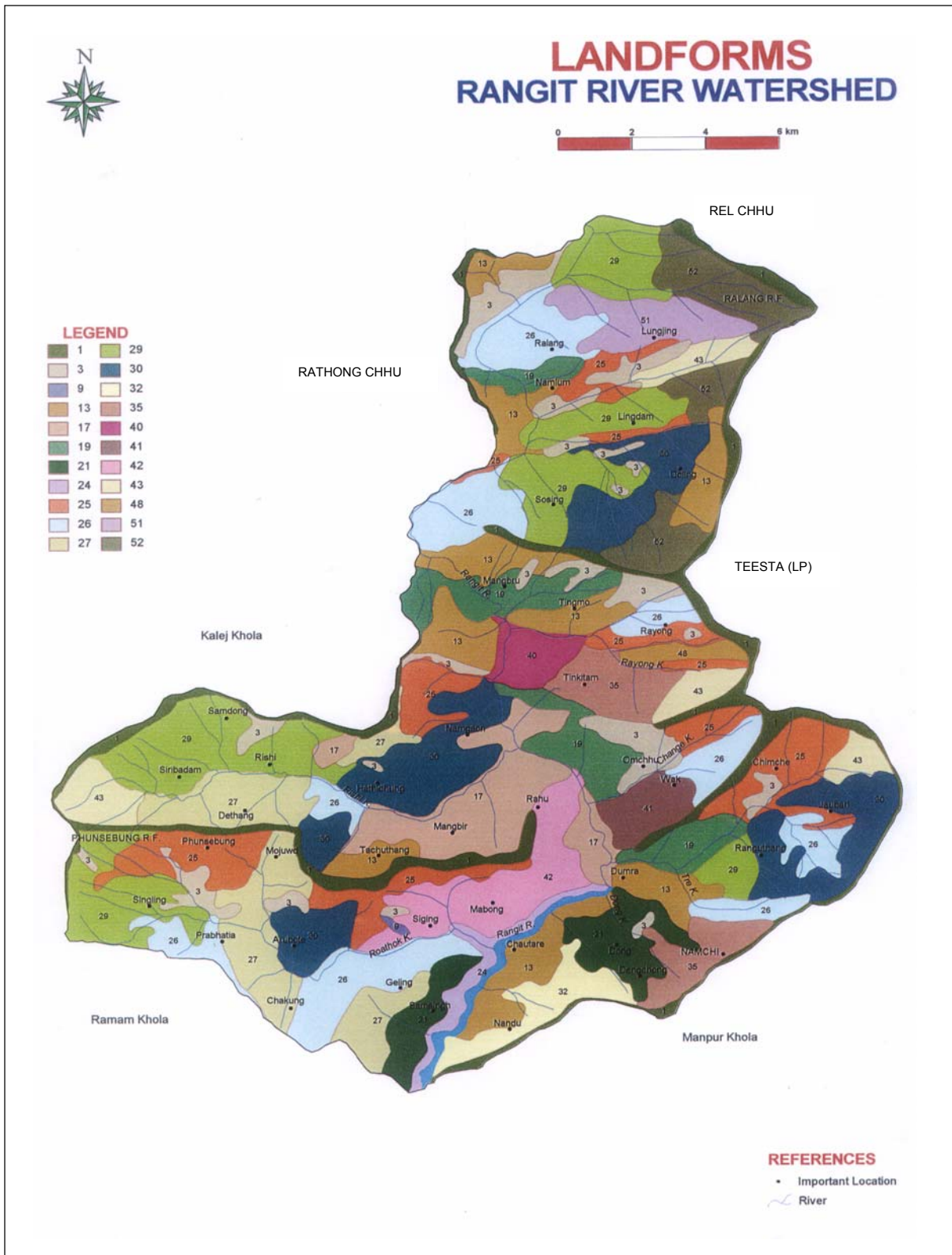


Fig. 4.122 Landforms of Rangit river watershed

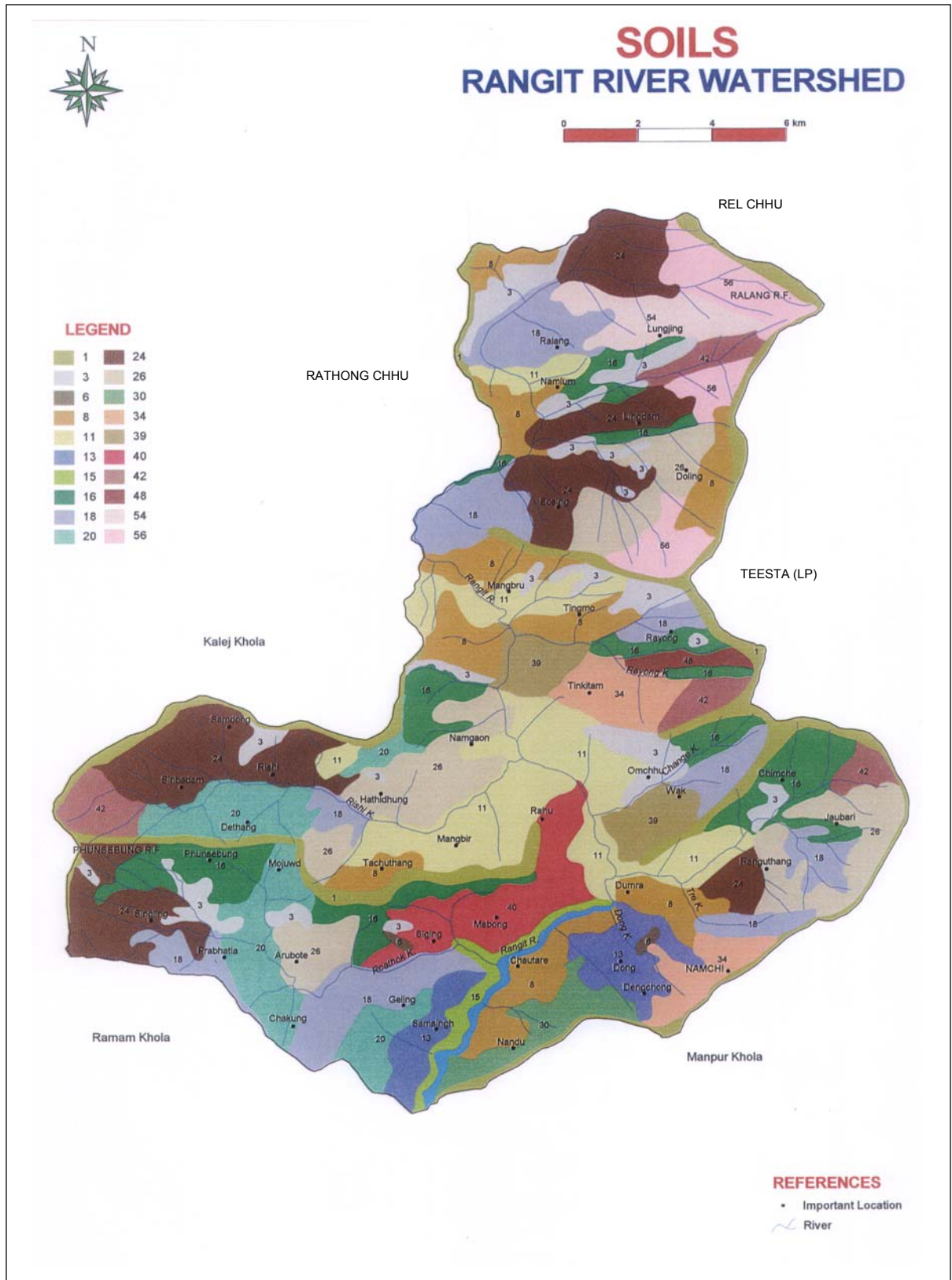


Fig. 4.123 Soils of Rangit river watershed

4.16.3 Soil depth

Five soil depth classes have been identified and mapped into seven mapping units at the level of association of soil depth classes (Table 4.108) and presented in Fig. 4.124. Mapping unit 1 comprising association of deep and moderately deep soil depth class cover the area of 14,116.2 ha (48.6%). Map unit 2 comprising of deep and moderately shallow depth class, map unit 5 comprising of moderately shallow and deep depth class and map unit 3 with moderately deep and deep class are also extensively distributed which covered 5,071.5 ha (17.5%), 4,746.7 ha (16.3%) and 2,894.9 ha (10.0%) respectively. The mapping unit 6 comprising Rock and very shallow soil depth class is really problematic which require soil and water conservation through afforestation.

Table 4.108 Soil depth of Rangit River watershed

Map unit	Description	Soil Map units	Area (In ha)	% of watershed
1	Deep-mod deep	13,15,24,34,39,48,40,11,1 8,42	14116.2	48.6
2	Deep-mod shallow	20,26,30	5071.5	17.5
3	Mod deep-deep	1,56	2894.9	10.0
4	Mod shallow	6	19.8	0.1
5	Mod shallow-deep	8,16	4746.7	16.3
6	Rock-very shallow	3	1458.3	5.0
7	Shallow-mod deep	54	592.5	2.0
		Miscellaneous	157.1	0.5

4.16.4 Surface texture

Nine textural classes have been identified and mapped into 12 mapping units at the level of association of textural classes (Table 4.109) and presented in Fig. 4.125. Silt loam and loam are dominant textural classes and contribute a part of association in mapping unit 1,2,4,9,11,12. Soil mapping unit 2,6,7,8,11,12,13 are evenly distributed covering more than 10 per cent of the total area of the watershed.

Table 4.109 Surface texture of Rangit River watershed

Map unit	Description	Soil Map units	Area (In ha)	% of watershed
1	cl-l	15,40	1309.4	4.5
2	l-sl	8,34	3323.1	11.5
3	ls-l	6	19.8	0.1
4	R-l	3	1458.3	5.0
5	sc-scl	39	711.4	2.4
6	sl-cl	13,48,18	3933.5	13.5
7	sl-gl	11	2939.5	10.1
8	sl-sicl	1,56	2894.9	10.0
9	sic-l	26	2811.3	9.7
10	sil-cl	16	2322.5	8.0
11	sil-l	20,30,42	3128.2	10.8
12	sil-sl	24,54	4048.0	13.9
		Miscellaneous	157.1	0.5

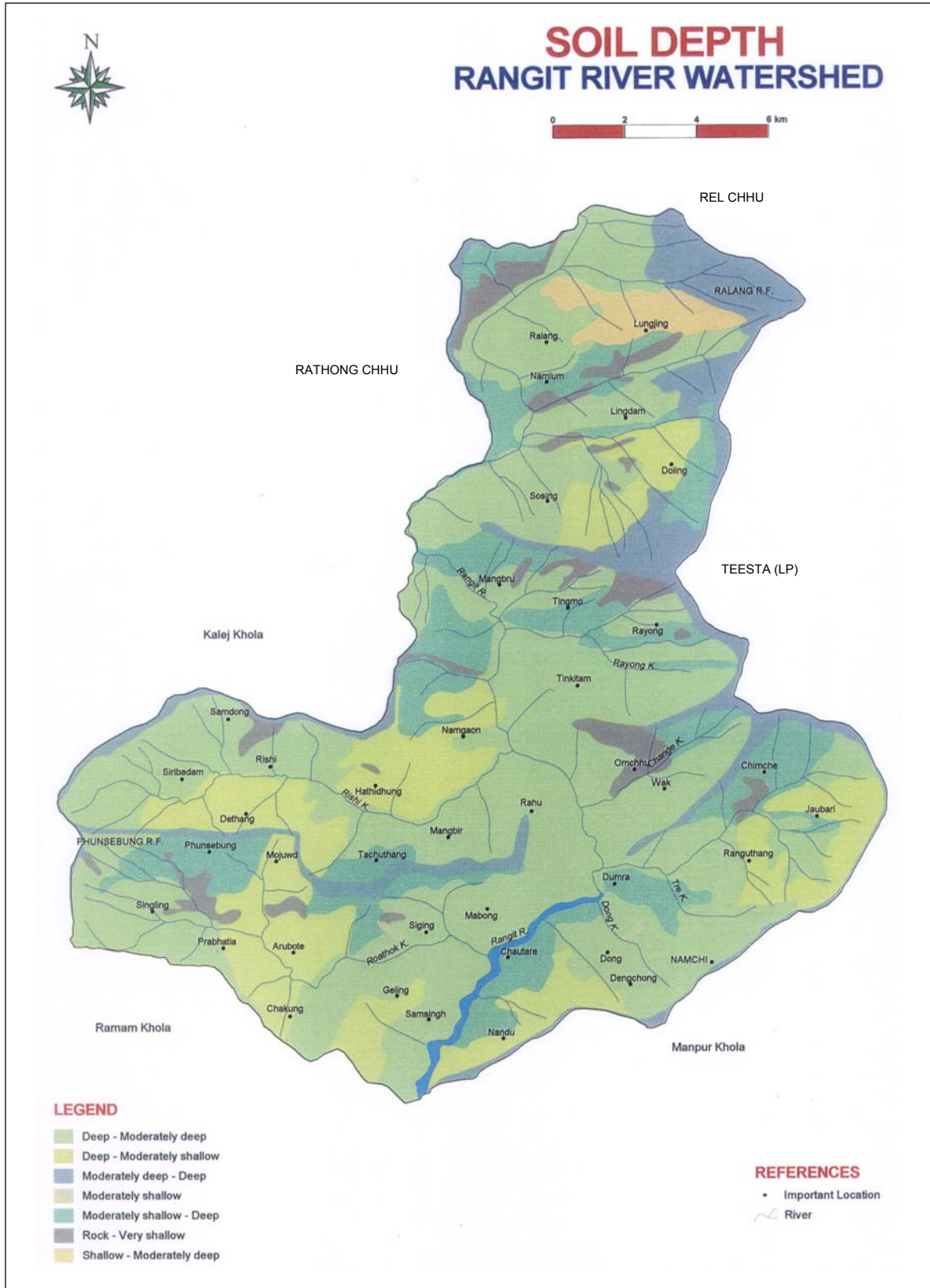


Fig. 4.124 Soil depth class of Rangit river watershed

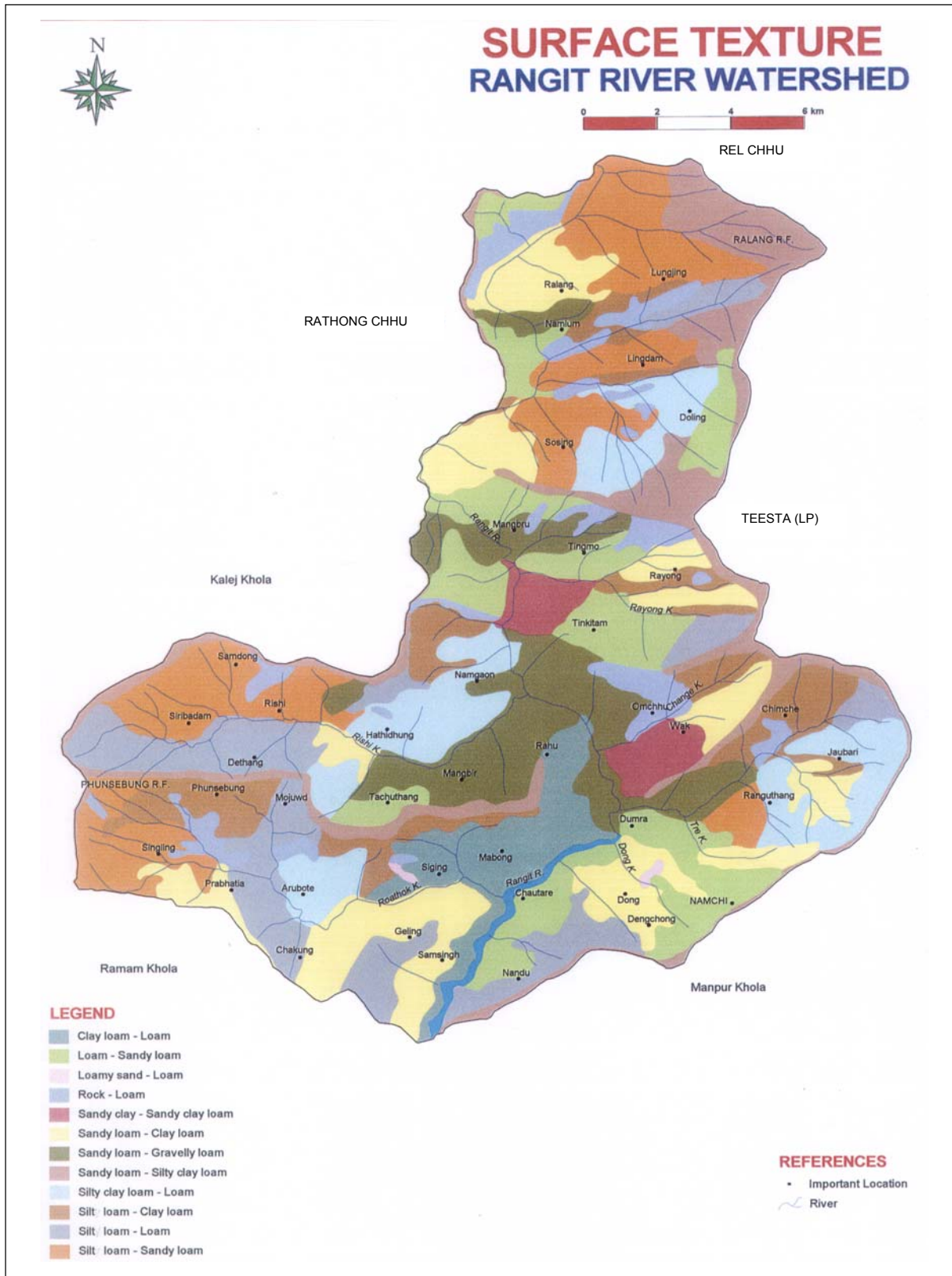


Fig. 4.125 Surface texture class of Rangit river watershed

4.16.5 Soil erosion

Soil loss by water erosion as moderate, severe and very severe erosion classes have been identified in this watershed. The classes of different soil erosion have been mapped into seven soil mapping units at the level of association of erosion classes (Table 4.110) and presented in Fig. 4.126. Moderate soil erosion alone covered 17,782.2 ha (61.2%) of the watershed while severe erosion alone covered 592.5 ha (2.0%). The most problematic unit 7 comprising the association of very severe and severe erosion class covers an area of 898.1 ha (3.1%) where soil conservation measure should be taken on the priority basis.

Table 4.110 Soil erosion of Rangit River watershed

Map unit	Description	Soil Map units	Area (In ha)	% of watershed
1	M	1,13,15,24,26,30,39,40,56,16,18	17782.2	61.2
2	M-S	8,48,11,42	6391.0	22.0
3	R-VS	3	1458.3	5.0
4	S	54	592.5	2.0
5	S-M	6	19.8	0.1
6	VS-M	20	1754.2	6.1
7	VS-S	34	898.9	3.1
		Miscellaneous	157.1	0.5

4.16.6 Soil reaction

Four types of soil reaction classes have been identified in Rangit River Watershed (Table 4.111) and mapped in Fig. 4.127. Soils belong to moderate to extremely acidic reaction class. Mapping unit 1 comprising extremely acidic – strongly acidic (Ex-S) association covered largest area of 10,486.0 ha (36.1%), followed by very strongly acidic – strongly acidic (VS-S) in 6,598.8 ha (22.7%) and extremely acidic – very strongly acidic (Ex-Vs) in 5,262.0 ha (18.1%).

Table 4.111 Soil reaction of Rangit River watershed

Map unit	Description	Soil Map units	Area (In ha)	% of watershed
1	EX-S	8,13,20,24,30,54,42	10486.0	36.1
2	EX-VS	11,16	5262.0	18.1
3	M-VS	15,39,48	1177.4	4.1
5	R-S	3	1458.3	5.0
6	S-EX	1	1791.5	6.2
7	S-VS	40,6,56	2125.9	7.3
8	VS-S	26,34,18	6598.8	22.7
		Miscellaneous	157.1	0.5

4.16.7 Land capability class (LCC)

Five types of land capability classes and seven types of land capability sub-classes have been identified in Rangit River watershed (Table 4.112) and presented in Fig. 4.128.

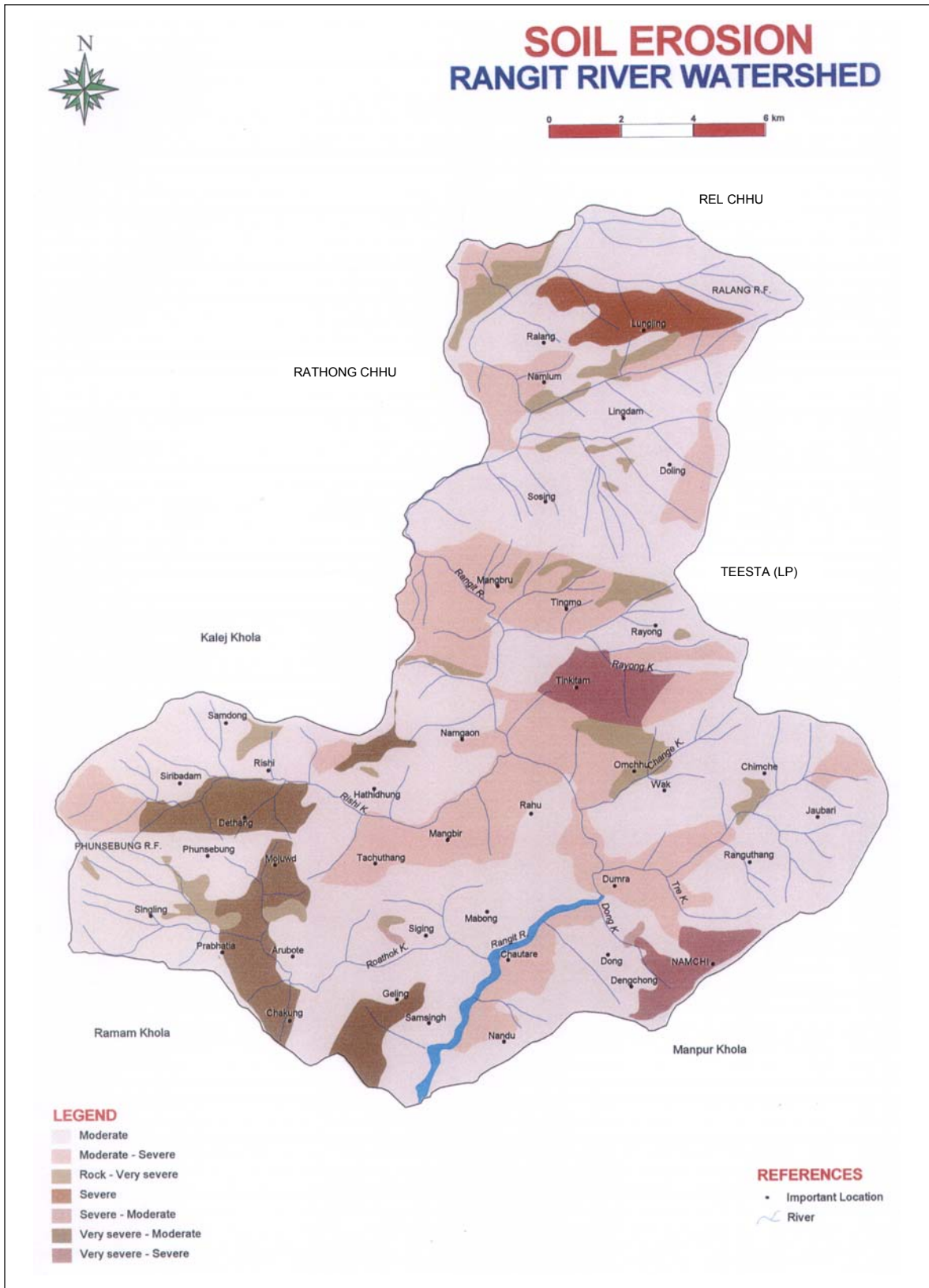


Fig. 4.126 Soil erosion class of Rangit river watershed

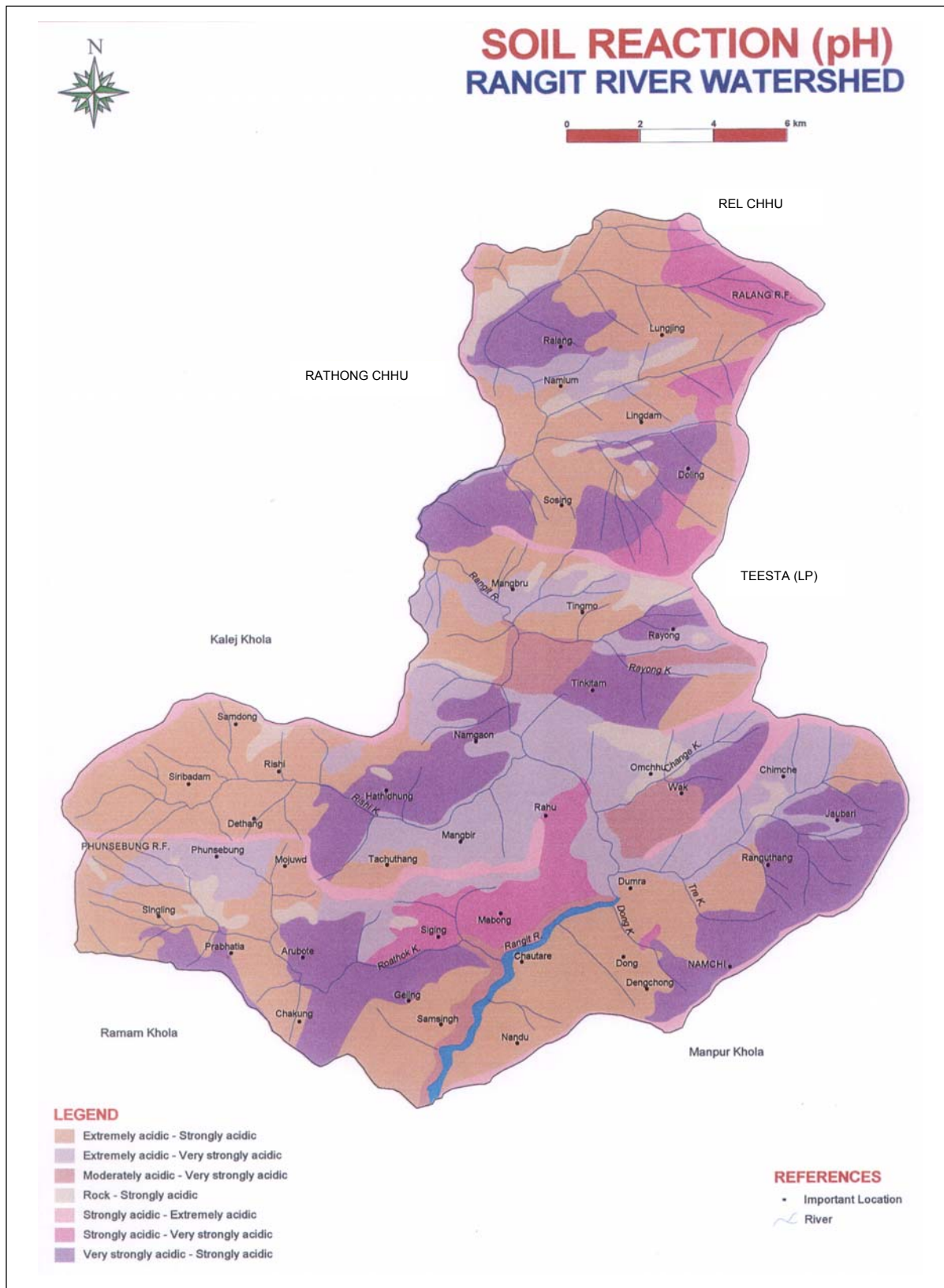


Fig. 4.127 Soil reaction class of Rangit river watershed

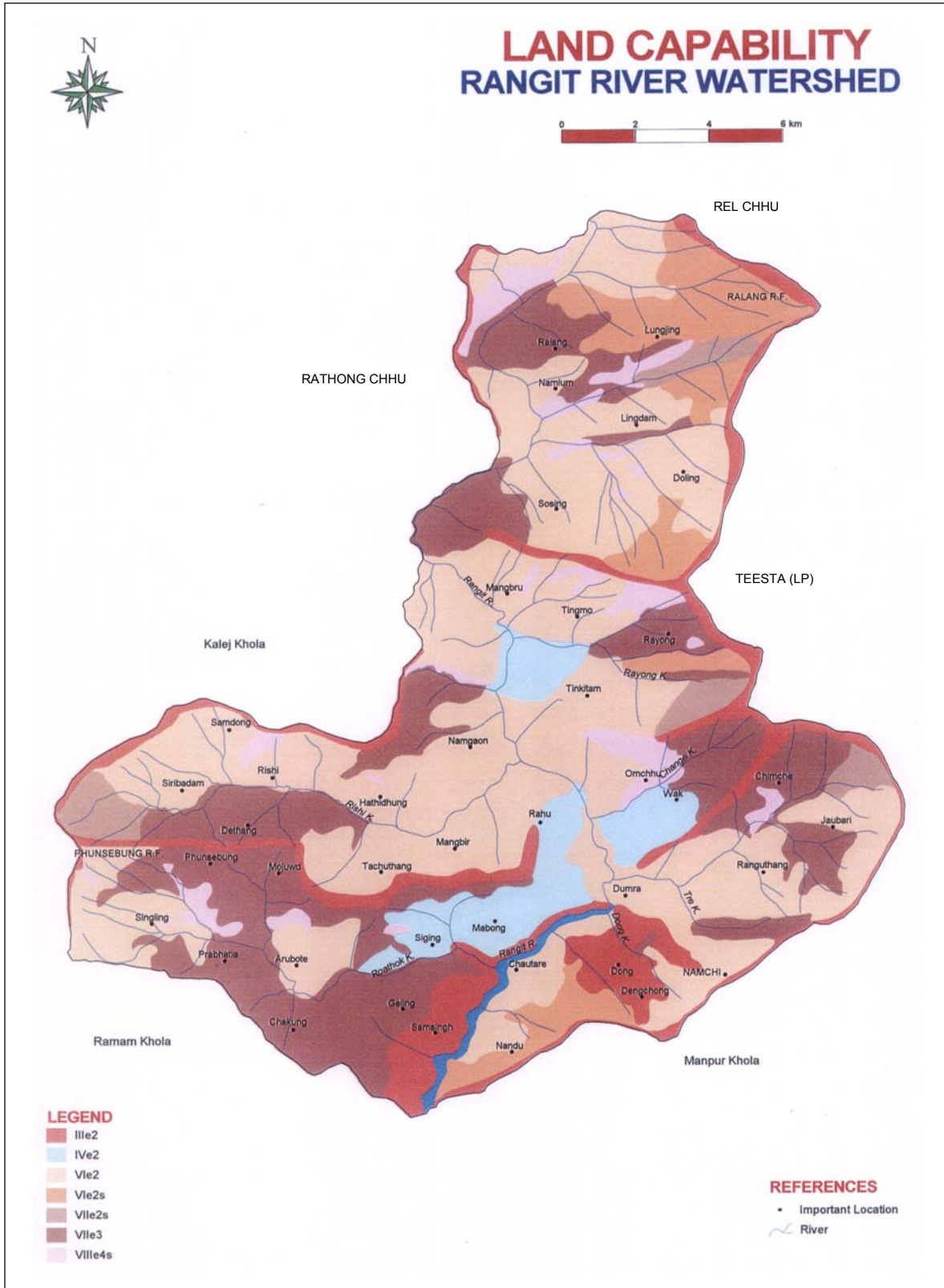


Fig. 4.128 Land capability class of Rangit river watershed

Table 4.112 Land capability of Rangit River watershed

Map unit	Description	Soil Map units	Area (In ha)	% of watershed
1	IIIe2	1,13,15	2983.8	10.3
2	IVe2	39,40	1714.1	5.9
3	VIe2	8,24,26,34,11	12529.4	43.2
4	VIe2s	30,48,54,56	2358.0	8.1
5	VIIe2s	42	868.0	3.0
6	VIIe3	6,20,16,18	6988.1	24.0
7	VIIIe4s	3	1458.3	5.0
		Miscellaneous	157.1	0.5

The land capability sub-class VIe2 (mapping unit 3) occupies largest area of 12,529.4 ha (43.2%) whereas the land capability sub-class VIIe2s (mapping unit 5) occupies least area of 868.0 ha (3.0%). The mapping units 5,6 and 7 comprising land capability sub-classes VIIe2s, VIIe3 and VIIIe4s and representing rocky cliff, landslide zone, part of mid mountain (>50% slope) and part of high mountain (>50% slope) really possesses serious problem of soil erosion which can be used either for forestry or recreation/pasture with proper soil conservation measure

4.16.8 Soil-site suitability for rice

The soils of Rangit river watershed have been evaluated for its suitability to rice cultivation. The result revealed that about 12,681.3 ha areas were found to be marginally suitable (S3) for rice (Table 4.113 and

Fig. 4.129). Moderately to marginally suitable (S2-S3) areas occupy 1,505.7 ha and marginally to moderately suitable (S3-S2) areas occupy 3,825.1 ha. Not suitable to marginally suitable (N-S3) areas occupy 4,089.4 ha and 1,478.1 ha land are completely unsuitable for paddy cultivation mostly due to very steep slope, very severe soil limitations including acidity.

Table 4.113 Soil-site suitability for rice of Rangit River watershed

Sl.No.	Suitability class	Map unit nos.	Area (ha)
1.	S2-S3	30,40	1505.7
2.	S3-S2	11,13	3825.1
3.	S3	1,8,15,18,24,56,39	12681.3
4.	S3-N	20,26,48,54	5320.3
5.	N-S3	16,34,42	4089.4
6.	N	3,6	1478.1
	Miscellaneous		157.1
Total			29057.0

4.16.9 Soil-site suitability for maize

About 11,410.9 ha area in the Rangit river watershed is found to be only moderately suitable (S2) for maize. Areas moderately suitable to marginally suitable (S2-S3) and marginally suitable to moderately suitable (S3-S2) for maize occupy 5,743.2 ha; 8,571.8 ha respectively (Table 4.114 and Fig. 4.130). It is found to be unsuitable in 157.1 ha areas representing rocky cliff and landslide zone due to very severe limitation of erosion, soil depth and fertility status.

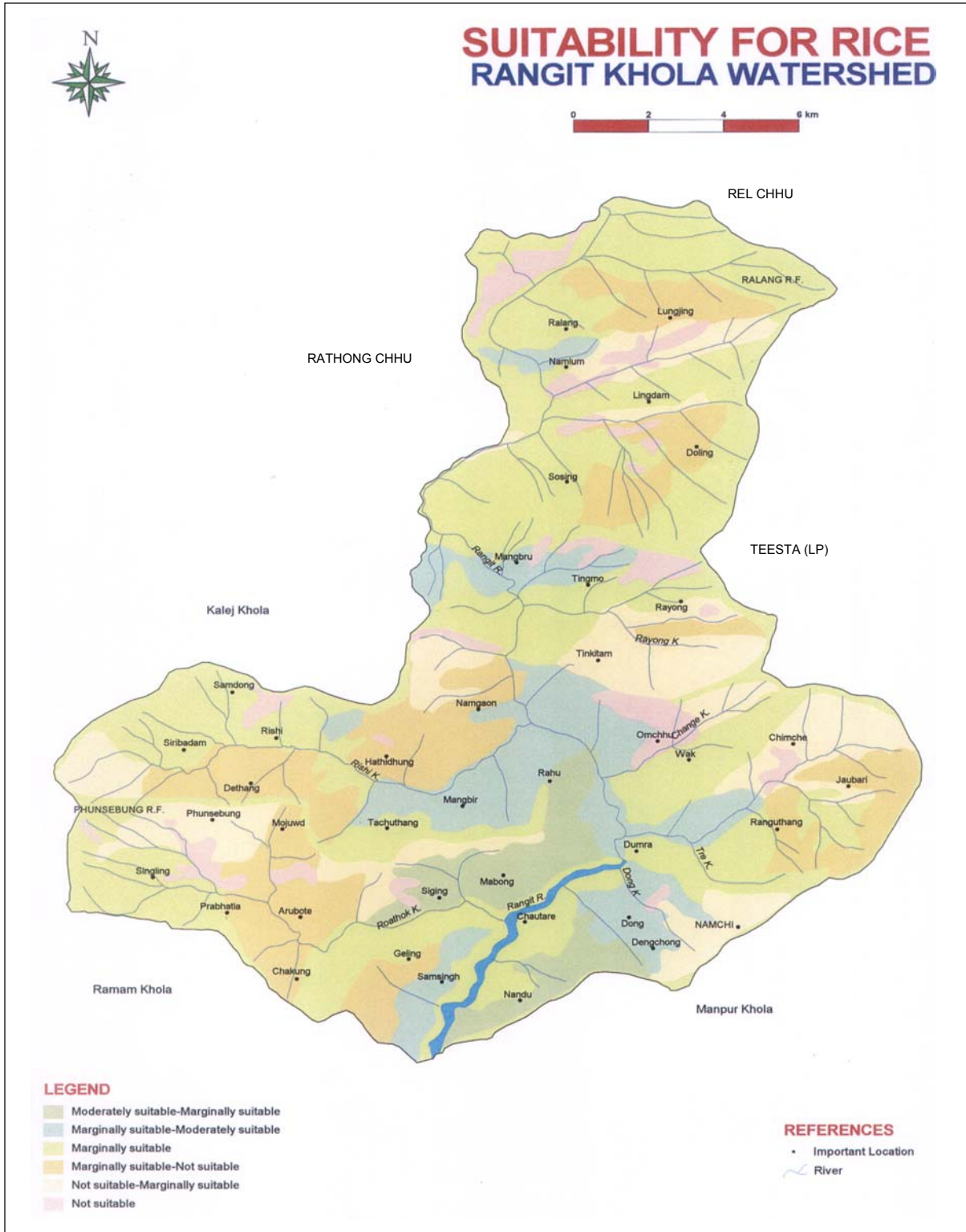


Fig. 4.129 Soil site suitability for rice in Rangit river watershed

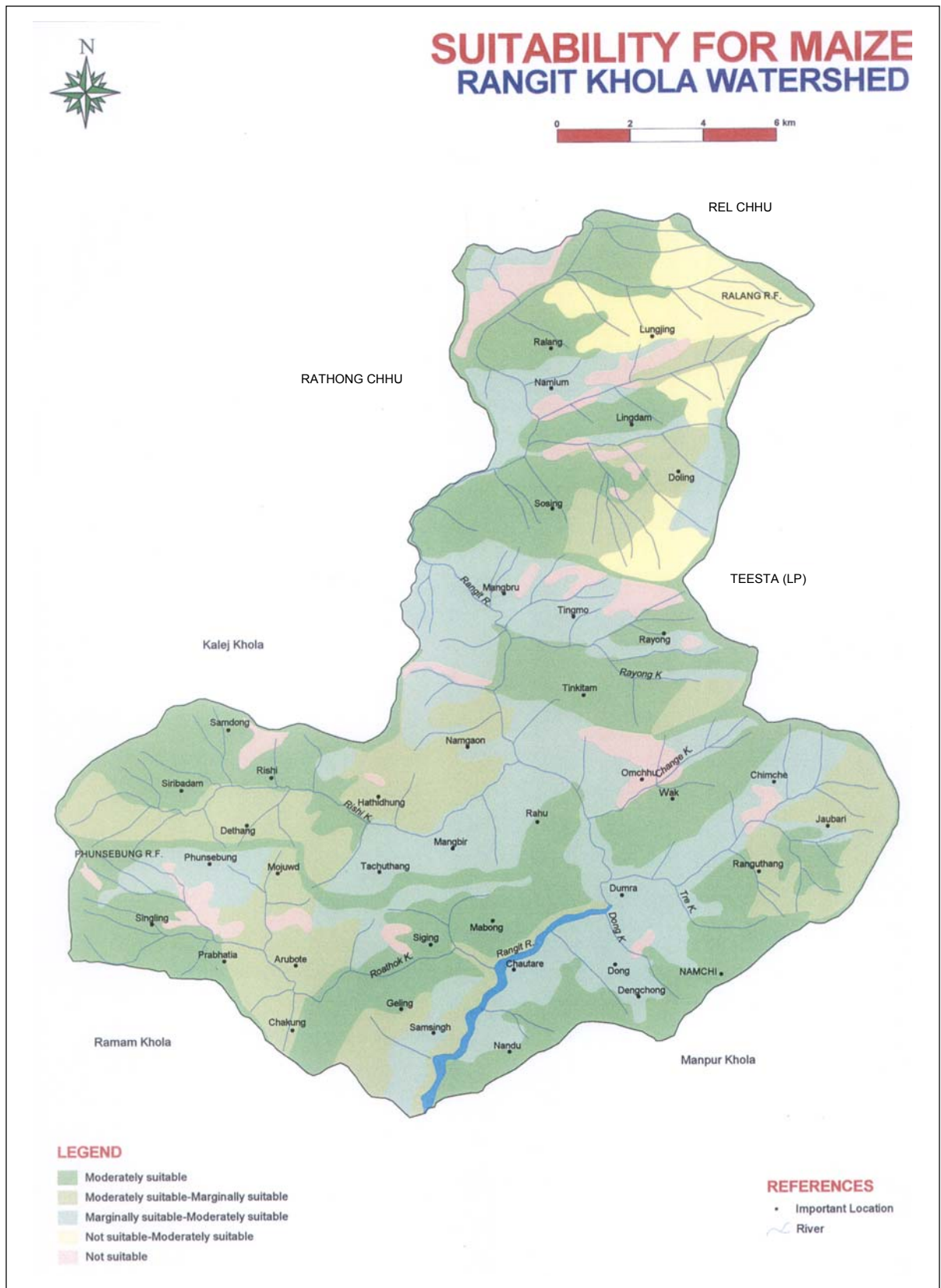


Fig. 4.130 Soil site suitability for maize in Rangit river watershed

Table 4.114 Soil-site suitability for maize of Rangit River watershed

Sl.No.	Suitability class	Map unit nos.	Area (ha)
1.	S2	1,18,24,30,34,39,40,48	11410.9
2.	S2-S3	15,20,26,42	5743.2
3.	S3-S2	8,11,13,16	8571.8
4.	N-S2	54,56	1695.9
5.	N	3,6	1478.1
	Miscellaneous		157.1
Total			29057.0

4.17 MANPUR KHOLA WATERSHED

4.17.1 Landforms

Five broad landform regions viz. ridge, rocky cliff, low mountain, narrow valley and mid mountain were identified in the watershed for the inventorisation of the soils developed on these geomorphic units (Fig. 4.131).

