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Soil Series and Land Capability Classification of Itanagar Capital Complex

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Abstract

Soil plays an important role in landslide studies. Various parameters of the soil help to evaluate the extent of soil degradation leading to soil erosion and subsequently slide down. Itanagar Capital Complex (ICC) of the State of Arunachal Pradesh experiences a number of landslides, hence, soils of this place have been studied.

The soils of Itanagar Capital Complex, have been analysed in terms of the morphological, physical and chemical properties. It led to identify twelve soil series with relation to nine landforms.

Each soil series has been given a 'Landslide Index' on the basis of soil properties, slope, erosion and proneness to landslides. The landslide index grades soil-site characteristic within a range of 0 to 100, where the minimum value (0) shows no risk and the maximum value (100) indicates highest degree of proneness to landslides.

Soil series with respect to their land capability classification revealed that most of the twelve soil series fall under Class VII category, though a few individual soil sites fall under other land capability classes, viz. Class III, Class VI, and Class VIII.

Keywords: Landslide; Rudraprayag; Uttarakhand; Kinematic Analysis.

INTRODUCTION

Soil is one of the important parameter in landslide studies. It needs special attention as the soil parameters in terms of the morphological, physical and chemical properties bear the signatures, which can help to assess the degree of soil degradation. The soil erosion is the most active form of soil degradation and assessed by the soil properties.

The Itanagar Capital Complex of Arunachal Pradesh is most vulnerable to soil erosion because of its geomorphological expressions and anthropogenic activities. These, in turn, are causing landslide hazards. Classic examples of such landslide can be sites along the Banderdewa-Itanagar-Gohpur road section, and other road sections in the Itanagar Capital Complex. Soil erosion has also been intensified by anthropogenic activities, where people are disturbing hill slopes and making tableland for construction of buildings. Other potential causes include widening of roads, heavy rainfall, steep slopes, etc.

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The geology of Itanagar and landslide occurrences therein have been discussed by Singh T. [2005, 2006, 2007 and 2009], Singh T. and Devi [2006], Singh T. *et al.* [2007], and Singh Y. *et al.* [2008]. They have also shown the soil characteristics, such as erosion and degradation, which are prone to landslide incidences in the region.

Methodology

The first step to assess soil erosion, soil degradation and its proneness to landslides is to prepare the soil map of the area. The soil map was, thus, prepared using the following standard technique.

To begin with, base line data was collated and compiled. It included physiography, relief, drainage, climate, geology, natural vegetation, land use and other related data on agriculture and socio economic factors. Thereafter, systematic visual interpretation of the False Colour Composite (FCC) images was carried out considering image characteristics, viz. colour, tone, texture, shape, size, pattern, location, drainage line network and also the vegetation. Based on these characteristics, different features were recognised and limits of different homogeneous areas were drawn on the imagery, which were subsequently verified in the field. It was ensured during the ground truth that each of the landform unit is represented by a minimum of three observation points to establish land, soil and physiographic relationships.

By these combinations, features were recognised and limits of different homogeneous areas were drawn on the imagery and finally prepared the Soil Series Map (Figure 1). Simultaneously, legend was established highlighting physiographic units, image characteristics, soil erosion status, terrain conditions, and land use as components.

Lastly, soil profile and morphometric characteristics of the landforms, such as slope, erosion status, stoniness, land-use data, etc., were analysed that helped to identify the soil series. Subsequently, each soil series was assigned 'Landslide Index' on the basis of soil properties, slope, erosion and proneness to landslides, and was assessed for the land capability classification.

Results

In all 12 Soil Series were identified in the Itanagar Capital Complex, belonging to three Orders, viz., Entisol, Inceptisol and Ultisol.

Soil Analysis

The soils on the hills, foothills and basins are shallow and are prone to erosion. The advanced stage of tropical soil weathering further make the substrata soft in terms of sandstone and loose in terms of sand, causing more erosion. Coarser texture of the soils and steep slopes make these landforms more vulnerable to landslides.

In all, twelve 'Soil Series' have been identified, which are restricted to the nine landform units. Further, each soil series has been assigned a 'Landslide Index' on the basis of soil properties, slope, erosion and proneness to landslides, as observed at the benchmark spot of each soil profile. The landslide index grades soil-site characteristics within a range of 0 to 100, where the minimum value (0) shows no risk and the maximum value (100) indicates highest degree of proneness to landslides. The soil association on various landforms have been converted into Landslide Indices Association.