4.17.2 Soils

Soils of Manpur Watershed have been mapped into seventeen soil mapping units at the level of soil series association (Table 4.115 and Fig. 4.132). Soil map unit 11 comprising of Manging – Singrep – Rorethang association of low mountain covers an area of 2,405.1 ha (29.6%) followed by soil mapping unit 28 and 18 of mid mountain covering 1,260.9 ha (15.5%) and 985.4 ha (12.1%) area respectively of the watershed.

Table 4.115 Soils of Manpur Khola watershed

Soil unit	Soil Series Association	Area (In ha)	% of watershed
1	Maling-Rayong	648.7	8.0
3	Rock outcrops - Jorpul	196.1	2.4
4	Hilley-Singrep - Chatten	144.2	1.8
5	Bhusuk- Karporang - Tibik	47.4	0.6
6	Karporang - Hilley	43.4	0.5
8	Bhasme – Chautare - Legship	232.4	2.9
10	Chalumthang – Rorethang - Bhasme	148.6	1.8
11	Mangjing – Singrep - Rorethang	2405.1	29.6
12	Lingtse – Chautare - Chalumthang	340.5	4.2
15	Mangreng – Karfecter- Mangjing	540.0	6.7
16	Tumin –Phong - Chautare	156.8	1.9
18	Phong – Khedi - Maniram	985.4	12.1
20	Chakung – Tumin - Sajong	623.1	7.7
26	Dikling – Hilley	169.2	2.1
28	Samdur – Khedi - Bhusuk	1260.9	15.5
30	Rumtek – Tumin	127.9	1.6
34	Namchi– Synggyang	44.0	0.5
	Miscellaneous	1.1	0.0
	Total	8115.0	100.0

4.17.3 Soil depth

Four types of soil depth classes viz. very shallow, moderately shallow, moderately deep and deep have been identified (Table 4.116) and mapped (Fig. 4.133) at the level of soil depth class association into

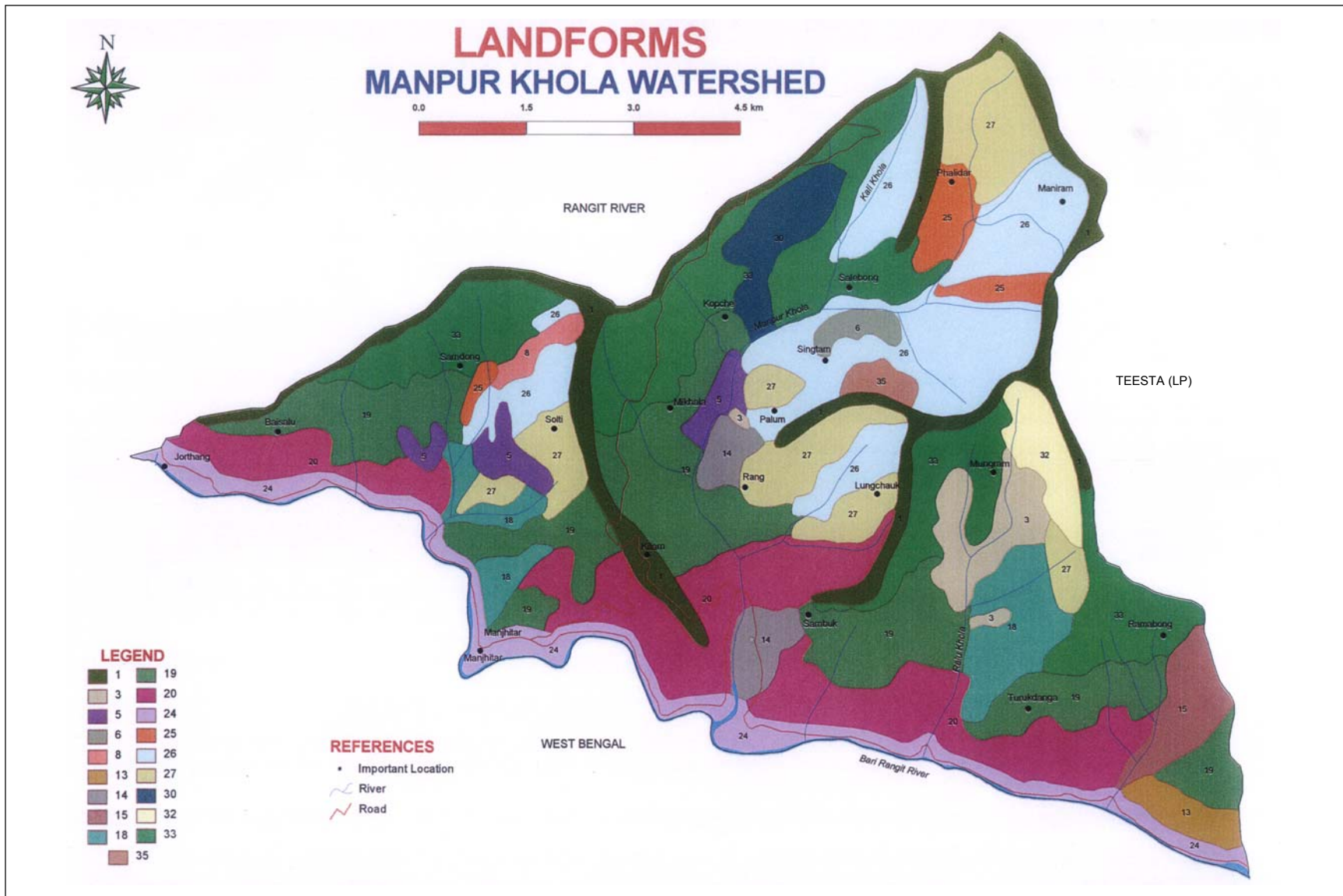


Fig. 4.131 Landform of Manpur Khola watershed

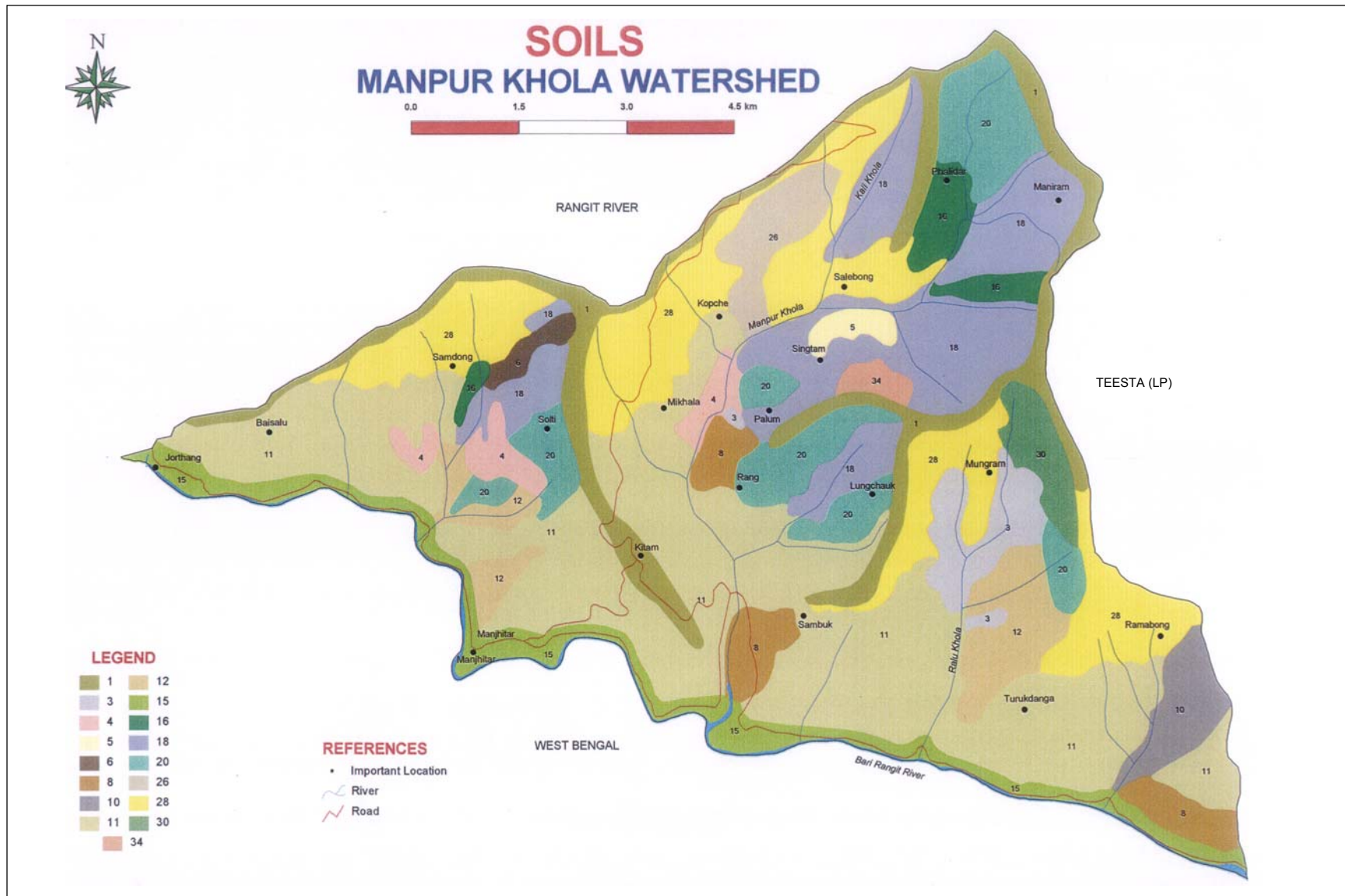


Fig. 4.132 Soils of Manpur Khola watershed

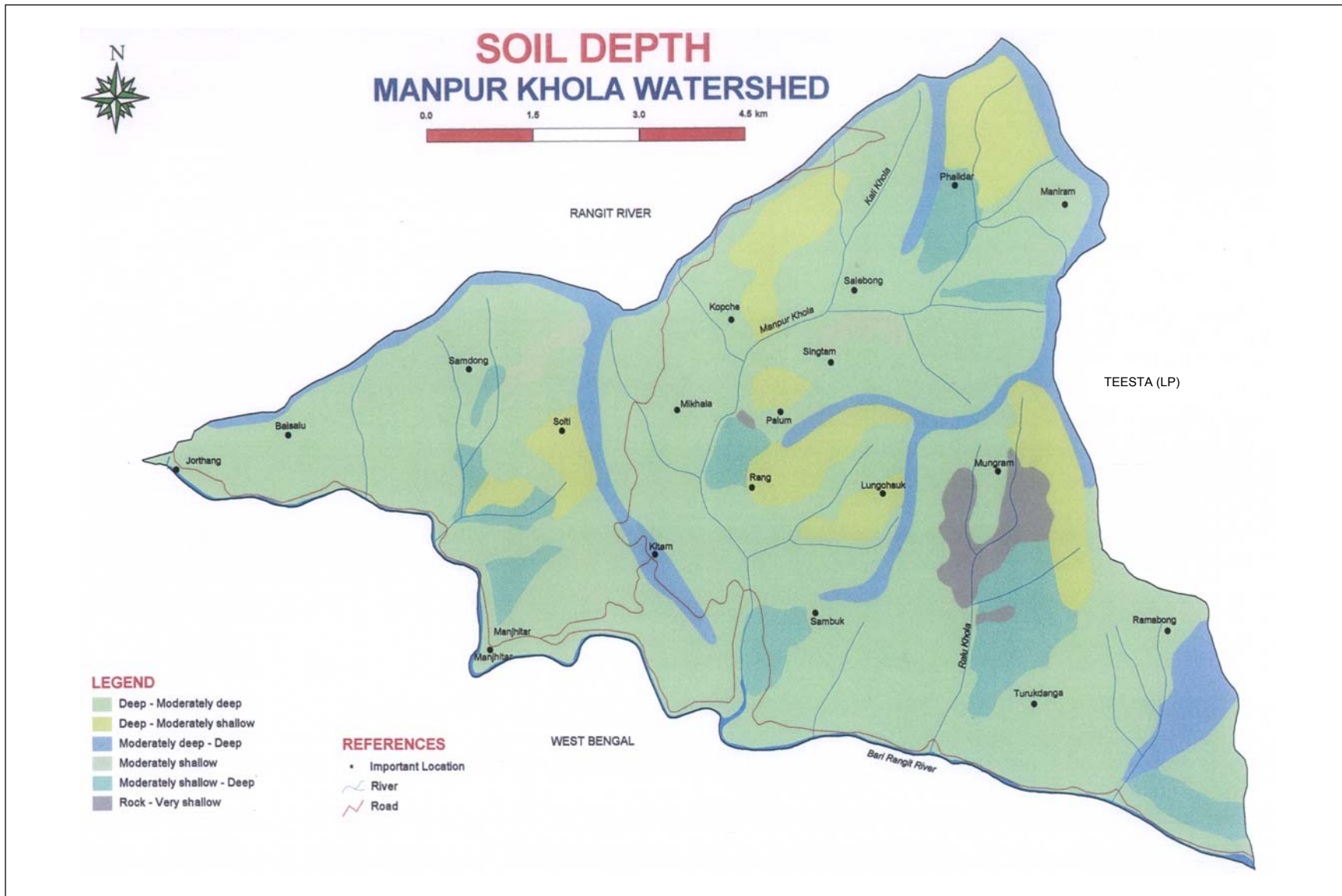


Fig. 4.133 Soil depth class of Manpur Khola watershed

six mapping units. Deep – moderately deep association (mapping unit 1) covers an area of 5,379.6 ha (66.3%) followed by deep – moderately shallow (mapping unit 2) depth class in 920.2 ha (11.3%). About 2.4 per cent area of the watershed comprises Rock – very shallow association is very problematic area which require efficient conservation measure.

Table 4.116 Soil depth of Manpur Khola watershed

Map unit	Description	Soil Map units	Area (In ha)	% of watershed
1	Deep-mod.deep	4,15,28,34,11,18	5379.6	66.3
2	Deep-mod. shallow	20,26,30	920.2	11.3
3	Mod. deep-deep	1,10	797.3	9.8
4	Mod. shallow	5,6	90.8	1.1
5	Mod. shallow-deep	8,12,16	729.7	9.0
6	Rock-very shallow	3	196.1	2.4
		Miscellaneous	1.1	0.1

4.17.4 Surface texture

Eight surface soil textural classes have been identified (Table 4.117) and mapped (Fig. 4.134) in eleven mapping units at the level of association of surface textural class. Sandy loam – gravelly loam association (mapping unit 7) covers an area of 2,405.1 ha (29.6%) followed by loam – sandy loam association (mapping unit 3) in 2,022.0 ha (24.9%). The mapping unit 2 comprising gravelly sandy loam – loamy sand association occupying an area of 47.4 ha (0.6%) is very

susceptible to erosion and hence efficient soil conservation should be applied in this area.

Table 4.117 Surface texture of Manpur Khola watershed

Map unit	Description	Soil Map units	Area (In ha)	% of watershed
1	cl-l	15	540.0	6.7
2	gsl-ls	5	47.4	0.6
3	l-sl	4,8,28,34,12	2022.0	24.9
4	ls-l	6	43.4	0.5
5	R-l	3	196.1	2.4
6	sl-cl	18	985.4	12.1
7	sl-gl	11	2405.1	29.6
8	sl-sicl	1	648.7	8.0
9	sicl-l	26	169.2	2.1
10	sil-cl	16	156.8	1.9
11	sil-l	20, 30, 10	899.6	11.1
		Miscellaneous	1.1	0.1

4.17.5 Soil erosion

Moderate, severe, very severe soil erosion class have been identified (Table 4.118) and mapped (Fig. 4.135) in six mapping units at the level of association of soil erosion classes. Moderate erosion alone (mapping unit 1) covers an area of 3,888.9 ha (47.9%) followed by association of moderate – severe association (mapping unit 2) in 3,318.2 ha (40.9%). About 667.1 ha (8.2%) area comprising very

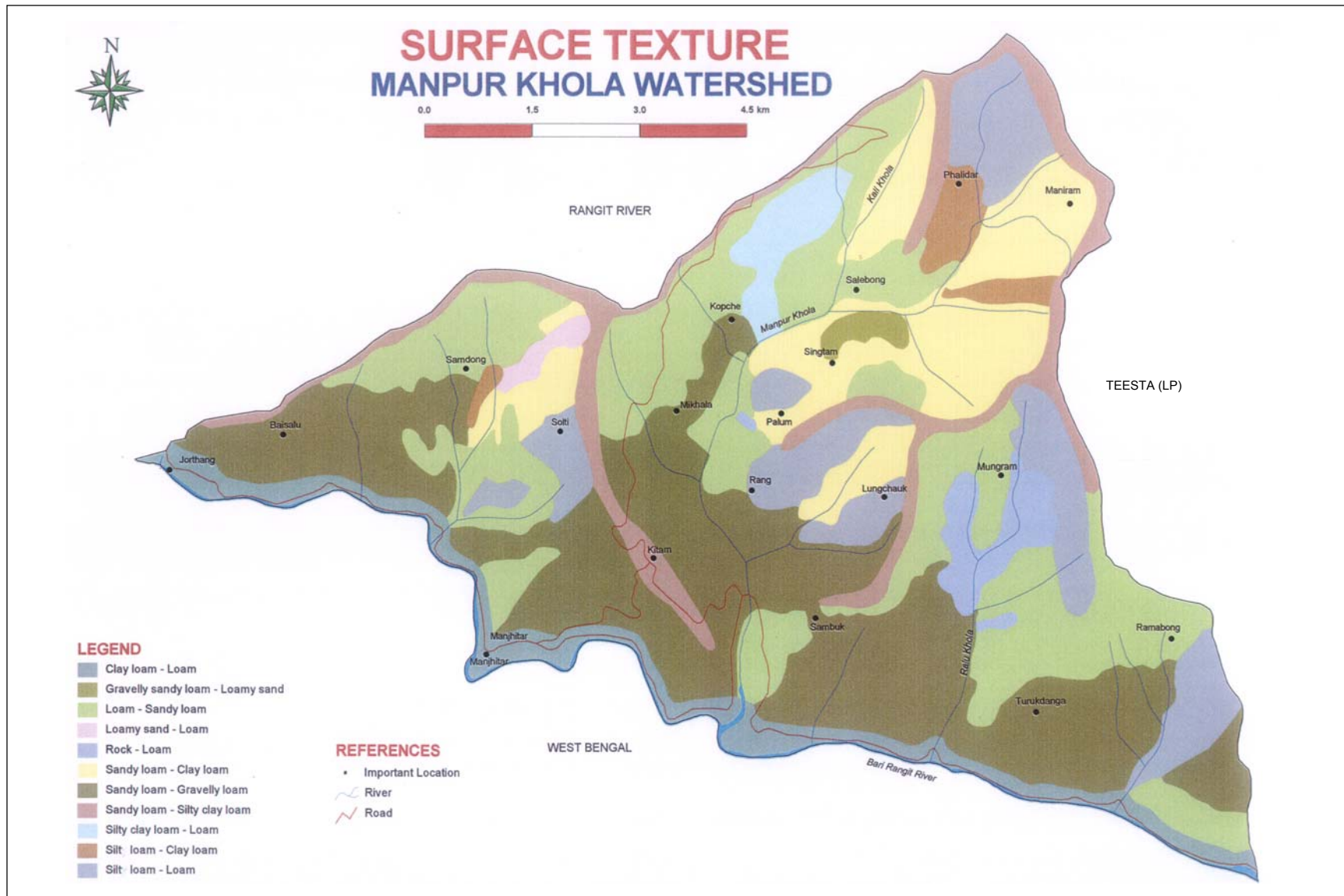


Fig. 4.134 Surface texture class of Manpur Khola watershed

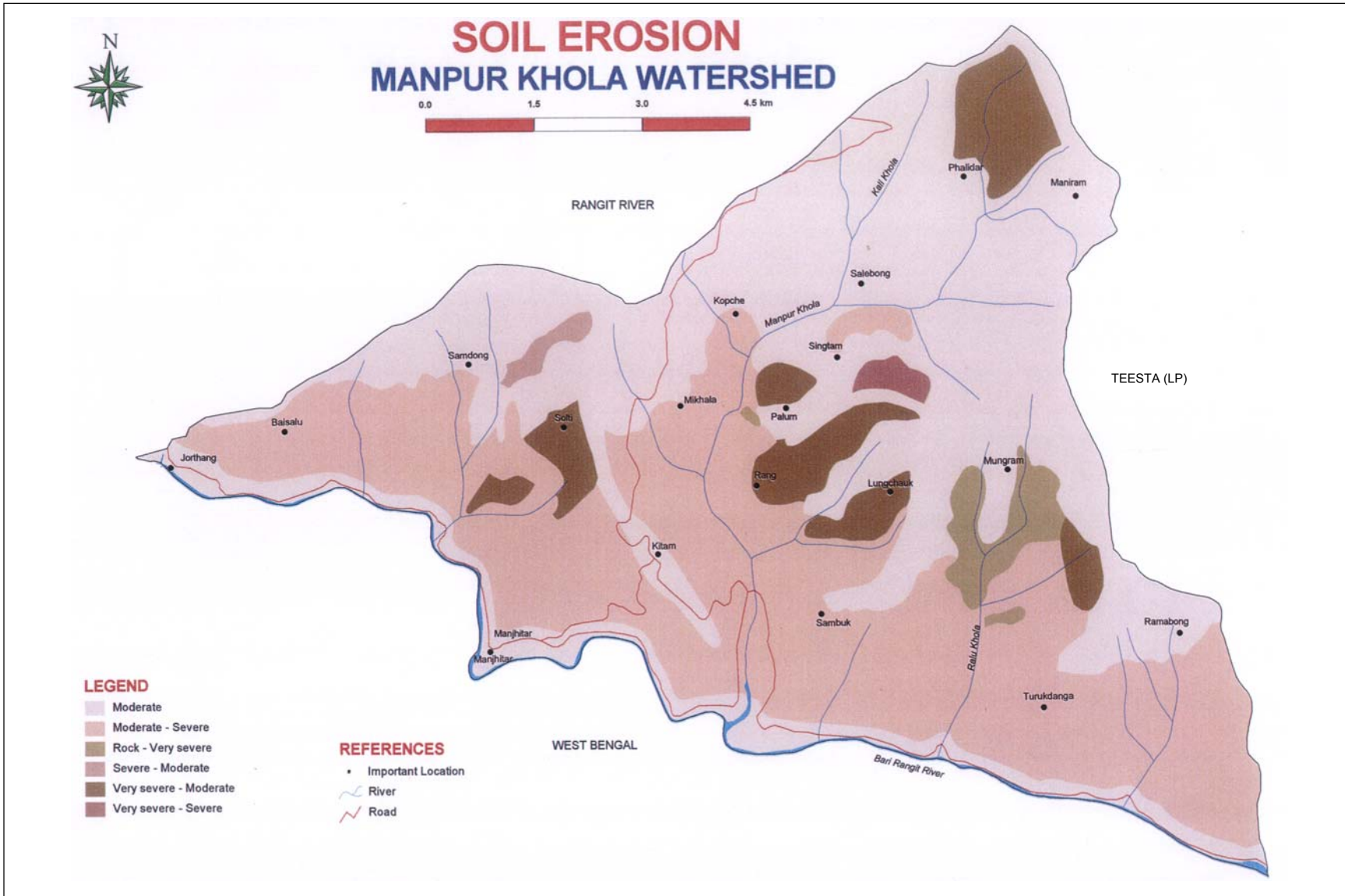


Fig. 4.135 Soil erosion class of Manpur Khola watershed

severe – severe association class mostly belongs to mid mountain of 30-50% slope and above should be managed efficiently to protect and conserve the natural resource.

Table 4.118 Soil erosion of Manpur Khola watershed

Map unit	Description	Soil Map units	Area (In ha)	% of watershed
1	M	1,15,26,28,30,16,18	3888.9	47.9
2	M-S	4,5,8,10,11,12	3318.2	40.9
3	R-VS	3	196.1	2.4
4	S-M	6	43.4	0.5
5	VS-M			
6	VS-S	20,34	667.1	8.2
		Miscellaneous	1.1	0.1

4.17.6 Soil reaction

Five types of soil reaction class have been identified (Table 4.119) and (fig. 4.136) mapped into ten mapping units at the level of association of soil reaction classes. Mapping unit 10 and mapping unit 2 are the most dominant association covering 2,651.1 ha (32.7%) and 2,561.9 ha (31.6%) area of the watershed. The mapping unit 2 comprising extremely acidic – very strongly acidic association covering 2,651.1 ha (32.7%) can be efficiently managed through growing acid tolerant crops viz. tea, coffee etc.

Table 4.119 Soil reaction of Manpur Khola watershed

Map unit	Description	Soil Map units	Area	% of watershed
			(In ha)	
1	EX-S	8,20,30	983.4	12.1
2	EX-VS	11,16	2561.9	31.6
3	M-VS	15	540.0	6.7
5	R-S	3	196.1	2.4
6	SL-VS	10	148.6	1.8
7	S-EX	1	648.7	8.0
8	S-M	12	340.5	4.2
9	S-VS	6	43.4	0.5
10	VS-S	4,5,26,28,34,18	2651.1	32.7
		Miscellaneous	1.1	0.1

4.17.7 Land capability class (LCC)

Five land capability classes viz. III, IV, VI, VII and VIII and six land capability sub-classes have been identified (Table 4.120) in the watershed and mapped (Fig. 4.137).

Table 4.120 Land capability of Manpur Khola watershed

Map unit	Description	Soil Map units	Area	% of watershed
			(In ha)	
1	IIIe2	1,15	11887.7	14.6
2	IVe2	10	148.6	1.8
3	VIe2	8,26,34,11	2850.7	35.1
4	VIe2s	28,30,12	1729.3	21.3

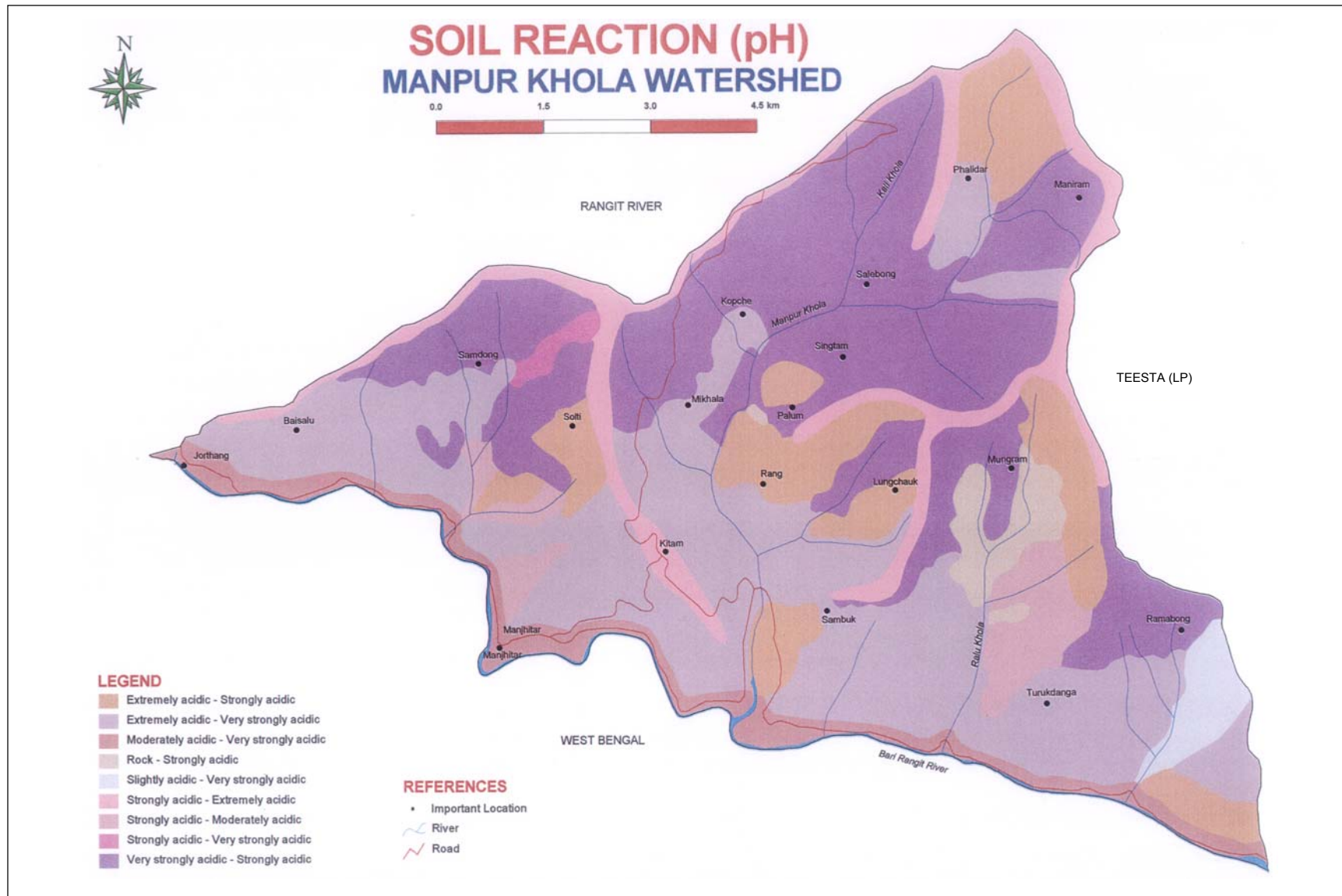


Fig. 4.136 Soil reaction class of Manpur Khola watershed

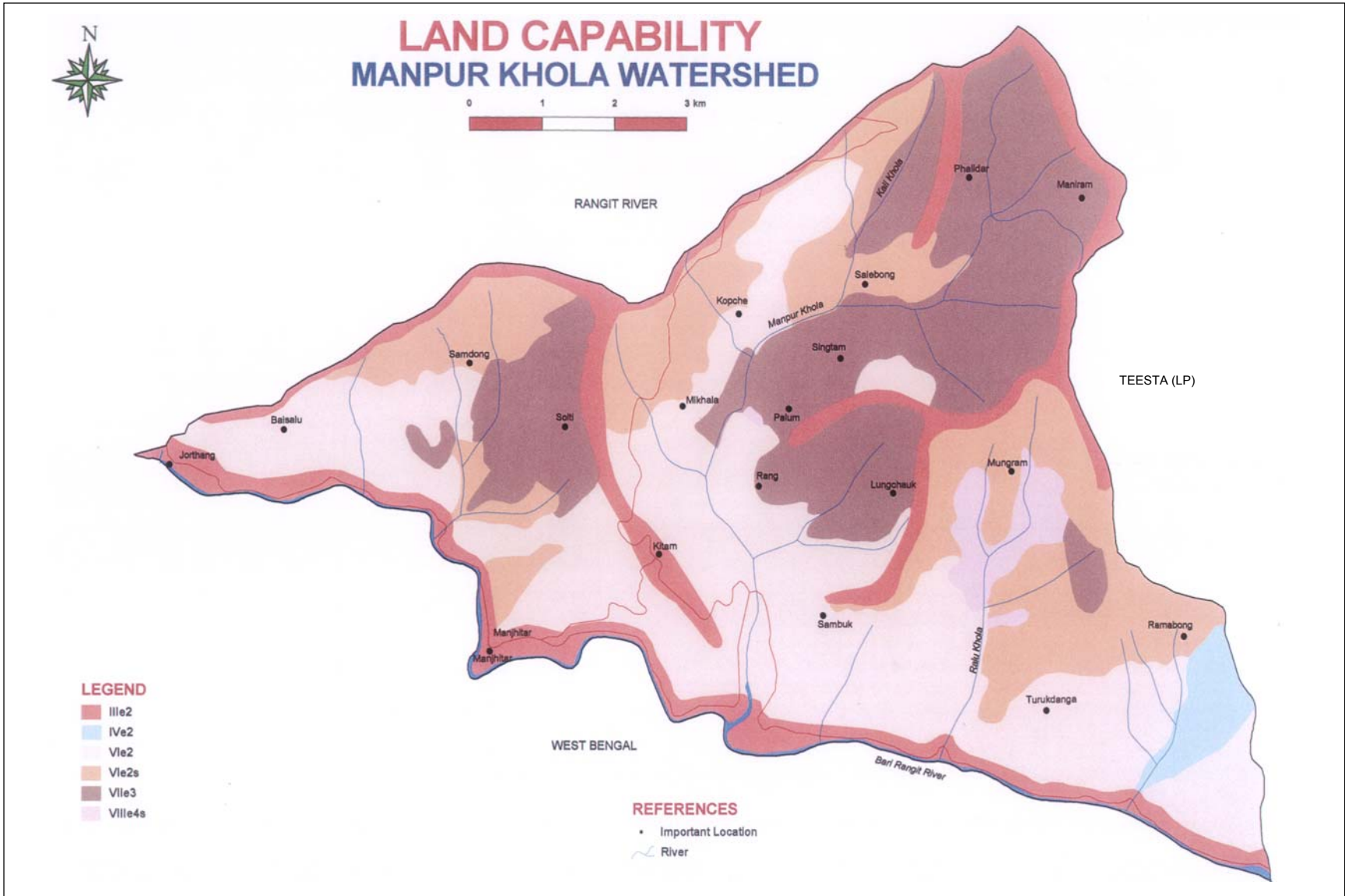


Fig. 4.137 Land capability class of Manpur Khola watershed

5	VIIe3	4,5,6,20,16,18	2000.3	24.7
6	VIIIe4s	3	196.1	2.4
		Miscellaneous	1.1	0.1

The land capability sub-class IIIe2 (mapping unit 1) occupies largest area of 11,887.7 ha (14.6%) while land capability sub-class IVe2 (mapping unit 2) occupies least area of 148.6 ha (1.8%). The rocky cliff representing the land capability sub-class VIIIe4s is the real problematic zone which is very susceptible to landslide or mass movement.

4.17.8 Soil-site suitability for rice

In Manpur Khola watershed, soils were evaluated for soil-site suitability for rice and the result revealed that 468.4 ha area has been found to be moderately to marginally suitable (S2-S3) for rice cultivation, marginally to moderately suitable (S3-S2) in 2,405.3 ha and only marginally suitable (S3) in 3,816.0 ha (Table 4.121 and Fig. 4.138). About 239.5 ha area under rocky cliff and landslide zone (mapping unit 3 & 6) were found to be unsuitable due to steep slope, shallow soil depth and gravelly soils.

Table 4.120 Soil-site suitability for rice of Manpur Khola watershed

Sl.No.	Suitability class	Map unit nos.	Area (ha)
1.	S2-S3	12,30	468.4
2.	S3-S2	11	2405.3
3.	S3	1,8,10,15,18,28	3816.0

4.	S3-N	20,26	792.3
5.	N-S3	4,5,16,34	392.4
6.	N	3,6	239.5
	Miscellaneous		1.1
		Total	8115.0

4.17.9 Soil-site suitability for maize

Maize is found to be moderately suitable (S2) alone in 3,407.6 ha in the Manpur Khola watershed and moderately to marginally suitable (S2-S3) in 1,332.3 ha, marginally to moderately suitable (S3-S2) in 2,942.9 ha area. It is only marginally suitable in 191.6 ha area of escarpments and unsuitable in 239.5 ha area representing rocky cliff and landslide zone (Table 4.122 and Fig. 4.139).

Table 4.122 Soil-site suitability for maize of Manpur Khola watershed

Sl.No.	Suitability class	Map unit nos.	Area (ha)
1.	S2	1,12,18,28,30,34	3407.6
2.	S2-S3	15,20,26	1332.3
3.	S3-S2	8,10,11,16	2942.9
4.	S3	4,5	191.6
5.	N	3,6	239.5
	Miscellaneous		1.1
		Total	8115.0

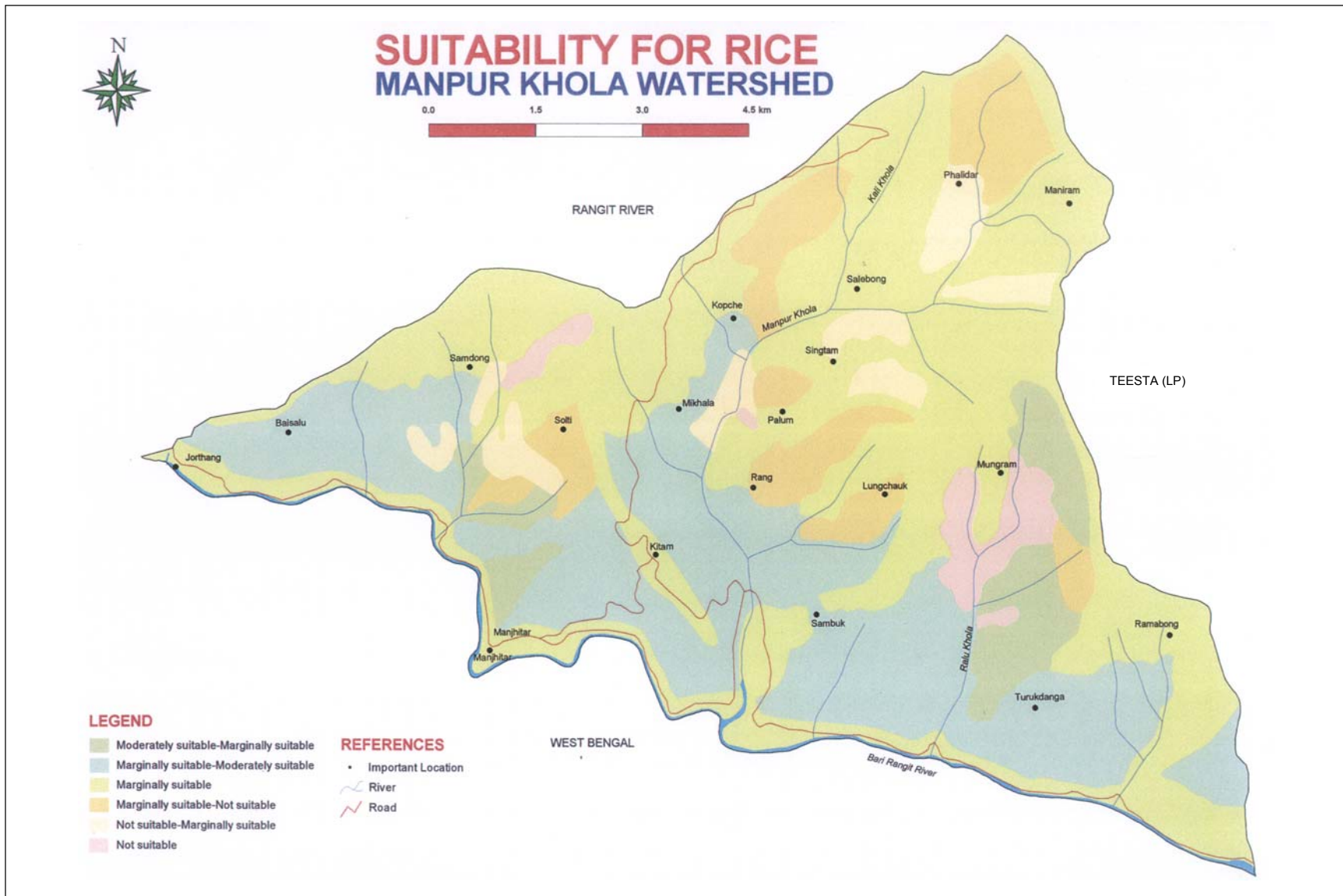


Fig. 4.138 Soil-site suitability for rice in Manpur Khola watershed

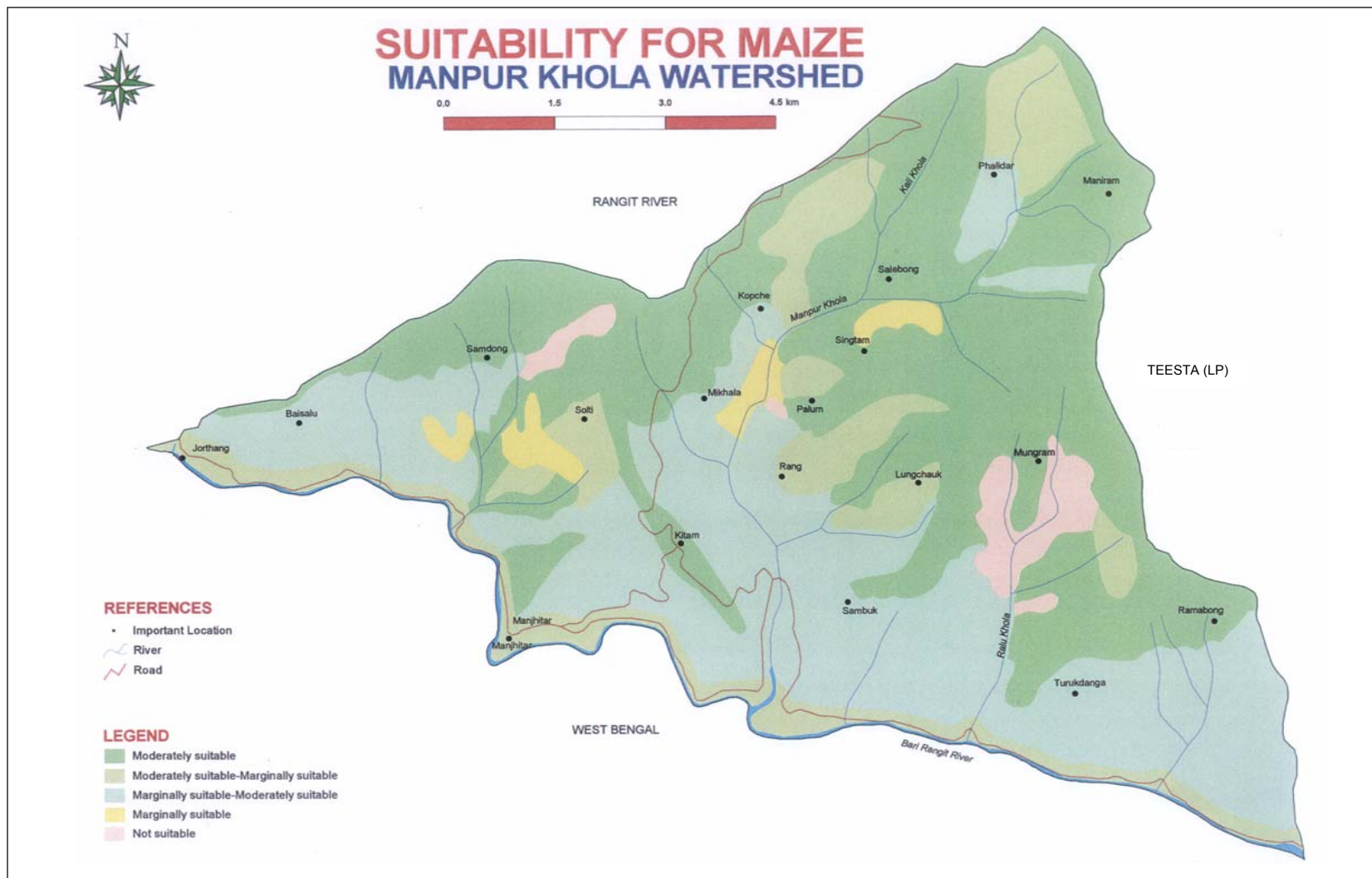


Fig. 4.139 Soil-site suitability for maize in Manpur Khola watershed

ANNEXURE



1. LEGSHIP SERIES

Legship series is a member of coarse-loamy, mixed, thermic family of Typic Udorthents. Typically, Legship soils have dark brown to yellowish brown, strongly acidic, sandy loam to loamy sand A horizon.

Typifying Pedon : Legship – sandy loam- forest

Horizon	Depth (cm)	Description
A11	0-13	Dark Brown (7.5 YR 3/4) sandy loam; weak medium subangular blocky structure, friable, slightly sticky and slightly plastic; few coarse pores; common very fine roots; strongly acidic, pH 5.4; gradual smooth boundary
A12	13-35	Dark brown (10 YR 4/3) sandy loam; weak medium subangular blocky structure, friable, slightly sticky and slightly plastic; many very fine roots; pH 4.9; gradual smooth boundary
A13	35-55	Dark Yellowish brown (10 YR 3/4) sandy loam; weak medium subangular blocky structure, friable, slightly sticky and slightly

		plastic; many very fine to fine roots; pH 4.9; gradual smooth boundary
A14	55-95	Dark Yellowish brown (10 YR 3/6) sandy loam; weak medium subangular blocky structure, friable, slightly sticky and slightly plastic; few very fine to fine roots; pH 5.2; gradual smooth boundary
AC	95-125	Yellowish brown (10 YR 5/4) loamy sand; friable, non sticky and non plastic; very few very fine roots; pH 5.2;

Type location: Latitude 27°17'4"N and Longitude 88°17'05"E (78A/8)
Vill. Legship, Tehsil Gayalzing, Distt. West Sikkim, State Sikkim

Ranges in characteristics: The thickness of the solum ranges from 120 to 130 cm. The thickness of A horizon ranges from 120-130 cm. Its colour is in hue 7.5YR to 10YR and value 3 to 5, chroma 3 to 6. Its texture varies from sandy loam to loamy sand.

Geographically associated soils: Legship Soils are associated with the Chongrang and Bhasme Soils which are coarse loamy mixed thermic, Entic Hapludolls and coarse loamy, mixed, thermic Typic Udorthents

Drainage and Permeability: Excessively drained with rapid permeability

Land Use and Vegetation: Mainly under thin forest. Vegetation includes utis, panisaj, champ, ber etc.

Distribution and extent: The Legship soils are extensively distributed in the soil map unit no. 8 and 22 of West Sikkim (1,181.1 ha) East Sikkim (421.8 ha) and South Sikkim (1068.2 ha) districts of the Sikkim State.

Interpretation: Legship soils are coarser in texture developed on steep slope with severe erosion. Major problems of the soils are steep slope, severe erosion, coarser texture etc. These soils are mostly under thin forest.

Interpretative groupings

Land capability sub-class : Vlle3s
 Productivity rating : Average (III)
 (Forest)

Soil-site suitability

Crops	Soil Site Suitability Class	Farmer's yield	Improved Yield
		-----yield t/ha-----	
Rice	S3	0.65	1.50
Maize	S3	1.20	2.00

ANALYTICAL DATA

Horizon	Depth (cm)	Size Class and particle diameter (mm)			Textural Class	Coarse fragments > 2 mm (%)
		Sand	Silt	Clay		
		(2-0.05)	(0.05– 0.002)	(<0.002)		
A11	0-13	66.3	24.4	9.3	sl	5
A12	13-35	66.7	24.0	9.3	sl	8
A13	35-55	69.9	20.8	9.3	sl	15
A14	55-95	76.1	14.6	9.3	sl	25
AC	95-125	81.5	9.2	9.3	ls	-

Depth (cm)	pH (1:2.5) H ₂ O	Organic carbon %	Extractable bases					CEC	Base Saturation %
			Ca	Mg	Na	K	SUM		
			<-----cmol (p+) kg ⁻¹ ----->						
0-13	5.4	2.66	4.0	1.0	0.2	0.1	5.3	8.0	66
13-35	4.9	2.15	3.1	0.8	0.2	0.2	4.3	6.9	62
35-55	4.9	1.37	2.3	0.6	0.1	0.1	3.1	4.8	65
55-95	5.2	0.98	1.4	0.5	0.1	0.1	2.1	3.2	66
95-125	5.2	0.58	1.1	0.4	0.1	0.1	1.7	2.6	65

2. LINGTSE SERIES

Lingtse series is a member of coarse-loamy, mixed, thermic family of Typic Udorthents. Lingtse soils have very dark yellowish brown to dark brown, moderately acidic, loam A horizon, underlined by weathered parent materials.

Typifying Pedon: Lingtse –loam- cultivated

Horizon	Depth (cm)	Description
Ap	0-18	Dark Yellowish Brown (10 YR 3/4) loam; moderate medium subangular blocky structure, friable, slightly sticky and slightly plastic; many coarse pores; common fine roots; pH 5.8; abrupt wavy boundary
AC	18-65	Dark brown (10 YR 4/3) loam; moderate medium subangular blocky structure, friable, slightly sticky and slightly plastic; pH 5.6;
Cr	65+	Weathered rock parent materials

Type location: Latitude 27°16'48"N and Longitude 88°36'35"E (78A/8) Vill. Lingtse, Tehsil Singtam, Distt. East Sikkim, State Sikkim

Ranges in characteristics: The thickness of the solum ranges from 60 to 70 cm. The thickness of A horizon ranges from 65 to 70 cm. Its colour is in hue 10 YR, value 3 to 4 and chroma 3 to 4. Its texture is loam.

Geographical setting: Lingtse soils occur on steeply sloping hills slope of the Himalayan Mountain at an elevation of 1500 m above MSL. The climate is temperate with mean annual temperature 11.4° to 19.9° C and mean annual rainfall of 3500 mm.

Geographically associated soils: Lingtse Soils are associated with the Chautare and Chalumthang soils which are coarse-loamy, mixed, thermic, Typic Udorthents and coarse-loamy, mixed, thermic, Typic Hapludalfs.

Drainage and Permeability: Well drained and moderate permeability.

Land Use and Vegetation: Mainly under cultivation with Rice, Maize etc. vegetation includes chilaune, utis etc.

Distribution and extent: The Lingtse soils are extensively distributed in the soil map unit 12, East Sikkim (249.5 ha) and South Sikkim (209.2ha) districts of the Sikkim State.

Interpretation: Lingtse soils are coarse in texture underlain by weathered parent materials. The major problems of these soils are steep slope, moderate erosion, soil depth etc. These soils are used for terraced cultivation of rice and maize.

Interpretative groupings

Land capability sub-class	:	VIIe3s
Productivity rating	:	Average (III)
(Forest)		

Soil-site suitability

Crops	Soil Site Suitability Class	Farmer's yield	Improved Yield
		-----yield t/ha-----	
Rice	S3	0.85	1.50
Maize	S2	1.35	2.00

ANALYTICAL DATA

Horizon	Depth (cm)	Size Class and particle diameter (mm)			Textural Class	Coarse fragments > 2 mm (%)
		Sand (2-0.05)	Silt (0.05- 0.002)	Clay (<0.002)		
Ap	0-18	49.7	36.9	13.4	I	10
AC	18-65	47.6	41.6	10.8	I	15

Depth (cm)	pH (1:2.5) H ₂ O	Organic carbon %	Extractable bases					CEC	Base Saturation %
			Ca	Mg	Na	K	SUM		
<-----cmol (p+) kg ⁻¹ ----->									
0-18	5.8	3.42	5.0	1.0	0.2	0.2	6.4	12.1	53
18-65	5.6	2.70	2.7	0.4	0.1	0.1	3.3	8.5	39

3. SINGGYANG SERIES

Singgyang series is a member of coarse loamy, mixed, thermic family of Typic Udorthents. Singgyang soils have dark brown, very strongly acidic, loam to sandy loam A horizon.

Typifying Pedon: Singgyang – sandy loam- forest

Horizon	Depth (cm)	Description
A11	0-15	Dark Brown (10 YR 4/3) oam; weak medium subangular blocky structure; friable, lightly sticky and slightly plastic; common coarse pores; many very fine roots; pH 4.7; gradual smooth boundary
A12	15-45	Dark brown (10 YR 3/3) sandy loam; weak medium subangular blocky structure; friable, slightly sticky and slightly plastic; common very fine roots; pH 5.0; gradual smooth boundary.
A13	45-75	Dark brown (10 YR 3/4) sandy loam; weak medium subangular blocky structure, friable, slightly sticky and slightly plastic; few very fine roots; pH 4.9; gradual smooth boundary.
A14	75-120	Dark brown (10 YR 3/4) sandy loam; weak medium subangular blocky structure;, friable, slightly sticky and slightly plastic; few very fine roots; pH 4.9;

Type location: Latitude 27°18'37" N and Longitude 88°13'18"E (78A/3)
Vill. Singgyang, Tehsil Tikjuk, Distt. West Sikkim, State Sikkim

Ranges in characteristics: The thickness of the solum ranges from 120 to 130 cm. The thickness of A horizon ranges from 120 to 130 cm. Its colour is in hue 10 YR, value 3 to 4 and Chroma 3 to 4. Its texture ranges from loam to sandy loam.

Geographical Setting: Singgyang soils occur on very steeply sloping hill slope of the Himalayan Mountain at an elevation of 2000 m above MSL. The climate is temperate with mean annual temperature 12.9° to 22.8° C and mean annual rainfall of 2723 mm

Geographically associated soils: Singgyang Soils are associated with the Maniram and Damthang Soils which are loamy- skeletal, mixed, thermic, Pachic Hapludolls and fine loamy, mixed, thermic, Humic Hapludalfs.

Drainage and Permeability: Excessively drained and very rapid permeability.

Land Use and Vegetation: Mainly under mixed forest. Vegetation includes banmara, champ, chilaune, bamboo etc.

Distribution and extent: The Singgyang soils are extensively distributed in the soil map unit no. 22, 34 and 44 of West Sikkim (3795.1 ha) East Sikkim (2375.4 ha) and South Sikkim (2751.2.ha) districts of the Sikkim State.

Interpretation: Singgyang soils are coarser in texture and are very susceptible to soil erosion. The major problems of these soils are steep slope, severe erosion, high soil acidity etc. These soils are used for terraced cultivation of rice and maize in patches.

Interpretative groupings

Land capability sub-class : VI e2
 Productivity rating : Average (III)
 (Forest)

Soil-site suitability

Crops	Suitability class	Farmer's yield	Improved Yield
		-----yield t/ha-----	
Rice	S3	0.90	1.50
Maize	S2	1.25	2.00

ANALYTICAL DATA

Horizon	Depth (cm)	Size Class and particle diameter (mm)			Textural Class	Coarse fragments > 2 mm (%)
		Sand (2-0.05)	Silt (0.05-0.002)	Clay (<0.002)		
A11	0-15	51.2	36.2	12.6	L	10
A12	15-45	67.1	29.6	3.3	sl	5
A13	45-75	61.8	34.9	3.3	sl	8
A14	75-120	67.4	28.3	4.3	sl	10

Depth (cm)	PH (1:2.5) H ₂ O	Organic carbon %	Extractable bases					CEC	Base Saturation %
			Ca	Mg	Na	K	SUM		
0-15	4.7	3.43	4.8	0.8	0.5	0.4	6.5	13.7	47

15-45	5.0	2.80	5.3	0.7	0.4	0.2	6.6	13.8	48
45-75	4.7	3.12	5.0	0.6	0.4	0.2	6.2	13.2	47
75-120	4.9	3.35	5.2	0.5	0.5	0.2	6.4	13.2	48

4. KHEDI SERIES

Khedi series is a member of coarse-loamy, mixed, thermic family of Typic Hapludults. Typically, Khedi soils have very dark greyish brown, strongly acidic, sandy loam. A horizon and very dark grey to dark brown, very strongly acidic to strongly acidic, sandy loam to loam B horizons underlain by weathered parent material.

Typifying Pedon: Khedi – sandy loam- cultivated

Horizon	Depth (cm)	Description
Ap	0-9	Very dark greyish brown (10 YR 3/2) sandy loam; weak medium subangular blocky structure; friable, non sticky and non plastic; many coarse pores; common fine roots; pH 5.1; clear smooth boundary
Bt1	9-63	Very dark grey (10 YR 3/1) sandy loam; moderate medium subangular blocky structure; friable, slightly sticky and slightly plastic; thin & patchy cutans; few fine roots; pH 4.6; gradual smooth boundary

Bt2	63-90	Dark brown (10 YR 3/3) loam; moderate medium subangular blocky structure; friable, slightly sticky and slightly plastic, thin patchy cutans; few fine roots; pH 5.2;
Cr	90+	Weathered Rocks

Type location: Latitude 27°18'44" N and Longitude 88°42'25"E (78A/11) Vill. Khedi, Tehsil Bhusuk, Distt. East Sikkim, State Sikkim.

Ranges in characteristics: The thickness of the solum ranges from 90 to 100 cm. The thickness of A horizon ranges from 9 to 15 cm. Its colour is in hue 10 YR, value 3 and chroma 2. Its texture is sandy loam. The thickness of B horizon ranges from 85 to 90 cm. Its colour is in hue 10 YR, value 3, chroma 1 to 3. Its texture ranges from sandy loam to loam.

Geographical Setting: Khedi soils occur on steeply sloping hilly slope of the Himalayan Mountain at an elevation of 2850 m above MSL. The climate is temperate with means annual temperature 11.4°C to 19.9°C and mean annual rainfall of 3500 mm.

Geographically associated soils: Khedi soils are associated with the Maniram and Rongnek soils which are loamy- skeletal, mixed, thermic, Pachic Hapludolls and coarse- loamy, mixed, thermic, Typic Udorthents.

Drainage and Permeability: Well drained with rapid permeability.

Land Use and Vegetation: Mainly under cultivation of Rice and maize. Vegetation includes chilaune, utis, ber etc.

Distribution and extent: The Khedi soils are extensively distributed in the soil map unit Nos. 18, 24 and 56 of West Sikkim (5533.9 ha) East Sikkim (2386.8 ha) and South Sikkim (1718.9 ha) districts of the Sikkim State.

Interpretation: Khedi Soils are coarser in texture that is underlined by weathered parent material. Major problems of the soils are steep slope, moderate erosion, coarse texture etc. These soils are susceptible to mass movement/landslide. These soils are mostly under Rice cultivation alongwith the thin forest.

Interpretative groupings

Land capability sub-class : VI e2s
 Productivity rating : Poor(IV)
 (Forest)

Soil-site suitability

Crops	Soil Site suitability Class	Farmer's yield	Improved Yield
		-----yield t/ha-----	
Rice	S3	1.00	1.50
Maize	S2	1.35	2.00

ANALYTICAL DATA

Horizon	Depth (cm)	Size Class and particle diameter (mm)			Textural Class	Coarse fragments > 2 mm (%)
		Sand (2-0.05)	Silt (0.05– 0.002)	Clay (<0.002)		
Ap	0-9	65.1	23.9	11.0	sl	8
Bt1	9-63	52.6	30.1	17.3	sl	10
Bt2	63-90	41.6	36.5	21.9	l	15

Depth (cm)	PH (1:2.5) H ₂ O	Organic carbon %	Extractable bases					CEC	Base Saturation %
			Ca	Mg	Na	K	SUM		
			←-----cmol (p+) kg ⁻¹ -----→						
0-9	5.1	2.92	2.0	0.9	0.3	0.2	3.4	11.4	30
9-63	4.6	2.57	1.6	0.3	0.3	0.2	2.4	11.2	21
63-90	5.2	2.41	1.6	0.5	0.2	0.2	2.5	12.0	21

5. TUMIN SERIES

Tumin series is a member of fine loamy, mixed, thermic family of Humic Hapludalfs. Tumin soils have very dark grey, extremely acidic, silt loam. A horizon and very dark grayish brown, very strongly acidic, silt loam B horizon.

Typifying Pedon : Tumin – silt loam- forest

Horizon	Depth (cm)	Description
A	0-19	Very dark grey (10 YR 3/1) silt loam; moderate medium subangular blocky

		structure; friable, slightly sticky and plastic; few fine pores; many coarse roots; pH 4.3; gradual smooth boundary.
Bt1	19-45	Very dark greyish brown (10 YR 3/1) silt loam; moderate medium subangular blocky structure; friable, slightly sticky and plastic; thin & patchy cutan; many coarse roots; pH 4.7; gradual smooth boundary
Bt2	45-66	Very dark greyish brown (10 YR 3/2) silt loam; moderate medium subangular blocky structure; friable, slightly sticky and plastic; fine patchy cutan; common coarse roots; pH 4.6

Type location: Latitude 27°19'25" N and Longitude 88°31'07"E (78A/12) Vill. Tumin, Tehsil Pakyong, Dist. East Sikkim, State Sikkim.

Ranges in characteristics: The thickness of the solum ranges from 65 to 75 cm. The thickness of A horizon ranges from 15 to 20 cm. Its colour is in hue 10 YR, value 3 and chroma 1. Its texture is silt loam. The thickness of B horizon ranges from 60 to 65 cm. Its colour is in hue 10 YR value 3 and chroma 1 to 2. Its texture is silt loam.

Geographical Setting: Tumin soils occur on very steeply sloping hill of the Himalayan Mountain at an elevation of 1940 m above MSL. The climate is temperate with mean annual temperature 11.4° to 19.9° C and mean annual rainfall of 3493 mm.

Geographically associated soils: Tumin Soils are associated with the Phong and Chautare Soils which are fine- loamy, mixed, thermic, Typic Dystrudepts and coarse- loamy, mixed, thermic Typic Hapludalfs.

Drainage and Permeability: Well drained and moderate permeability.

Land Use and Vegetation: Mainly under dense forest of pine, chilaune etc.

Distribution and extent: The Tumin soils are extensively distributed in the soil map unit No. 16, and 20 of West Sikkim (2477.3 ha), East Sikkim (663.9 ha) and South Sikkim (1143.7.ha) districts of the Sikkim State.

Interpretation: Tumin soils are fine loamy in texture developed on very steep slope of the Himalayan Mountain. The major problems of these soils are very steep slope, moderate soil erosion, high soil acidity etc. These soils are mostly under forest and are not suitable for cultivation

Interpretative groupings

Land capability sub-class : VI e2
 Productivity rating : Good (II)
 (Forest)

ANALYTICAL DATA

Horizon	Depth (cm)	Size Class and particle diameter (mm)			Textural Class	Coarse fragments > 2 mm (%)
		Sand (2-0.05)	Silt (0.05– 0.002)	Clay (<0.002)		
A	0-19	37.7	52.9	9.4	Sil	8
Bt1	19-45	33.9	50.6	15.5	Sil	15
Bt2	45-66	32.8	50.6	16.6	Sil	25

Depth (cm)	pH (1:2.5) H ₂ O	Organic carbon %	Extractable bases					CEC	Base Saturation %
			Ca	Mg	Na	K	SUM		
			<----- cmol (p+) kg ⁻¹ ----->						
0-19	4.3	3.66	5.3	1.0	0.6	0.2	7.1	13.2	54
19-45	4.7	3.43	3.7	0.9	0.4	0.2	5.2	13.0	40
45-66	4.6	3.51	3.8	0.9	0.4	0.1	5.2	13.5	39

6. PIRIK SERIES

Pirik series is a member of coarse-loamy, mixed, thermic family of Humic Dystrudets. Typically, Pirik soils have dark brown, very strongly acidic, silt loam. A horizon and dark yellowish brown to dark brown, very strongly acidic to strongly acidic silt loam B horizon.

Typifying Pedon : Pirik – silt loam- cultivated

Horizon	Depth (cm)	Description
Ap	0-20	Dark Brown (7.5 YR 4/3) silt loam; moderate medium subangular blocky structure; friable, slightly sticky and slightly plastic; common fine pores; few fine roots; pH 4.8; gradual smooth boundary
Bw1	20-35	Dark yellowish brown (10 YR 3/4) silt loam; moderate medium subangular blocky structure; friable, sticky and plastic; few fine roots; pH 5.0; clear smooth boundary
Bw2	35-75	Dark Yellowish brown (10 YR 3/4) silt loam; moderate medium subangular blocky structure; friable, slightly sticky and slightly plastic; few fine roots; pH 5.0; clear smooth boundary
Bw3	75-106	Dark brown (10 YR 3/3) silt loam; moderate medium subangular blocky structure; friable, slightly sticky and slightly plastic; few very fine roots; pH 4.8; clear smooth boundary
Bw4	106-150	Dark brown (10 YR 3/3) silt loam; moderate medium subangular blocky structure; friable, slightly sticky and slightly plastic; very few very fine roots; pH 5.2;

Type location: Latitude 27°17'39" N and Longitude 88°38'45"E (78A/8)
Vill. Pirik, Tehsil Pakyong, Distt. East Sikkim, State Sikkim.

Ranges in characteristics: The thickness of the solum ranges from 150 to 160 cm. The thickness of the A horizon ranges from 15 to 20 cm. Its colour is in hue 10YR and value 4, chroma 3. Its texture is silt loam. The thickness of the B horizon is 135 to 140 cm. Its colour is in hue 10 YR, value 3 and chroma 3 to 4. Its texture is silt loam.

Geographical Setting: Pirik soils occur on steeply sloping hill of the Himalayan Mountain at an elevation of 1450 m above MSL. The climate is temperate with mean annual temperature 11.4 to 19.9° C and mean annual rainfall of 3492mm.

Geographically associated soils: Pirik Soils are associated with the Mangjing and Rumtek Soils which are coarse- loamy, mixed, thermic Typic Endoaquepts and fine- loamy, mixed, thermic Humic Hapludults.

Drainage and Permeability: Well drained with rapid permeability.

Land Use and Vegetation: Mainly under forest alongwith terraced cultivation of Rice, maize, etc. Vegetation includes chilaune, utis etc.

Distribution and extent: The Pirik soils are extensively distributed in the soil map unit no. 32, 38 of West Sikkim (796.0 ha), East Sikkim (2175.6 ha) and South Sikkim (2743.2 ha) districts of the Sikkim State.

Interpretation: Pirik Soil are coarse loamy in texture, developed on steeply sloping hills with moderate erosion. The major problems of the

soils are steep slope, high soil erosion, high soil acidity and low base status. The soils may be used for terraced cultivation of rice, maize etc.

Interpretative groupings

Land capability sub-class : IV e2
 Productivity rating : Good (II)
 (Forest)

Soil-site suitability

Crops	Soil Site suitability	Farmer's yield	Improved Yield
	Class	-----yield t/ha-----	
Rice	S3	0.85	1.50
Maize	S2	1.20	2.00

ANALYTICAL DATA

Horizon	Depth (cm)	Size Class and particle diameter (mm)			Textural Class	Coarse fragments > 2 mm (%)
		Sand (2-0.05)	Silt (0.05– 0.002)	Clay (<0.002)		
Ap	0-20	24.9	57.2	17.9	sil	5
Bw1	20-35	23.5	59.9	16.9	sil	8
Bw2	35-75	26.1	56.4	17.5	sil	8
Bw3	75-106	31.3	55.0	13.7	sil	10
Bw4	106-150	26.3	58.5	15.2	sil	10

Depth (cm)	pH (1:2.5) H ₂ O	Organic carbon %	Extractable bases					CEC	Base Saturation %
			Ca	Mg	Na	K	SUM		
			←-----cmol (p+) kg ⁻¹ -----→						
0-20	4.8	3.52	1.6	0.6	0.2	0.2	2.6	10.4	25
20-35	5.0	3.29	1.3	0.5	0.2	0.2	2.2	9.7	23
35-75	5.0	2.74	1.1	0.5	0.2	0.1	1.9	9.2	21
75-106	4.8	2.66	1.5	0.7	0.3	0.2	2.7	8.8	31
106-150	5.2	2.82	3.0	1.0	0.3	0.3	4.6	10.0	46

7. CHAKUNG SERIES

Chakung series is a member of fine - loamy, mixed, thermic family of Humic Hapludalfs. Typically, Chakung soils have brown, very strongly acidic, silt loam. A horizon and dark yellowish brown to dark brown, very strongly acidic, silt loam to silty clay loam B horizon.

Typifying pedon: Chakung – silt loam - cultivated

Horizon	Depth (cm)	Description
Ap	0-13	Brown (10 YR 4/3) silt loam; moderate medium subangular blocky structure; very friable, slightly sticky and slightly plastic; medium common medium pores; common very fine roots; pH 4.6; gradual smooth boundary
Bt1	13-37	Dark yellowish brown (10 YR 4/4) silt loam; moderate medium subangular blocky structure;

friable, slightly sticky and slightly plastic; thin and patchy cutan; many very fine roots; pH 4.6; gradual smooth boundary.

Bt2 37-66 Dark yellowish brown (10 YR 4/4) silt loam; moderate medium subangular blocky structure; friable, slightly sticky and slightly plastic; thin and patchy cutan, few very fine roots; pH 4.6; gradual smooth boundary.

Bt3 66-90 Dark brown (7.5YR 4/4) silty clay loam; moderate medium subangular blocky structure; friable, slightly sticky and slightly plastic; thin and patchy cutan, very few very fine roots; pH 4.7; clear smooth boundary.

Bt4 90-120+ Dark brown (7.5YR 4/4) silty clay loam; moderate medium subangular blocky structure; friable, sticky and plastic; few medium roots; pH 4.9.

Type location: Latitude 27°13'45" N and Longitude 88°14'45"E (78A/4)
Village: Chakung; Tehsil – Soreng; Distt. West Sikkim,

Ranges in characteristics: The thickness of the solum ranges from 120-130 cm. The thickness of A horizon ranges from 10-15 cm. Its colour is in hue 10YR, value 4 and chroma 3. Texture is silt loam. The thickness of B horizon ranges from 110-115 cm. Its colour ranges from

10YR to 7.5YR, value 4 and chroma 4. Its textural class ranges from silt loam to silty clay loam.

Geographical Setting: Chakung soils occur on very steeply sloping hill of the Himalayan Mountain at an elevation of 1400m above MSL. The climate is temperate with mean annual temperature 12.9 to 23.8° C and mean annual rainfall of 2793 mm.

Geographically associated soils Chakung soils are associated with the Sajong and Tumin soils which are coarse- loamy, mixed, thermic Humic Dystrudepts and fine- loamy, mixed, thermic, Humic Hapludalfs.

Drainage and Permeability: Excessively drained with rapid permeability.

Land Use and Vegetation: Cultivation of maize, Rice, etc. Vegetation includes dhupi, abmuiso, fern etc.

Distribution and extent: The Chakung soils are extensively distributed in the soil map unit no. 20 of West Sikkim (1729.3 ha), East Sikkim (510.7 ha) and South Sikkim (1521.8 ha) districts of the Sikkim State.

Interpretation: Chakung soils are fine loamy in texture that have been developed from granite gneiss parent material. The soils are mostly reddish brown to dark brown in colour and shows the evidence for the illuviation of clay in lower layers Major problems of the soils are very steep slope, soil erosion, soil acidity etc. These soils support the growth

of Dhupi plantation and forest. Terraced cultivation is also practiced in the areas giving rise to the cultivation of maize and Rice etc.

Interpretative groupings

Land capability sub-class : Vlle3
 Productivity rating : Excellent (I)
 (Forest)

Soil-site suitability

Crops	Soil Site suitability Class	Farmer's yield	Improved Yield
		-----yield t/ha-----	
Rice	S3	0.85	1.50
Maize	S2	1.20	2.00

ANALYTICAL DATA

Depth (cm)	Horizon	Sand	Silt	Clay	Texture	Coarse frag. vol. (%)
		(2.0-0.05 mm) (%)	(0.05-0.002mm) (%)	(<0.002 mm) (%)		
0-13	Ap	30.2	59.5	10.3	Sil	5
13-37	Bt1	20.4	63.3	16.3	Sil	8
37-66	Bt2	15.3	63.4	21.3	Sil	13
66-90	Bt3	7.9	61.8	30.3	Sicl	15
90-120+	Bt4	7.3	57.4	35.3	Sicl	18

Depth (cm)	pH 1:2.5 H ₂ O	Org. C. (%)	Exchangeable bases					CEC	Base saturation (%)
			Ca	Mg	Na	K	Sum		
			←----- cmol (p+) kg ⁻¹ ----->						
0-13	4.6	5.30	5.1	0.8	1.0	1.2	8.1	14.0	58
13-37	4.6	3.12	2.3	0.3	1.1	1.7	5.4	12.5	43

37-66	4.6	2.53	3.0	0.5	0.4	0.6	4.5	11.6	39
66-90	4.7	1.17	2.6	0.4	0.2	0.4	3.6	10.8	33
90-120+	4.9	1.05	2.9	0.6	0.3	0.4	4.2	12.8	33

8. CHAUTARE SERIES

Chautare series is a member of coarse-loamy, mixed, thermic family of Humic Hapludalfs. Typically, Chautare soils have very dark grayish brown, moderately acidic, sandy loam. A horizon and very dark greyish brown, strongly to moderately acidic, sandy loam B horizon.

Typifying pedon: Chautare – sandy loam - forest

Horizon	Depth (cm)	Description
A	0-13	Very dark greyish brown (10 YR 3/2) sandy loam; weak fine subangular blocky structure; loose, friable, slightly sticky and slightly plastic; medium many pores; common very fine roots; pH 5.4; gradual smooth boundary
Bt1	13-35	Very dark greyish brown (10 YR 3/2) sandy loam; weak fine subangular blocky structure; friable, slightly sticky and slightly plastic; thin

and patchy cutan, common very fine roots; pH 5.1; gradual smooth boundary.

Bt2 35-75 Dark greyish brown (10 YR 4/2) sandy loam; weak fine subangular blocky structure; friable, slightly sticky and slightly plastic; thin and patchy cutans, fine, common roots; pH 6.0; gradual smooth boundary.

Bt3 75-105 Dark grayish brown (10YR 4/2) sandy loam; weak fine subangular blocky structure; friable, slightly sticky and slightly plastic; few fine roots; pH 5.8;

Type location: Latitude 27°10'00" N and Longitude 88°18'45"E (78A/4)
Village : Chautare Tehsil – Jorethang; Distt. South Sikkim,

Ranges in characteristics: The thickness of the solum ranges from 100-110 cm. The thickness of A horizon ranges from 10-15 cm. Its colour is in hue 10YR, value 3 and chroma 2. Its texture is sandy loam. The thickness of B horizon ranges from 90-100 cm. It's colour is in hue 10YR, value 3 to 4 and chroma 2. Its texture is sandy loam.

Geographical Setting: Chautare soils occur on steeply sloping low Hill of the Himalayan mountain at an elevation of 700 m above MSL. The climate is temperate with mean annual temperature 13.5 to 21.0° C and mean annual rainfall of 2995 mm.

Geographically associated soils: Chautare soils are associated with the Lingtse and Phong Soils which are coarse- loamy, mixed, thermic, Typic Udorthents and fine- loamy, mixed, thermic, Typic Dystrudepts.

Drainage and Permeability: Somewhat excessively drained with rapid permeability.

Land Use and Vegetation: Mainly under mixed forest with Simul, Malway, Chilaune etc.

Distribution and extent: The Chautare soils are extensively distributed in the soil map unit no. 8, 12 and 16 of West Sikkim (1694.7 ha) East Sikkim (773.4 ha) and South Sikkim (1572.6 ha) districts of the Sikkim State.

Interpretation: Chautare soils are coarse textured. These soils are susceptible to erosion due to steep slope, coarse texture. Major problems are steep slope, coarse texture, soil erosion These soils are mostly under forest and agriculture is done in patches.

Interpretative groupings

Land capability sub-class	:	Vie2s
Productivity rating (Forest)	:	Average (III)

Soil-site suitability

Crops	Soil Site suitability	Farmer's yield	Improved Yield
	Class	-----yield t/ha-----	
Rice	S3	0.8	1.4
Maize	S2	1.10	2.0

ANALYTICAL DATA

Horizon	Depth (cm)	Size Class and particle diameter (mm)			Textural Class	Coarse fragments > 2 mm (%)
		Sand (2-0.05)	Silt (0.05– 0.002)	Clay (<0.002)		
Ap	0-13	55.8	29.7	14.5	sl	10
Bt1	13-35	54.2	29.3	16.5	sl	15
Bt2	35-75	56.8	24.7	18.5	sl	20
Bt3	75-105	56.1	24.4	19.5	sl	30

Depth (cm)	pH (1:2.5) H ₂ O	Organic carbon %	Extractable bases					CEC	Base Saturation %
			Ca	Mg	Na	K	SUM		
<-----mol (p+) kg ⁻¹ ----->									
0-13	5.4	2.19	6.4	1.8	0.2	0.2	8.6	13.0	66
13-35	5.1	2.26	6.7	2.0	0.3	0.2	9.2	14.4	64
35-75	6.0	1.39	4.2	1.7	0.3	0.1	6.3	7.8	81
75-105	5.8	0.95	4.0	1.6	0.3	0.1	6.0	7.2	83

9. NAMCHI SERIES

Namchi series is a member of fine- loamy, mixed, thermic family of Humic Eutrudepts. Typically, Namchi soils have dark brown, extremely

acidic, loam. A horizon and dark brown to dark yellowish brown, very strongly acidic to strongly acidic, loam B horizon

Typifying pedon: Namchi - loam - forest

Horizon	Depth (cm)	Description
A	0-13	Dark brown (10 YR 3/3) loam; moderate medium subangular blocky structure; friable, slightly sticky and slightly plastic; common very fine roots; pH 3.1; gradual smooth boundary.
Bw1	13-38	Dark brown (10 YR 3/3) loam; moderate medium subangular blocky structure; friable, slightly sticky and slightly plastic; fine, common very fine roots; pH 4.9; gradual smooth boundary.
Bw2	38-82	Dark greyish brown (10 YR 4/2) loam; moderate medium subangular blocky structure; friable, slightly sticky and slightly plastic; few very fine roots; pH 5.0; gradual smooth boundary.
Bw3	82-95	Dark yellowish brown (10YR 4/4) loam; moderate medium subangular blocky structure; friable, slightly sticky and slightly plastic; few very fine roots; pH 5.1; gradual smooth boundary.

Bw4 95-125 Dark yellowish brown (10YR 4/6) loam; moderate medium subangular blocky structure; friable, slightly sticky and slightly plastic; few very fine roots; pH 5.1;

Type location: Latitude 27°10'12" N and Longitude 88°14'45"E (78A/4)
Village: Namchi Tehsil – Namchi; Distt. South Sikkim,

Ranges in characteristics: The thickness of the solum ranges from 120-130 cm. The thickness of A horizon ranges from 10-15 cm. Its colour is in hue 10YR, value 3 and chroma 3. Its texture is loam. The thickness of B horizon is 110-120 cm. Its colour is in hue 10YR, value 3 to 4 and chroma 2 to 6. Its texture is loam.

Geographical Setting: Namchi soils occur on steeply sloping low hill of the Himalayan mountain at an elevation of 1400 m above MSL. The climate is temperate with mean annual temperature is 11.5 to 24.5° C and mean annual rainfall of 3500 mm.

Geographically associated soils: Namchi soils are associated with the Bhusuk and Singgyang soils which are loamy- skeletal, mixed, thermic, Humic Dystrudepts and coarse- loamy, mixed thermic, Typic Udorthents

Drainage and Permeability: Excessively drained and moderate permeability.