The defined landforms and soils relationship are given below in Table 1.

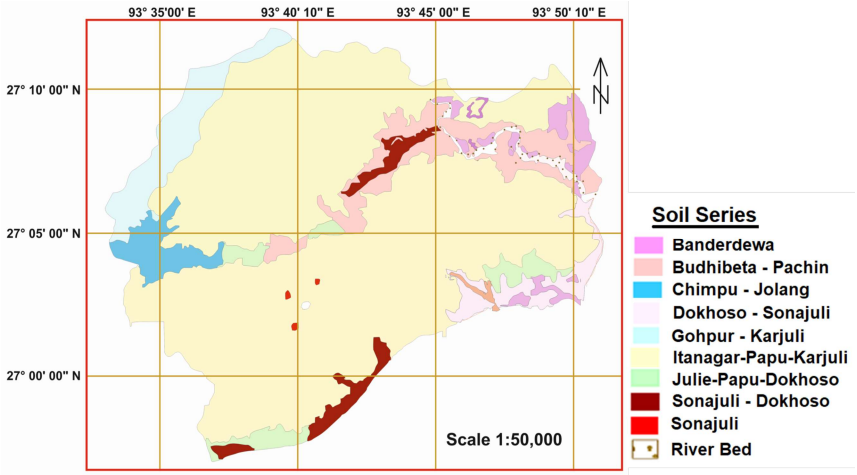

Figure 1: Soil Series Map of the Itanagar Capital Complex

Table 1: Landforms and Soils Relationship in Itanagar Capital Complex

Landform	Soil Series	Soil Association	Map Unit	Landslide Index*
Medium Hills	Gohpur	Gohpur - Karjuli	5 – 9	100 – 80
Low Hills	Itanagar - Papu - Karjuli	Itanagar - Papu - Karjuli	6 –11 – 9	40 – 60 – 80
Foothills / Piedmont	Julie	Julie - Papu - Dokhoso	8 – 11 – 4	70 – 60 – 60
Inter-hill Basin	Budhibeta-Pachin	Pachin - Budhibeta	10 – 2	50 – 30
Very narrow Inter-hill Basin	Chimpu - Jolang	Chimpu - Jolang	3 – 7	70 – 70
Gullied / Degraded Land	Banderdewa	Gullied Land / Degraded Land - Banderdewa	13 – 1	100 – 100
Barren Land	Sonajuli	Sonajuli	12	
Valley Floor	Dokhoso	Dokhoso - Sonajuli	4 – 12	60 – 70
Grassland	Dokhoso	Dokhoso - Sonajuli	12 – 4	60 – 70

*Landslide index has been ascribed on the basis of **(i)** soil properties, (ii) slope, **(iii)** erosion and **(iv)** proneness to landslides as observed at the Benchmark spot of each soil profile

Characteristics and Classification of Soils

During the field survey for soil mapping and observations to understand behaviour of the sediments/soil in slope failure, 15 soil samples were collected from different locations. Based on the field and laboratory data 12 Soil Series were identified. The data suggests that these Soil Series belong to three Orders, viz., Entisol, Inceptisol and Ultisol.

The taxonomic grouping of the 12 Soil Series have been given in Table 2. Brief morphological description of these 12 Soil Series have been shown in Table 3. Further, physical and chemical characteristics of these Soil Series have been given in Tables 4 and 5, respectively.