Land Use and Vegetation: Mainly under mixed forest with okhra, dhupi, katus, etc

Distribution and extent: The Namchi soils are extensively distributed in the soil map unit no. 32 & 34 of West Sikkim (2621.3 ha), East Sikkim (3123.8 ha) and South Sikkim (3123.8 ha) districts of the Sikkim State.

Interpretation: Namchi soils are fine-loamy in texture. These soils are susceptible to erosion due to steep slope. Major limitations of these soils are steep slope, gravelly substratum, soil erosion. These soils are mostly under forest and terraced cultivation may be done for agriculture.

Interpretative groupings

Land capability sub-class : Vie2s
 Productivity rating : Good (II)
 (Forest)

Soil-site suitability

Crops	Soil Site suitability Class	Farmer's yield	Improved Yield
		-----yield t/ha-----	
Maize	S2	1.10	2.0

ANALYTICAL DATA

Horizon	Depth (cm)	Size Class and particle diameter (mm)			Textural Class	Coarse fragments > 2 mm (%)
		Sand (2-0.05)	Silt (0.05– 0.002)	Clay (<0.002)		
A	0-13	37.2	43.3	19.5	I	8
Bw1	13-38	36.0	43.5	20.5	I	10

Bw2	38-62	36.1	46.2	18.7		15
Bw3	62-95	34.2	43.1	22.7		30
Bw4	95-125	37.7	38.6	23.7		40

Depth (cm)	pH (1:2.5) H ₂ O	Organic carbon %	Extractable bases					CEC	Base Saturation %
			Ca	Mg	Na	K	SUM		
			<-----cmol (p+) kg ⁻¹ ----->						
0-13	5.1	2.70	8.4	1.2	0.4	0.3	10.3	15.3	67
13-38	4.9	2.50	7.7	0.9	0.4	0.2	9.2	13.6	67
38-62	5.0	2.58	6.4	0.6	0.3	0.1	7.4	12.4	60
62-95	5.1	1.79	6.4	0.6	0.3	0.2	7.5	12.3	61
95-125	5.1	1.39	6.5	0.5	0.3	0.2	7.4	12.3	60

10. TARNU SERIES

Tarnu series is a member of course- loamy, mixed, thermic family of Typic Udorthents. Typically, Tarnu soils have very dark grayish brown to dark brown, moderately acidic, loam A horizon.

Typifying pedon: Tarnu - sandy loam - forest

Horizon	Depth (cm)	Description
A11	0-15	Very dark grayish brown (10YR 3/2) sandy loam; weak fine subangular blocky structure; loose, friable, slightly sticky and slightly plastic; common fine roots; pH 5.9; gradual smooth boundary.

A12	15-45	Very dark grayish brown (10YR 3/2) sandy loam; weak fine subangular blocky structure; friable, slightly sticky and slightly plastic; common fine roots; pH 5.6; gradual smooth boundary.
A13	45-75	Dark brown (10 YR 3/3) sandy loam; weak fine subangular blocky structure; friable, slightly sticky and slightly plastic; few fine roots; pH 5.6; gradual smooth boundary.
AC	75-100	Dark yellowish brown (10YR 3/4) sandy loam; weak fine subangular blocky structure; friable, slightly sticky and slightly plastic; very few very fine roots, pH 5.1;

Type location: Latitude 27°19'15" N and Longitude 88°15'18"E (78A/13) Village: Tarnu Tehsil – Rimbi; Distt. West Sikkim,

Ranges in characteristics: The thickness of the solum ranges from 90-110 cm. The thickness of A horizon ranges from 75-80cm. Its colour is in hue 10YR, value 3 and chroma 2. Its texture is sandy loam

Geographical Setting: Tarnu soils occur on steeply sloping low hill of the Himalayan mountain at an elevation of 1500 m above MSL. The climate is temperate with mean annual temperature 12.9 to 22.8° C and mean annual rainfall of 3500 mm.

Geographically associated soils: Tarnu soils are associated with the Martam and Sajong Soils which are Coarse- loamy, mixed, thermic, Lithic Udorthents and Coarse- loamy, mixed, thermic, Humic Dystrudepts.

Drainage and Permeability : Excessive with rapid permeability.

Land Use and Vegetation : Mainly under mixed forest of malata, sirish, chilaune.

Distribution and extent: The Tarnu soils are widely distributed in the soil map unit no. 48, 50, and 58 in West Sikkim (1767.7 ha), East Sikkim (911.9 ha) and South Sikkim (2532.1 ha) districts of the Sikkim State.

Interpretation: Tarnu soils are coarse textured. These soils are susceptible to erosion due to steep slope. Major problems of these soils are steep slope, coarser soil texture, soil erosion. These soils are mostly under forest. Terraced cultivation may be done in patches.

Interpretative groupings

Land capability sub-class : Vie2s
 Productivity rating : Average (III)
 (Forest)

Soil-site suitability

Crops	Soil Site suitability Class	Farmer's yield	Improved Yield
		----- yield t/ha-----	
Maize	S2	1.20	2.00

ANALYTICAL DATA

Horizon	Depth (cm)	Size Class and particle diameter (mm)			Textural Class	Coarse fragments > 2 mm (%)
		Sand (2-0.05)	Silt (0.05– 0.002)	Clay (<0.002)		
A11	0-15	63.1	27.9	9.0	sl	20
A12	15-45	69.9	26.2	3.9	sl	25
A13	45-75	67.2	25.5	7.3	sl	30
AC	75-110	68.5	26.6	4.9	sl	35

Depth (cm)	pH (1:2.5) H ₂ O	Organic carbon %	Extractable bases					CEC	Base Saturation %
			Ca	Mg	Na	K	SUM		
			<-----cmol (p+) kg ⁻¹ ----->						
0-15	5.9	4.7	7.7	1.6	0.5	0.6	10.4	16.0	65
15-45	5.6	3.9	6.4	1.4	0.6	0.6	9.0	14.6	62
45-75	5.6	2.3	5.2	1.0	0.5	0.4	7.1	11.2	63
75-110	5.1	1.6	2.9	0.7	0.5	0.3	4.4	7.4	59

11. CHALUMTHANG SERIES

Chalumthang series is a member of coarse-loamy, mixed, thermic, Typic Hapludalfs. Typically, Chalumthang soils have brown, slightly acidic, silt loam A horizon and dark grayish brown, moderately acidic, silt loam to loam B horizon underlined by weathered parent material.

Typifying pedon: Chalumthang - silt loam – cultivated

Horizon	Depth (cm)	Description
Ap	0-16	Brown (10YR 5/3) silt loam; weak fine subangular blocky structure; soft, very friable, non sticky and plastic; many fine pores; common very fine to fine roots; coarse few gravels and stones; pH 6.2; clear smooth boundary.
AB	16-30	Brown (10YR 5/3) silt loam; few fine distinct yellowish red (5YR 4/6) mottles; weak fine subangular blocky structure; very friable, non sticky and non plastic; fine, many pores; few very fine roots; few, coarse gravels and stones; pH 6.0; clear smooth boundary.
Bt1	30-52	Dark grayish brown (2.5 Y 4/2) silt loam; few fine distinct yellowish red (5YR 4/6) mottles; weak fine subangular blocky structure; very friable, non-sticky and non plastic; thin and patchy cutans, few very fine roots; few coarse gravels and stones; pH 6.0; clear smooth boundary.
Bt2	52-80	Very dark grayish brown (10 YR 3/2) loam; medium, moderate subangular blocky structure; friable, non-sticky and non plastic; thin and patchy cutans, many coarse gravels and stones; pH 5.9;
Cr	80+	Weathered parent rock

Type location: Latitude 27°13'15" N and Longitude 88°29'06"E (78A/8)

Village: Chalumthang, Tehsil – Namphing; Distt. South Sikkim,

Ranges in characteristics: The thickness of the solum ranges from 75-85 cm. The thickness of A horizon ranges from 0-20 cm. Its colour is in hue 10YR, value 5 and chroma 3. Its texture is sandy loam. The thickness of B horizon ranges from 65 to 70 cm. Its colour ranges from 2.5Y to 10YR, value 3 to 5 and chroma 2 to 3. Its textural class ranges from silt loam to loam.

Geographical Setting: Chalumthang soils occur on moderately steeply sloping low hill of the Himalayan mountain at an elevation of 950 m above MSL. The climate is temperate with mean annual temperature 13.5 to 24° C and mean annual rainfall of 3200 mm.

Geographically associated soils: Chalumthang soils are associated with the Rorethang and Bhasme soils which are coarse- loamy, mixed, thermic, Typic Hapludalfs and coarse- loamy, mixed, thermic, Typic Udorthents.

Drainage and Permeability: Well drained with moderate to rapid permeability.

Land Use and Vegetation: Mainly under cultivation of Rice, maize, etc. Vegetation includes chilaune, utis, champ, etc.

Distribution and extent: The Chalumthang soils are widely distributed in the soil map unit no. 10 and 12 of West Sikkim (133.4 ha), East Sikkim (1325.2 ha) and South Sikkim (771.4 ha) districts of the Sikkim State.

Interpretation: Chalumthang soils are coarse loamy in texture underlined by weathered parent material. The major problems of these soils are moderately steep slope, severe erosion. These soils may be used for terraced cultivation of maize, Rice etc

Interpretative groupings

Land capability sub-class : Ive2
 Productivity rating : Average (III)
 (Forest)

Soil site suitability

Crops	Soil Site suitability Class	Farmer's yield	Improved Yield
		-----yield t/ha-----	
Rice	S3	0.90	1.22
Maize	S2	1.35	2.00

ANALYTICAL DATA

Horizon	Depth (cm)	Size Class and particle diameter (mm)			Textural Class	Coarse fragments > 2 mm (%)
		Sand	Silt	Clay		
		(2-0.05)	(0.05– 0.002)	(<0.002)		
Ap	0-16	42.2	51.5	6.3	sil	5
AB	16-30	40.6	53.2	6.2	sil	8

Bt1	30-52	23.9	65.6	10.5	sil	15
Bt2	52-80	36.8	49.3	13.9	I	20

Depth (cm)	pH (1:2.5) H ₂ O	Organic carbon %	Extractable bases					CEC	Base Saturation %
			Ca	Mg	Na	K	SUM		
			<-----cmol (p+) kg ⁻¹ ----->						
0-16	5.3	1.3	2.7	1.0	0.3	0.6	4.6	5.6	82
16-30	5.0	0.7	2.1	1.0	0.3	0.5	3.9	5.1	76
30-52	5.2	0.3	2.9	1.0	0.3	0.1	4.3	5.4	80
52-80	4.9	1.8	6.4	1.6	0.3	0.1	8.4	10.4	81

12. DAMTHANG SERIES

Damthang series is a member of fine- loamy, mixed, thermic family of Humic Hapludults. Typically, Damthang soils have dark brown, extremely acidic, silt loam A horizon and dark brown to strong brown, extremely acidic, silt loam to silty clay loam B horizon.

Typifying pedon: Damthang - silt loam - cultivated

Horizon	Depth (cm)	Description
Ap	0-12	Dark brown (7.5YR3/4) silt loam; moderate medium subangular blocky structure; very friable, slightly sticky and slightly plastic; many medium pores; many very fine roots; pH 4.2;

		gradual smooth boundary.
Bt1	12-33	Dark brown (7.5YR 4/4) silt loam; moderate medium subangular blocky structure; friable, slightly sticky and slightly plastic; thin and patchy cutans, common very few roots; pH 3.9; gradual smooth boundary.
Bt2	33-65	Strong brown (7.5YR 4/6) silt loam; moderate medium subangular blocky structure; friable, slightly sticky and slightly plastic; thin and patchy cutans, few very fine and medium roots; pH 3.9; gradual smooth boundary.
Bt3	65-95	Strong brown (7.5YR 4/6) silt loam; moderate medium subangular blocky structure; friable, slightly sticky and slightly plastic; thin and patchy cutans, very few very fine roots; pH 4.3; gradual smooth boundary.
Bt4	95-125	Strong brown (7.5YR 4/6) silty clay loam; moderate medium subangular blocky structure; friable, slightly sticky and slightly plastic; few very fine and coarse roots; pH 4.3.

Type location: Latitude 27°14'30" N and Longitude 88°24'30"E (78A/8)
 Village: Damthang, Tehsil – Namchi; Distt. South Sikkim,

Ranges in characteristics: The thickness of the solum ranges from 120-130 cm. The thickness of A horizon ranges from 10-15 cm. Its colours in hue 7.5YR, value 3 and chroma 4. Its texture is silt loam. The

thickness of B horizon ranges from 110 – 120 cm. Its colour is in hue 7.5YR, value 4 and chroma 4 to 6. Its textural class ranges from silt loam to silty clay loam.

Geographical Setting: Damthang soils occur on very steeply sloping low hill of the Himalayan mountain at an elevation of 2000 m above MSL. The climate is temperate with mean annual temperature 13.5 to 24.0°C and mean annual rainfall of 2263.3 mm.

Geographically associated soils: Damthang soils are associated with the Chongrang and Synggyang soils which are coarse loamy, mixed, thermic, Entic Hapludolls and coarse loamy, mixed, thermic, Typic Udorthents .

Drainage and Permeability: Excessively drained and moderate permeability.

Land Use and Vegetation: Mainly under cultivation of maize and Rice. Vegetation includes dhupi and chilaune.

Distribution and extent: The Damthang soils are widely distributed in the soil map unit no. 42, 44, and 46 of West Sikkim (5044.6 ha), East Sikkim (3679.5 ha) and South Sikkim (3240.8 ha) districts of the Sikkim State.

Interpretation: Damthang soils are fine loamy in texture and have developed on very steeply sloping hills with strong soil acidity. These soils are mostly under terraced cultivation of maize etc.

Interpretative groupings

Land capability sub-class : VIIe2s
 Productivity rating : Average (III)
 (Forest)

Soil -site suitability

Crops	Soil Site suitability	Farmer's yield	Improved Yield
	Class	-----yield t/ha-----	
Maize	S2	1.30	2.00

ANALYTICAL DATA

Horizon	Depth (cm)	Size Class and particle diameter (mm)			Textural Class	Coarse fragments > 2 mm (%)
		Sand (2-0.05)	Silt (0.05– 0.002)	Clay (<0.002)		
Ap	0-12	37.7	51.6	10.7	Sil	5
Bt1	12-33	17.5	66.8	15.7	Sil	5
Bt2	33-65	17.9	64.4	17.7	Sil	2
Bt3	65-95	14.6	60.7	24.7	Sil	2
Bt4	95-125+	13.9	54.4	31.7	Sicl	10

Depth (cm)	pH (1:2.5) H ₂ O	Organic carbon %	Extractable bases					CEC	Base Saturation %
			Ca	Mg	Na	K	SUM		
			<-----cmol (p+) kg ⁻¹ ----->						
0-12	4.2	6.36	2.9	0.7	0.3	0.3	4.2	18.0	23
12-33	3.9	3.98	1.0	0.3	0.3	0.2	1.8	13.8	13
33-65	3.9	3.62	0.6	0.3	0.2	0.1	1.2	8.8	14
65-95	4.3	1.99	0.6	0.2	0.2	0.1	1.1	8.1	14
95-125+	4.3	1.03	0.6	0.2	0.2	0.1	1.1	8.2	13

13. DARAGAON SERIES

Daragaon series is a member of fine- loamy, mixed, thermic family of Typic Eutrudepts. Typically, Daragaon soils have dark yellowish brown, moderately acidic, sandy clay. A horizon and dark yellowish brown to yellowish brown, moderately acidic, clay loam to sandy clay loam B horizon over weathered granite gneiss.

Typifying pedon: Daragaon – sandy clay - cultivated

Horizon	Depth (cm)	Description
Ap	0-12	Dark yellowish brown (10YR 3/4) sandy clay; moderate medium subangular blocky structure; friable, slightly sticky and slightly plastic; common fine pores; common fine roots; pH 5.8; gradual smooth boundary.

Bw1	12-33	Dark yellowish brown (10YR 4/4) clay loam; moderate medium subangular blocky structure; firm, sticky and plastic; few very fine roots; pH 5.7; clear smooth boundary.
Bw2	33-63	Dark yellowish brown (10YR 4/6) sandy clay loam; moderate medium subangular blocky structure; few very fine roots; pH 5.9; clear smooth boundary.
Bw3	63-110	Yellowish brown (10YR 5/4) sandy clay loam; moderate medium subangular blocky structure; firm, sticky and plastic; pH 5.9.
Cr	110+	Weathered granite gneiss parent material.

Type location: Latitude 27°19'23" N and Longitude 88°36'39"E (78A/11) Village: Daragaon, Tehsil – Tadong; Distt. East Sikkim,

Ranges in characteristics: The thickness of the solum ranges from 100 to 110 cm. The thickness of A horizon ranges from 10-15 cm. Its colour is in hue 10YR, value 3 and chroma 4. Its texture is sandy clay loam. The thickness of B horizon ranges from 90 to 100 cm. Its colour is in hue 10 YR, value 4 to 5 and chroma 4 to 6. Its texture ranges from sandy clay loam to clay loam.

Geographical Setting: Daragaon soils occur on moderately steeply sloping low hill of the Himalayan mountain at an elevation of 1120 m above MSL. The climate is temperate with mean annual temperature 11.40 to 19.9° C and mean annual rainfall of 3500 mm.

Geographically associated soils: Daragaon soils are associated with the Gaucharan and Dharamdin soils which are fine, mixed, thermic, Typic Hapludults and fine-loamy, mixed, thermic, Fluventic Eutrudepts.

Drainage and Permeability: Moderately well drained and slow permeability.

Land Use and Vegetation: Mainly under cultivation of Rice, maize etc. Vegetation includes utis, chilaune etc.

Distribution and extent: The Daragaon soils are widely distributed in the soil map unit no. 39 of West Sikkim (502.6 ha), East Sikkim (1204.2 ha) districts of the Sikkim State.

Interpretation: Daragaon soils are fine loamy in texture and have been developed from granite gneiss parent materials on moderately steeply sloping hill slope. Major problems of these soils are moderately steep slope, moderate erosion. Terraced cultivation may be done in this soil with proper soil and water conservation.

Interpretative groupings

Land capability sub-class	:	Ive2
Productivity rating	:	Good (II)
(Forest)		

Soil- site suitability

Crops	Soil Site suitability Class	Farmer's yield	Improved Yield
		-----yield t/ha-----	
Rice	S3	0.85	1.50
Maize	S2	1.20	2.00

ANALYTICAL DATA

Horizon	Depth (cm)	Size Class and particle diameter (mm)			Textural Class	Coarse fragments > 2 mm (%)
		Sand (2-0.05)	Silt (0.05– 0.002)	Clay (<0.002)		
Ap	0-12	49.9	10.0	40.1	sc	5
Bw1	12-33	44.7	23.4	31.9	cl	5
Bw2	33-63	51.3	21.6	27.1	scl	8
Bw3	63-110	55.4	20.1	24.5	scl	10
Cr	110+	-	-	-	-	-

Depth (cm)	pH (1:2.5) H ₂ O	Organic carbon %	Extractable bases					CEC	Base Saturation %
			Ca	Mg	Na	K	SUM		
<-----cmol (p+) kg ⁻¹ ----->									
0-15	5.8	1.77	4.4	1.4	0.2	0.3	6.3	9.6	66
15-45	5.7	0.90	3.7	1.2	0.2	0.2	5.5	8.5	65
45-75	5.9	0.85	2.3	1.0	0.2	0.3	3.8	5.8	66
75-110	5.9	0.39	2.4	1.0	0.2	0.3	3.9	5.6	70
110+	-	-	-	-	-	-	-	-	-

14. RUMTEK SERIES

Rumtek series is a member of fine- loamy, mixed, thermic family of Humic Hapludults. Typically, Rumtek soils have very dark brown, extremely acidic, silt loam. A horizon and dark brown to dark yellowish brown, extremely acidic, silt loam to loam B horizon.

Typifying pedon: Rumtek – silt loam- forest

Horizon	Depth (cm)	Description
A	0-16	Dark brown (10YR 4/3) silt loam; massive structure; friable, slightly sticky and slightly plastic; many coarse pores; many coarse roots; pH 4.2; clear smooth boundary.
BA	16-38	Dark yellowish brown (10YR 3/4) silt loam; moderate medium subangular blocky structure; firm, sticky and plastic; common coarse roots; pH 4.3; gradual wavy boundary.
Bt1	38-64	Dark brown (10YR 3/3) silt loam; moderate medium subangular blocky structure; firm, sticky and plastic; thin and patchy clay cutans, common fine roots; pH 4.4; abrupt wavy boundary.
Bt2	64-90	Dark brown (10YR 3/3) loam; moderate medium subangular blocky structure; firm, sticky and

plastic; thin and patchy clay cutans, few fine roots; pH 4.5; clear smooth boundary.

Bt3 90-150 Dark yellowish brown (10YR 4/4) silt loam; moderate medium subangular blocky structure; pH 4.5.

Type location: Latitude 27°18'37" N and Longitude 88°34'12"E (78A/11) Village: Rumtek, Tehsil – Ranipul; Dist. East Sikkim,

Ranges in characteristics: The thickness of the solum ranges from 140-150 cm. The thickness of A horizon ranges from 15 to 20 cm. Its colour is in hue 10YR, value 4 and chroma 3. Its texture is silt loam. The thickness of B horizon ranges from 120-130 cm. Its colour is in hue 10YR, value 3 to 4, chroma 3 to 4. Its texture varies from silt loam to loam.

Geographical Setting: Rumtek soils occur on steeply sloping hill of the Himalayan mountain at an elevation of 1450 m above MSL. The climate is temperate with mean annual temperature 11.4 to 19.9° C and mean annual rainfall of 3500 mm.

Geographically associated soils: Rumtek soils are associated with the Tumin and Pirik soils which are fine- loamy, mixed, thermic, Humic Hapludults and coarse-loamy, mixed, thermic, Humic Dystrudepts .

Drainage and Permeability: Moderately well drained and moderate permeability.

Land Use and Vegetation: Mainly under mixed forest with Utis, sal, etc.

Distribution and extent: The Rumtek soils are widely distributed in the soil map unit no. 30 and 38 of West Sikkim (1644.8 ha), East Sikkim (2588.4 ha) and South Sikkim (3543.9 ha) districts of the Sikkim State.

Interpretation: Rumtek soils are fine- loamy in texture, developed on steeply sloping hill slope from granite gneiss parent material. These soils are susceptible to erosion due to steep slope. The major problems of these soils are steep slope, moderate soil erosion, high soil acidity with low base status. These soils are mostly under forest but can be used for terraced cultivation.

Interpretative groupings

Land capability sub-class : Ive2
 Productivity rating : Good (II)
 (Forest)

Soil- site suitability

Crops	Soil Site suitability Class	Farmer's yield	Improved Yield
		-----yield t/ha-----	
Rice	S3	0.55	1.50
Maize	S2	1.25	2.00

ANALYTICAL DATA

Horizon	Depth (cm)	Size Class and particle diameter (mm)			Textural Class	Coarse fragments > 2 mm (%)
		Sand (2-0.05)	Silt (0.05– 0.002)	Clay (<0.002)		
A	0-16	18.1	59.8	22.1	sil	2
BA	16-38	20.9	59.0	20.1	sil	5
Bt1	38-64	21.6	54.2	24.2	sil	2
Bt2	64-90	29.0	47.0	24.0	l	5
Bt3	90-150	22.7	51.7	25.6	sil	8

Depth (cm)	pH (1:2.5) H ₂ O	Organic carbon %	Extractable bases					CEC	Base Saturation %
			Ca	Mg	Na	K	SUM		
			<-----cmol (p+) kg ⁻¹ ----->						
0-16	4.2	3.13	1.0	0.3	0.2	0.3	1.8	12.2	15
16-38	4.3	1.80	0.6	0.2	0.3	0.2	1.3	9.3	14
38-64	4.4	2.11	0.6	0.2	0.3	0.1	1.2	9.6	13
64-90	4.5	1.99	0.7	0.2	0.3	0.1	1.3	9.8	13
90-150	4.5	1.56	0.7	0.2	0.2	0.1	1.2	10.5	11

15. RORETHANG SERIES

Rorethang series is a member of the coarse- loamy, mixed, thermic family of Typic Hapludalfs. Typically, these soils have very dark yellowish brown, very strongly acidic, silt loam. A horizon and dark yellowish brown, very strongly acidic, loam to silt loam B horizon underlain by weathered parent material.

Typifying pedon: Rorethang – silt loam - cultivated

Horizon	Depth (cm)	Description
Ap	0-17	Dark yellowish brown (10YR 4/4) silt loam; weak medium subangular blocky structure; very friable, non sticky and non plastic; many medium pores; many coarse roots; pH 4.7; gradual smooth boundary.
Bt	17-60	Dark yellowish brown (10YR 3/4) loam; moderate medium subangular blocky structure; friable, slightly sticky and plastic; thin and patchy cutan, common coarse roots; pH 4.8; gradual wavy boundary.
BC	60-78	Dark yellowish brown (10YR 3/4) silt loam; moderate medium subangular blocky structure; friable, sticky and plastic; common fine roots; pH 4.9.
R	78+	Weathered parent material.

Type location: Latitude 27°12'09" N and Longitude 88°37'25"E (78A/12) Village: Rorethang Tehsil – Pakyong ; Distt. East Sikkim.

Ranges in characteristics: The thickness of the solum ranges from 70 to 75 cm. The thickness of A horizon ranges from 15 to 18 cm. Its colour is in hue 10YR, value 4 and chroma 4. Its texture is silt loam. The

thickness of B horizon range from 60-70 cm. Its colour is in hue 10YR, value 3 and chroma 4. Its texture ranges from loam to silt loam.

Geographical Setting: Rorethang soils occur on very steeply sloping low hill of the Himalayan mountain at an elevation of 950 m above MSL. The climate is temperate with mean annual temperature 11.4 to 19.9° C and mean annual rainfall of 3492 mm.

Geographically associated soils: Rorethang soils are associated with the Mangjing and Singrep soils which are coarse- loamy, mixed, thermic, Typic Endoaquepts and loamy-skeletal, mixed, thermic, Entic Haludolls.

Drainage and Permeability: Well drained and moderate permeability.

Land Use and Vegetation: Mainly under mixed forest with Malata, Sirish, Chilaune.

Distribution and extent: The Rorethang soils are widely distributed in the soil map unit no. 10, 11, and 58 of West Sikkim (534.4 ha), East Sikkim (920.2 ha) and South Sikkim (1923.7 ha) districts of the Sikkim State.

Interpretation: Rorethang soils are coarse loamy in texture underline by weathered parent materials. Major limitations of these soils are very steep slope, moderate erosion high soil acidity. These soils may be used for terraced cultivation.

Interpretative groupings

Land capability sub-class : Vie2s
 Productivity rating : Average (III)
 (Forest)

Soil-site suitability

Crops	Soil Site suitability Class	Farmer's yield	Improved Yield
		-----yield t/ha-----	
Rice	S3	0.80	1.50
Maize	S2	1.30	2.00

ANALYTICAL DATA

Horizon	Depth (cm)	Size Class and particle diameter (mm)			Textural Class	Coarse fragments > 2 mm (%)
		Sand (2-0.05)	Silt (0.05– 0.002)	Clay (<0.002)		
Ap	0-17	34.0	52.0	14.0	sil	20
Bt	17-60	29.9	48.9	21.2	l	25
BC	60-78	31.4	58.0	10.6	sil	30
R	78+	-	-	-	-	

Depth (cm)	pH (1:2.5) H ₂ O	Organic carbon %	Extractable bases					CEC	Base Saturation %
			Ca	Mg	Na	K	SUM		
			<-----cmol (p+) kg ⁻¹ ----->						
0-17	4.7	1.71	2.2	0.5	0.3	0.2	3.2	7.5	43
17-60	4.8	1.40	1.8	0.4	0.3	0.1	2.6	6.1	43
60-78	4.9	1.17	1.7	0.2	0.1	0.1	2.1	4.7	45
78+	-	-	-	-	-	-	-	-	-

16. BHASME SERIES

Bhasme series is a member of coarse loamy, mixed, thermic family of Typic Udorthents. Typically, Bhasme soils have dark brown to dark yellowish brown, extremely acidic to very strongly acidic, loam to silt loam A horizon and underlined by weathered parent material.

Typifying pedon: Bhasme – loam - forest

Horizon	Depth (cm)	Description
A	0-16	Dark brown (10YR 3/3 loam; moderate, medium, subangular blocky structure; friable, sticky and plastic; common fine pores; pH 4.4; clear smooth boundary.
A12	16-41	Dark yellowish brown (10YR 3/4 silt loam; friable, slightly sticky and slightly plastic; common fine roots; pH 4.8; gradual smooth boundary.
AC	41-69	Dark yellowish brown (10YR 3/4 silt loam; moderate, medium, subangular blocky structure; few fine roots; pH 5.2.
Cr	69+	Weathered granite-gneiss.

Type location: Latitude 27°12'34" N and Longitude 88°36'18"E (78A/12) Village: Bhasme, Tehsil – Rorethang; Distt. East Sikkim,

Ranges in characteristics: The thickness of the solum ranges from 65 to 75 cm. The thickness of A horizon ranges from 65 to 70 cm. Its colour is in hue 10YR, value 3 and chroma 3 to 4. Its texture is loam to silt loam.

Geographical Setting: Bhasme soils occur on steeply sloping low hill of the Himalayan mountain at an elevation of 1750 m above MSL. The climate is temperate with mean annual temperature 11.4 to 18.9° C and mean annual rainfall of 3500 mm.

Geographically associated soils: Bhasme Soils are associated with the Chautare and Chalumthang soils which are coarse-loamy, mixed, thermic, Humic Hapludalf and coarse loamy mixed thermic Typic Hapludalfs respectively.

Drainage and Permeability: Well drained and moderate permeability.

Land Use and Vegetation: Mainly under forest with some patches under cultivation. Vegetation includes utis, dhupi, chilaune, etc.

Distribution and extent: The Bhasme soils are widely distributed in the soil map unit no. 48, 50, and 58 of West Sikkim (1527.7 ha), East Sikkim (1326.5 ha) and South Sikkim (1860.6 ha) districts of the Sikkim State.

Interpretation: Bhasme soils are coarse in texture underlined by the weathered parent material. These soils have the major limitation of

steep slope, severe erosion, high soil acidity etc. These soils are mostly under thin forest. But these soils may be used for terraced cultivation.

Interpretative groupings

Land capability sub-class : Vie2
 Productivity rating : Average (III)
 (Forest)

Soil-site suitability

Crops	Soil Site suitability Class	Farmer's yield		Improved Yield
		----- yield t/ha-----		
Rice	S3	0.85	1.50	
Maize	S3	1.20	2.00	

ANALYTICAL DATA

Horizon	Depth (cm)	Size Class and particle diameter (mm)			Textural Class	Coarse fragments > 2 mm (%)
		Sand (2-0.05)	Silt (0.05- 0.002)	Clay (<0.002)		
Ap	0-16	35.9	49.8	14.3	l	10
A12	16-41	33.9	52.9	13.2	sil	15
AC	41-69	32.0	51.2	16.8	sil	20
Cr	69+	-	-	-	-	

Depth (cm)	pH (1:2.5) H ₂ O	Organic carbon %	Extractable bases					CEC	Base Saturation %
			Ca	Mg	Na	K	SUM		
-----cmol (p+) kg ⁻¹ ----->									
0-16	4.4	4.7	2.7	0.6	0.4	0.2	3.9	8.0	49
16-41	4.8	3.9	1.7	0.3	0.2	0.1	2.3	6.4	36
41-69	5.2	2.3	1.8	0.5	0.2	0.1	2.6	7.9	33
69+	-	-	-	-	-	-	-	-	-

17. DIKLING SERIES

Dikling series is a member of fine, mixed, thermic family of Humic Hapludults. Typically, Dikling soils have dark yellowish brown, very strongly acidic, silty clay loam A horizon and dark yellowish brown, very strongly acidic, silty clay to clay B horizon.

Typifying pedon: Dikling – Silty clay loam - forest

Horizon	Depth (cm)	Description
Ap	0-13	Dark yellowish brown (10YR 4/6 silty clay loam; moderate, medium, subangular blocky structure; firm sticky and plastic; common fine pores; many coarse roots; pH 4.6; clear smooth boundary.
Bt1	13-30	Dark yellowish brown (10YR 4/4 clay; moderate, medium, subangular blocky structure; firm sticky and plastic; thin patchy clay cutans, many coarse roots; pH 4.5; clear smooth boundary.
Bt2	30-65	Dark yellowish brown (10YR 4/4) silty clay; strong, medium, subangular blocky structure; very firm, very sticky and very plastic; thin, patchy clay cutans; many coarse roots; pH 4.5; gradual smooth boundary.
Bt3	65-105	Dark yellowish brown (10YR 3/4 silty clay; strong, medium, subangular blocky structure;

very firm, very sticky and plastic; thin, patchy clay cutans; few fine roots; pH 4.8; gradual smooth boundary.

Bt4 105-150 Dark yellowish brown (10YR 3/4 clay; strong, medium, subangular blocky structure; very firm, very sticky and very plastic; pH 4.6;

Type location: Latitude 27°14'28" N and Longitude 88°34'30"E (78A/12) Village: Dikling Tehsil – Pakyong; Distt. East Sikkim,

Ranges in characteristics: The thickness of the solum ranges from 150 to 160 cm. The thickness of A horizon ranges from 10 to 15 cm. Its colour is in hue 10YR, value 4 and chroma 6. Its texture is silty clay loam. The thickness of B horizon ranges from 135-140 cm. Its colour is in hue 10YR, value 3 to 4 and chroma 4 to 6. It's texture ranges from silty clay loam to silty clay

Geographical Setting: Dikling soils occur on steeply sloping hill slope of the Himalayan mountain at an elevation of 1750m above MSL. The climate is temperate with mean annual temperature 11.4 to 19.9° C and mean annual rainfall of 3492 mm.

Geographically associated soils: Dikling soils are associated with the Hilley and Khedi soils which are fine loamy, mixed, thermic, Humic Dystrudepts and fine loamy, mixed, thermic, Humic Hapludults.

Drainage and Permeability: Well drained and moderate permeability.

Land Use and Vegetation: Thin Forest Vegetation includes utis, dhupi, pine etc.

Distribution and extent: The Dikling soils are widely distributed in the soil map unit no. 26 and 58 of West Sikkim (4187.7ha), East Sikkim (3091.5 ha) and South Sikkim (2234.1 ha) districts of the Sikkim State.

Interpretation: Dikling soils are fine textured have been developed on granite gneiss. The major problems are steep slope, severe erosion hazard, very strong soil acidity and low base status. These soils are moderately to marginally suitable for terraced cultivation.

Interpretative groupings

Land capability sub-class : VIe2
 Productivity rating (Forest) : Good (II)

Soil-site suitability

Crops	Soil Site suitability	Farmer's yield	Improved Yield
	Class	-----yield t/ha-----	
Rice	S3	1.00	1.50
Maize	S2	1.80	2.00

ANALYTICAL DATA

Horizon	Depth (cm)	Size Class and particle diameter (mm)			Textural Class	Coarse fragments > 2 mm (%)
		Sand (2-0.05)	Silt (0.05– 0.002)	Clay (<0.002)		
Ap	0-13	11.9	51.6	36.5	sicl	2
Bt1	13-30	4.0	38.2	57.8	c	3
Bt2	30-65	5.9	47.7	46.4	sic	3
Bt3	65-105	3.9	47.7	48.7	sic	3
Bt4	105-150	3.4	37.0	59.6	c	5

Depth (cm)	pH (1:2.5) H ₂ O	Organic carbon %	Extractable bases					CEC	Base Saturation %
			Ca	Mg	Na	K	SUM		
<-----cmol (p+) kg ⁻¹ ----->									
0-13	4.6	3.33	1.0	0.5	0.3	0.3	2.1	15.8	13
13-30	4.5	1.13	0.8	0.3	0.2	0.2	1.5	12.8	12
30-65	4.5	1.17	0.6	0.2	0.2	0.2	1.2	10.6	11
65-105	4.8	1.25	0.6	0.2	0.1	0.2	1.1	11.5	10
105-150	4.6	1.48	0.7	0.2	0.1	0.2	1.2	12.2	10

18. SAJONG SERIES

Sajong series is a member of coarse-loamy, mixed thermic family of Humic Dystrudepts. Typically, Sajong soils have dark brown, extremely acidic, silt loam. A horizon and dark yellowish brown to yellowish brown, extremely acidic, loam B horizon.

Typifying pedon: Sajong – silt loam - forest

Horizon	Depth (cm)	Description
Ap	0-26	Dark brown (10YR 3/3 silt loam; weak, medium, subangular blocky structure; friable, slightly sticky and plastic; many medium to coarse pores; common coarse roots; pH 3.7; abrupt wavy boundary.
Bw	26-72	Dark yellowish brown (10YR 3/4 loam; weak, medium, subangular blocky structure; friable, slightly sticky and plastic; many medium to coarse pores; common coarse roots pH 4.2;
Cr	72+	Weathered parent materials, rocks & boulders.

Type location: Latitude 27°12'43" N and Longitude 88°33'22"E (78A/12) Village: Sajong, Tehsil – Gangtok; Distt. East Sikkim.

Ranges in characteristics: The thickness of the solum ranges from 70 to 75 cm. The A horizon is about 20 to 26 cm thick. Its colour is in hue 10YR, value 3 and chroma 3. Its texture ranges from loam to Silt loam. Its colour is in hue 10YR, value 3 and chroma 3 to 4. Its texture ranges from silt loam to loam. The thickness of B horizon ranges from 50 to 55 cm. Its colour is in hue 10YR, value 3 and chroma 3 to 4. Its texture is silt loam.

Geographical Setting: Sajong soils occur on steeply sloping hill slope of the Himalayan mountain at an elevation of 1780 m above MSL. The

climate is temperate with mean annual temperature 11.9 to 19.9° C and mean annual rainfall of 2500 mm

Geographically associated soils: Sajong Soils are associated with the Chakung and Tarnu Soils which are fine loamy, mixed, thermic, Humic Hapludult and coarse loamy, mixed thermic Typic Udorthents.

Drainage and Permeability: Well drained with rapid permeability.

Land Use and Vegetation: Mainly under Mixed forest with Chilaune, Bamboo (F1).

Distribution and extent: The Sajong soils are widely distributed in the soil map unit no. 48, 50 and 54 in West Sikkim (3587.6 ha), East Sikkim (2406 ha) and South Sikkim (697.4 ha) districts of the Sikkim State.

Interpretation: Sajong soils are coarse textured and have been developed on granite gneiss. The major problems are steep slope, severe erosion hazard, very strong soil acidity and low base status. These soils are moderately to marginally suitable for terraced cultivation.

Interpretative groupings

Land capability sub-class	:	Vie2s
Productivity rating (Forest)	:	Poor (IV)

Soil-site suitability

Crops	Soil Site suitability Class	Farmer's yield	Improved Yield
		-----yield t/ha-----	
Rice	N2	-	-
Maize	S3	1.20	1.50

ANALYTICAL DATA

Horizon	Depth (cm)	Size Class and particle diameter (mm)			Textural Class	Coarse fragments > 2 mm (%)
		Sand (2-0.05)	Silt (0.05– 0.002)	Clay (<0.002)		
Ap	0-26	41.7	51.7	6.6	l	25
Bw	26-72	47.7	44.1	8.2	sil	30

Depth (cm)	pH (1:2.5) H ₂ O	Organic carbon %	Extractable bases					CEC	Base Saturation %
			Ca	Mg	Na	K	SUM		
			<-----cmol (p+) kg ⁻¹ ----->						
0-26	3.7	3.66	0.9	0.4	0.3	0.2	1.8	13.0	14
26-72	4.2	2.18	0.6	0.2	0.3	0.1	1.2	6.7	18

19. RONGNEK SERIES

Rongnek series is a member of coarse-loamy, mixed thermic family of Typic Udorthents. Rongnek soils have very dark brown, extremely acidic, sandy loam. A horizon and dark brown to yellowish brown, very strongly acidic to strongly acidic, loam B horizon underlain by weathered parent materials.

Typifying pedon: Rongnek – sandy loam - forest

Horizon	Depth (cm)	Description
Ap	0-15	Dark brown (7.5YR 3/2) sandy loam; weak medium granular structure; friable, non sticky and non plastic; many coarse pores; common coarse roots; pH 4.8; abrupt wavy boundary.
AC	15-50	Dark brown (7.5YR 3/4) gravelly sandy loam; weak, medium, granular structure; many coarse pores; common coarse roots; pH 4.8;
Cr	50+	Weathered parent material.