Table 2. Taxonomic grouping of soil series in itanagar capital complex

Soil Series	Order	Suborder	Great Group	Subgroup	Particle size class	Mineralogy class
Banderdewa	Ultisol	Humult	Kanhaplohumult	Typic Kanhaplohumult	Fine-loamy	Mixed
Budhibeta	Ultisol	Humult	Kanhaplohumult	Typic Kanhaplohumult	Fine-loamy	Mixed
Chimpu	Ultisol	Humult	Kanhaplohumult	Typic Kanhaplohumult	Fine-loamy	Mixed
Dokhoso	Inceptisol	Aquept	Endoaquept	Typic Endoaquept	Fine-loamy	Mixed
Gohpur	Entisol	Orthent	Udorthent	Typic Udorthent	Loamy	Mixed
Itanagar	Entisol	Orthent	Udorthent	Typic Udorthent	Loamy	Mixed
Jolang	Inceptisol	Udept	Dystrudept	Humic Dystrudept	Coarse-loamy	Mixed
Julie	Ultisol	Humult	Kanhaplohumult	Typic Kanhaplohumult	Fine-loamy	Mixed
Karjuli	Entisol	Orthent	Udorthent	Lithic Udorthent	Loamy	Mixed
Pachin	Inceptisol	Udept	Dystrudept	Humic Dystrudept	Fine-loamy	Mixed
Papu	Ultisol	Humult	Kanhaplohumult	Typic Kanhaplohumult	Coarse- loamy	Mixed
Sonajuli	Entisol	Orthent	Udorthent	Typic Udorthent	Loamy	Mixed

Table 3: Brief morphological descriptions of selected horizons of different Soil Series in Itanagar Capital Complex

Soil Series	Solum thickness (cm)	Horizon	Depth (cm)	Colour	Texture	Efferv-escence	Concre-tions	Remarks
								Gullied/Degraded land associated with Banderdewa Soil Series.
Banderdewa Series	47	A1	13	10 YR 3/6	1s	Nil	Nil	Yellowish brown, moderately deep, loamy sand, well drained, severely to very severely eroded, moderately to strongly sloping (8-15%) foothills. Dark colour surface horizons indicate >1% organic carbon. This is common in the forest soils of Arunachal Pradesh. These soils qualify for Humults.
Budhibeta Sereis	30	A1	10	10 YR4/6	sc1	Nil	Nil	Dark yellowish brown, moderately deep, sandy clay loam, well drained, severely eroded, strongly sloping (8-15%) very narrow inter-hill basin.
		Bt1	30	10 YR 4/4	c1	Nil	Nil	Dark colour surface horizons indicate >1% organic carbon. This is common in the forest soils of Arunachal Pradesh. These soils qualify for Humults.
Chimpu Series	61	Bt1A11	5	10 YR 4/2	sc1	Nil	Nil	Greyish brown, deep, sandy clay loam, well drained, moderate to severely eroded, strongly to steeply sloping (8-15 & 15-35%) very narrow Inter-hill basin. Dark colour surface horizons indicate >1% organic carbon. This is common in the forest soils of Arunachal Pradesh. These soils qualify for Humults.
Dokhoso Series	40	A1	11	10 YR 3/3	s1	Nil	Nil	Brown to dark brown, moderately deep, sandy loam, poorly drained, moderately eroded, very gently sloping (1-5%) alluvial plain.
Gohpur Series	40	A1	12	10 YR 4/6	s1	Nil	Nil	Light yellowish brown, moderately deep, sandy loan, rapidly drained, severely eroded, very steeply sloping (30-35%) medium hills.
Itanagar Series	13	A1	13	10 YR 4/6	sc1	Nil	Nil	Yellowish brown, shallow, sandy clay loam, rapidly drained, severely eroded, steeply sloping (15-30%) low hills.
Jolang Series	70	A11	8	10 YR 4/3	sc1	Nil	Nil	Brown, deep, sandy loam, well drained, moderately to severely eroded, strongly sloping (8.15%), narrow Inter-hill basin.
		2Bw3	70	10 YR 4/4	s1	Nil	Nil	Dark colour surface horizons indicate >1% organic carbon. This is common in the forest soils of Arunachal Pradesh, and qualify for humic subgroup.
Julie Series	60	A1	29	10 YR 7/6	sc1	Nil	Nil	Yellowish brown, deep, sandy clay loam. Rapidly drained, severely eroded, steeply sloping (8-15%) foothills / piedmont. Dark colour surface horizons indicate >1% organic carbon. This is common in the forest soils of Arunachal Pradesh. These soils qualify for Humults.
Karjuli Series	60	Ap	13	10 YR ¾	gsc1	Nil	Nil	Yellowish brown, moderately deep, gravelly sandy loam, rapidly drained, moderately eroded, steeply sloping (15-30%) low hills.
Pachin Series	66	A1	13	10 YR ¾	sc1	Nil	Nil	Dark yellowish brown, deep, sandy clay loam, well drained, moderately eroded, moderately sloping (8-15%), inter-hill basin (valley). Dark colour surface horizons indicate >1% organic carbon. This is common in the forest soils of Arunachal Pradesh. These soils qualify for humic subgroup.
		Bw1	50	10 YR 5/4	sc1	Nil	Nil	
		2bt1	41	10 YR 4/6	sc1	Nil	Nil	
		Bt1	60	10 YR 4/4	c1	Nil	Nil	
		Bw1	30	10 YR 7/6	gs1	Nil	Nil	

Papu Series	42	Ap	13	10 YR 4/4	sc1	Nil	Nil	Light yellowish brown, moderately deep, sandy clay loam, well drained, moderately to severely eroded, steeply sloping (15-30%) low hills. Dark colour surface horizons indicate >1% organic carbon. This is common in the forest soils of Arunachal Pradesh. These soils qualify for Humults.
		Bt1	29	10 YR ¾	c1	Nil	Nil	
		Bt2	42	10 YR 5/4	c1	Nil	Nil	
		Bw1	40	10 YR 4/4	s1	Nil	Nil	
		Bwg1	40	10 YR 6/3	sc1	Nil	Nil	
		Bt1	29	10 YR 4/4	s1	Nil	Nil	
Sonajuli Series	57	A1	18	10 YR 6/6	1s	Nil	Nil	Brown, shallow, loamy sand, rapidly drained, moderately to severely eroded, moderately sloping (1-5%) valley floor.

Table 4: Physical Characteristics of Soil Series in Itanagar Capital Complex

Soil Series	Horizon	Depth (cm)	Soil Texture (%)			Gravel % (>2mm)	Colour	Electrical Conductivity (EC) dSm^{-1}
			Sand	*Silt*	*Clay*			
Banderdewa Series	A1	0-13	82.3	5.4	12.3	2.6	Yellowish brown (10YR 5/6 D) to dark yellowish brown (10 YR 3/6 M)	<0.03
	Bt1	13-29	75.1	8.7	16.2	4.1	Yellowish brown (10YR 5/4 D) to dark yellowish brown (10 YR 4/4 M)	<0.03
	Bt2	29-47	73.6	9.0	17.4	3.7	Yellowish brown (10YR 5/6 D) to dark yellowish brown (10 YR 4/6 M)	<0.03
	C	47-109+	Weathered sandy material with assorted pebbles and cobbles				-	-
Budhibeta Series	A1	0-10	68.4	21.2	10.4	2.5	Yellowish brown (10 YR 5/4 D) to dark yellowish brown (10 YR 4/6 M)	<0.03
	Bt1	10-30	42.9	27.6	29.5	3.2	Yellowish brown (10 YR 5/6 D) to dark yellowish brown (10 YR 4/4 M)	<0.03
	C	30-60+	Weathered sandstone with slight soil				Light yellowish brown (10 YR 6/4 D)	-
Chimpu Series	A11	0-5	53.0	24.3	22.7	2.1	Greyish brown (10 YR 5/2 D) to dark greyish brown (10 YR 4/2 M)	<0.03
	A12	5-17	58.9	22.8	18.3	1.2	Pale brown (10 YR 6/3 D) to brown (10 YR 5/3 M)	<0.03
	2Bt1	17-41	52.5	24.2	23.3	1.5	Light yellowish brown (10 YR 6/4 D) to dark yellowish brown (10 YR 4/6 M)	<0.03
	2Bt2	41-63	56.3	22.3	21.4	2.2	Yellow (10 YR 7/6 D) to yellowish brown (10 YR 5/6 M)	<0.03
	C	63-100+	Sandstone decomposed material				Very pale brown (10 YR 7/3 D) to yellowish brown (10 YR 5/4 M)	-
Dokhoso Series	Ap	0-11	69.3	13.2	17.5	2.1	Brown (10 YR 5/3 D) to dark brown (10 YR 3/3 M)	<0.03
	Bw1	11-20	63.6	14.1	22.3	2.0	- do -	<0.03
	Bwg1	20-40	61.9	15.0	23.1	1.5	Pale brown (10 YR 6/3 D) to dark brown (10 YR 3/3 M)	<0.03
		40+	Water				-	-
Gohpur Series	A11	0-12	71.6	11.1	17.3	3.5	Very pale brown (10 YR 7/4 D) to dark yellowish brown (10 YR 4/6 M)	<0.03
	A12	12-40	73.7	10.2	16.1	7.8	Light yellowish brown (10 YR 6/4 D) to dark yellowish brown (10 YR 4/4 M)	<0.03
	C1	40-75	Weathered sandstone				Light yellowish brown (10 YR 6/4 D) to brown (10 YR 4/3 M)	-
	C2	75-110	Weathered sandstone leading to friable loose sand				-	-