Type location: Latitude 27°20'28" N and Longitude 88°39'06"E (78A/12) Village: Rongnek, Tehsil – Gangtok; Distt. East Sikkim,

Ranges in characteristics: The thickness of the solum ranges from 45 to 50 cm. The thickness of the A horizon ranges from 50-55 cm. Its colour is in hue 7.5YR, value 3 and chroma 2 to 4. Its texture is sandy loam.

Geographical Setting: Rongnek soils occur on steeply sloping hill of the Himalayan mountain at an elevation of 1800 m above MSL. The climate is temperate with mean annual temperature 11.4 to 19.9° C and mean annual rainfall of 3500 mm.

Geographically associated soils: Rongnek soils are associated with the Khedi and Sajong Soils which are fine loamy, mixed, thermic, Humic Hapludults and coarse loamy, mixed, thermic, Humic Dystrudepts respectively.

Drainage and Permeability: Well drained with rapid permeability.

Land Use and Vegetation: Mainly under mixed forest with Pinus, Utis (F2).

Distribution and extent: The Rongnek soils are widely distributed in the soil map unit no. 54 of West Sikkim (2467ha) and East Sikkim (907.4 ha) districts of the Sikkim State.

Interpretation: Rongnek soils are coarse textured underlined by weathered parent material. These soils are susceptible to erosion due to steep slope Major problems of these soils are steep slope, coarse soil texture, severe soil erosion, high soil acidity. These soils are mostly under forest.

Interpretative groupings

Land capability sub-class	:	Vle2s
Productivity rating (Forest)	:	Extremely Poor (V)

ANALYTICAL DATA

Horizon	Depth (cm)	Size Class and particle diameter (mm)			Textural Class	Coarse fragments > 2 mm (%)
		Sand (2-0.05)	Silt (0.05– 0.002)	Clay (<0.002)		
Ap	0-15	66.9	21.7	11.4	sl	15
AC	15-50	63.5	22.5	13.9	sl	25

Depth (cm)	pH (1:2.5) H ₂ O	Organic carbon %	Extractable bases				CEC	Base Saturation %	
			Ca	Mg	Na	K			SUM
<-----cmol (p+) kg ⁻¹ ----->									
0-15	4.8	6.00	8.1	0.9	0.4	0.4	9.8	19.0	52
15-50	4.8	3.27	3.0	0.7	0.3	0.4	4.4	10.2	43

20. KARFACTOR SERIES

Karfector series is a member of fine-loamy, mixed thermic Humic Hapludalfs. Typically, Karfector soils have dark brown, moderately acidic, loam A horizon and very dark grayish brown to yellowish brown, strongly acidic, loam B horizon

Typifying pedon: Karfector – loam - cultivated

Horizon	Depth (cm)	Description
Ap	0-11	Dark brown (10YR 3/3 loam; weak, moderate, subangular blocky structure; friable, slightly sticky and slightly plastic; common medium

		pores; many very fine roots; pH 5.7; gradual smooth boundary.
Bt1	11-30	Very dark grayish brown (10YR 3/2) loam; moderate, medium, subangular blocky structure; friable, slightly sticky and slightly plastic; common fine roots; pH 5.8; gradual smooth boundary.
Bt2	30-55	Dark brown (10YR 4/3 loam; moderate, medium, subangular blocky structure; friable, slightly sticky and slightly plastic; thin and patchy cutans, few very fine roots; pH 5.2; gradual smooth boundary.
Bt3	55-82	Dark yellowish brown (10YR 4/4 loam; moderate, medium, subangular blocky structure; friable, slightly sticky and slightly plastic; thin and patchy cutans, few very fine roots; pH 5.0; gradual smooth boundary.
Bt4	82-107	Dark yellowish brown (10YR 4/4 loam; moderate, medium, subangular blocky structure; friable, slightly sticky and slightly plastic; thin and patchy cutans, very fine, few roots; pH 5.4; gradual smooth boundary.
Bt5	107-135+	Yellowish brown (10YR 5/4 loam; moderate, medium, subangular blocky structure; friable, slightly sticky and slightly plastic; very fine, few roots; pH 5.3.

Type location: Latitude 27°08'30" N and Longitude 88°17'03"E (78A/4)

Village: Karfactor, Tehsil – Jorethang; Dist. South Sikkim,

Ranges in characteristics: The thickness of the solum ranges from 130 to 140 cm. The thickness of the A horizon ranges from 10 to 15 cm. Its colour is in hue 10YR, value 3 and chroma 3. The thickness of B horizon ranges from 120 to 130 cm. Its colour is in hue 10YR, value 3 to 5 and chroma 2 to 8. Its textural class is loam.

Geographical Setting: Karfactor soils occur on narrow valley at an elevation of 400 m above MSL. The climate is temperate with mean annual temperature 13.5 to 24.5° C and mean annual rainfall of 3500 mm.

Geographically associated soils: Karfactor soils are associated with the Dharamdin and Lingtse soils which are fine loamy mixed, thermic, Fluventic Entrodepts and Coarse loamy mixed, thermic, Typic Udorthents soils.

Drainage and Permeability: Moderately well drained with rapid permeability.

Land Use and Vegetation: Mainly under cultivation of Rice. Vegetation includes dhupi, champ, ber, utis, etc.

Distribution and extent: The Karfactor soils are widely distributed in the map unit no. 14 and 15 of West Sikkim (172.2 ha), East Sikkim (287.2 ha) and South Sikkim (1355 ha) districts of the Sikkim State.

Interpretation : Karfactor soils are fine loamy in texture and developed in the narrow valley from alluvium and colluvium. These soils have very little limitation and are suitable for agriculture.

Interpretative groupings

Land capability sub-class : Ille2
 Productivity rating (Forest) : Good (II)

Soil-site suitability

Crops	Soil Site suitability Class	Farmer's yield	Improved Yield
		-----yield t/ha-----	
Rice	S3	0.80	1.50
Maize	S2	1.25	2.00

ANALYTICAL DATA

Horizon	Depth (cm)	Size Class and particle diameter (mm)			Textural Class	Coarse fragments > 2 mm (%)
		Sand (2-0.05)	Silt (0.05–0.002)	Clay (<0.002)		
		Ap	0-11	51.9		
Bt1	11-30	39.3	42.6	18.1	I	-
Bt2	30-55	32.5	45.4	22.1	I	-



Bt3	55-82	38.2	38.7	23.1		3
Bt4	82-107	40.3	35.6	24.1		8
Bt5	107- 135+	45.5	30.4	24.1		25

Depth (cm)	pH (1:2.5) H ₂ O	Organic carbon %	Extractable bases					CEC	Base Saturation %
			Ca	Mg	Na	K	SUM		
			<-----cmol (p+) kg ⁻¹ ----->						
0-11	5.7	1.99	4.8	1.6	0.3	0.1	6.9	9.8	70
11-30	5.8	1.71	7.0	1.5	0.2	0.1	8.8	12.6	70
30-55	5.2	1.27	2.9	1.3	0.2	0.1	4.5	7.9	57
55-82	5.0	0.91	1.7	1.3	0.2	0.1	3.3	6.1	54
82-107	5.4	0.83	1.9	1.4	0.2	0.1	3.6	6.5	55
107-135+	5.3	0.68	1.8	1.4	0.2	0.2	3.6	6.6	55

21. SAMDUR SERIES

Samdur series is a member of fine-loamy, mixed thermic Humic Eutrudepts. Typically, Samdur soils have dark brown, very strong acidic, loam A horizon and dark brown to dark yellowish brown, very strongly acidic to strongly acidic, silt loam to loam B horizon.

Typifying pedon: Samdur – loam - cultivated

Horizon	Depth (cm)	Description
Ap	0-18	Dark brown (10YR 4/3) loam; moderate, medium, subangular blocky structure; friable, slightly sticky and slightly plastic; few fine pores;

		common fine roots; pH 4.5; gradual smooth boundary.
Bw1	18-38	Dark brown (10YR 3/3) silt loam; weak, medium, subangular blocky structure; friable, slightly sticky and slightly plastic, few fine roots; pH 4.6; gradual smooth boundary.
Bw2	38-58	Very dark grayish brown (10YR 3/2) loam; weak, moderate, subangular blocky structure; friable, slightly sticky and slightly plastic; fine, few roots; pH 5.2; abrupt wavy boundary.
Bw3	58-80	Dark yellowish brown (10YR 4/4) loam; weak, moderate, subangular blocky structure; friable, slightly sticky and slightly plastic; pH 5.2; gradual wavy boundary.
BC	80-101+	Dark yellowish brown (10YR 4/6) loam; weak, moderate, subangular blocky structure; friable, slightly sticky and slightly plastic; common, many pores, pH 5.0.

Type location: Latitude 27°22'52" N and Longitude 88°36'07"E (78A/11) Village: Samdur, Tehsil – Tadong; Distt. East Sikkim.

Ranges in characteristics: The thickness of the solum ranges from 100-110 cm. The thickness of A horizon ranges from 15-20 cm. Its colour is in hue 10YR, value 4 and chroma 3. Its texture is sandy loam. The thickness of B horizon ranges from 85-90 cm. Its colour is in hue

10YR, value 3 to 4, chroma 2 to 6. Its texture varies from silt loam to loam.

Geographical Setting: Samdur soils occur on steeply sloping low hill of the Himalayan mountain at an elevation of 1352 m above MSL. The climate is temperate with mean annual temperature 11.4 to 19.9° C and mean annual rainfall of 3500 mm.

Geographically associated soils: Samdur soils are associated with the Khedi and Bhusuk Soils which are fine loamy, mixed, thermic, Humic Hapludults and loamy skeletal, mixed, thermic, Humic Dystrudepts.

Drainage and Permeability: Well drained and moderate permeability.

Land Use and Vegetation: Mainly under cultivation of Rice, maize etc. Vegetation includes utis, chilaune, bamboo, etc.

Distribution and extent: The Samdur soils are widely distributed in the map unit no. 28, and 36 in West Sikkim (212.5ha), East Sikkim (1507.3 ha) and South Sikkim (2021.9 ha) districts of the Sikkim State.

Interpretation: Samdur Soil are fine textured, developed on very steep hill slope and are moderately eroded. The major problems of these soils are very steep slope, moderate erosion, high soil acidity. These soils are cultivated for rice, maize through terracing and bunding.

Interpretative groupings

Land capability sub-class : Vlle3
 Productivity rating (Forest) : Good (II)

Soil-site suitability

Crops	Soil Site suitability Class	Farmer's yield	Improved Yield
		-----yield t/ha-----	
Rice	S3	0.70	1.50
Maize	S2	1.35	2.00

ANALYTICAL DATA

Horizon	Depth (cm)	Size Class and particle diameter (mm)			Textural Class	Coarse fragments > 2 mm (%)
		Sand (2-0.05)	Silt (0.05-- 0.002)	Clay (<0.002)		
Ap	0-18	30.4	49.8	19.8	I	10
Bw1	18-38	28.6	50.9	20.5	sil	10
Bw2	38-58	31.1	48.9	20.0	I	15
Bw3	58-80	35.2	44.5	20.3	I	20
BC	80-101+	38.1	44.3	17.6	I	25

Depth (cm)	pH (1:2.5) H ₂ O	Organic carbon %	Extractable bases					CEC	Base Saturation %
			Ca	Mg	Na	K	SUM		
<-----cmol (p+) kg ⁻¹ ----->									
0-18	4.5	2.26	2.0	0.5	0.3	0.1	2.9	8.3	35
18-38	4.6	1.83	1.9	0.9	0.7	0.3	3.8	6.7	57
38-58	5.2	1.75	2.5	0.9	0.4	0.2	4.0	6.6	61

58-80	5.2	1.05	1.9	0.9	0.4	0.1	3.3	5.3	62
80-101+	5.0	0.62	1.5	0.7	0.3	0.1	2.6	4.0	65

22. GOUCHARAN SERIES

Goucharan series is a member of coarse loamy, mixed, thermic family of Typic Udorthents. Typically, Goucharan soils have dark brown, moderately acidic, sandy clay loam A horizon and dark yellowish brown, neutral, sandy loam Ac horizon.

Typifying Pedon: Goucharan – sandy clay loam – forest

Horizon	Depth (cm)	Description
A	0-19	Dark brown (10 YR 4/3) sandy clay loam; weak medium sub-angular blocky structure, friable and slightly sticky and slightly plastic; many coarse pores; common fine roots; pH 5.7; gradual wavy boundary
A12	19-53	Dark Brown (10 YR 4/3) sandy loam; weak medium sub-angular blocky structure, friable slightly sticky and slightly plastic; common coarse pores; few fine roots; pH 6.6; abrupt wavy boundary
AC	53-94	Dark yellowish brown (10 YR 4/6) sandy loam; weak, medium, sub angular blocky structure; friable and slightly sticky; slightly plastic;

		common coarse pores; few very fine roots; pH 7.0; abrupt wavy boundary
Cr	94+	Weathered Rock

Type location: Latitude 27°17'22" and Longitude 88°37'01" E (78A/11)
Vill. Goucharan, Dist. East Sikkim, State Sikkim.

Ranges in characteristics: The thickness of the solum ranges from 80 to 90 cm. The thickness of A horizon ranges from 10 to 15 cm,. The colour is in hue 10YR and value 4, chroma 3. Its texture ranges from sandy clay loam to sandy loam. The depth of B horizon ranges from 60 to 80 cm. The colour is in hue 10YR, value 3 to 4 and chroma 4 to 6. The texture varies from loam to sandy loam and structure medium weak subangular blocky to fine structure less.

Geographical Setting: Goucharan soils are formed over weathered granite gneiss and moderately steeply sloping high mountains. The climate is humid with mean annual temperature of 10°C and mean annual rainfall of 3250 mm.

Geographically associated soils: Goucharan soils are associated with the Tarnu soils and Daragoan soils which are coarse-loamy mixed thermic Typic Udorthents and fine loamy, mixed, thermic, Typic Entrudepts.

Drainage and Permeability: Well drained with moderate permeability.

Land Use and Vegetation: Thin forest with sparse vegetation. The Vegetation includes Chilaune, Bamboo, Lampateng, etc.

Distribution and extent: The Goucharan soils are extensively distributed in the soil map unit no. 39 and 58 in East Sikkim and West Sikkim districts of the Sikkim State having an area of 1078.9 ha.

Interpretation: Goucharan soils are moderately deep, light textured and also poor in nutrient contents. However, proper measures should be taken to promote natural forestry in these soils.

Interpretative groupings

Land capability sub-class : IVe2
 Productivity rating (Forest) : Good (II)

ANALYTICAL DATA

Horizon	Depth (cm)	Size Class and particle diameter (mm)			Textural Class	Coarse fragments > 2 mm (%)
		Sand (2-0.05)	Silt (0.05– 0.002)	Clay (<0.002)		
A	0-19	58.1	20.6	21.3	scl	5
A12	19-53	59.7	22.4	17.9	sl	10
AC	53-94	71.7	21.0	7.3	sl	15

Depth (cm)	pH (1:2.5) H ₂ O	Organic carbon %	Extractable bases					CEC	Base Saturation %
			Ca	Mg	Na	K	SUM		
			<-----cmol (p+) kg ⁻¹ ----->						
0-19	5.7	28.0	9.0	1.8	0.8	1.5	13.1	17.4	75
19-53	6.6	26.5	6.5	1.7	0.8	1.5	10.5	13.0	81
53-94	7.0	5.8	1.5	0.7	0.7	1.3	4.2	5.0	84

23. RUBAM SERIES

Rubam series is a member of loamy skeletal, mixed, thermic family of Lithic Ustorthents. Rubam soils have dark brown, strongly acidic, gravelly sandy clay loam A horizon underlain by weather rock.

Typifying Pedon: Rubam - gravelly sandy clay loam - forest

Horizon	Depth (cm)	Description
A	0-20	Dark brown (10 YR 3/3) gravelly sandy clay loam; fine weak granular structure, loose, very friable non sticky and non plastic; coarse common pores; coarse many roots; pH 5.2;
Cr	20-35	Watershed parent material
R	35+	Hard rock

Type location: Latitude 27°38'05" N and Longitude 88°42'25" E (78A/10) Vill. Rubam, Distt. North Sikkim, State Sikkim

Ranges in characteristics: The thickness of the solum ranges from 15 to 20 cm. The thickness of A horizon ranges from 10 to 20 cm. Its colour is in hue 10YR and value 3 to 4, chroma 3. Its texture ranges from sandy clay loam to gravelly loam with 60 –70% coarse gravels. The A horizon is generally underlain by weathered rocks.

Geographical Setting: Rubam soils are formed over weathered granite gneiss on the ridge lines of the mountains range at an elevation of 3250 m above MSL. The climate is temperate with mean annual temperature of 7.8°C and mean annual rainfall of 2050 mm.

Geographically associated soils: Rubam Soils are associated with the Salem soils which is fine loamy, mixed, thermic Humic Dystrudepts.

Drainage and Permeability: Excessively drained with rapid permeability.

Land Use and Vegetation: Moderately dense forest and fully stocked vegetation. The Vegetation includes chilaune, utis, sal, dhupi etc.

Distribution and extent: The Rubam soils are extensively distributed in the map unit no.2 in North Sikkim districts of the Sikkim State having an area of 3079.8 ha.

Interpretation: Rubam soils are very shallow, light textured and extremely gravelly. The nutrient status is also poor. However, these soils have the potentiality of supporting a good forest growth.

Interpretative groupings

Land capability sub-class : Vle2s
 Productivity rating (Forest) : Average (III)

ANALYTICAL DATA

Horizon	Depth (cm)	Size Class and particle diameter (mm)			Textural Class	Coarse fragments > 2 mm (%)
		Sand (2-0.05)	Silt (0.05– 0.002)	Clay (<0.002)		
AC	0-20	66.6	26.7	6.7	sl	35-40

Depth (cm)	pH (1:2.5) H ₂ O	Organic carbon %	Extractable bases					CEC	Base Saturation %
			Ca	Mg	Na	K	SUM		
<-----cmol (p+) kg ⁻¹ ----->									
0-20	5.2	22.2	4.4	1.1	0.4	0.5	6.4	8.6	74

24. KARPORANG SERIES

Karporang series is a member of coarse loamy, mixed, thermic family of Typic Udorthents. Karporang soils have very dark grayish brown, strongly acidic, loamy sand A horizon and dark brown, very strongly acidic, loamy sand AC horizon.

Typifying Pedon: Karporang – loamy sand – forest

Horizon	Depth (cm)	Description
A	0-17	Very dark greyish brown (10 YR 3/2) loamy sand; weak medium granular structure, friable, non sticky and non plastic; many coarse pores; many coarse roots; pH 5.1; gradual wavy boundary
A12	17-35	Dark brown (10 YR 3/3) loamy sand; weak medium granular structure, very friable, non sticky and non plastic; coarse many pores; coarse common roots; pH 4.7; abrupt wavy boundary
AC	35-70	Dark yellowish brown (10 YR 3/4) loamy sand; weak, medium, sub angular blocky structure; friable and slightly sticky; slightly plastic; coarse common pores; very fine few roots; pH 7.0; abrupt wavy boundary
Cr	70+	Weathered parent materials, Rocks and boulders

Type location: Latitude 27°23'03" N and Longitude 88°41'57" E (78A/11) Vill. Karporang, Distt. East Sikkim, State Sikkim.

Ranges in characteristics: The thickness of the solum ranges from 15 to 70 cm. The thickness of A horizon ranges from 12 to 15 cm. The colour is in hue 10YR and value 2 to 3, chroma 3 to 2. Its texture ranges from sandy loam to loamy sand. The depth of B horizon ranges from 50

to 60 cm. The colour is in hue 10YR, value 3 to 4 and chroma 4. The texture varies from sandy loam to loamy sand and the structure varies from weak granular to fine structure less.

Geographical Setting: Karporang soils are formed over weathered granite gneiss and very steep landslide zone. The soils are highly eroded. The climate is humid with mean annual temperature of 15 °C and mean annual rainfall of 3450 mm.

Geographically associated soils: Karporang Soils are associated with the Hilley soils which is fine loamy, mixed thermic Humic Dystrudepts.

Drainage and Permeability: Well drained with rapid permeability.

Land Use and Vegetation: Thin forest with sparse vegetation. The Vegetation includes pakasaj, chilaune, and shrubs.

Distribution and extent: The Karporang soils are extensively distributed in the soil map unit no. 6 in East Sikkim (707.3 ha.) district of Sikkim State.

Interpretation: Karporang soils are moderately shallow, coarse loamy and light textured. The soils are subject to severe erosion and should be brought under afforestation programme.

Interpretative groupings

Land capability sub-class : Vlle3s
 Productivity rating (Forest) : Average (III)

ANALYTICAL DATA

Horizon	Depth (cm)	Size Class and particle diameter (mm)			Textural Class	Coarse fragments > 2 mm (%)
		Sand (2-0.05)	Silt (0.05– 0.002)	Clay (<0.002)		
A	0-17	81.3	15.0	3.7	Is	12
A12	17-35	75.5	17.9	6.6	Is	15
AC	35-70	79.3	14.1	6.6	Is	18
Cr	70+					

Depth (cm)	pH (1:2.5) H ₂ O	Organic carbon %	Extractable bases					CEC	Base Saturation %
			Ca	Mg	Na	K	SUM		
<-----cmol (p+) kg ⁻¹ ----->									
0-17	5.1	32.7	3.2	1.0	0.3	0.3	4.8	6.7	72
17-35	4.7	19.8	0.5	0.4	0.3	0.2	1.4	3.5	40
35-70	4.9	19.1	0.5	0.3	0.2	0.1	1.1	3.0	37
70+									

25. CHATTEN SERIES

Chaten series is a member of loamy skeletal, mixed thermic family of Lithic Udorthents. Typically, Chhaten soils have dark yellowish brown,

moderately acidic, sandy loam A horizon underlain by weathered rock granite gneiss parent material and hard rock.

Typifying Pedon: Chatten – sandy loam – forest

Horizon	Depth (cm)	Description
A	0-20	Dark yellowish Brown (10 YR 3/4) sandy loam; weak medium subangular blocky structure, soft, friable slightly sticky and slightly plastic; many coarse pores; many coarse roots; pH 5.4; slightly acidic
Cr	20-35	Weathered Rock
R	35+	Hard Rocks and boulders

Type location: Latitude 27°42'24" N and Longitude 88°33'45.6" E (78A/10) Vill. Chatten, Tehsil Lachung, Distt. North Sikkim, State Sikkim.

Ranges in characteristics: The thickness of the solum ranges from 20 to 25 cm. The thickness of A horizon ranges from 15 to 20 cm. The colour is in hue 10YR value 3 to 4, chroma 2 to 4. Its texture varies from sandy loam to loamy sand. The structure varies from fine to very fine, weak subangular blocky to granular.

Geographical Setting: Chatten soils are formed over weathered granite gneiss and occurs on very steeply sloping mountains. The climate is

temperate with mean annual temperature of 6.2°C and mean annual rainfall of 1720 mm.

Geographically associated soils: Chatten soils are associated with Gyer and Menshithang soils which are coarse loamy, mixed, thermic Typic Udorthents and loamy skeletal, mixed thermic, Lithic Haplumbrepts respectively .

Drainage and Permeability: Somewhat excessively drained with very rapid permeability

Land Use and Vegetation: Mainly under thin forest. The Vegetation includes utis, rhododendron, dwarf Junifers, etc.

Distribution and extent: The Chatten soils are extensively distributed in the soil map unit no. 45 and 17 in Lachung and Lachen in North Sikkim (538.3 ha) of the Sikkim State.

Interpretation: Chatten soils are very shallow, gravely and moderately acidic. The soils are not suitable for cultivation due to textural class and terrain condition. They should be kept under forest vegetation cover.

Interpretative groupings

Land capability sub-class : VIIe2s
Productivity rating (Forest) : Average (III)

ANALYTICAL DATA

Horizon	Depth (cm)	Size Class and particle diameter (mm)			Textural Class	Coarse fragments > 2 mm (%)
		Sand (2-0.05)	Silt (0.05– 0.002)	Clay (<0.002)		
A	0-20	70.9	23.8	5.3	sl	35

Depth (cm)	pH (1:2.5) H ₂ O	Organic carbon %	Extractable bases					CEC	Base Saturation %
			Ca	Mg	Na	K	SUM		
			<-----cmol (p+) kg ⁻¹ ----->						
0-20	5.4	1.6	3.2	0.6	0.2	0.3	4.3	7.5	57

26. LINGTHEM SERIES

Lingthem series is a member of coarse loamy, mixed, thermic family of Dystric Eutrudepts. Lingthem soils have very dark grayish brown, extremely acidic, Silt loam A horizon and dark brown, very strongly acidic, loamy B horizon.

Typifying Pedon : Lingthem – silt loam- forest

Horizon	Depth (cm)	Description
A	0-29	Very dark greyish brown (10 YR 3/2) silt loam; weak fine crumb structure, loose soft friable slightly sticky and slightly plastic; coarse gravels, many medium pores; fine few roots; pH 4.2; clear smooth boundary

Bw1	29-66	Very dark greyish brown (10 YR 3/2) silt loam; weak fine subangular blocky structure, loose friable slightly sticky and slightly plastic; few medium pores; fine very few roots; pH 4.5; gradual smooth boundary
Bw2	66-150	Dark brown (10 YR 4/3) loam; weak, fine sub angular blocky structure; loose soft, friable slightly sticky slightly plastic; coarse gravels, few common pores; pH 4.7;

Type location: Latitude 27°30'15" N and Longitude 88° 31 ' 10" E (78A/10) Vill. Lingthem, Tehsil. Mangan Dist. North Sikkim, State Sikkim

Ranges in characteristics: The thickness of the solum ranges from 100 to 120 cm. The thickness of A horizon ranges from 25 to 30 cm. The colour is in hue 10YR and value 2 to 3, chroma 1 to 2. Its texture ranges from loam to Silt loam. The thickness of B-horizon ranges from 90 to 110 cm. The colour is in hue 10YR, value 3 to 4 and Chroma 2 to 3. The texture varies from loam to silt loam and the structure varies from weak to moderate subangular blocky.

Geographical Setting: Lingthem soils are formed over weathered granite gneiss parent material on steeply sloping mid mountains. The climate is temperate with mean annual temperature of 6.3°C and mean annual rainfall of 2925 mm.

Geographically associated soils: Lingthem Soils are associated with Lema and Singhik soils which are loamy skeletal, mixed, thermic, Entic Hapludolls and coarse loamy mixed thermic Typc Dystrudepts.

Drainage and Permeability: Well drained with rapid permeability.

Land Use and Vegetation: Mainly under thick forest. The Vegetation includes Pakasaj, Lampate, Chilaune, Utis and Eucalyptus.

Distribution and extent: The Lingthem soils are extensively distributed in the soil map unit no. 29,27 and 55 in North Sikkim and West Sikkim (3251.1 ha) districts of the Sikkim State.

Interpretation: Lingthem soils are deep, medium textured and developed on steep slope, and these are not suitable for cultivation due to textural class and soil condition. These soils should be kept under vegetation cover with some indigeneous forest species.

Interpretative groupings

Land capability sub-class	:	Vle2
Productivity rating (Forest)	:	Good (II)

ANALYTICAL DATA

Horizon	Depth (cm)	Size Class and particle diameter (mm)			Textural Class	Coarse fragments > 2 mm (%)
		Sand (2-0.05)	Silt (0.05– 0.002)	Clay (<0.002)		
A	0-29	32.2	53.4	14.4	sil	8
Bw1	29-66	27.4	55.2	17.4	sil	10
Bw2	66- 150	35.4	46.2	18.4	l	16

Depth (cm)	pH (1:2.5) H ₂ O	Organic carbon %	Extractable bases					CEC	Base Saturation %
			Ca	Mg	Na	K	SUM		
<-----cmol (p+) kg ⁻¹ ----->									
0-29	4.2	2.4	2.9	1.1	0.3	0.2	4.5	11.2	40
29-66	4.5	2.2	3.3	2.1	0.4	0.1	5.9	13.5	44
66-150	4.7	1.2	4.5	2.3	0.4	0.1	7.3	14.6	80

27. LEMA SERIES

Lema series is a member of loamy skeletal, mixed, thermic family of Entic Hapludolls. Lema soils have gray, very strongly acidic, loamy. A horizon and dark grayish brown, moderately acidic, sandy loam B horizon.

Typifying Pedon: Lema – loam- cultivated

Horizon	Depth (cm)	Description
A	0-53	Grey (10 YR 2/1) loam; weak fine crumb subangular blocky structure, loose firm slightly sticky and slightly plastic; common fine porosity, few very fine common roots; fine and coarse gravels pH 5.0; abrupt smooth boundary
Bw1	53-74	Dark greyish brown (10 YR 4/4) sandy loam; weak fine subangular blocky structure, loose non sticky and non plastic fine medium porosity, common very fine few roots; fine and coarse gravels and stone, pH 5.5; gradual wavy boundary
Bw2	74-100	Brown to dark brown (10 YR 4/3) sandy loam; weak, fine angular blocky structure; loose friable slightly sticky; slightly plastic common fine medium porosity coarse gravels and stone, pH 6.3;

Type location: Latitude 27°39'40" N and Longitude 88° 44' 10" E (78A/10) Vill. Lema, Block – Chungthang Distt. North Sikkim, State Sikkim

Ranges in characteristics: The thickness of the solum ranges from 70 to 90 cm. The thickness of A horizon ranges from 35 to 50 cm. The colour is in hue 10YR and value 2 to 3, chroma 1 to 2. Its texture ranges

from sandy loam to loam. The thickness of B horizon ranges from 50 to 60 cm. The colour is in hue 10YR, value 4 to 6 and Chroma 3 to 4. The texture varies from loam to sandy loam and the structure varies from weak to moderate subangular blocky.

Geographical Setting: Lema soils are formed over weathered granite gneiss parent material on very steeply sloping mountains. The climate is temperate with mean annual temperature of 7.9°C and mean annual rainfall of 652 mm.

Geographically associated soils: Lema Soils are associated with the Chatten and Menstithang soils which are loamy skeletal mixed thermic, Lithic Udorthents and loamy skeletal mixed thermic Lithic Eutrudepts.

Drainage and Permeability: Well drained with rapid permeability.

Land Use and Vegetation: Mainly under thin forest with sparse vegetation. The Vegetation includes Mawa, Rani, Champ, Bhauni etc. In some areas maize and potato are also grown.

Distribution and extent: The Lema soils are extensively distributed in the soil map unit no. 41 and 45 in North Sikkim (3031.8 ha) district of the Sikkim State.

Interpretation: Lema soils are deep, light textured and somewhat poor in nutrient status. These soils are partially under agriculture. After proper terracing and addition of compost manures, the soils have been brought

under the cultivation of maize. However, in forest areas, indigenous species should be introduced to develop forestry

Interpretative groupings

Land capability sub-class : Vle2s
 Productivity rating (Forest) : Average (III)

Soil-site suitability

Crop	Soil Site Suitability Class	Farmer's yield	
		-----yield t/ha-----	Improved Yield
Potato	S3	2.3	3.3
Maize	S3	1.1	1.35

ANALYTICAL DATA

Horizon	Depth (cm)	Size Class and particle diameter (mm)			Textural Class	Coarse fragments > 2 mm (%)
		Sand (2-0.05)	Silt (0.05- 0.002)	Clay (<0.002)		
A	0-53	40.2	47.1	12.7	I	15
Bw1	53-74	76.4	11.9	11.7	sl	35
Bw2	74-100	75.0	14.3	10.7	sl	40

Depth (cm)	pH (1:2.5) H ₂ O	Organic carbon %	Extractable bases					CEC	Base Saturation %
			Ca	Mg	Na	K	SUM		
<-----cmol (p+) kg ⁻¹ ----->									
0-53	5.0	3.3	3.8	2.2	0.2	--	6.2	11.2	55
53-74	5.5	1.8	1.8	1.3	0.2	0.1	3.4	5.6	61
74-100	6.3	1.3	1.5	1.2	0.2	0.1	3.0	4.8	63

28. RUGLO SERIES

Ruglo series is a member of coarse loamy, mixed, thermic family of Entic Hapludolls. Ruglo soils have very dark gray, strongly acidic, loamy A horizon and very dark grayish brown, extremely acidic, sandy loam B horizon.

Typifying Pedon: Ruglo – sandy loam- cultivated

Horizon	Depth (cm)	Description
Ap	0-40	Very dark grey (10 YR 3/1) sandy loam; fine very weak granular structure, loose soft friable non sticky and non plastic; many fine pores, few very fine roots; pH 5.1; clear smooth boundary
Bw1	40-60	Very dark Greyish brown (10 YR 3/2) sandy loam; fine granular structure, loose soft friable non sticky and non plastic, medium fine porosity, few very fine roots; fine and coarse gravels and stone pH 5.5; gradual smooth boundary
Bw2	60-83	Brown to dark brown (10 YR 6/3) sandy loam; fine single grain structure, friable non sticky, non plastic medium porosity, coarse gravels and stone pH 4.4;

Type location: Latitude 27°32'0" N and Longitude 88° 28' 55" E (78A/6)
Vill. Ruglo, Distt. North Sikkim, State Sikkim

Ranges in characteristics: The thickness of the solum ranges from 70 to 90 cm. The thickness of A horizon ranges from 30 to 40 cm. The colour is in hue 10YR, value 2 to 3, chroma 1 to 2. Its texture ranges from loam to sandy loam. The thickness of B horizon ranges from 50 to 60 cm. The colour is in hue 10YR, value 3 to 6 and Chroma 2 to 3. The texture varies from sandy loam to loam and the structure varies from structure less to very weak granular.

Geographical Setting: Ruglo soils are formed over weathered granite gneiss parent material on steeply sloping mountains. The climate is temperate with mean annual temperature of 9.2°C and mean annual rainfall of 2885 mm.

Geographically associated soils: Ruglo Soils are associated with the Lingthem and Theng soils which are coarse loamy, mixed, thermic, Dystric Eutrudepts and loamy skeletal mixed thermic Typic Udorthents respectively.

Drainage and Permeability: Well drained with rapid permeability.

Land Use and Vegetation: Mainly under cultivation of maize. The natural vegetation includes Utis, Chilaune and bamboo, etc.

Distribution and extent: The Ruglo soils are extensively distributed in the soil map unit no. 35 in North Sikkim district (1590.5 ha) of the Sikkim State.

Interpretation: Ruglo Soil are moderately deep, light textured and somewhat medium in nutrient status. These soils are partially under agriculture. After proper terracing and addition of compost manures, the soils have been brought under the cultivation of maize.

Interpretative groupings

Land capability sub-class : Vle2
 Productivity rating (Forest) : Good (II)

Soil-site suitability

Crop	Soil Site Suitability	Farmer's yield	Improved Yield
	Class	-----yield t/ha-----	
Millet	S3	0.9	1.5
Maize	S3	1.05	1.25

ANALYTICAL DATA

Horizon	Depth (cm)	Size Class and particle diameter (mm)			Textural Class	Coarse fragments > 2 mm (%)
		Sand (2-0.05)	Silt (0.05-0.002)	Clay (<0.002)		
Ap	0-40	66.3	22.8	10.9	sl	5
Bw1	40-60	70.5	17.6	11.9	sl	10
Bw2	74-100	72.2	15.9	11.9	sl	20

Depth (cm)	pH (1:2.5 H ₂ O)	Organic carbon %	Extractable bases				CEC	Base Saturation %	
			Ca	Mg	Na	K			
<-----cmol (p+) kg ⁻¹ ----->									
SUM									
0-40	5.1	4.1	2.6	1.0	0.1	0.1	3.8	6.7	57

40-60	5.5	3.4	2.4	1.2	0.1	0.3	4.0	8.8	46
74-100	4.4	2.0	1.0	Tr	0.1	0.1	1.2	2.4	50

29. MENSITHANG SERIES

Menshithang series is a member of loamy skeletal, mixed, thermic family of Lithic Eutrudepts. Menshithang soils have very dark yellowish brown, moderately acidic, loamy sand A horizon and light yellowish brown, nearly neutral, sandy loam B horizon.

Typifying Pedon: Menshithang – loamy sand- forest

Horizon	Depth (cm)	Description
A	0-12	Very dark yellowish brown (10 YR 3/4) loamy sand; fine granular structure, loose, very friable and non sticky and non plastic; common coarse pores; many coarse roots; strongly acidic pH 5.4; clear smooth boundary
Bw1	12-37	Light yellowish brown (10 YR 6/4) sandy; very fine granular structureless, loose, very friable non sticky and non plastic; common coarse pores; many coarse roots; strongly acidic pH 5.4; clear smooth boundary
Cr	37-45	Weathered Rock
	45+	Hard Rock

Type location: Latitude 27°38'40" N and Longitude 88°36'44.3" E (78A/10) Vill. Menshithang, Tehsil Chungthang Distt. North Sikkim, State Sikkim

Ranges in characteristics: The thickness of the solum varies from 10 to 15 cm. The thickness of A horizon ranges from 5 to 15 cm. The colour is in hue 10YR and value 3 to 4, chroma 4. Its texture ranges from loamy sand to sandy loam. The thickness of B horizon ranges from 20 to 30 cm. The colour is in hue 10YR, value 3 to 6 and Chroma 2 to 3. The texture varies from loamy sand to sandy loam and the structure varies from structure less to very fine granular.

Geographical Setting: Menshithang soils are formed over weathered granite gneiss parent material on moderately steeply sloping mountains. The climate is temperate with mean annual temperature of 10°C and mean annual rainfall of 2350 mm.

Geographically associated soils: Menshithang Soils are associated with the Lema and Bitchu soils which are loamy skeletal, mixed, thermic, Entic Hapludolls and coarse loamy, mixed thermic, Humic Eutrudepts respectively.

Drainage and Permeability: Somewhat excessively drained with rapid permeability.

Land Use and Vegetation: Mainly under thick forest with dense canopy. The Vegetation includes okhrot, phalat and musre katus, etc.

Distribution and extent: The Menshithang soils are extensively distributed in the soil map unit no. 41 and 49 in North Sikkim (1977.2 ha) district of the Sikkim State.

Interpretation: Menshithang soils are shallow, light textured and the waterholding capacity is very low. The soils are mainly suitable for forest plantations.

Interpretative groupings

Land capability sub-class : Vle2s
 Productivity rating (Forest) : Average (III)

ANALYTICAL DATA

Horizon	Depth (cm)	Size Class and particle diameter (mm)			Textural Class	Coarse fragments > 2 mm (%)
		Sand (2-0.05)	Silt (0.05– 0.002)	Clay (<0.002)		
A	0-12	86.1	10.6	3.3	ls	30
Bw1	12-37	90.6	6.1	3.3	s	60

Depth (cm)	pH (1:2.5) H ₂ O	Organic carbon %	Extractable bases					CEC	Base Saturation %
			Ca	Mg	Na	K	SUM		
<-----cmol (p+) kg ⁻¹ ----->									
0-12	5.4	2.5	3.5	0.4	0.2	0.2	4.3	8.0	54
12-37	5.5	0.2	0.9	0.2	0.1	0.1	1.3	1.6	81

30. RAPUNG SERIES

Rapung series is a member of coarse loamy, mixed, thermic family of Typic Eutrudepts. Rapung soils have dark brown, strongly acidic, sandy loam. A horizon and B horizon is dark yellowish brown, strongly acidic, sandy loam. C horizon is Weathered rock.

Typifying Pedon: Rapung – sandy loam- forest

Horizon	Depth (cm)	Description
A	0-21	Dark brown (10 YR 3/3) sandy loam; weak subangular blocky structure, soft, friable and slightly sticky and slightly plastic; common coarse pores; many coarse roots; strongly acidic pH 4.9; clear smooth boundary.
Bw	21-45	Dark yellowish brown (10 YR 3/4) sandy loam, medium weak subangular blocky structure, friable and slightly sticky and slightly plastic; common coarse pores; many coarse roots; strongly acidic pH 4.9.
Cr	45-60	Weathered rock.

Type location: Latitude 27°38'38.8" N and Longitude 88°36'36.5" E (78A/10) Vill. Rapung, Tehsil Chungthang Distt. North Sikkim, State Sikkim.