Itanagar Series	A1	0-13	65.5	10.2	24.3	5.6	Yellowish brown (10 YR 5/6 D) to dark yellowish brown (10 YR 4/6 M)	<0.03
	C	13-40	Highly weathered gneissic parent material				-	-
	R	40-55+	Weathered parent rock (Gneiss)				-	-
Jolang Series	A11	0-8	52.7	12.5	22.3	2.3	Yellowish brown (10 YR 5/4 D) to brown (10 YR 4/3 M)	<0.03
	2Bw1	8-18	70.7	14.2	15.1	1.5	Brown (10 YR 5/3 D) to dark yellowish brown (10 YR 3/4 M)	<0.03
	2Bw2	18-43	68.4	15.3	16.3	2.0	Yellowish brown (10 YR 5/6 D) to dark yellowish brown (10 YR 4/4 M)	<0.03
	2Bw3	43-70	65.6	16.0	18.4	3.1	Brownish yellow (10 YR 6/6 D) to dark yellowish brown (10 YR 4/6 M)	<0.03
	2Bw4	70-132	75.2	11.7	13.1	2.5	Brownish yellow (10 YR 6/6 D) to dark yellowish brown (10 YR 4/6 M)	<0.03
	3C	132+	Loamy sand				Dark yellowish brown (10 YR 4/6 M)	-
Julie Series	A1	0-29	54.6	20.1	25.3	2.3	Yellow (10 YR 7/6 D) to yellowish brown (10 YR 5/6 M)	<0.03
	Bt1	29-60	47.6	22.3	30.1	3.1	Yellowish brown (10 YR 5/4 D) to yellowish brown (10 YR 4/4 M)	<0.03
	C	60-170+	Weathered sandstone				Yellowish brown (10 YR 5/4 D) to yellowish brown (10 YR 5/6 M)	-
Karjuli Series	A1	0-13	66.3	11.4	22.3	16.8	Light olive brown (2.5 YR 5/4 D) to dark yellowish brown (10 YR 3/4 M)	0.03
	Bw1	13-30	72.9	12.0	15.1	17.2	Yellow (10 YR 7/6 D) to yellowish brown (10 YR 5/4 M)	0.03
	C1	30-60	Weathered sandstone with soil material				Very pale brown (10 YR 7/4 D) to yellowish brown (10 YR 5/4 M)	-
	C2	60-170+	Decomposed sandstone				-	-
Pachin Series	A1	0-13	49.5	28.2	22.3	1.3	Brown (10 YR 5/3 D) to dark yellowish brown (10 YR 3/4 M)	<0.03
	Bw1	13-30	45.7	27.6	26.7	1.6	Brown (10 YR 5/3 D) to dark brown (10 YR 4/3 M)	<0.03
	Bw2	30-49	46.7	25.1	28.2	1.5	Brown (10 YR 5/3 D) to yellowish brown (10 YR 5/4 M)	<0.03
	Bw3	49-66	12.4	30.1	27.4	2.2	Light yellowish brown (10 YR 6/4 D) to dark brown (10 YR 4/3 M)	<0.03
	C	66-111+	Sand layer deposit				Yellowish (2.5 YR 7/4 D) to brown (10 YR 5/3 M)	-
Papu Series	A1	0-13	43.7	27.1	29.2	2.7	Light yellowish brown (10 YR 6/4 D) to dark yellowish brown (10 YR 4/4 M)	<0.03
	Bt1	13-29	37.6	28.3	34.1	6.3	Light yellowish brown (10 YR 6/4 D) to dark brown (10 YR 3/4 M)	<0.03
	Bt2	29-42	41.5	25.3	33.2	2.3	Light yellowish brown (10 YR 6/4 D) to yellowish brown (10 YR 5/4 M)	<0.03
	BC	42-74	Weathered sandstone mixed with soil material				Light yellowish brown (10 YR 6/4 D) to brown (10 YR 4/3 M)	-
	C	74-160+	Weathered sandstone with assorted pebbles and cobbles				-	-

Sonajuli Series	A1	0-18	83.8	11.2	5.0	3.5	Brown (10 YR 4/3 D) to dark brown (10 YR 3/3 M)	0.03
	2C1	18-26	Coarse sand, river bed deposit				-	-
	3C2	26-44	Red coarse sand deposit				-	-
	4C3	44-54	Coarse sand deposit				-	-
	5C4	54-130	Greyish white sand deposit				-	-
	6C5	130-164+	Different sized pebbles and cobbles					-

Table 5: Chemical Characteristics of Soil Series in Itanagar Capital Complex

Soil Series	Horizon	Depth (cm)	Organic Contents (%)	pH	Ca	Mg	Na	K	Cation Exchange Capacity (CEC)
					Cmol(+)/kg				
Banderdewa Series	A1	0-13	1.6	5.3	2.1	1.0	0.2	0.4	5.5
	Bt1	13-29	1.0	5.4	3.5	0.8	1.3	1.4	7.3
	Bt2	29-47	0.8	5.3	4.0	1.2	0.2	0.5	8.0
	C	47-109+			Weathered sandy material				
Budhibeta Series	A1	0-10	1.7	5.3	2.4	1.2	0.2	0.3	3.7
	Bt1	10-30	0.9	5.2	2.6	2.3	0.3	05	8.9
	C	30-60+			Weathered sandstone				
Chimpu Series	A11	0-5	2.0	5.6	4.0	3.2	0.3	0.2	13.2
	A12	5-17	1.8	5.5	3.5	1.0	0.4	0.1	10.4
	2Bt1	17-41	1.0	5.3	4.5	2.0	0.3	0.2	13.3
	2Bt2	41-63	0.8	5.3	3.5	1.5	0.3	0.2	12.1
	C	63-100+			Sandstone decomposed material				
Dokhoso Series	Ap	0-11	1.4	5.3	3.5	1.5	0.2	0.3	7.8
	Bw1	11-20	0.9	5.5	4.3	1.4	0.3	0.4	10.0
	Bwg1	20-40	0.8	5.4	3.7	1.0	0.2	10.4	10.4
		40+	Water						
Gohpur Series	A11	0-12	1.1	5.3	3.0	2.2	0.3	0.4	7.8
	A12	12-40	1.0	5.3	2.5	3.1	0.2	0.3	7.3
	C1	40-75			Weathered sandstone				
	C2	75-110			Sand (weathered sandstone)				
Gohpur Series	A11	0-12	1.1	5.3	3.0	2.2	0.3	0.4	7.8
	A12	12-40	1.0	5.3	2.5	3.1	0.2	0.3	7.3
	C1	40-75			Weathered sandstone				
	C2	75-110			Sand (weathered sandstone)				

	A1	0-13	1.0	5.6	4.0	1.4	0.1	0.2	11.0
Itanagar Series	C	13-40	Highly weathered gneissic parent material						
	R	40-55+	Weathered parent rock (Gneiss)						
	A11	0-8	1.6	5.5	5.0	2.3	0.2	0.4	13.7
	2Bw1	8-18	0.9	5.3	3.2	1.5	0.3	0.2	7.5
	2Bw2	18-43	0.7	5.3	3.1	2.0	0.3	0.4	8.0
Jolang Series	2Bw3	43-70	0.5	5.4	3.3	2.1	0.2	0.3	8.3
	2Bw4	70-132	0.5	5.3	2.5	1.3	0.2	0.3	5.9
	3C	132+	Loamy sand						
	A1	0-29	1.0	5.7	4.5	2.7	0.2	0.4	11.2
Julie Series	Bt1	29-60	0.7	5.6	6.1	2.1	0.3	0.3	13.5
	C	60-170+	Weathered sandstone						
	A1	0-13	1.1	5.3	3.2	2.3	0.3	0.2	10.0
	Bw1	13-30	0.7	5.5	2.7	1.7	0.2	0.1	6.8
Karjuli Series	C1	30-60	Weathered sandstone with soil material						
	C2	60-170+	Decomposed sandstone						
	A1	0-13	1.5	5.6	3.5	3.2	0.3	0.3	9.7
	Bw1	13-30	0.8	5.6	3.4	1.5	0.4	0.2	8.2
Pachin Series	Bw2	30-49	0.6	5.5	2.5	2.4	0.3	0.4	8.7
	Bw3	49-66	0.5	5.3	3.2	1.7	0.3	0.3	8.3
	C	66-111+	Sand layer deposit						
	A1	0-13	1.9	5.6	3.6	1.0	0.3	0.2	13.1
	Bt1	13-29	1.1	5.7	3.2	0.5	0.5	0.6	15.3
Papu Series	Bt2	29-42	0.8	5.6	3.1	0.4	0.4	0.4	15.0
	BC	42-74	Parent material mixed with soil material						
	C	74-160+	Weathered sandstone						
	A1	0-18	0.8	5.1	1.1	0.2	0.1	0.2	2.3
	2C1	18-26	Coarse sand						
Sonajuli Series	3C2	26-44	Red coarse sand deposit						
	4C3	44-54	Coarse sand deposit						
	5C4	54-130	Greyish white sand deposit						
	6C5	130-164+	Different size coarse materials						