Ranges in characteristics: Rapung Soils are shallow. The thickness of the solum varies from 30 to 45 cm. The thickness of A horizon ranges from 15 to 20 cm. The colour is in hue 10YR and value 3 to 4, chroma 3. Its texture ranges from sandy loam to loamy sand. The structure varies from fine to very fine weak and subangular blocky. The thickness of B horizon ranges from 25 to 40 cm. The colour is in hue 10YR, value 3 to 4 and Chroma 4 to 6. The texture varies from sandy loam to loamy sand and the structure varies from weak to moderate subangular blocky.

Geographical Setting: Rapung soils are formed over weathered granite gneiss parent material steeply sloping mountains. The climate is temperate with mean annual temperature of 7.9°C and mean annual rainfall of 2050 mm.

Geographically associated soils: Rapung Soils are associated with the Menshithang and Singhik soils which are loamy skeletal, mixed, thermic, Lithic Eutrudepts and coarse loamy, mixed, thermic, Typic Dystrudepts respectively.

Drainage and Permeability: Somewhat excessively drained with rapid permeability.

Land Use and Vegetation: Mainly under thick forest with sparse vegetation. The Vegetation includes utis, chiloune, dhupitc.

Distribution and extent: The Rapung soils are extensively distributed in the soil map unit no. 49 and 23 in North Sikkim (1628.9 ha) district of the Sikkim State.

Interpretation: Rapung soils are shallow, light textured and the waterholding capacity is very low. The soils are strongly acidic. The soils are mainly suitable for forest species.

Interpretative groupings

Land capability sub-class : Vle2s
 Productivity rating (Forest) : Average (III)

ANALYTICAL DATA

Horizon	Depth (cm)	Size Class and particle diameter (mm)			Textural Class	Coarse fragments > 2 mm (%)
		Sand (2-0.05)	Silt (0.05– 0.002)	Clay (<0.002)		
A	0-21	69.8	26.5	3.7	SI	10
Bw	21-45	64.7	30.6	4.7	SI	15

Depth (cm)	pH (1:2.5) H ₂ O	Organic carbon %	Extractable bases					CEC	Base Saturation %
			Ca	Mg	Na	K	SUM		
<-----cmol (p+) kg ⁻¹ ----->									
0-21	4.9	4.6	3.6	0.3	.0.3	0.3	4.4	12.0	37
21-45	4.9	2.3	2.3	0.3	0.2	0.1	2.9	7.0	41

31. THANGU SERIES

Thangu series is a member of loamy-skeletal, mixed, thermic family of Typic Dystrocrepts. Typically, Thangu soils have very dark grayish brown, very strongly acidic, silt loam A horizon and B horizon is dark yellowish brown, very strongly to strongly acidic.

Typifying Pedon: Thangu – silt loam- cultivated

Horizon	Depth (cm)	Description
Ap	0-25	Very dark grayish brown (10 YR 3/2) silt loam; very fine weak crumb structure, loose, friable and slightly sticky and slightly plastic; common fine pores; coarse many roots; very strongly acidic pH 4.5; abrupt broken boundary.
Bw1	25-46	Dark yellowish brown (10 YR 3/6) loam, very fine weak crumb/subangular blocky structure, friable and slightly sticky and slightly plastic; many very fine pores; many very fine and few roots; coarse gravels and stones. Very strongly acidic, pH 4.7; diffuse broken boundary.

w2	46-59	Dark yellowish brown (10 YR 4/6) sandy loam, very fine structure, loose and slightly sticky and slightly plastic, fine many medium pores; common very fine roots; coarse gravels and stones pH 5.1; very strongly acidic coarse gravels and stone.
Cr	59+	Weathered Rock.

Type location: Latitude 27°53'55" N and Longitude 88°32'30" E (78A/9) Vill. Thangu, Tehsil Lachen Distt. North Sikkim, State Sikkim.

Ranges in characteristics: The thickness of the solum varies from 50 to 60 cm. The thickness of A horizon ranges from 20 to 25 cm. The colour is in hue 10YR and value 2 to 3, chroma 1 to 2. Its texture varies from loam to silt loam. The depth of B horizon ranges from 35 to 40 cm. The colour is in hue 10YR, value 3 to 4 and chroma 4 to 6. The texture varies from sandy loam to loamy sand and the structure is very fine, weak to structureless and crumb.

Geographical Setting: Thangu soils are formed over weathered granite gneiss parent material on steeply sloping extremely high mountains at an elevation of 2750 m above MSL. The climate is temperate with mean annual temperature of 2.3°C and mean annual rainfall of 828.5 mm.

Geographically associated soils: Thangu Soils are associated with the Yumthang and Kalep soils which are coarse loamy, mixed, mesic

Humic Pachic Dystrudepts and coarse loamy, mixed, mesic Humic Dystrocryepts, respectively.

Drainage and Permeability: Well drained with very rapid permeability.

Land Use and Vegetation: Thangu soils are partially under forest cover and partially under agriculture. The Vegetation includes Dhupi Junifers and Rhododendron etc.

Distribution and extent: The Thangu soils are extensively distributed in the soil map unit no.63 in the North Sikkim district of the Sikkim State having an area of 72446.8 ha.

Interpretation: Thangu Soil are moderately shallow and extremely, light textured extremely gravelly in nature. However, with proper management practices these soils may be brought under cultivation of horticultural crops. Some of the areas are under forest where indigenous forest species may be introduced in afforestation programme.

Interpretative groupings

Land capability sub-class	:	Vle2s
Productivity rating (Forest)	:	Average (III)

Soil-site suitability

Crop	Soil Site Suitability Class	Farmer's yield	Improved Yield
		-----yield t/ha-----	
Maize	S3	1.1	1.3

ANALYTICAL DATA

Horizon	Depth (cm)	Size Class and particle diameter (mm)			Textural Class	Coarse fragments > 2 mm (%)
		Sand (2-0.05)	Silt (0.05– 0.002)	Clay (<0.002)		
Ap	0-25	35.0	51.7	13.3	sil	10
Bw1	25-46	49.0	37.7	13.3	l	25.0
Bw2	46-59	53.4	33.3	13.3	sl	30

Depth (cm)	pH (1:2.5) H ₂ O	Organic carbon %	Extractable bases					CEC	Base Saturation %
			Ca	Mg	Na	K	SUM		
			<-----cmol (p+) kg ⁻¹ ----->						
0-25	4.5	4.3	2.8	1.2	0.5	0.5	5.0	10.2	49
25-46	4.7	3.8	3.0	1.2	0.5	0.3	5.0	9.6	52
46-59	5.1	2.6	3.4	1.6	0.4	0.1	5.5	9.8	56

32. MANUL SERIES

Manul series is a member of coarse loamy, mixed, thermic family of Typic Dystrudepts. Manul soils have very dark yellowish brown, moderately acidic, silt loam A horizon and B horizon is dark yellowish brown, moderately acidic.

Typifying Pedon: Manul – sandy loam- cultivated

Horizon	Depth (cm)	Description
Ap	0-22	Dark yellowish brown (10 YR 3/4) sandy loam; medium weak subangular blocky structure, soft, friable and slightly sticky and slightly plastic; many coarse pores; common fine roots; moderately acidic pH 5.4; clear smooth boundary.
Bw1	22-53	Dark yellowish brown (10 YR 4/4) sandy loam; medium weak subangular blocky structure, soft, friable sticky and plastic; common fine pores; few fine roots; moderately acidic pH 5.4; gradual smooth boundary.
Bw2	53-76	Dark yellowish brown (10 YR 4/6) sandy loam, medium moderate subangular blocky structure friable, slightly sticky and slightly plastic; few fine pores; few very fine roots; moderately acidic pH 5.5.
Cr	76+	Weathered Rock.

Type location: Latitude 27°30'57.1" N and Longitude 88°33'44.1" E (78A/10) Vill. Manul, Tehsil Mangan Distt. North Sikkim, State Sikkim.

Ranges in characteristics: The thickness of the solum varies from 60 to 75 cm. The thickness of A horizon ranges from 10 to 25 cm. The

colour is in hue 10YR and value 3 to 4, chroma 4. Its texture varies from loam to sandy loam. The depth of B horizon ranges from 50 to 60 cm. The colour is in hue 10YR, value 2 to 4 and chroma 4 to 6. The texture varies from sandy loam to loamy sand and the structure is moderate subangular blocky.

Geographical Setting: Manul soils are formed over weathered granite gneiss on steeply sloping mountains at an elevation of 2700 m above MSL. The climate is temperate with mean annual temperature of 6.8°C and mean annual rainfall of 2250 mm.

Geographically associated soils: Manul soils are associated with the Gyer soils which is coarse loamy, mixed, thermic, Typic Udorthents.

Drainage and Permeability : Well drained with very rapid permeability.

Land Use and Vegetation: Manul soils are partially under forest cover and partially under agriculture. The Vegetation includes Dhupi Junifers and Rhododendron etc.

Distribution and extent: The Manul soils are extensively distributed in the soil map unit no. 33 in the North Sikkim (1547.1 ha) district of the Sikkim State.

Interpretation: Manul soils are moderately deep light textured. However, these soils are cultivated to maize with proper management practices like terracing, etc.

Interpretative groupings

Land capability sub-class : Vle2
 Productivity rating (Forest) : Average (III)

Crop	Soil Site Suitability	Farmer's yield	Improved Yield
	Class	-----yield t/ha-----	
Maize	S3	1.05	1.2

ANALYTICAL DATA

Horizon	Depth (cm)	Size Class and particle diameter (mm)			Textural Class	Coarse fragments > 2 mm (%)
		Sand (2-0.05)	Silt (0.05– 0.002)	Clay (<0.002)		
Ap	0-22	60.7	31.6	7.7	sl	15
Bw1	22-53	56.0	35.3	8.7	sl	20
Bw2	53-76	58.2	31.5	10.3	sl	35

Depth (cm)	pH (1:2.5) H ₂ O	Organic carbon %	Extractable bases					CEC	Base Saturation %
			Ca	Mg	Na	K	SUM		
								<-----cmol (p+) kg ⁻¹ ----->	
0-22	5.4	3.7	5.0	1.0	0.4	0.4	6.8	12.4	55
22-53	5.4	3.1	4.0	1.0	0.2	0.3	5.5	11.3	49
53-76	5.5	2.3	3.6	0.5	0.2	0.3	4.6	10.5	44

33. MALTIN SERIES

Maltin series is a member of coarse loamy, mixed, thermic family of Typic Dystrudepts. Maltin soils have yellowish brown, moderately acidic, sandy loam A horizon and B horizon is Dark yellowish brown, moderately acidic.

Typifying Pedon: Maltin – sandy loam- forest

Horizon	Depth (cm)	Description
A	0-40	Yellowish brown (10 YR 5/4) sandy loam; fine granular structure, loose, very friable, non sticky and non plastic; common coarse pores; common coarse roots; moderately acidic pH 5.5; clear smooth boundary
Bw1	40-60	Dark yellowish brown (10 YR 4/6) sandy loam; fine weak granular structure, very friable non sticky and non plastic; many coarse pores; common coarse roots; moderately acidic pH 5.7; gradual smooth boundary
Bw2	60-83	Dark yellowish brown (10 YR 4/4) sandy loam, fine weak granular structure friable, slightly sticky and slightly plastic; many medium pores; common medium roots; slightly acidic pH 6.1.

Type location: Latitude 27°29'38" N and Longitude 88°33'12" E (78A/10) Vill. Maltin, Tehsil Mangan Distt. North Sikkim, State Sikkim.

Ranges in characteristics: Maltin soils are moderately deep. The thickness of A horizon ranges from 10 to 40 cm. The colour is in hue 10YR and value 4 to 5, chroma 4. Its texture varies from sandy loam to loamy sand. The structure is fine granular. The depth of B horizon ranges from 30 to 70 cm. The colour is in hue 10YR, value 3 to 4 and Chroma 6 to 4. The texture varies from sandy loam to loamy sand and the structure is fine weak granular.

Geographical Setting: Maltin soils are formed over weathered granite gneiss on steeply sloping mountains at an elevation of 2850 m above MSL. The climate is temperate with mean annual temperature of 8.9°C and mean annual rainfall of 2250 mm.

Geographically associated soils: Maltin Soils are associated with the Lachen soils which is coarse loamy, mixed, thermic, Lithic Udorthents.

Drainage and Permeability: Excessively drained with rapid permeability.

Land Use and Vegetation: Maltin soils are under moderately dense forest cover. The vegetation includes utis, chiloune and bushy plants, etc.

Distribution and extent: The Maltin soils are extensively distributed soil map unit no.62 in the North Sikkim (1531.7) district of the Sikkim State

Interpretation: Maltin Soil are moderately deep and full of gravels, lighter in texture and poor in water holding capacity and is suitable for forestry.

Interpretative groupings

Land capability sub-class : Vle2s
 Productivity rating (Forest) : Average (III)

ANALYTICAL DATA

Horizon	Depth (cm)	Size Class and particle diameter (mm)			Textural Class	Coarse fragments > 2 mm (%)
		Sand (2-0.05)	Silt (0.05–0.002)	Clay (<0.002)		
A	0-40	66.8	27.9	5.3	sl	17
Bw1	40-60	67.8	25.9	6.3	sl	23
Bw2	60-83	61.8	31.9	6.3	sl	38

Depth (cm)	pH (1:2.5) H ₂ O	Organic carbon %	Extractable bases					CEC	Base Saturation %
			Ca	Mg	Na	K	SUM		
<-----cmol (p+) kg ⁻¹ ----->									
0-40	5.5	1.8	4.5	0.8	0.2	0.3	5.8	8.5	68
40-60	5.7	1.1	3.9	0.9	0.2	0.4	5.4	7.5	72
60-83	6.1	1.5	5.2	0.8	0.2	0.4	6.6	8.4	79

34. SINGHIK SERIES

Singhik series is a member of coarse loamy, mixed, thermic family of Typic Dystrudepts. Singhik soils have dark brown, moderately acidic, loamy sand. A horizon and B horizon is dark yellowish brown, moderately acidic loamy sand.

Typifying Pedon: Singhik – loamy sand - cultivated

Horizon	Depth (cm)	Description
Ap	0-23	Dark brown (10 YR 3/3) loamy sand; medium weak subangular blocky structure, soft, friable and slightly sticky and slightly plastic; many coarse pores; many coarse roots; strongly acidic pH 4.7; clear smooth boundary
Bw	23-56	Dark yellowish brown (10 YR 3/6) loamy sand; fine weak granular structure, very friable non sticky and non plastic; many coarse pores; common coarse roots; nearly neutral pH 6.9;
Cr	56+	Granite Gneiss weathered rock

Type location: Latitude 27°30'15" N and Longitude 88°31'20" E (78A/10) Vill. Singhik, Tehsil Mangan Distt. North Sikkim, State Sikkim

Ranges in characteristics: Singhik soils are moderately shallow. The thickness of A horizon ranges from 10 to 25 cm. The colour is in hue

10YR and value 3 to 4, chroma 3. Its texture varies from sandy loam to loamy sand the structure is fine granular. The depth of B-horizon ranges from 20 to 40 cm. The colour is in hue 10YR, value 3 to 4 and Chroma 6. The texture is loamy sand and the structure varies from fine weak granular to very is fine weak granular.

Geographical Setting: Singhik soils are formed over weathered granite gneiss on steeply sloping mountains at an elevation of 2850 m above MSL. The climate is temperate with mean annual temperature of 9.3°C and mean annual rainfall of 2995 mm.

Geographically associated soils: Singhik Soils are associated with Tibik, Ruglo and Lingthem soils which are loamy skeletal, mixed, thermic, Lithic Udorthents; coarse loamy, mixed, thermic, Entic Hapludolls and coarse loamy, mixed, thermic, Pachic Haplumbrepts, respectively.

Drainage and Permeability: Somewhat Excessively drained with rapid permeability.

Land Use and Vegetation: Singhik soils are partially cultivated to maize. Natural Vegetation includes utis, bushes.

Distribution and extent: The Singhik soils are extensively distributed in the soil map unit no. 9, 21 and 23 in the North Sikkim (1641.1 ha) district of the Sikkim State.

Interpretation: Singhik soils are moderately shallow, lighter in texture and poor in water holding capacity and is marginally suitable for maize.

Interpretative groupings

Land capability sub-class : Vle2
 Productivity rating (Forest) : Good (II)

Soil-site suitability

Crops	Soil Site Suitability Class	Farmer's yield	Improved Yield
		-----yield t/ha-----	
Maize	S3	1.05	1.21

ANALYTICAL DATA

Horizon	Depth (cm)	Size Class and particle diameter (mm)			Textural Class	Coarse fragments > 2 mm (%)
		Sand (2-0.05)	Silt (0.05– 0.002)	Clay (<0.002)		
Ap	0-23	73.8	22.9	3.3	Is	25
Bw	23-56	72.3	23.4	4.3	Is	40

Depth (cm)	pH (1:2.5) H ₂ O	Organic carbon %	Extractable bases					CEC	Base Saturation %
			Ca	Mg	Na	K	SUM		
			<-----cmol (p+) kg ⁻¹ ----->						
0-23	4.7	8.5	4.8	1.3	0.4	0.5	7.0	14.5	48
3-56	7.9	3.3	3.8	0.4	0.2	0.4	4.6	6.3	73

35. BYUMA SERIES

Byuma series is a member of coarse loamy, mixed, thermic family of Typic Dystrudepts. Byuma soils have very dark brown, slightly acidic, sandy loam A horizon and B horizon is very dark greyish brown to very dark grey, slightly acidic sandy loam.

Typifying Pedon: Byuma – sandy loam - cultivated

Horizon	Depth (cm)	Description
Ap	0-18	Dark brown (10 YR 3/3) sandy loam; fine weak granular structure, soft, very friable and non sticky and non plastic; common coarse pores; common fine roots; strongly acidic pH 5.1; abrupt smooth boundary
Bw1	18-40	Very dark greyish brown (10 YR 3/2) sandy loam; fine weak granular structure, very friable slightly sticky and slightly plastic; many coarse pores; few fine roots; strongly acidic pH 5.1, gradual wavy boundary
Bw2	40-68	Very dark grey (10 YR 3/1), sandy loam; fine weak granular structure, friable slightly sticky and slightly plastic; common fine pores; few fine roots; strongly acidic pH 5.2,
Cr	68+	Granite gneiss weathered rock.

Type location: Latitude 27°37'47.8" N and Longitude 88°42-7.5" E (78A/10) Vill. Byuma, Tehsil Chungthang Distt. North Sikkim, State Sikkim.

Ranges in characteristics: Byuma Soils are moderately shallow. The thickness of A horizon ranges from 16 to 18 cm,. The colour is in hue 10YR and value 3 to 4, chroma 3. Its texture varies from sandy loam to loamy sand. The structure is fine granular to weak. The depth of B horizon ranges from 40 to 50 cm. The colour is in hue 10YR, value 3 to 4 and chroma 1 to 2. The texture is sandy loam and the structure varies from fine weak granular to very medium weak granular.

Geographical Setting: Byuma soils are formed over weathered granite gneiss on steeply sloping mountains at an elevation of 2500 m above MSL. The climate is temperate with mean annual temperature of 9.8°C and mean annual rainfall of 2050 mm.

Geographically associated soils: Byuma soils are associated with Ship and Lachung soils which are loamy skeletal, mixed, thermic, Lithic Udorthents and loamy skeletal, mixed, thermic, Typic Udorthents respectively.

Drainage and Permeability: Well drained with rapid permeability.

Land Use and Vegetation: Byuma soils are mainly cultivated to maize. Natural Vegetation includes utis, chilaune etc.

Distribution and extent: The Byuma soils are extensively distributed in the soil map unit no. 57 & 60 in the North Sikkim (5084.9) district of the Sikkim State.

Interpretation: Byuma soils are moderately shallow, lighter in texture and poor in water holding capacity and is marginally suitable for maize.

Interpretative groupings

Land capability sub-class : Vle2s

Productivity rating (Forest) : Average (III)

Soil-site suitability

Crops	Soil Site Suitability Class	Farmer's yield	Improved Yield
		-----yield t/ha-----	
Maize	S3	1.1	1.25

ANALYTICAL DATA

Horizon	Depth (cm)	Size Class and particle diameter (mm)			Textural Class	Coarse fragments > 2 mm (%)
		Sand	Silt	Clay		
		(2-0.05)	(0.05– 0.002)	(<0.002)		
Ap	0-18	59.7	36.0	4.3	sl	10
Bw1	18-40	58.0	36.7	5.3	sl	15
Bw2	40-68	59.6	35.1	5.3	sl	20

Depth (cm)	pH (1:2.5) H ₂ O	Organic carbon %	Extractable bases					CEC	Base Saturation %
			Ca	Mg	Na	K	SUM		
			<-----cmol (p+) kg ⁻¹ ----->						
0-18	5.1	5.85	5.6	0.6	0.2	0.4	6.8	16.0	43

18-40	5.1	5.25	4.0	0.4	0.2	0.2	4.8	15.4	31
40-68	5.2	4.84	3.3	0.3	0.2	0.2	4.0	14.2	28

36. BITCHU SERIES

Bitchu series is a member of coarse loamy, mixed, thermic family of Entic Haplumbrepts. Bitchu soils have very dark grayish brown, strongly acidic, sandy loam A horizon and B horizon is brown to dark brown, strongly acidic sandy loam.

Typifying Pedon: Bitchu – sandy loam - forest

Horizon	Depth (cm)	Description
A	0-27	Very dark greyish Brown (10 YR 3/2) sandy loam; medium weak subangular blocky structure, very soft, friable slightly sticky and slightly plastic; medium many pores; fine common roots; strongly acidic pH 4.1, gradual wavy boundary
Bw	27-55	Brown to dark brown (10 YR 4/3) sandy loam; medium weak subangular blocky structure, friable, slightly sticky and slightly plastic; coarse many pores; fine few roots; strongly acidic pH 4.9,
Cr	55+	Granite gneiss weathered rock

Type location: Latitude 27°36'31.3" N and Longitude 88°34'35" E (78A/10) Vill. Bitchu, Tehsil Chungthang Distt. North Sikkim, State Sikkim.

Ranges in characteristics: Bitchu soils are moderately shallow. The thickness of A horizon ranges from 20-25 cm. The colour is in hue 10YR and value 3 to 4, chroma 2. Its texture varies from sandy loamy to loam. The structure is medium, moderate, subangular blocky. The depth of B horizon ranges from 30 to 50 cm. The colour is in hue 10YR, value 3 to 4 and Chroma 3. The texture is loamy to sandy loam

Geographical Setting: Bitchu soils are developed over weathered granite gneiss and occurs on steeply sloping mountains at an elevation of 2850 m above MSL. The climate is temperate with mean annual temperature of 7.8°C and mean annual rainfall of 1850 mm.

Geographically associated soils: Bitchu soils are associated with Chatten and Lachen soils which are loamy skeletal, mixed, thermic Lithic Udorthents and coarse loamy, mixed, thermic, Lithic Udorthents.

Drainage and Permeability: Somewhat Excessively drained with moderate permeability.

Land Use and Vegetation : Degraded Forest land. Natural vegetation includes utis, grassland, dhupi etc.

Distribution and extent: The Bitchu soils are extensively distributed in soil map unit no 31 and 53 in the North Sikkim (1168 ha) district of the Sikkim State.

Interpretation: Bitchu soils are moderately shallow, lighter in texture, strongly acidic and very poor in nutrient content. With proper management practices may be reclaimed for forestry.

Interpretative groupings

Land capability sub-class : VIIe2s

Productivity rating (Forest) : Average (III)

ANALYTICAL DATA

Horizon	Depth (cm)	Size Class and particle diameter (mm)			Textura I Class	Coarse fragments > 2 mm (%)
		Sand (2-0.05)	Silt (0.05– 0.002)	Clay (<0.002)		
A	0-27	55.6	33.1	5.3	sl	25
Bw	27-55	61.1	33.6	5.3	sl	27

Depth (cm)	pH (1:2.5) H ₂ O	Organic carbon %	Extractable bases					CEC	Base Saturation %
			Ca	Mg	Na	K	SUM		
<-----cmol (p+) kg ⁻¹ ----->									
0-27	4.1	6.54	1.2	0.3	0.3	0.2	2.0	14.0	14
27-55	4.9	3.47	1.3	0.4	0.2	0.1	2.0	9.0	22

37. PAKEL SERIES

Pakel series is a member of coarse loamy, mixed, thermic family of Entic Haplumbrepts. Pakel soils have very dark yellowish brown, moderately acidic, loamy sand A horizon and B horizon is Dark yellowish brown, moderately acidic loamy sand.

Typifying Pedon: Pakel – loamy sand - forest

Horizon	Depth (cm)	Description
A	0-23	Dark yellowiish brown (10 YR 4/4) loamy sand; fine weak granular structure, loose, very friable, non sticky and non plastic; common coarse pores; common medium roots; moderately acidic pH 5.1, clear smooth boundary
Bw	23-52	Dark yellowiish brown (10 YR 3/4) loamy sand; fine weak granular structure, very friable, Non sticky and non plastic; coarse many pores; medium common roots; moderately acidic pH 5.0
Cr	52+	Granite gneiss weathered rock

Type location: Latitude 27°32'32" N and Longitude 88°37'55" E (78A/10) Vill. Pakel, Tehsil Mangan Distt. North Sikkim, State Sikkim.

Ranges in characteristics: Pakel soils are moderately shallow. The thickness of A horizon ranges from 10 to 25 cm. The colour is in hue 10YR and value 3 to 4, chroma 4. Its texture varies from loamy sand to sand. The structure is fine weak granular. The depth of B horizon ranges from 20 to 50 cm. The colour is in hue 10YR, value 3 to 4 and chroma 3. The texture is loamy to sandy loam. Structure varies from fine weak granular to very fine structureless.

Geographical Setting: Pakel soils are developed on weathered granite gneiss and occurs on steeply sloping mountains at an elevation of 3050 m above MSL. The climate is temperate with mean annual temperature of 8.9°C and mean annual rainfall of 1890 mm.

Geographically associated soils: Pakel Soils are associated with Tibik and Theng soils which are loamy skeletal, mixed, thermic, Lithic Udorthents and loamy skeletal, mixed, thermic, Typic Udorthents respectively.

Drainage and Permeability: Somewhat Excessively drained with rapid permeability.

Land Use and Vegetation : Degraded Forest land. Natural vegetation utis, grassland, dhupi, siris etc.

Distribution and extent: The Pakel soils are extensively distributed in the soil map unit no. 19 and 47 in the North Sikkim (1536.6 ha) district of the Sikkim State.

Interpretation: Pakel soils are moderately shallow, lighter in texture, strongly in acidic and very poor in nutrient content. With proper management practices may be reclaimed for forestry.

Interpretative groupings

Land capability sub-class : VIe2
 Productivity rating (Forest) : Average (III)

ANALYTICAL DATA

Horizon	Depth (cm)	Size Class and particle diameter (mm)			Textural Class	Coarse fragments > 2 mm (%)
		Sand (2-0.05)	Silt (0.05–0.002)	Clay (<0.002)		
A	0-23	76.2	20.5	3.3	Is	15
Bw1	23-52	75.7	21.0	3.3	Is	25

Depth (cm)	pH (1:2.5) H ₂ O	Organic carbon %	Extractable bases					CEC	Base Saturation %
			Ca	Mg	Na	K	SUM		
<-----cmol (p+) kg ⁻¹ ----->									
0-23	5.1	8.43	5.2	1.5	0.3	0.4	7.4	14.3	52
23-52	5.0	4.01	3.8	1.3	0.2	0.3	5.6	11.2	50

38. LACHEN SERIES

Lachen series is a member of coarse loamy, mixed, thermic family of Lithic Udorthents. Lachen soils have very black to very dark greyish

brown, moderately acidic, sandy loamy A horizon and weathered granite gneiss in Cr horizon.

Typifying Pedon: Lachen – sandy loam - forest

Horizon	Depth (cm)	Description
A	0-17	Black (10 YR 2/1) sandy loam; medium weak subangular blocky structure, soft, friable, slightly sticky and slightly plastic; coarse common pores; medium many roots; strongly acidic pH 5.2, abrupt wavy boundary
AC	17-35	Very dark greyish brown (10 YR 3/2) loamy sand; medium weak subangular blocky structure, friable, slightly sticky and slightly plastic; coarse many pores; medium many roots; strongly acidic pH 5.3
Cr	35-40	Granite gneiss weathered rock
R	40+	Hard rock

Type location: Latitude 27°43'21.3" N and Longitude 88°33'21.5" E (78A/10) Vill. Lachen P.S. Lachen Distt. North Sikkim, State Sikkim.

Ranges in characteristics: Lachen soils are shallow. The thickness of A horizon ranges from 12-16 cm. The colour is in hue 10YR and value 2 to 3, chroma 1. Its texture varies from sandy loam to sandy clay loam. The structure is fine weak to moderate medium subangular blocky. Its

sub surface horizon is 20-30 cm thick. Its colour is in hue 10 YR value 3-4 and chroma 2. The texture varies from loamy sand to sandy loam

Geographical Setting: Lachen soils are formed over weathered granite gneiss and occurs on steeply sloping mountains at an elevation of 3100 m above MSL. The climate is temperate with mean annual temperature of 3.8°C and mean annual rainfall of 1657 mm.

Geographically associated soils Lachen Soils are associated with Maltin and Bitchu soils which are Coarse loamy, mixed, thermic, and Typic Dystrudepts and Coarse loamy, mixed, thermic, Entic Haplumbrepts respectively

Drainage and Permeability: Somewhat Excessively drained with rapid permeability.

Land Use and Vegetation: Degraded Forest land. Natural Vegetation Bamboo, Dhupi etc.

Distribution and extent: The Lachen soils are extensively distributed in soil map unit no.53 and 62 in the North Sikkim (1701.8 ha) district of the Sikkim State.

Interpretation: Lachen Soil are shallow, lighter in texture, and very poor in available water holding capacity. These soils are mainly suitable for forestry.

Interpretative groupings

Land capability sub-class	:	Vle2s
Productivity rating (Forest)	:	Average (III)

ANALYTICAL DATA

Horizon	Depth (cm)	Size Class and particle diameter (mm)			Textural Class	Coarse fragments > 2 mm (%)
		Sand (2-0.05)	Silt (0.05– 0.002)	Clay (<0.002)		
		A	0-17	67.5		
AC	17-35	76.5	19.8	3.3	ls	20

Depth (cm)	pH (1:2.5) H ₂ O	Organic carbon %	Extractable bases					CEC	Base Saturation %
			Ca	Mg	Na	K	SUM		
			<-----cmol (p+) kg ⁻¹ ----->						
0-17	5.2	19.7	9.8	1.0	0.2	0.3	11.3	26.8	42
17-35	5.3	5.71	7.9	0.4	0.2	0.1	8.6	18.0	48

39. SHIP SERIES

Ship series is a member of loamy skeletal, mixed, thermic family of Lithic Udorthents. Ship soils have dark brown, moderately acidic, sandy loamy A horizon underlain by weathered granite gneiss and hard rocks.

Typifying Pedon: Ship – sandy loam - forest

Horizon	Depth (cm)	Description
A	0-20	Dark brown (10 YR 3/3) sandy loam; fine weak granular blocky structure, loose, very friable, non sticky and non plastic; many coarse pores; many coarse roots; moderately acidic pH 6.2,
Cr	20-30	Granite gneiss weathered rock
R	30+	Hard rock

Type location: Latitude 27°33'19.4" N and Longitude 88°38'37" E (78A/10) Vill. Ship Tehsil Chungthang Distt. North Sikkim, State Sikkim.

Ranges in characteristics: Ship soils are very shallow. The thickness of A horizon ranges from 15 to 20 cm. The colour is in hue 10YR and value 3 to 4, chroma 3 to 6. Its texture varies from sandy loam to loamy sand. The structure is very fine weak granular.

Geographical Setting: Ship soils are formed over weathered granite gneiss and occurs on very steeply sloping mountains. The climate is temperate with mean annual temperature of 7.5°C and mean annual rainfall of 1725 mm.

Geographically associated soils: Ship soils are associated with Chatten and Gyer soils which are loamy skeletal, mixed thermic, Lithic Udorthents and loamy skeletal, mixed thermic, Typic Udorthents.

Drainage and Permeability: Excessively drained with very rapid permeability.

Land Use and Vegetation: Degraded forest land. Natural vegetation includes utis, chilaune, dhupi, panksaj etc.

Distribution and extent: The Ship soils are extensively distributed in the soil map unit no. 47, 55 and 57 in the North Sikkim district (6743.1 ha) of the Sikkim State.

Interpretation: Ship soils are very shallow, full of gravels, lighter in texture, and very poor in nutrient contents. However, with proper management practices, these soils may be reclaimed for forestry development.

Interpretative groupings

Land capability sub-class : VIIe2s
 Productivity rating (Forest) : Average (III)

ANALYTICAL DATA

Horizon	Depth (cm)	Size Class and particle diameter (mm)			Textural Class	Coarse fragments > 2 mm (%)
		Sand (2-0.05)	Silt (0.05– 0.002)	Clay (<0.002)		
A	0-20	66.6	26.7	6.7	sl	50-60



CISMHR

Depth (cm)	pH (1:2.5) H ₂ O	Organic carbon %	Extractable bases					CEC	Base Saturation %
			Ca	Mg	Na	K	SUM		
			<-----cmol (p+) kg ⁻¹ ----->						
0-20	6.2	2.22	4.4	1.1	0.4	0.5	6.4	8.6	55

40. TIBIK SERIES

Tibik series is a member of loamy-skeletal, mixed, thermic family of Lithic Udorthents. Tibik soils have very black to very dark greyish brown, slightly acidic, loamy sand A horizon and weathered granite gneiss in Cr horizon.

Typifying Pedon: Tibik – loamy sand - forest

Horizon	Depth (cm)	Description
A	0-21	Very dark greyish brown (10 YR 3/2) loamy sand; fine granular structure, very loose, non sticky and non plastic; many coarse pores; many coarse roots; slightly acidic pH 5.3
AC	21-40	Dark yellowish brown (10 YR 3/4) sandy loam; fine granular structure, moderately acidic pH 5.6
Cr	40+	Granite Gneiss weathered rock

Type location: Latitude 27°36'18.4" N and Longitude 88°39'6.1" E (78A/10) Vill. Tibik, P.S.Chungthang Distt. North Sikkim, State Sikkim.

Ranges in characteristics: Tibik soils are shallow. The thickness of A horizon ranges from 30 to 40cm. The colour is in hue 10YR and value 3 to 4, chroma 2. Its texture varies from sandy loam to loamy sand. The structure is fine structureless to fine weak granular blocky.

Geographical Setting: Tibik soils are formed over weathered granite gneiss and occurs on steeply sloping mountains at an elevation of 3050 m above MSL. The climate is temperate with mean annual temperature of 8.5°C and mean annual rainfall of 1800 mm.

Geographically associated soils: Tibik soils are associated with Maltin and Lachen soils which are coarse loamy mixed, thermic Typic Dystrudepts and coarse loamy mixed, thermic Lithic Udorthents respectively

Drainage and Permeability: Excessively drained with good permeability

Land Use and Vegetation: Degraded Forest. Natural Vegetation includes utis, chilaune etc.

Distribution and extent: The Tibik soils are extensively distributed in the soil map unit no. 5,19,21,43,45 and 51 in the North Sikkim district (5354.7 ha) of the Sikkim State.

Interpretation: Tibik soils are shallow, gravelly and very lighter in texture, and very poor in available water holding capacity. These soils are mainly suitable for forestry

Interpretative groupings

Land capability sub-class : Vle2
 Productivity rating (Forest) : Average (III)

ANALYTICAL DATA

Horizon	Depth (cm)	Size Class and particle diameter (mm)			Textural Class	Coarse fragments > 2 mm (%)
		Sand (2-0.05)	Silt (0.05– 0.002)	Clay (<0.002)		
A	0-21	78.9	18.4	2.7	ls	30-35
AC	21-40	63.8	29.5	6.7	sl	35-40

Depth (cm)	pH (1:2.5) H ₂ O	Organic carbon %	Extractable bases					CEC	Base Saturation %
			Ca	Mg	Na	K	SUM		
<-----cmol (p+) kg ⁻¹ ----->									
0-21	5.2	3.71	4.3	0.7	0.3	0.4	5.7	11.0	52
21-40	5.6	0.32	2.2	0.3	0.1	0.1	2.7	3.9	69

41. THENG SERIES

Theng series is a member of loamy-skeletal, mixed, thermic family of Typic Udorthents. Typically, Theng soils have dark brown, moderately

acidic, loamy sand A horizon and dark yellowish brown, sandy loam, slightly acidic AC horizon.

Typifying Pedon: Theng – sandy loam – forest

Horizon	Depth (cm)	Description
A	0-31	Dark brown (10 YR 3/3) sandy loam; fine weak granular structure, loose, non sticky and non plastic; coarse many pores; medium common roots; moderately acidic pH 5.6; clear smooth boundary.
AC	31-63	Dark yellowiish brown (10 YR 3/4) sandy loam; fine weak granular structure, very friable, non sticky and non plastic; coarse many pores; medium many roots; slightly acidic pH 6.2

Type location: Latitude 27°34'5.6" N and Longitude 88°39'14.7" E (78A/10) Vill. Theng, P.S.Chungthang Distt. North Sikkim, State Sikkim.

Ranges in characteristics: Theng soils are shallow. The thickness of A horizon ranges from 45 to 55 cm. The colour is in hue 10YR and value 3 to 4, chroma 3 to 4. Its texture varies from sandy loam to loamy sand. The structure is fine to very fine weak granular.

Geographical Setting: Theng soils are formed over weathered granite gneiss and occurs on very steeply sloping mountains at an elevation of

3050 m above MSL. The climate is temperate with mean annual temperature of 10°C and mean annual rainfall of 1650 mm.

Geographically associated soils: Theng soils are associated with Mensithang and Bitchu soils which are loamy skeletal mixed thermic, Lithic Eutrudepts and coarse loamy mixed, thermic Humic Eutrudepts respectively.

Drainage and Permeability: Excessively drained with good permeability.

Land Use and Vegetation: Moderately dense forest. Natural vegetation dhupi, utis, chilaune etc.

Distribution and extent: The Theng soils are extensively distributed in the soil map unit no. 47, 17 and 35 in the North Sikkim (5416.3) district of the Sikkim State.

Interpretation: Theng Soil are moderately shallow, gravelly and lighter in texture, and very poor in available water holding capacity. These soils are mainly suitable for forestry.

Interpretative groupings

Land capability sub-class	:	Vle2s
Productivity rating (Forest)	:	Average (III)

ANALYTICAL DATA

Horizon	Depth (cm)	Size Class and particle diameter (mm)			Textural Class	Coarse fragments > 2 mm (%)
		Sand (2-0.05)	Silt (0.05– 0.002)	Clay (<0.002)		
A	0-31	67.7	29.0	3.3	sl	25-30
AC	31-63	67.7	28.6	3.7	sl	30-35

Depth (cm)	pH (1:2.5) H ₂ O	Organic carbon %	Extractable bases					CEC	Base Saturation %
			Ca	Mg	Na	K	SUM		
			<-----cmol (p+) kg ⁻¹ ----->						
0-31	5.6	4.05	6.1	1.1	0.2	0.2	7.6	12.7	60
31-63	6.2	1.75	5.8	1.1	0.3	0.2	7.4	9.6	77

42. GYER SERIES

Gyer series is a member of coarse loamy, mixed, thermic family of Typic Udorthents. Typically, Gyer soils have very dark grey, slightly acidic, sandy loam A horizon and weathered rock below A horizon followed by hard rock.

Typifying Pedon: Gyer – sandy loam - cultivated

Horizon	Depth (cm)	Description
Ap	0-36	Very dark grey (10 YR 3/1) sandy loam; medium

weak subangular blocky structure, soft, friable, slightly sticky and slightly plastic; many medium pores; common medium roots; slightly acidic pH 5.9; clear smooth boundary.

Cr 36-49 Weathered granite gneiss rock.

Type location: Latitude 27°33'17" N and Longitude 88°38'14" E (78A/10) Vill. Gyer, P.S.Chungthang Distt. North Sikkim, State Sikkim.

Ranges in characteristics: Gyer soils are shallow to moderately shallow. The thickness of A horizon ranges from 15 to 36 cm, its colour is in hue 10YR and value 3 to 4, chroma 1. The texture varies from loamy to loamy sand and the structure is medium weak subangular blocky to very fine structureless. The A horizon is underlain by weathered granite gneiss materials

Geographical Setting: Gyer soils are formed over weathered granite gneiss on steeply sloping mountains at an elevation of 2650 m above MSL. The climate is temperate with mean annual temperature of 10°C and mean annual rainfall of 1750 mm.

Geographically associated soils: Gyer soils are associated with Maltin and Theng soils which are coarse loamy mixed thermic Typic Dystrudepts and loamy skeletal mixed thermic Typic Udorthents respectively.

Drainage and Permeability: Excessively drained with very rapid permeability.

Land Use and Vegetation: Cultivated to Maize. Natural vegetation includes dhupi, utis, bamboo etc.

Distribution and extent: The Gyer soils are extensively distributed in soil map unit no 25 and 33 in the North Sikkim district (1588.6 ha) of the Sikkim State

Interpretation: Gyer soils are shallow, gravelly and lighter in texture, and very poor in available water holding capacity. These soils are mainly suitable for forestry. However, with proper management practices, maize is being cultivated in pockets.

Interpretative groupings

Land capability sub-class : Vle2s
 Productivity rating (Forest) : Average (III)

Soil-site suitability

Crops	Soil Site Suitability	Farmer's yield	Improved Yield
	Class	-----yield t/ha-----	
Maize	S3	1.2	1.35

ANALYTICAL DATA

Horizon	Depth (cm)	Size Class and particle diameter (mm)			Textural Class	Coarse fragments > 2 mm (%)
		Sand (2-0.05)	Silt (0.05– 0.002)	Clay (<0.002)		
Ap	0-36	60.1	35.2	4.7	sl	10-15

Depth (cm)	pH (1:2.5) H ₂ O	Organic carbon %	Extractable bases					CEC	Base Saturation %
			Ca	Mg	Na	K	SUM		
			<-----cmol (p+) kg ⁻¹ ----->						
0-36	5.9	5.43	5.9	0.7	0.2	0.3	7.1	10.8	66

43. LACHUNG SERIES

Lachung series is a member of loamy skeletal, mixed thermic family of Lithic Udorthents. Typically, Lachung soils are dark brown, moderately acidic, sandy loam A horizon underlain by weathered rock and hard rock.

Typifying Pedon: Lachung – sandy loam – cultivated

Horizon	Depth (cm)	Description
Ap	0-21	Dark brown (10 YR 3/3) sandy loam; fine weak granular structure, soft friable and non sticky and non plastic; common coarse pores; common fine

		roots; strongly acidic, pH 4.7; gradual wavy boundary
C	43-92	Brown to dark brown (10 YR 4/3) loamy sand; fine weak granular structure, friable and non sticky and non plastic; coarse common pores; few fine roots; moderately acidic, pH 5.2;
Cr	92+	Weathered rock.

Type location: Latitude 27°39'22.1" N and Longitude 88°43'40.6" E (78A/10) Vill. Lachung, Tehsil Lachung, Distt. North Sikkim, State Sikkim.

Ranges in characteristics: Lachung soils are moderately deep. A horizon ranges from 20 to 22cm thick. The colour is in hue 10YR and value 3 to 4, chroma 3. Its texture varies sandy loam to loamy sand. The C horizon is 60 to 90 cm thick, colour is in hue 10 YR; Value 3 to 4. chroma 4 to 3 and texture varies from loamy sand to sandy loam.

Geographical Setting: Lachung soils are formed over colluvium and on steeply sloping mountains. The climate is subalpine with mean annual temperature of 10°C and mean annual rainfall of 1716 mm.

Geographically associated soils: Lachung soils are associated with the Lachen soils and Byuma soils which are coarse loamy, mixed, thermic Lithic Udorthents and coarse loamy, mixed, thermic Typic Dystrudepts respectively.

Drainage and Permeability: Excessively drained with rapid permeability.

Land Use and Vegetation: Cultivated to horticultural crops. The Vegetation includes Rhododron, Oak etc.

Distribution and extent: The Lachung soils are extensively distributed in the soil map unit no. 60 in North Sikkim (125334.9 ha) in the district of Sikkim State.

Interpretation: Lachung soils are very shallow, full of gravels and lighter in texture. The soils are marginally suitable for growing horticultural crops.

Interpretative groupings

Land capability sub-class : VIe2
 Productivity rating (Forest) : Average
 (III)

Soil-site suitability

Crop	Soil Site Suitability	Farmer's yield	Improved Yield
	Class	-----yield t/ha-----	
Maize	S3	1.1	1.25

ANALYTICAL DATA

Horizon	Depth (cm)	Size Class and particle diameter (mm)			Textural Class	Coarse fragments > 2 mm (%)
		Sand (2-0.05)	Silt (0.05– 0.002)	Clay (<0.002)		
Ap	0-20	65.3	30.4	4.3	sl	35-40

Depth (cm)	pH (1:2.5) H ₂ O	Organic carbon %	Extractable bases					CEC	Base Saturation %
			Ca	Mg	Na	K	SUM		
			←-----cmol (p+) kg ⁻¹ ----->						
0-20	4.7	7.81	1.7	0.7	0.3	0.4	3.1	5.6	55

44. PUCHIKONGMA SERIES

Puchikongma series is a member of coarse loamy, mixed, thermic family of Typic Udipsamments. Puchikongma soils have dark brown, strongly acidic, loamy sand A horizon and dark yellowish brown, very strongly acidic, loamy C horizon.

Typifying Pedon: Puchikongma – loamy sand- degraded grassland

Horizon	Depth (cm)	Description
A	0-21	Dark brown (10 YR 3/3) loamy sand; fine weak granular structure, soft friable and non sticky and non plastic; coarse common pores; fine common roots; strongly acidic, pH 4.7; gradual wavy

		boundary
C1	21-43	Dark yellowish brown (10 YR 3/4) loamy sand; fine weak granular structure, soft very friable and non sticky and non plastic; coarse common pores; few fine roots; moderately acidic, pH 4.6; gradual smooth boundary
C2	43-92	Brown to dark brown (10 YR 4/3) loamy sand; fine weak granular structure, friable and non sticky and non plastic; coarse common pores; few fine roots; moderately acidic, pH 5.2;
Cr	92+	Weathered rock

Type location: Latitude 27°44'19.5" N and Longitude 88°32'58.4" E (78A/10) Vill. Puchikongma, Tehsil Lachung, Distt. North Sikkim, State Sikkim.

Ranges in characteristics: Puchikongma soils are moderately deep. A horizon ranges from 20 to 22cm. The colour is in hue 10YR and value 3 to 4, chroma 3. Its texture varies from sandy loam to loamy sand. The C horizon is 60 to 90 cm thick, colour is in hue 10 YR; value 3 to 4; chroma 4 to 3 and texture varies from loamy sand to sandy loam.

Geographical Setting: Puchikongma soils are formed over weathered granite gneiss parent material on steeply sloping mountains. The climate is temperate with mean annual temperature of 6.3°C and mean annual rainfall of 1755 mm.

Geographically associated soils: Puchikongma soils are associated with the Bitchu and Rapung Soils which are coarse loamy mixed thermic Humic Eutrudepts and coarse loamy mixed thermic Typic Eutrudepts soils.

Drainage and Permeability: Somewhat excessively drained with rapid permeability.

Land Use and Vegetation: Degraded grassland. Vegetation includes bamboo and bushes.

Distribution and extent: The Puchikongma soils are extensively distributed in the soil map unit no. 60 in North Sikkim (8774.3 ha) districts of the Sikkim State.

Interpretation: Puchikongma soils are very light textured and susceptible to water erosion. May be reclaimed to support forest vegetation.

Interpretative groupings

Land capability sub-class : Vle2
 Productivity rating (Forest) : Poor (IV)

ANALYTICAL DATA

Horizon	Depth (cm)	Size Class and particle diameter (mm)			Textural Class	Coarse fragments > 2 mm (%)
		Sand (2-0.05)	Silt (0.05– 0.002)	Clay (<0.002)		
A	0-21	83.1	11.6	5.3	ls	15-20

C1	21-43	79.6	15.1	5.3	ls	25
C2	43-92	79.2	16.5	4.3	ls	30

Depth (cm)	pH (1:2.5) H ₂ O	Organic carbon %	Extractable bases					CEC	Base Saturation %
			Ca	Mg	Na	K	SUM		
			<-----cmol (p+) kg ⁻¹ ----->						
0-21	4.7	6.37	2.3	0.5	0.3	0.3	3.4	17.7	19
21-43	4.6	4.05	1.7	0.4	0.2	0.1	2.4	12.1	20
43-92	5.2	3.04	1.0	0.2	0.3	0.4	1.9	10.2	19

45. MALING SERIES

Maling series is a member of coarse loamy, mixed, thermic Humic Dystrudepts. Typically Maling soils have very dark grayish brown, strongly acidic, sandy loam A horizon and dark brown to dark reddish brown, strongly acidic, sandy loam B horizon.

Typifying Pedon: Maling- sandy loam-cultivated.

Horizon	Depth (cm)	Description
Ap	0-25	Very dark grayish brown (10YR 3/2 sandy loam; weak, fine sub-angular blocky structure; loose, friable, slightly sticky and slightly plastic; many coarse pores; many fine roots; pH 5.1; clear, smooth boundary.

Bw1	25-47	Dark brown (10YR 3/3 sandy loam; weak, fine, sub-angular blocky structure; loose friable, slightly sticky and slightly plastic; medium and fine, common pores; few, fine roots; pH 5.2; clear, wavy boundary
Bw2	47-58	Dark reddish brown (5YR 3/3) sandy loam; weak, medium, sub-angular blocky structure; loose friable, slightly sticky and slightly plastic; medium and fine, common pores; few, fine roots; pH 5.2; gradual, smooth boundary
C	58-76	Dark reddish brown (5YR 3/4) loamy sand; weak, fine, granular structure; loose friable, non sticky and non plastic; few, fine pores; few, fine roots; pH 5.3.

Type location: Latitude 27°30'15" N and Longitude 88°33'10" E (78A/12) Village: Maling, Tehsil - Mangan, Distt. North Sikkim.

Ranges in characteristics: The thickness of the solum varies from 22 to 60 cm. The A horizon is 21 to 25cm thick. Its colour is in hue 10YR, value is of 3 and chroma varies from 1 to 3. The texture is sandy loam to loam. The thickness of B horizon is 20-30 cm. Its colour is in hue 10YR to 5YR, value varies from 3 to 4 and chroma also from 3 to 4. Its textural class is loam to sandy clay loam.

Geographical Setting: Malling soils occur on steeply sloping summit and ridges of Himalayan mountain at an elevation of 1330 m above

MSL. The climate is temperate with mean annual temperature 8.1° C and mean annual rainfall of 3450 mm.

Geographically associated soils: Maling soils are associated with Rayong Soils which is Fine, mixed, thermic Humic Pachic Dystrudepts

Drainage and Permeability: Somewhat excessively drained with rapid permeability.

Land Use and Vegetation: Maize is cultivated in patches- the natural vegetations are utis, chilaune, bamboo, titapaty, etc.

Distribution and extent: The Maling soils are widely distributed in the soil map unit no. 1 in North Sikkim (10579 ha) districts of the Sikkim State.

Interpretation: Soils are moderately deep, strongly acidic and sandy loam. The area should be kept under forest. However, maize is also grown in some packets with medium yield.

Interpretative groupings

Land capability sub-class	:	IIIe2
Productivity rating (Forest)	:	Average (III)

Soil-site suitability

Crops	Soil Site suitability Class	Farmer's yield	Improved Yield
		-----yield t/ha-----	
Maize	S3	0.8	1.00

ANALYTICAL DATA

Horizon	Depth (cm)	Size Class and particle diameter (mm)			Textural Class	Coarse fragments > 2 mm (%)
		Sand (2-0.05)	Silt (0.05–0.002)	Clay (<0.002)		
Ap	0-25	69.4	21.3	9.3	sl	10
Bw1	25-47	69.7	21.0	9.3	sl	10-15
Bw2	47-58	68.4	21.3	10.3	sl	30-35
C	58-76	80.3	10.4	9.3	ls	>50

Depth (cm)	pH (1:2.5) H ₂ O	Organic carbon %	Extractable bases					CEC	Base Saturation %
			Ca	Mg	Na	K	SUM		
			-----cmol (p+) kg ⁻¹ ----->						
0-25	3.8	2.7	1.6	0.6	0.3	0.1	2.6	6.5	40
25-47	4.1	1.9	2.0	0.5	0.3	0.2	3.0	7.0	43
47-58	4.2	1.6	2.6	0.6	0.3	0.2	3.7	8.1	46
58-76	4.4	1.5	2.2	0.6	0.3	0.1	3.2	6.6	48

46. RAYONG SERIES

Rayong series is a member of fine loamy, mixed, thermic Humic Pachic Dystrudepts. Typically Rayong soils have dark brown, strongly

acidic, Silt loam A horizon and dark yellowish brown, strongly acidic, Silt loam to clay loam B horizon.

Typifying Pedon: Rayong – silty clay loam-forest

Horizon	Depth (cm)	Description
A	0-17	Dark brown (10YR 3/3) silty clay loam; weak fine granular structure; soft, friable, sticky and plastic; few medium and many coarse pores; many fine roots; pH 4.3, clear, smooth boundary.
Bw1	17-27	Dark yellowish brown (10YR 4/4) silt loam; weak medium granular to sub-angular blocky structure; friable, sticky and plastic; many fine roots; pH 4.4; gradual, smooth boundary.
Bw2	27-55	Dark yellowish brown (10YR 4/4) silty clay loam; weak medium granular to sub-angular blocky structure; friable, sticky and plastic; many fine roots; pH 4.1; gradual, smooth boundary.
Bw3	55-81	Dark yellowish brown ((10YR 4/4) silty clay loam; firm, sticky and plastic, pH 4.1 gradual, smooth boundary.
Bw4	81-100	Dark yellowish brown (10YR 4/4) silty clay loam; firm, sticky and plastic; pH 4.8.

Type location: Latitude 27°15'40" N and Longitude 88°21'50" E (78A/12) Village: Rayong R.F., Distt. South Sikkim.

Ranges in characteristics: The solum is 90-100 cm. The thickness of A horizon varies from 16 to 25cm. The colour of A horizon is in hue 10YR, value 3 and chroma 3. Its texture is silty clay loam. The thickness of B horizon varies from 80-90 cm, Its colour is in hue 10YR, value 4 and chroma 4. Its textural class ranges from silt loam to silty clay loam.

Geographical Setting: Rayong soils occur on moderately sloping summit and ridges of Himalayan mountain at an elevation of 2190 m above MSL. The climate is temperate with mean annual temperature 8.6 °C and mean annual rainfall of 3350 mm.

Geographically associated soils: Rayong soils are associated with the Maling soils which is coarse loamy, mixed, thermic Humic Dystrudepts.

Drainage and Permeability: Well drained and medium permeability.

Land Use and Vegetation: Forest and its vegetations are champ, utis, buk, banmara, dhupi, etc.

Distribution and extent: The Rayong soils are widely distributed in the soil map unit no. 1 in South Sikkim (9937 ha) districts of the Sikkim State.

Interpretation: Rayong soils are deep, lighter in texture and the water holding capacity is poor. The CEC is also low and the soils are best suited to development of forestry.

Interpretative groupings

Land capability sub-class : IIIe2
 Productivity rating (Forest) : Average (III)

ANALYTICAL DATA

Horizon	Depth (cm)	Size Class and particle diameter (mm)			Textural Class	Coarse fragments > 2 mm (%)
		Sand (2-0.05)	Silt (0.05– 0.002)	Clay (<0.002)		
A	0-17	6.0	64.5	29.5	sicl	5
Bw1	17-27	4.4	73.2	22.5	Sil	5-10
Bw2	27-55	4.4	65.1	30.5	Sicl	5-10
Bw3	55-81	4.0	63.5	32.5	Sicl	5-10
Bw4	81-100	4.0	57.5	38.5	Sicl	20-30

Depth (cm)	pH (1:2.5) H ₂ O	Organic carbon %	Extractable bases					CEC	Base Saturation %
			Ca	Mg	Na	K	SUM		
			<-----cmol (p+) kg ⁻¹ ----->						
0-17	4.3	3.8	3.1	4.0	0.2	0.1	7.4	16.5	45
17-27	4.4	3.4	2.9	3.8	0.2	0.2	7.1	15.8	45
27-55	4.1	3.0	2.7	2.9	0.1	0.2	5.9	14.5	41
55-81	4.1	2.5	2.5	2.8	0.2	0.1	5.6	13.6	41
81-100	4.8	1.5	2.9	3.1	0.2	0.1	6.3	12.5	50

47. MANGJING SERIES

Mangjing series is a member of coarse loamy, mixed, hyperthermic Typic Endoaquepts. Typically, Mangjing soils have gray,

strongly acidic sandy loam A horizon and gray to grayish brown, moderately acidic, sandy loam to loam B horizon.

Typifying Pedon: Mangjing- sandy loam –cultivated

Horizon	Depth (cm)	Description
Ap	0-20	Grey (5YR 5/1) sandy loam; weak fine sub angular blocky structure; friable, slightly sticky; few, fine to medium stones and gravels; common very fine to fine pores; common very fine to fine roots; pH 4.3; clear, smooth boundary.
Bw1	20-47	Grey (5YR 5/1) sandy loam; weak fine sub angular blocky structure; friable, slightly sticky; few, fine to medium stones and gravels; many very fine to fine roots; few fine prominent dark brown (7.5YR 4/4) mottles, pH 5.2; clear, smooth boundary.
Bw2	47-72	Grey (5YR 5/1) sandy loam, weak fine sub angular blocky structure; firm, slightly sticky; few medium to coarse stones and gravels; few, very fine roots; few fine prominent dark yellowish brown (10YR 4/6) mottles, pH 5.4; gradual, smooth boundary.
Bw3	72-89	Grey (5YR 5/1) sandy loam, moderate medium

		sub angular blocky structure; firm, slightly sticky; few fine prominent dark yellowish brown (10YR 4/6) mottles, pH 5.4; clear, smooth boundary.
Bw4	89-112	Grey (10YR 5/1) sandy loam; moderate medium sub angular blocky structure; firm, slightly sticky; few fine prominent dark yellowish brown (10YR 4/6) mottles; pH 5.4; clear, smooth boundary.
Bw5	112-131	Greyish brown (10 YR 5/2) sandy loam; weak fine sub angular blocky structure; firm, slightly sticky; pH 5.4; clear smooth boundary.
Bw6	131-155+	Light brownish Grey (10 YR 6/2) sandy loam; massive structure; non sticky, friable.

Type location: Latitude 27°19'20" N and Longitude 88°27'10" E (78A) Village Mangjing, South district of Sikkim, State Sikkim.

Ranges in characteristics: The thickness of the solum ranges from 150-160 cm. The thickness of A horizon ranges from 15-20 cm. Its colour is in hue 5YR with value 5 and chroma 1. The texture is sandy loam. The thickness of B horizons ranges from 110-150 cm. Its colour is in hue 5YR to 10YR with value 5 to 6 and chroma 1 to 2. Its texture is sandy loam.

Geographical Setting: Mangjing soils occur on moderately river terraces at an elevation of 700 m above MSL. The climate is temperate with mean annual temperature 8.9° C and mean annual rainfall of 1450 mm.

Geographically associated soils: Mangjing soils are associated with the Dharamdin and Singrep soils which are fine loamy, mixed, thermic, Fluventic Eutrudepts, and loamy-skeletal, mixed thermic, Entic Hapludolls.

Drainage and Permeability: Imperfectly drained with medium permeability.

Land Use and Vegetation: Soils are under intensive Rice and vegetable cultivation.

Distribution and extent: The Mangjing soils are widely distributed in the soil map unit no. 11, 15 and 38 in East Sikkim (968 ha) districts of the Sikkim State.

Interpretation: Maize, rice and wheat are moderately suitable. Other agricultural crops like mustards, vegetables, ginger, millets may be grown effectively through proper soil conservation measures.

Interpretative groupings

Land capability sub-class : IIIe2
 Productivity rating (Forest) : Medium (II)

Soil-site suitability

Crops	Soil Site suitability Class	Farmer's yield	Improved Yield
		-----yield t/ha-----	
Rice	S2	1.2	1.4
Maize	S2	1.8	2.0

ANALYTICAL DATA

Horizon	Depth (cm)	Size Class and particle diameter (mm)			Textural Class	Coarse fragments > 2 mm (%)
		Sand (2-0.05)	Silt (0.05– 0.002)	Clay (<0.002)		
Ap	0-20	56.7	30.2	13.1	sl	10
Bw1	20-47	52.5	32.2	15.3	sl	10
Bw2	47-72	50.3	34.2	15.5	sl	15
Bw3	72-89	63.8	30.2	16.0	sl	10
Bw4	89-112	48.5	34.4	17.1	sl	15
Bw5	112-131	53.5	31.2	15.3	sl	15
Bw6	131-155+	76.8	10.2	12.0	ls	35

Depth (cm)	pH (1:2.5) H ₂ O	Organic carbon %	Extractable bases					CEC	Base Saturation %
			Ca	Mg	Na	K	SUM		
<-----cmol (p+) kg ⁻¹ ----->									
0-20	4.3	2.7	3.5	1.5	0.1	0.1	4.3	9.1	57
20-47	5.2	2.5	3.9	1.4	0.1	0.1	4.2	9.4	59
47-72	5.4	0.8	3.3	1.8	0.1	0.1	4.3	7.2	59
72-89	5.4	0.7	2.9	1.4	0.1	0.1	4.5	7.4	60
89-112	5.4	0.7	3.0	1.6	0.1	0.1	4.8	8.1	59
112-131	5.4	0.7	2.9	1.6	0.1	0.2	4.8	7.9	60
131-155+	5.8	0.6	2.9	1.6	0.1	0.2	4.8	7.0	68

48. HILLEY SERIES

Hilley series is a member of fine-loamy, mixed, thermic, Humic Dystrudepts. Typically, Hilley soils have very dark grayish brown, moderately acidic, loamy A horizon and brown moderately acidic loamy B horizon.

Typifying Pedon: Hilley- loam- cultivated

Horizon	Depth (cm)	Description
Ap	0-24	Very dark grayish brown (10 YR 3/2) loam; weak fine granular structure; friable, slightly sticky and slightly plastic; few fine pores; many fine, medium roots; pH 4.7; gradual wavy boundary
Bw	24-46	Brown (10 YR 4/3) gravelly loam; weak, fine, granular or sub angular blocky structure; friable, slightly sticky and slightly plastic; many coarse and medium roots; pH 4.7; gradual, smooth boundary
C	46-75	Brown (10 YR 4/3) gravelly loam; common, fine and coarse gravels and stones; friable, slightly sticky and slightly plastic; few fine roots; -pH 4.8.

Type location: Latitude 27°09'40" N and Longitude 88°05'50" E (78A)
 Village Hilley, Distt. West Sikkim, State Sikkim.

Ranges in characteristics: The thickness of soil solum ranges between 45 to 50 cm. The depth of A horizon varies from 20 to 24 cm. The colour is in hue of 10YR, value 3 and chroma 2. The textural class is loam. The depth of B horizon ranges from 25 to 30 cm. Its colour is hue 10YR, value 4 and chroma 3. Its textural class is loam.

Geographical Setting: Hilley soils occur on very steeply sloping mountains at an elevation of 2500 m above MSL. The climate is temperate with mean annual temperature 6.9° C and mean annual rainfall of 3900 mm.

Geographically associated soils: Hilley soils are associated with the Singrep and Chatten soils which are loamy-skeletal, mixed, thermic, Entic Hapludolls and loamy-skeletal, mixed, thermic, Lithic Udorthents.

Drainage and Permeability: Excessively drained and medium permeability.

Land Use and Vegetation: Cultivated-maize and potato.

Distribution and extent: The Hilley soils are widely distributed in the soil map unit no. 4 and 26 in West Sikkim (3153 ha) district of the Sikkim State.

Interpretation: Soils are moderately deep, acidic with low organic carbon content. They have severe limitation of slope. Cultivation with terracing to some extent controls soil erosion.

Interpretative groupings

Land capability sub-class	:	VIIe3
Productivity rating (Forest)	:	Medium (II)

Soil-site suitability

Crops	Soil Site suitability	Farmer's yield	Improved Yield
	Class	-----yield t/ha-----	
Maize	S3	1.25	1.8

ANALYTICAL DATA

Horizon	Depth (cm)	Size Class and particle diameter (mm)			Textural Class	Coarse fragments > 2 mm (%)
		Sand (2-0.05)	Silt (0.05– 0.002)	Clay (<0.002)		
Ap	0-24	52.0	30.4	17.5	10	3
Bw	24-46	42.5	37.6	19.9	30	10
C	46-75	44.0	39.1	16.9	35	25

Depth (cm)	pH (1:2.5) H ₂ O	Organic carbon %	Extractable bases					CEC	Base Saturation %
			Ca	Mg	Na	K	SUM		
-----cmol (p+) kg ⁻¹ ----->									
0-24	4.7	1.7	1.2	3.5	0.3	0.2	5.2	11.0	47
24-46	4.8	1.0	1.7	1.8	0.2	0.1	3.8	7.7	49
46-75	4.8	0.7	1.0	1.0	0.1	0.1	2.4	5.0	48

49. SINGREP SERIES

Singrep series is a member of loamy-skeletal, mixed, thermic Entic Hapludolls. Typically, Singrep soils are having dark grayish brown, moderately acidic, gravelly loam A horizon and olive, moderately acidic, gravelly sandy loam C horizon.

Typifying Pedon: Hilley- loam- cultivated

Horizon	Depth (cm)	Description
Ap	0-29	Dark grayish brown (10 YR 4/2) gravelly loam; weak, fine, granular structure; friable, non sticky; non plastic few fine gravels; fine and medium common pores; fine many roots; pH 4.8; clear, wavy boundary
C11	29-57	Olive (10YR 5/3) gravelly sandy loam; common, medium and coarse gravels; friable and non sticky; non plastic fine and medium, common pores; fine few roots; pH 5.2, gradual, smooth boundary
C12	57-90	Olive (10YR 5/3) gravelly sandy loam; partly decomposed soil, pH 5.4.

Type location: Latitude 27°8'30" N and Longitude 88°13'50" E (78A/)
 Village Singrep, Tehsil-Soreng, Distt. West Sikkim.

Ranges in characteristics: The soils are moderately deep. The depth of A horizon varies from 25-30 cm. The colour is in hue of 10YR, value 4 and chroma 2. The textural class is gravelly loam. The depth of C horizon varies from 25 to 75 cm. Its colour is in hue 10YR, value 5 and chroma 3. Its textural class is gravelly sandy loam.

Geographical Setting: Singrep soils occur on very steeply sloping mountains at an elevation of 750 m above MSL. The climate is temperate with mean annual temperature 11.5° C and mean annual rainfall of 3000 mm.

Geographically associated soils: Singrep soils are associated with the Hilley and Mangjing soils which are fine-loamy, mixed, thermic, Humic Dystrudepts and coarse-loamy, mixed, thermic, Typic Endoaquepts.

Drainage and Permeability: Somewhat excessively drained with rapid permeability.

Land Use and Vegetation: Maize, bamboo, gokul etc.

Distribution and extent: The Singrep soils are widely distributed in the soil map unit no. 4 and 11 in West Sikkim (8819 ha) district of the Sikkim State.

Interpretation: Soils developed on escarpments have been brought under maize and vegetable cultivation. Soil conservation measures must be adopted to arrest soil erosions.

Interpretative groupings

Land capability sub-class : Vle2
Productivity rating (Forest) :

Soil-site suitability

Crops	Soil Site suitability Class	Farmer's yield	Improved Yield
		-----yield t/ha-----	
Maize	S3	1.3	1.8

ANALYTICAL DATA

Horizon	Depth (cm)	Size Class and particle diameter (mm)			Textural Class	Coarse fragments > 2 mm (%)
		Sand (2-0.05)	Silt (0.05–0.002)	Clay (<0.002)		
Ap	0-29	50.0	36.5	13.5	Sl	25
C11	29-57	69.2	20.3	12.0	Sl	35
C12	57-90	71.0	17.5	11.5	sl	45

Depth (cm)	pH (1:2.5) H ₂ O	Organic carbon %	Extractable bases					CEC	Base Saturation %
			Ca	Mg	Na	K	SUM		
<-----cmol (p+) kg ⁻¹ ----->									
0-29	4.8	2.9	3.3	1.6	0.2	0.1	4.7	7.0	52
29-57	5.2	2.1	3.3	1.3	0.2	0.2	4.1	5.9	55
57-90	5.4	0.4	1.7	1.4	0.2	0.2	3.6	5.2	56

50. MANGRENG SERIES

Mangreng series is a member of coarse loamy, mixed, hyperthermic, Humic Eutrudepts. Typically, Mangreng soils have very dark gray, slightly acidic, gravelly loam A horizon and dark yellowish brown to dark grayish brown slightly acidic silt loam B horizon

Typifying Pedon: Mangreng- gravelly silt loam –cultivated

Horizon	Depth (cm)	Description
Ap	0-18	Dark brown (10 YR 3/3) gravelly loam; puddle, many fine, very fine and few medium roots; pH 6.5; clear smooth boundary
Bw1	18-34	Dark yellowish brown (10 YR 4/3) gravelly silt loam; weak medium, subangular blocky; friable, slightly sticky and plastic; common fine and very fine roots; pH 6.4; clear, wavy boundary
Bw2	34-72	Very dark grayish brown (10 YR 3/2) gravelly silt loam; massive structure; very friable and slightly sticky; few fine, very fine and many coarse roots, pH 6.1; gradual, irregular boundary
Bw3	72-100	Dark grayish brown (10 YR 4/2) gravelly silt loam, massive structure; very friable and slightly sticky; few fine roots, pH 6.1; clear, smooth boundary
Bw4	100-125	Brown (10YR5/3M) gravelly loam; massive, pH 6.0

Type location: Latitude 27°10'30" N and Longitude 88°31'10" E (78A/8)
 Village: Mangreng, Namthang circle, South Sikkim, Sikkim State.

Ranges in characteristics: The thickness of the solum ranges from 120-130 cm. The thickness of A horizon ranges from 15-20 cm. Its colour of A horizon is in hue 10 YR with value 3 to 4 and chroma 2 to 3.

Its texture is silt loam gravelly loam. The underlying C horizon possesses massive structure.

Geographical Setting: Mangreng soils occur on gently sloping narrow valley at an elevation of 750 m above MSL. The climate is temperate with mean annual temperature 11.5° C and mean annual rainfall of 3000 mm.

Geographically associated soils: Mangreng soils are associated with the Karfacter and Mangjing soils which are Fine loamy, mixed thermic Humic Hapludalfs and coarse loamy, mixed, thermic, Typic Endoaquepts.

Drainage and Permeability: Well drained with moderate permeability.

Land Use and Vegetation: Mainly cultivated for Rice, maize etc. The Vegetation includes chilaune utis, and bamboo.

Distribution and extent: The Mangreng soils are widely distributed in the soil map unit no.15 in West Sikkim (8819 ha) district of the Sikkim State.

Interpretation: Soils developed on escarpments have been brought under maize and vegetable cultivation. Soil conservation measures must be adopted to arrest soil erosions

Interpretative groupings

Land capability sub-class : Vie2
 Productivity rating (Forest) : Average (III)

Soil-site suitability

Crops	Soil Site suitability Class	Farmer's yield	
		Farmer's yield	Improved Yield
-----yield t/ha-----			
Rice	S2	1.2	1.45
Maize	S3	1.7	1.95

ANALYTICAL DATA

Horizon	Depth (cm)	Size Class and particle diameter (mm)			Textural Class	Coarse fragments > 2 mm (%)
		Sand (2-0.05)	Silt (0.05– 0.002)	Clay (<0.002)		
A	0-18	21.2	66.7	12.1	I	20
Bw1	18-34	20.0	68.9	11.1	sil	25
Bw2	34-72	27.2	61.8	10.9	sil	30
Bw3	72-100	37.6	51.3	11.1	sil	30
Bw4	100-125	49.6	41.3	9.1	I	50

Depth (cm)	pH (1:2.5) H ₂ O	Organic carbon %	Extractable bases					CEC	Base Saturation %
			Ca	Mg	Na	K	SUM		
<-----cmol (p+) kg ⁻¹ ----->									
0-18	6.5	2.7	3.0	2.9	0.1	0.2	6.2	10.1	61
18-34	6.4	2.5	3.1	2.8	0.1	0.2	6.2	9.5	65
34-72	6.1	1.6	2.8	2.1	0.1	0.1	5.1	7.5	68
72-100	6.1	1.5	2.6	1.9	-	0.1	4.6	7.0	65
100-125	6.0	1.4	2.1	1.5	-	0.1	3.7	6.1	60

51. CHONGRANG SERIES

Chongrang series is a member of coarse loamy, mixed, thermic Entic Hapludolls. Typically, Chongrang soils have very dark grayish brown, very strongly acidic, silt loam A horizon and dark yellowish brown to light grey, very strongly to slightly acidic, loam to sandy loam B horizon

Typifying Pedon: Chongrang-silt loam- cultivated

Horizon	Depth (cm)	Description
Ap	0-28	Very dark grayish brown (10YR 3/2) silt loam; weak fine sub angular blocky structure; soft, friable, slightly sticky and slightly plastic; common fine pores, common medium and fine roots; pH 4.4, clear, smooth boundary.
Bw1	28-47	Dark yellowish brown (10YR 3/6) loam; moderate medium sub angular blocky structure; friable, sticky and plastic; few fine gravels and stones; common fine roots; pH 4.5, gradual, smooth boundary
Bw2	47-70	Yellowish brown (10YR 5/4) gravelly loam; friable, sticky and plastic; common fine, medium gravels and stones; few fine roots; pH 5.8, gradual, smooth boundary

Bw3 70-100 Light grey (10YR 7/2) gravelly sandy loam; friable, non-sticky and non-plastic; common medium and fine gravels and stones; common fine roots; pH 5.9.

Type location: Latitude 27°20'05" N and Longitude 88°17' E (78A/8)
Vill: Chongrang, Tehsil – Gyalzing, Distt. West Sikkim.

Ranges in characteristics: The thickness of the solum ranges from 100-110 cm. The depth of A horizon varies from 25-30 cm. The colour is in hue 10YR, value 3 and chroma 2. The textural class is silt loam. The depth of B horizon ranges from 75-80 cm. Its colour is in hue 10YR, value 3 to 7 and chroma 2 to 6.

Geographical Setting: Chongrang soils occur on very steeply sloping side slope of the Himalayan Mountain at an elevation of 1850 m above MSL. The climate is temperate with mean annual temperature 10.2° C and mean annual rainfall of 3450mm.

Geographically associated soils: Chongrang soils are associated with the Legship and Damthang soils which are coarse-loamy, mixed, thermic, Typic Udorthents and fine -loamy, mixed, thermic, Humic Hapludults.

Drainage and Permeability: Somewhat excessively drained and moderate permeability.

Land Use and Vegetation: Mainly under cultivation with Maize. The Natural vegetation includes chilaune, utis etc.

Distribution and extent: The Chongrang soils are extensively distributed in the soil map unit 22 and 42 in West Sikkim (4980 ha) and South Sikkim (5150 ha) districts of the Sikkim State.

Interpretation: Soils are coarse loamy, acidic and excessively drained. Proper soil conservation measures and diversification of drainage lines is essential to protect soils from landslides.

Interpretative groupings

Land capability sub-class	:	VIIe3s
Productivity rating (Forest)	:	Average (III)

Soil-site suitability

Crops	Soil Site Suitability Class	Farmer's yield	Improved Yield
		-----yield t/ha-----	
Rice	S3	1.2	1.35
Maize	S2	1.7	1.8

ANALYTICAL DATA

Horizon	Depth (cm)	Size Class and particle diameter (mm)			Textural Class	Coarse fragments > 2 mm (%)
		Sand (2-0.05)	Silt (0.05– 0.002)	Clay (<0.002)		
Ap	0-28	26.4	52.9	20.7	sil	10

Bw1	28-47	43.6	36.7	19.7		15
Bw2	47-70	50.0	33.3	16.7		25
Bw3	70-100	55.6	32.7	11.7		35

Depth (cm)	pH (1:2.5) H ₂ O	Organic carbon %	Extractable bases					CEC	Base Saturation %
			Ca	Mg	Na	K	SUM		
			<-----cmol (p+) kg ⁻¹ ----->						
0-28	4.4	2.5	3.5	2.5	0.4	0.4	6.3	12.8	53
28-47	4.5	0.85	3.1	2.3	0.4	0.3	5.8	11.5	53
47-70	5.8	0.42	2.9	1.8	0.4	0.3	5.4	8.7	62
70-100	5.9	0.42	2.2	0.9	0.3	0.4	3.8	5.9	64

52. MANIRAM SERIES

Maniram series is a member of loamy skeletal, mixed, thermic Pachic Hapludolls. Typically, Maniram soils have very dark grayish brown, strongly acidic, gravelly silt loam A horizon and dark brown to yellowish brown, moderately acidic, gravelly silt loam B horizon.

Typifying Pedon: Maniram-gravelly silt loam-cultivated

Horizon	Depth (cm)	Description
Ap	0-12	Very dark grayish brown (10 YR 3/2) gravelly silt loam; weak fine granular structure; soft, friable, slightly sticky and slightly plastic; many fine and medium, pores; many fine and medium roots; pH

		5.1, clear, smooth boundary.
Bw1	12-27	Dark brown (10 YR 3/3) gravelly silt loam; weak, fine crumb structure; very friable, slightly sticky and slightly plastic; many medium and coarse roots; pH 5.6, gradual, smooth boundary
Bw2	27-54	Dark brown (10 YR 3/3) gravelly silt loam; weak, fine crumb structure; very friable, slightly sticky and slightly plastic; few fine and medium gravels; many medium roots; pH 5.9, gradual, smooth boundary
C1	54-83	Yellowish brown (10 YR 5/6) gravelly Silt loam; - weak, fine granular structure; very friable, slightly sticky and slightly plastic; few fine and medium gravels; many medium roots; pH 6.1, gradual smooth boundary
C2	83-100	Yellowish brown (10 YR 5/6) gravelly silt loam; very friable, non-sticky and non-plastic; common fine and medium gravels and stones; few fine, roots; pH 6.0.

Type location: Latitude 27°10'05" N and Longitude 88°24'40" E (78A/8)
 Vill. Maniram, Tehsil Pakyong, Distt. South Sikkim, State Sikkim.

Ranges in characteristics: The thickness of solum ranges from 50 to 55 cm. The thickness of A horizon is 10 to 15 cm. Its colour is in hue 10 YR and value 3 and chroma 2. Its texture is gravelly loam. The thickness

of B horizon varies from 40 to 45 cm with colour is in hue 10YR, value 3-5 and chroma 3 -6. Textural class is gravelly silt loam.

Geographical Setting: Maniram soils occur on very steeply sloping hill of the Himalayan Mountain at an elevation of 1770 m above MSL. The climate is temperate with mean annual temperature 12.5° C and mean annual rainfall of 3430 mm.

Geographically associated soils: Maniram soils are associated with the Damthang and Jorpul Soils which are fine-loamy, mixed, thermic, Humic Hapludults and loamy-skeletal, mixed, thermic Lithic Udorthents

Drainage and Permeability: somewhat excessively drained with rapid permeability.

Land Use and Vegetation: Mostly cultivated for maize and Rice. The vegetation includes chilaune, utis etc.

Distribution and extent: The Maniram soils are extensively distributed in the soil map unit no. 46, 44 and 52 of West Sikkim (2240.2 ha) and South Sikkim (1208.8 ha) districts of the Sikkim State.

Interpretation: Deep soils of Maniram series have been rated as marginally suitable for maize and Rice due to its textural class and terrain condition. Soil conservation measures should be adopted to arrest soil erosion.