Detailed description of the Soil Series in Itanagar Capital Complex is given below.

Soils of Bandardewa Series: The Bandardewa Series is a member of fine-loamy, mixed, hyperthermic, and belongs to the family of Typic Kanhaplohumult. These soils are well drained, yellowish brown, loamy sand to sandy loam in texture and about 45-60 cm thick. These soils have medium water holding capacity with medium productivity potential.

Developed on weathered sandstone, these soils occur on moderately to strongly sloping foothills, and are subject to severe to very severe erosion. These soils are under wastelands and under shrubs (Figure 1).

Figure 1

Soils of Budhibeta Series: The Budhibeta Series is a member of fine-loamy, mixed, hyperthermic, and belongs to the family of Typic Kanhaplohumult. These soils are well drained, dark yellowish brown with sandy clay loam texture and about 25-35 cm thick. These soils have poor water holding capacity and poor productivity potential.

Developed on weathered sandstones, these soils occur on moderately to gently sloping very narrow inter-hill basin and are subjected to severe erosion. These soils are under reserved forests (Figure 2a and 2b).

Figure 2a

Figure 2b

Soils of Chimpu Series: The Chimpu Series is a member of fine loamy, mixed, hyperthermic, and belongs to the family of Typic Kanhaplohumult. These soils are well drained, greyish brown to dark greyish brown with sandy clay loam texture and 75-80 cm thickness. These soils have poor water holding capacity with poor productivity potential.

Developed on weathered sandstone Chimpu soils are observed on moderately sloping eroded

inter-hill basin and are prone to moderate to severe erosion. These soils are mainly under mixed forest vegetation (Figure 3).

Figure 3

Soils of Dokhosa Series: Dokhosa Series is a member of fine-loamy, mixed, hyperthermic, and belongs to the family of Typic Endoaquept. These soils are somewhat poorly drained, brown to dark brown, sandy loam to sandy clay loam and about 45-55 cm thick. Below this depth ground water is observed. These soils have medium water holding capacity with medium productivity potential.

Figure 4a

Developed on alluvium mixed with colluvium of sandstone these soils occurs on moderately sloping valley floor and are subject to moderate erosion. These soils are used for growing paddy, papaya, arum and turmeric (Figure 4a and 4b)

Figure 4b

Soils of Gohpur Series: The Gohpur Series is a member of the loamy, mixed, hyperthermic, and belongs to the family of Typic Udorthent. These soils are rapidly drained, light yellowish brown to dark yellowish brown with sandy-loam to loamy sand texture and about 35-45 cm thick. These soils have low water holding capacity and low productivity potential.

Figure 5

Developed on weathered sandstones these soils are subject to severe to very severe erosion. These

soils are under reserve forest (Figure 5).

Soils of Itanagar Series: The Itanagar Series is a member of loamy, mixed, hyperthermic, and belongs to the family of Typic Udorthent. These soils are rapidly drained, yellowish brown to dark yellowish brown with sandy clay loam textures and with 15-20 cm thickness. These soils have poor water holding capacity and poor productivity potential.

Developed on weathered sandstones and gneiss these soils occur on moderately steeply to steeply sloping low hills and are prone to severe erosion. These soils are under dense mixed forests (Figure 6). At places they are kept fallow. Sometimes these are used for minor crops.