Interpretating groupings

Land capability sub-class : Vlle3s
 Productivity rating (Forest) : Average (III)

Soil-site suitability

Crop	Soil Site Suitability Class	Farmer's yield	Improved Yield
		-----yield t/ha-----	
Rice	S3	1.6	1.85
Maize	S3	1.2	1.5

ANALYTICAL DATA

Horizon	Depth (cm)	Size Class and particle diameter (mm)			Textural Class	Coarse fragments > 2 mm (%)
		Sand	Silt	Clay		
		(2-0.05)	(0.05- 0.002)	(<0.002)		
Ap	0-12	24.0	61.8	14.2	sil	15
B	12-27	22.0	62.9	15.1	sil	30
C1	27-54	23.6	64.4	12.0	sil	40
C2	54-83	26.0	61.3	12.2	sil	40
C3	83-100	40.4	46.6	13.0	sil	45

Depth (cm)	PH (1:2.5) H ₂ O	Organic carbon %	Extractable bases					CEC	Base Saturation %
			Ca	Mg	Na	K	SUM		
			<-----cmol (p+) kg ⁻¹ ----->						
0-12	5.1	3.1	5.1	2.0	-	0.4	7.5	13.0	58
12-27	5.6	2.6	3.8	3.1	-	0.3	7.2	10.9	66
27-54	5.9	2.3	3.1	2.9	-	0.3	6.3	9.5	66
54-83	6.1	1.1	2.6	1.2	0.1	0.2	4.1	6.0	68
83-100	6.0	1.0	2.6	1.2	0.1	0.3	4.2	6.4	66

53. PHONG SERIES

Phong series is a member of fine loamy, mixed, thermic Typic Dystrudepts. Typically Phong soils have dark brown, very strongly acidic, clay loam A horizon and dark yellowish brown moderately acidic silty clay loam to clay loam B horizon.

Typifying Pedon: Phong - clay loam – cultivated

Horizon	Depth (cm)	Description
Ap	0-14	Dark brown (10YR 3/3) clay loam; weak medium granular or sub angular blocky structure; slightly hard, friable, slightly sticky; fine few gravels; common medium pores, many medium roots; pH 4.7, clear smooth boundary.
Bw1	14-74	Dark Yellowish brown (10YR 4/6) silty clay loam; moderate, coarse granular or sub angular blocky structure; friable, slightly sticky and slightly plastic; few fine gravels; many medium roots; pH 4.6, gradual irregular boundary.
Bw2	74-113	Dark Yellowish brown (10YR 3/6) silty clay loam; moderate, coarse granular or sub angular blocky structure; firm, slightly sticky and plastic; few medium stones; common medium roots; pH 4.8, gradual, irregular boundary.

Bw3 113-150 Dark Yellowish brown (10YR 3/6) gravelly clay loam; moderate, coarse sub angular blocky structure; very firm, sticky and plastic; medium, common gravels; fine, many pores, fine, few roots; pH 4.8.

Type location: Latitude 27°11'N and Longitude 88°27'40" E (78A/8) Vill. Phong, Tehsil Pakyong, Distt. South Sikkim, State Sikkim.

Ranges in characteristics: The thickness of the solum ranges from 140-150 cm. Depth of A horizon varies from 10-15 cm with colours is in hue of 10YR with value and chroma 3. The textural class is clay loam. The thickness of B horizon ranges from 125-130 cm. Its colour is in hue 10YR, value 3 to 4 and chroma 6. The texture of B horizon varies from silty clay loam to gravelly clay loam.

Geographical Setting: Phong soils occur on very steeply sloping hill of the Himalayan Mountain at an elevation of 1450 m above MSL. The climate is temperate with mean annual temperature 14° C to 19.9C and mean annual rainfall of 2950 mm.

Geographically associated soils: Phong Soils are associated with the Khedi and Maniram soils which are coarse-loamy, mixed, thermic, Typic Hapludults and loamy-skeletal, mixed, thermic Pachic Hapludolls.

Drainage and Permeability: Some what excessively drained and slow permeability.

Land Use and Vegetation: Mostly used for cultivation of maize and Rice. The natural vegetations are utis, gogun, bamboo etc.

Distribution and extent: The Phong soils are extensively distributed in the soil map unit no. 18 and 16 of East Sikkim (5328.8 ha) and South Sikkim (ha) districts of the Sikkim State.

Interpretation: Soils are deep and moderately acidic. Soil-site suitability studies indicate that rice and maize are moderately suitable. Soil conservation measures should be taken to arrest soil erosion

Interpretating groupings

Land capability sub-class : VIIe3
 Productivity rating (Forest) : Good (II)

Soil-site suitability

Crop	Soil Site Suitability	Farmer's yield	Improved Yield
	Class	-----yield t/ha-----	
Rice	S3	1.5	1.75
Maize	S2	1.2	1.45

ANALYTICAL DATA

Horizon	Depth (cm)	Size Class and particle diameter (mm)			Textural Class	Coarse fragments > 2 mm (%)
		Sand (2-0.05)	Silt (0.05– 0.002)	Clay (<0.002)		
Ap	0-14	35.2	36.3	28.5	cl	10
Bw1	14-74	20.5	50.0	29.5	sicl	10



Bw2	74-113	21.0	38.6	32.4	sicl	15
Bw3	113-150	42.1	35.6	22.3	gcl	35

Depth (cm)	pH (1:2.5) H ₂ O	Organic carbon %	Extractable bases					CEC	Base Saturation %
			Ca	Mg	Na	K	SUM		
			<-----cmol (p+) kg ⁻¹ ----->						
0-14	4.7	2.5	5.0	3.7	0.2	0.1	9.0	16.4	55
14-74	4.6	2.3	4.8	3.2	0.2	0.2	8.4	14.8	57
74-113	4.8	1.6	4.2	2.7	0.2	0.1	7.2	12.7	57
113-150	4.8	1.0	4.5	2.0	0.2	0.1	7.1	12.0	61

54. BHUSUK SERIES

Bhusuk series is a member of loamy skeletal, mixed, thermic, Humic Dystrudepts. Typically Bhusuk soils have dark reddish brown, very strongly acidic, gravelly sandy loam A horizon and brown, very strongly acidic, gravelly sandy loam B horizon.

Typifying Pedon : Bhusuk- gravelly sandy loam-forest

Horizon	Depth (cm)	Description
A	0-26	Dark reddish brown (5 YR 3/2 M) gravelly sandy loam; weak, fine crumb structure; friable and slightly sticky; medium coarse fragments; few, fine pores; abundant, very fine to medium, coarse roots; pH 4.6, clear, wavy boundary

Bw	26-50	Brown (7.5 YR 5/4 M) gravelly sandy loam; weak, fine crumb structure; friable and slightly sticky; many coarse fragments few, fine pores; many coarse fragments; few, very fine medium roots; pH 4.7; clear, wavy boundary
C	50-71	Brown (7.5 YR 5/4 M) gravelly sandy loam; loose; friable and slightly sticky; many pores; many, fine roots; pH 4.8.

Type location: Latitude 27°19'52" N and Longitude 88°39'30" E (78A/8) Vill. Bhusuk, Tehsil Ranipool Distt. East Sikkim State Sikkim.

Ranges in characteristics: The thickness of the solum ranges from 50-60 cm. The thickness of A horizon ranges from 25-30 cm. Its colour is in hue 5YR with value 3 and chroma 2. Its texture is gravelly sandy loam. The thickness of B horizon ranges from 25-55 cm. Its colour is in hue 7.5YR with value 5 and chroma 4. Its texture is gravelly sandy loam.

Geographical Setting: Bhusuk soils occur on steeply sloping hill of the Himalayan Mountain at an elevation of 1500 m above MSL. The climate is temperate with mean annual temperature 12.6° C and mean annual rainfall of 2850 mm.

Geographically associated soils: Bhusuk soils are associated with the Karporang and Tibik soils which are coarse-loamy, mixed thermic, Typic Udorthents and loamy skeletal, mixed, thermic Lithic Udorthents.

Drainage and Permeability: Excessively drained with moderately rapid permeability.

Land Use and Vegetation: These soils are mostly under dense forest vegetation.

Distribution and extent: The Bhusuk soils are extensively distributed in the soil map unit no. 5, 32 and 28 of East Sikkim (6419 ha) districts of the Sikkim State.

Interpretation: Soils are moderately shallow with fair amount of coarse fragments. Due to topography and soil condition, the areas may be kept under forest.

Interpretating groupings

Land capability sub-class : VIIe3s
 Productivity rating (Forest) : Average (III)

ANALYTICAL DATA

Horizon	Depth (cm)	Size Class and particle diameter (mm)			Textural Class	Coarse fragments > 2 mm (%)
		Sand (2-0.05)	Silt (0.05– 0.002)	Clay (<0.002)		
A	0-26	79.4	3.4	17.2	gsl	20
B	26-50	72.4	8.4	19.2	gsl	30
C	50-71	78.0	7.2	14.8	gsl	50

Depth (cm)	pH (1:2.5) H ₂ O	Organic carbon %	Extractable bases					CEC	Base Saturation %
			Ca	Mg	Na	K	SUM		
			<-----cmol (p+) kg ⁻¹ ----->						
0-26	4.6	1.9	3.0	1.4	0.1	0.1	4.6	9.0	51
26-50	4.7	1.6	3.6	1.8	0.2	0.4	6.0	10.2	59
50-71	4.8	0.8	3.0	1.5	0.1	0.2	4.8	8.0	60

55. DOLING SERIES

Doling series is a member of fine loamy, mixed, thermic Typic Argiudolls. Typically Doling soils have dark brown, strongly acidic, Silt loam A horizon and dark brown to dark yellowish brown, moderately acidic, silty clay loam to gravelly clay loam B horizon.

Typifying Pedon: Doling-silt loam- cultivated.

Horizon	Depth (cm)	Description
Ap	0-13	Dark brown (10 YR 3/3) silt loam; weak, fine, granular structure; soft, very friable and slightly sticky; slightly plastic; fine and medium, many pores; fine, medium and coarse, many roots; pH 4.4; gradual, smooth boundary
Bt1	13-32	Dark brown (10 YR 3/3) silt loam; weak, fine, moderate, granular structure; soft friable and slightly sticky; slightly plastic; fine and medium, many pores; fine, medium and coarse, many

		roots; pH 5.2; gradual, smooth boundary
Bt2	32-65	Dark yellowish brown (10 YR 4/4) silty clay loam; weak, fine, moderate, sub angular blocky structure; slightly hard, very firm and sticky; plastic; very fine and many pores; fine, medium and coarse many roots; pH 5.5; gradual, smooth boundary
Bt3	65-100	Dark yellowish brown (10 YR 4/4) clay loam; medium, moderate, sub angular blocky structure; slightly hard, firm and sticky; plastic; very fine and fine, many pores; medium and coarse, many roots; pH 6.6.

Type location: Latitude 27°17'25" N and Longitude 88°20'50" E (78A/8) Vill. Doling, Tehsil. Pakyong, Distt. South Sikkim, State Sikkim.

Ranges in characteristics: The thickness of the solum ranges from 100-110 cm. A horizon ranges from 10 to 15 cm. Its colour is in hue 10YR value 2 to 3 and chroma 3. Its texture is silt loam. The thickness of B horizon ranges from 90 to 95 cm. Its colour is in hue of 10YR, value 3 to 4 and chroma 3 to 4. Textural class varies from silt loam to silty clay loam.

Geographical Setting: Doling soils occur on steeply sloping hill of the Himalayan Mountain at an elevation of 1780 m above MSL. The climate is temperate with mean annual temperature 12.8° C and mean annual rainfall of 2880 mm.

Geographically associated soils: Doling soils are associated with the Khedi and Samdur soils which are Coarse loamy mixed thermic, Typic Hapludults and Fine loamy, mixed, thermic Humic Eutrudepts.

Drainage and Permeability: Some what excessively drained and slow permeability.

Land Use and Vegetation: Terraced land under cultivation. The natural vegetations are katus, asarey, parchy, etc.

Distribution and extent: The Doling soils are extensively distributed in the soil map unit no. 36 and 24 of South Sikkim (7765.2ha) districts of the Sikkim State.

Interpretation: Soils are deep with high content of clay and organic carbon. Soils have been rated as moderately suitable for rice and maize. Adequate soil conservation measures are to be taken to control erosion.

Interpretative groupings

Land capability sub-class : Vie2
 Productivity rating (Forest) : Average (III)

	Soil Site Suitability Class	Farmer's yield -----yield t/ha-----	Improved Yield
Rice	S3	1.5	1.85
Maize	S3	1.7	2.1

ANALYTICAL DATA

Horizon	Depth (cm)	Size Class and particle diameter (mm)			Textural Class	Coarse fragments > 2 mm (%)
		Sand (2-0.05)	Silt (0.05– 0.002)	Clay (<0.002)		
Ap	0-13	12.0	66.4	21.6	sil	10
Bt1	13-32	21.4	50.4	28.2	sil	15
Bt2	32-65	17.3	49.2	33.5	sicl	15
Bt3	65-100	21.1	43.4	35.5	cl	25

Depth (cm)	pH (1:2.5) H ₂ O	Organic carbon %	Extractable bases					CEC	Base Saturation %
			Ca	Mg	Na	K	SUM		
			<-----cmol (p+) kg ⁻¹ ----->						
0-13	5.4	2.66	4.0	1.0	0.2	0.1	5.3	8.0	66
13-35	4.9	2.15	3.1	0.8	0.2	0.2	4.3	6.9	62
35-55	4.9	1.37	2.3	0.6	0.1	0.1	3.1	4.8	65
55-95	5.2	0.98	1.4	0.5	0.1	0.1	2.1	3.2	66

56. MARTAM SERIES

Martam series is a member of fine, mixed, thermic, Typic Paleudolls. Typically, Martam soils have dark yellowish brown, moderately acidic, clay loam A horizon and dark brown to strong brown moderately acidic clay loam to clay B horizon.

Typifying Pedon: Martam- clay loam –cultivated

Horizon	Depth (cm)	Description
Ap	0-16	Dark yellowish brown (10 YR 4/6) clay loam; weak, medium, sub angular blocky structure; firm and sticky; and plastic; few fine, gravels and stones; few fine pores; very few fine roots; pH 5; clear, smooth boundary
BA	16-42	Dark brown to brown (10 YR 4/3) clay loam; weak medium sub angular blocky structure; firm and slightly sticky; and plastic; few fine, medium quartz and gravels; few, common, very fine to fine pores; very fine to fine roots; pH 4.3; abrupt, smooth boundary
Bt1	42-67	Strong brown (7.5 YR 5/6) clay; moderate, medium, sub angular blocky structure; very firm and very sticky and plastic; few common fine to medium pores; few very, fine roots; pH 4.3; gradual, smooth boundary
Bt2	67- 83	Strong brown (7.5 YR 5/6) mottled with brown to strong brown (10 YR 4/3) clay; moderate, medium sub angular blocky structure; very firm and very sticky; very plastic; few; common fine to medium pores; few, very fine roots; pH 4.7; diffuse, smooth boundary
Bt3	83-110	Strong brown (7.5 YR 5/6) mottled with brown to

strong brown (10 YR 4/3) clay; moderate to medium sub angular blocky structure; very firm and very sticky; very plastic few common fine to medium pores; few, very fine roots; pH 4.8; diffused, smooth boundary.

Bt4 110-150 Strong brown (7.5 YR 5/) clay; moderate, sub angular blocky structure; very firm and very sticky; very plastic; common, fine pores; pH 4.9.

Type location: Latitude 27°17'50" N and Longitude 88°32'30" E (78A/8) Vill. Martam, Tehsil Gangtok, Distt. East Sikkim, State Sikkim.

Ranges in characteristics: The surface horizon is 12-17 cm thick and principal soil types are loam and clay loam and sandy clay loam. The colour is dark grayish brown to yellowish brown. The sub surface horizon is 98-136 cm thick. The colour ranges from dark red brown to strong brown.

Geographical Setting: Martam soils occur on steeply sloping hill of the Himalayan Mountain at an elevation of 2000 m above MSL. The climate is temperate with mean annual temperature 12.2° C and mean annual rainfall of 3050 mm.

Geographically associated soils: Martam Soils are associated with the Tarnu and Sajong soils which are coarse loamy mixed yperthermic, Typic Udorthents and coarse loamy, mixed, thermic, Humic Dystrudepts.

Drainage and Permeability: Somewhat excessively drained with moderately rapid permeability.

Land Use and Vegetation: These soils are mostly under Rice cultivation, and lands are well terraced and bunded. Natural Vegetation includes utis, Chilaune etc

Distribution and extent: The Martam soils are extensively distributed in the soil map unit no. 40 and 48 of East Sikkim (3134 ha) district of the Sikkim State.

Interpretation: Soils are deep and matured. They have been rated moderately suitable for maize. Cultivation may be practiced only with adequate soil conservation measures.

Interpretative groupings

Land capability sub-class : IVe2s
 Productivity rating (Forest) : Average (III)

	Soil Site Suitability	Farmer's yield	Improved Yield
	Class	-----yield t/ha-----	
Rice	S3	1.2	1.7
Maize	S2	1.8	2.5

ANALYTICAL DATA

Horizon	Depth (cm)	Size Class and particle diameter (mm)			Textural Class	Coarse fragments > 2 mm (%)
		Sand (2-0.05)	Silt (0.05– 0.002)	Clay (<0.002)		
Ap	0-16	38.7	24.0	37.3	cl	5
Bw1	16-42	39.7	22.0	38.3	cl	10
Bw2	42-67	27.7	25.0	47.3	c	10
Bw3	67- 83	26.7	27.0	46.3	c	5
Bw4	83-110	24.7	28.0	47.3	c	5
Bw5	110-150	20.7	29.0	50.3	c	25

Depth (cm)	pH (1:2.5) H ₂ O	Organic carbon %	Extractable bases					CEC	Base Saturation %
			Ca	Mg	Na	K	SUM		
			<-----cmol (p+) kg ⁻¹ ----->						
0-16	5.0	2.3	5.3	2.8	0.2	0.2	8.5	14.8	57
16-42	4.4	2.2	5.7	2.1	0.1	0.2	8.1	13.9	58
42-67	4.6	1.8	7.1	2.8	0.1	0.2	10.2	17.2	59
67- 83	4.8	1.5	8.0	2.1	0.1	0.1	10.3	17.5	59
83-110	4.8	1.3	7.9	2.0	0.1	0.1	10.1	16.8	60
110-152+	5.0	1.2	6.9	2.0	0.1	0.1	9.1	15.1	60

57. NUNG SERIES

Nung series is a member of fine loamy, mixed, thermic Typic Hapludolls. Typically Nung soils have very dark grayish brown, moderately acidic, sandy loam A horizon and dark brown moderately acidic sandy clay loam B horizon.

Typifying Pedon: Nung-sandy clay loam- cultivated

Horizon	Depth (cm)	Description
Ap	0-20	Very dark grayish brown (10 YR 3/2), sandy clay loam; weak, fine, sub-angular blocky structure; loose slightly friable and sticky; non plastic many fine pores; many fine roots; pH 5.0; clear, smooth boundary
Bw1	20-46	Dark brown (10 YR 4/3), sandy clay loam; moderate, fine, sub-angular blocky structure; loose and very sticky and plastic; many fine pores; many fine roots; pH 5.1, gradual, smooth boundary
Bw2	46-70	Dark brown (10 YR 4/4), sandy clay loam; moderate, fine, sub-angular blocky structure; loose and very sticky and plastic many fine pores; few fine roots; pH 5.2, gradual, smooth boundary
Bw3	70-115	Dark brown (10 YR 3/4), sandy clay loam; moderate, fine, sub-angular blocky structure; loose and very sticky and plastic; fine pores; pH 5.4.

Type location: Latitude 27°26'25" N and Longitude 88°36'10" E (78A/8)
 Vill. Nung, Tehsil: Mangan Dist. North Sikkim.

Ranges in characteristics: The thickness of soil solum is more than 100cm. The depth of A horizon varies from 20 to 25 cm. The colour is in hue 10YR, value 2 to 3 and chroma 1 to 2. The textural class is sandy clay loam. The depth of B horizon varies from 80 to 100cm. The colour is in hue 10YR, value 4 to 5 Chroma 3 to 4. The textural class is sandy clay loam.

Geographical Setting: Nung soils occur on steeply sloping side slope of the Himalayan Mountain at an elevation of 1525m above MSL. The climate is temperate with mean annual temperature 7.8° C and mean annual rainfall of 3150 mm

Geographically associated soils: Nung Soils are associated with the Lingthem soils which is coarse loamy mixed thermic, Dystric Eutrudepts.

Drainage and Permeability: Well drained, slow permeability.

Land Use and Vegetation: These soils are mostly under rice cultivation and the natural vegetation are bamboo, dhupi, katus etc.

Distribution and extent: The Nung soils are extensively distributed in the soil map unit no.27 of North Sikkim (4911ha) districts of the Sikkim State.

Interpretation: Nung Soils have been developed on steep slope. They have been rated as moderately suitable for rice and maize. Terraced land should be protected from soil erosion.

Interpretative groupings

Land capability sub-class : Vle2s
 Productivity rating (Forest) : Average (III)

Soil Site Suitability

	Soil Site Suitability	Farmer's yield	Improved Yield
	Class	-----yield t/ha-----	
Rice	S2	1.7	1.9
Maize	S2	1.6	2.1

ANALYTICAL DATA

Horizon	Depth (cm)	Size Class and particle diameter (mm)			Textural Class	Coarse fragments > 2 mm (%)
		Sand (2-0.05)	Silt (0.05– 0.002)	Clay (<0.002)		
A	0-20	61.9	11.6	26.5	scl	15
Bw1	20-46	59.5	11.6	28.9	scl	10
Bw2	46-70	57.8	11.2	31.0	scl	20
Bw3	70- 115	53.8	12.4	33.8	scl	30

Depth (cm)	pH (1:2.5) H ₂ O	Organic carbon %	Extractable bases					CEC	Base Saturation %
			Ca	Mg	Na	K	SUM		
			<-----cmol (p+) kg ⁻¹ ----->						
0-20	5.0	3.5	5.5	3.7	0.2	0.2	9.6	17.5	55
20-46	5.1	2.1	5.3	1.9	0.2	0.2	7.6	13.5	56
46-70	5.2	1.4	5.2	2.7	0.1	0.2	8.2	14.2	58
70-115	5.4	1.2	4.0	2.4	0.1	0.2	6.7	11.2	60

58. YUMTHANG SERIES

Yumthang series is a member of coarse loamy, mixed, mesic, Humic Pachic Dystrudepts. Typically Yumthang soils have black, moderately acidic, silt loam A horizon and black to dark yellowish brown moderately acidic silt loam B horizon.

Typifying Pedon: Yumthang- silt loam – forest

Horizon	Depth (cm)	Description
A	0-20	Black (10 YR 2/1) silt loam, weak, fine, crumb or sub-angular blocky structure; loose firm, slightly sticky and plastic; fine, common pore; very fine and fine, many roots; pH 4.8; gradual, smooth boundary.
Bw1	20-33	Black (10 YR 2/1) Silt loam, weak, fine sub-angular blocky structure; loose firm, slightly sticky; fine, common pore; medium and coarse many roots; pH 4.7; diffuse, wavy boundary.
Bw2	33-58	Very dark grayish brown (10YR 3/2) silt loam; weak, fine sub-angular blocky structure; slightly hard, firm, sticky and plastic, fine and medium many gravels; fine, many pores, fine and medium, common roots; pH 4.6; diffuse, wavy boundary.

Bw3	58-85	Dark yellowish brown (10YR 3/4) silt loam; weak, fine sub-angular blocky structure; soft, firm, sticky; very fine, many pores, very fine common roots; pH 4.8; diffuse, wavy boundary.
C	85-125	Dark yellowish brown (10YR 4/6) silt loam, weak, granular structure, soft, slightly sticky, fine, many pores, fine, common roots, pH 5.0.

Type location: Latitude 27°47'355 N and Longitude 88°42'50" E (78A/8) Vill. Yumthang, Dist. North Sikkim, State Sikkim.

Ranges in characteristics: The thickness of the solum is around 100 cm. The thickness of A horizon varies from 15-20 cm with the colour in hue of 10YR, value 2 to 3 and chroma 1 to 2. The texture ranges from silt loam to loam. The thickness of B horizon ranges from 20 – 60cm. Its colour is in hue of 10 YR or 2.5Y with value 3 to 4 and chroma 3 to 4. Its textural class ranges from sandy loam to silt loam.

Geographical Setting: Yumthang soils occur on steeply sloping hill of the Himalayan Mountain at an elevation of 3780 m above MSL. The climate is temperate with mean annual temperature 3.8° C and mean annual rainfall of 1476 mm.

Geographically associated soils: Yumthang soils are associated with the Thangu and Kalep soils which are loamy skeletal mixed thermic, Typic Dystrocrepts and coarse loamy, mixed, thermic Humic Dystrocryepts .

Drainage and Permeability: Somewhat excessively drained with rapid permeability.

Land Use and Vegetation: Forest- natural vegetations are gurash, augari, testapathi etc.

Distribution and extent: The Yumthang soils are extensively distributed in the soil map unit no. 59 and 61 of North Sikkim (40722 ha) districts of the Sikkim State.

Interpretation: Soils are characterised with high CEC and organic carbon content. The area is under forest. To preserve ecological balance of north district, forestland use should not be disturbed.

Interpretative groupings

Land capability sub-class : Vlle3s
 Productivity rating (Forest) : Average (III)

ANALYTICAL DATA

Horizon	Depth (cm)	Size Class and particle diameter (mm)			Textural Class	Coarse fragments > 2 mm (%)
		Sand (2-0.05)	Silt (0.05– 0.002)	Clay (<0.002)		
A	0-20	66.3	24.4	9.3	sil	5
Bw1	20-33	23.4	63.1	13.5	sil	10
Bw2	33-58	26.6	60.9	14.5	sil	28

Bw3	58-85	23.6	61.9	14.5	sil	30
C	85-125	35.2	51.6	16.2	l	40

Depth (cm)	pH (1:2.5) H ₂ O	Organic carbon %	Extractable bases					CEC	Base Saturation %
			Ca	Mg	Na	K	SUM		
			<-----cmol (p+) kg ⁻¹ ----->						
0-20	4.8	3.2	5.2	8.1	0.2	0.2	13.7	27.9	49
20-33	4.7	3.0	4.8	6.7	0.2	0.2	11.9	25.8	46
33-58	4.6	3.0	4.5	5.9	0.2	0.2	10.8	23.5	46
58-85	5.0	3.0	2.3	4.0	0.2	0.2	6.7	13.0	52
85-125	5.0	2.2	3.5	2.4	0.1	0.1	6.1	11.0	55

59. KALEP SERIES

Kalep series is a member of coarse loamy, mixed, mesic, Humic Dystrocryepts. Typically Kalep soils are moderately shallow, somewhat excessively drained and have black, strongly acidic, sandy loam A horizon and yellowish red, moderately acidic and sandy loam B horizon.

Typifying Pedon: Kalep-sandy loam-forest

Horizon	Depth (cm)	Description
A	0-18	Black (10 YR 2/1) sandy loam; weak, fine, crumb structure; loose, friable and slightly sticky very fine, few, coarse pores; common fine, roots; pH 4.4; abrupt, smooth boundary

Bw	20-36	Yellowish red (5YR 4/6) sandy loam, weak, fine, crumb to sub angular blocky structure; soft, friable, non-sticky to non-plastic, common fine, roots; pH 4.9, diffuse, broken boundary
C	36-64	Light olive brown (2.5YR 5/4) loamy sand; - structureless, pH5.2.

Type location: Latitude 27°52'10" N and Longitude 88°32'25" E (78A/8) Vill. Kalep; Distt. North Sikkim, State Sikkim.

Ranges in characteristics: The thickness of solum is 45-59 cm. The thickness of A horizon ranges from 18-25 cm. Its colour is in hue 10YR, value 2 to 3 and chroma 1 to 2. Its texture ranges from sandy loam to loam. The thickness of B horizon ranges from 40-45 cm. The colour is in hue 5YR to 10YR, value 4 to 5 and chroma 4 to 6. The texture ranges from sandy loam to sandy clay loam.

Geographical Setting: Kalep soils occur on steeply sloping hill of the Himalayan Mountain at an elevation of 3450 m above MSL. The climate is temperate with mean annual temperature 3.9° C and mean annual rainfall of 3500 mm.

Geographically associated soils: Kalep soils are associated with the Yumthang and Thangu Soils which are Coarse loamy mixed mesic, humic Dystrocrypts and loamy skeletal, mixed, thermic Typic Dystrocrepts.

Drainage and Permeability: Somewhat excessively drained with rapid permeability.

Land Use and Vegetation: Mainly under forest. Natural vegetation includes gurash, augari and rhododendron, etc.

Distribution and extent: The Kalep soils are extensively distributed in the soil map unit no. 7 and 61 of North Sikkim (157 ha) district of the Sikkim State.

Interpretation: Soils are developed under isomesic soil temperature and perudic soil moisture regime with a thickness of 36cm of solum. The area is under extensive forest. Indigenous forest species may be introduced in afforestation programme.

Interpretative groupings

Land capability sub-class : Vie2s
 Productivity rating (Forest) : Average (III)

ANALYTICAL DATA

Horizon	Depth (cm)	Size Class and particle diameter (mm)			Textural Class	Coarse fragments > 2 mm (%)
		Sand (2-0.05)	Silt (0.05–0.002)	Clay (<0.002)		
A	0-18	42.4	47.2	10.4	sl	10

Bw	20-36	56.8	28.8	14.4	sl	15
C	36-64	84.2	6.4	9.4	ls	40

Depth (cm)	pH (1:2.5) H ₂ O	Organic carbon %	Extractable bases					CEC	Base Saturation %
			Ca	Mg	Na	K	SUM		
			←-----cmol (p+) kg ⁻¹ -----→						
0-18	4.4	3.6	1.6	1.0	0.6	0.4	3.6	8.5	42
20-36	4.9	3.5	1.4	0.7	0.6	0.2	2.9	6.4	45
36-64	5.2	1.2	1.0	0.5	0.6	Tr.	2.1	4.1	51

60. JORPUL SERIES

Jorpul series is a member of loamy skeletal, mixed thermic, Lithic Udorthents. Typically Jorpul soils have dark brown, moderately acidic, loamy sand surface horizon only.

Typifying Pedon: Jorpul – loamy sand – barren land

Horizon	Depth (cm)	Description
A	0-19	Dark brown (10 YR 3/3) loamy sand; weak, fine, granular; friable; non-sticky, non plastic, fine common roots, pH 5.1.
Cr	19 – 25	Weathered parent materials

Type location: Latitude 27°41'48" N and Longitude 88°36'10"E (78A/8)
Vill. Jorpul, P.S. Mangan, District North Sikkim, Sikkim State.

Ranges in characteristics: The soil is very shallow. Thickness of A horizon ranges from 15-25cm with 10 YR in hue, value 2 to 3 and chroma 2 to 3. The textural class varies from sandy loam to loamy sand.

Geographical Setting: Jorpul soils occur on steeply sloping side slope of the Himalayan Mountain at an elevation of 2175 m above MSL. The climate is temperate with mean annual temperature 10.2° C and mean annual rainfall of 3000 mm.

Geographically associated soils: Jorpul Soils are associated with the rockout crops.

Drainage and Permeability: Excessively drained with moderate permeability.

Land Use and Vegetation: Barren land Natural vegetation includes grass. Banmara, etc.

Distribution and extent: The Jorpul soils are extensively distributed in the soil map unit no. 2 North Sikkim (10015 ha) districts of the Sikkim State.

Interpretation: Soils are very shallow and developed on rocky cliff. The area should maintain status que to preserve the ecological balance.

Interpretative groupings

Land capability sub-class : VIIIe4s
 Productivity rating (Forest) : Poor(IV)

ANALYTICAL DATA

Horizon	Depth (cm)	Size Class and particle diameter (mm)			Textural Class	Coarse fragments > 2 mm (%)
		Sand (2-0.05)	Silt (0.05– 0.002)	Clay (<0.002)		
A1	0-19	80.2	10.8	9.0	Ls	40

Depth (cm)	pH (1:2.5) H ₂ O	Organic carbon %	Extractable bases					CEC	Base Saturation %
			Ca	Mg	Na	K	SUM		
<-----cmol (p+) kg ⁻¹ ----->									
0-19	5.1	1.5	1.3	0.5	0.1	0.1	2.0	4.0	50

61. DHARAMDIN SERIES

Dharamdin series is a member of fine loamy, mixed, thermic Fluventic Eutrudepts. Typically Daramdin soils have dark brown,

moderately acidic, clay loam A horizon and dark brown to dark yellowish brown, slightly acidic, clay loam B horizon.

Typifying Pedon: Dharamdin- silt loam - cultivated

Horizon	Depth (cm)	Description
Ap	0-22	Dark brown (10YR4/3) silt loam; moderate, medium, subangular blocky structure; slightly sticky and slightly plastic; few to medium pores; plenty coarse roots, pH 5.3; clear, smooth boundary.
Bw1	22-45	Dark, brown (10YR4/3) silt loam; moderate medium, subangular blocky structure; Sticky and plastic; small to medium stones; plenty coarse roots, pH 5.5; gradual, smooth boundary.
Bw2	45-63	Dark yellowish brown (10YR4/4) silt loam; moderate, medium, sub-angular blocky structure; firm; sticky and plastic; fine to medium stones; medium fine roots; pH 5.6, gradual, smooth boundary.
Bw3	63-85	Dark yellowish brown (10YR4/4) silt loam; weak, fine, sub-angular block structure; firm; sticky and plastic; few fine roots, pH 5.8, diffuse, boundary.
Bw4	85-100	Dark yellowish brown (10YR4/4) loam, massive; firm sticky and plastic; many medium stones; few roots, pH 5.5.

Type location: Latitude 27°8'05" N and Longitude 88°10'20" E (78A/8)

Vill: Daramdin, District West Sikkim, Sikkim State.

Ranges in characteristics: The thickness of soil solum ranges more than 100 cm. The colour is in hue 10YR, value 4 to 5 and chroma 3 to 4. The textural class ranges from loam to Silt loam. The thickness of B horizon ranges from 20 to 100 cm. Its colour is in hue 2.5Y to 10 YR, value 4 to 5 and chroma 3 to 4. The texture is Silt loam to silty clay loam.

Geographical Setting: Daramdin soils occur on steeply sloping hill of Side slope of Himalayan Mountain at an elevation of 900m above MSL. The climate is temperate with mean annual temperature 12.2° C and mean annual rainfall of 1900 mm.

Geographically associated soils: Daramdin Soils are associated with the Lingthse and Karfgeter soils which are coarse loamy mixed thermic, typic Udorthents and fine loamy mixed thermic Humic Hapludalfs.

Drainage and Permeability: Well drained and slow permeability.

Land Use and Vegetation: Mainly under cultivation of maize. Natural Vegetation includes utis, dhupi and chilaune etc.

Distribution and extent: The Daramdin soils are extensively distributed in the soil map unit no. 13, 14, 39 and 40 of West Sikkim (1485 ha) districts of the Sikkim State.

Interpretation: Soils are deep, fine with good water holding capacity. As slope class and soil characteristics are favourable for cultivation in Sikkim, maize may be grown successfully.

Interpretative groupings

Land capability sub-class : IIIe2
 Productivity rating (Forest) : Average (III)

Soil Site Suitability

	Soil Site Suitability Class	Farmer's yield	
		yield t/ha	<i>Improved Yield</i>
Maize	S2	1.8	2.1

ANALYTICAL DATA

Horizon	Depth (cm)	Size Class and particle diameter (mm)			Textural Class	Coarse fragments > 2 mm (%)
		Sand (2-0.05)	Silt (0.05- 0.002)	Clay (<0.002)		
		A	0-22	23.0		
Bw1	22-45	19.2	53.2	27.6	sil	8
Bw2	45-63	19.0	54.4	26.6	sil	15
Bw3	63-85	18.0	49.4	32.6	l	25
Bw4	85-100	18.4	44.0	34.6	l	-

Depth (cm)	pH (1:2.5) H ₂ O	Organic carbon %	Extractable bases					CEC	Base Saturation %
			Ca	Mg	Na	K	SUM		
			<-----cmol (p+) kg ⁻¹ ----->						
0-22	5.3	1.9	3.8	3.5	0.2	0.1	7.6	11.8	64
22-45	5.5	1.2	4.1	3.1	0.2	0.2	7.6	10.9	70
45-63	5.6	0.50	4.0	4.1	0.2	0.1	6.1	8.4	72
63-85	5.8	0.52	3.9	4.0	0.2	0.2	8.3	11.1	75
85-100	5.5	0.80	4.2	3.5	0.2	0.1	8.0	11.6	69

62. SALEM SERIES

Salem series is a member of fine loamy, mixed, thermic Humic Dystrudepts. Typically Salem soils have very dark grayish brown, strongly acidic, silty clay loam A horizon and dark yellowish brown strongly acidic silty clay loam B horizon.

Typifying Pedon: Salem- silty clay loam-cultivated

Horizon	Depth (cm)	Description
Ap	0-13	Very dark grayish brown (10 YR 3/2) silty clay loam, weak, medium sub angular blocky structure; soft friable and sticky; plastic; few, fine and medium gravels and stones; common very fine pores; common fine roots; pH 4, clear, smooth boundary.

Bw1	13-25	Dark brown (10 YR 3/3) silty clay loam; weak, medium sub angular blocky structure; friable and sticky; plastic; few fine and medium gravels and stones; common very fine pores; few, fine roots; pH 4, gradual, smooth boundary.
Bw2	25-41	Dark yellowish brown (10 YR 3/4) silty clay loam; weak, medium sub-angular blocky; friable and sticky; plastic; few, fine gravels, few fine and medium pores; fine few roots; pH 4.1, gradual, wavy boundary
Bw3	41-78	Dark yellowish brown (10 YR 3/4) silty clay loam; weak, fine granular structure; friable and sticky; plastic; few fine pores; few very fine roots; pH 4.2, gradual, smooth boundary
C	78-150	Dark yellowish brown (10 YR 3/4) silty clay loam; friable and sticky; plastic; pH 4.2.

Type location: Latitude 27°10'20" N and Longitude 88°27' E (78A/8)
Vill. Salem, Tehsil Legship, Distt. South Sikkim State Sikkim.

Ranges in characteristics: The thickness of solum is 80-100 cm. The thickness of A horizon varies from 25-30 cm, the colour is in hue 10YR, value 2 to 3, the textural class is silty clay loam. The thickness of B horizon ranges from 70 to 105cm. The textural class ranges from clay loam to silty clay loam. The colour is in hue 10YR, value 3 to 4 and chroma 3 to 5.

Geographical Setting: Salem soils occur on steeply sloping hill of the side slope of Himalayan Mountain at an elevation of 1600 m above MSL. The climate is temperate with mean annual temperature 14° C and mean annual rainfall of 1500 mm.

Geographically associated soils: Salem Soils are associated with the Rubam soils which is loamy skeletal, mixed, thermic, Lithic Udorthents.

Drainage and Permeability: Some what excessively drained and slow permeability.

Land Use and Vegetation: Mainly under thin forest. Cultivation of Maize is a common practice. The natural vegetations are chilauni, siris, etc.

Distribution and extent: The Salem soils are extensively distributed in the soil map unit no. 2 of South Sikkim (23584 ha) district of the Sikkim State.

Interpretation: Soils are slightly acidic with moderate CEC, low base saturation. Textural class belongs to fine loamy. They have been rated as moderately suitable for maize and rice under hilly condition.

Interpretative groupings

Land capability sub-class : Vie2

Productivity rating (Forest) : Average (III)

Soil site suitability

	Soil Site Suitability Class	Farmer's yield	
		-----yield t/ha-----	
Rice	S3	1.2	1.6
Maize	S3	1.4	1.8

ANALYTICAL DATA

Horizon	Depth (cm)	Size Class and particle diameter (mm)			Textural Class	Coarse fragments > 2 mm (%)
		Sand (2-0.05)	Silt (0.05– 0.002)	Clay (<0.002)		
Ap	0-13	28.4	43.3	28.3	sicl	10
Bw1	13-25	26.0	47.7	30.3	sicl	15
Bw2	25-41	15.4	55.3	29.3	sicl	10
Bw3	41-78	19.1	53.6	27.3	sicl	10
C	78-150	18.2	52.5	29.3	sicl	30

Depth (cm)	pH (1:2.5) H ₂ O	Organic carbon %	Extractable bases					CEC	Base Saturation %
			Ca	Mg	Na	K	SUM		
<-----mol (p+) kg ⁻¹ ----->									
0-13	4.0	2.9	4.5	1.5	0.3	0.2	6.5	13.8	47
13-25	4.0	2.0	4.0	1.5	0.3	0.2	6.0	13.2	46
25-41	4.1	1.5	3.5	2.0	0.1	0.1	5.7	12.8	45
41-78	4.2	0.9	4.5	2.0	0.2	0.1	6.8	13.0	52
78-150	4.2	0.9	3.5	1.5	0.1	0.1	5.2	11.0	47

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