Figure 6

Soils of Jolang Series: The Jolang Series is a member of coarse-loamy, mixed, hyperthermic, and belongs to the family of Humic Dystrudept. These soils are well drained, brown to dark yellowish brown with sandy loam to sandy clay loam sand texture and 65 to 75 cm thickness. The soils have poor water holding capacity with poor productivity potential.

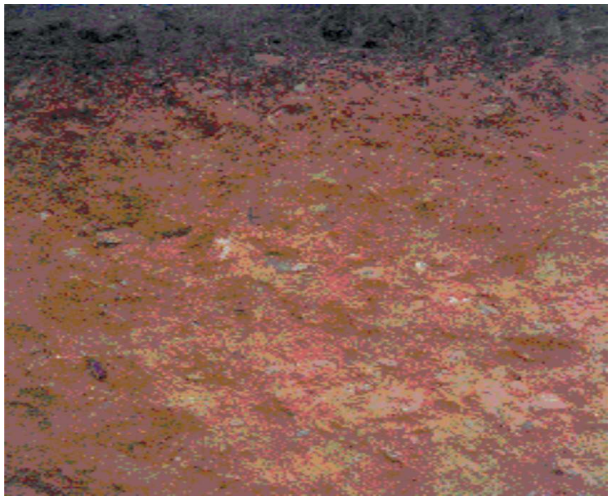

Figure 7

Developed on weathered sandstone Jolang soils occur on moderately sloping narrow valley and are prone to moderate to severe erosion. These soils are under dense reserve forests (Figure 7).

Soils of Julie Series: The Julie Series is a member of fine loamy, mixed, hyperthermic, and belongs to the family of Typic Kanhaplohumult. These soils are moderately well drained, yellow to yellowish brown with sandy clay loam to clay lam texture and 35-65 m thickness. These soils have poor water holding capacity with poor productivity potential.

These soils are developed on weathered sandstone on moderately to moderately steep sloping hill slopes and are prone to moderate to severe erosion (Figure 8).

Figure 8

Soils of Karjuli Series: The Karjuli Series is a member of loamy, mixed, hyperthermic, and belongs to the family of Typic Udorthent. These soils are somewhat excessively drained, yellow to yellowish brown with gravely sandy loam texture and 25-35 cm thick. These soils have low water holding capacity with poor productivity potential.

Developed on weathered sandstones these soils occur on moderately to steeply sloping low hills with moderate to severe erosion. These soils are under reserve forest (Figure 9).

Figure 9

Soils of Pachin Series : Pachin Series is a member of the fine-loamy, mixed, hyperthermic, calcareous and belongs to the family of Humic Dystrudept. These soils are well drained, dark yellowish to dark brown with sandy clay loam texture and 60-70 cm thickness. These soils have low water holding capacity and poor productivity potential.

These soils are developed on weathered sandstone in moderately to gently sloping inter-hill basin with moderate erosion. These soils are under reserve forests (Figure 10).

Figure 10

Soils of Papu Series: The Papu Series is a member of the fine loamy, mixed, hyperthermic, and belongs to the family of Typic Kanhaplohumult. These soils are well drained, light yellowish brown to dark brown with sandy clay loam to clay loam texture and 40-55 cm thickness. These soils have moderate water holding capacity with moderate to high productivity potential.

Developed on weathered sandstones moderately steep to steeply sloping low hills these soils are subject to moderate to severe erosion. These soils are under forest (Figure 11).

Figure 11

Soils of Sonajuli Series: The Sonajuli Series is a member of the loamy, mixed, hyperthermic, and belongs to the family of Typic Udorthent. These soils are rapidly drained, brown to dark brown loamy sand in texture and about 15-20 cm thick. These soils have poor water holding capacity and poor productivity potential.

Figure 12

Developed on weathered sandstone these soils

occur on moderately sloping inter-hill basins. These soils are under moderately dense forests (Figure 12). Part of this lands are also under grassland fallow.

DISCUSSION

The arable soils of different soil series have been grouped according to their potentialities and limitations for sustained production of commonly cultivated crops, and the non-arable soils (soils unsuited for long time sustained use of cultivated crops) are grouped according to their potential and limitations for the production of permanent vegetation.

An assessment of the Soil Series was made with respect to their land capability classification.

Land Capability Classification places all the soils in eight classes. The risk of soil damage or limitations in use is progressively greater in Class I to Class VIII. Soils in the first four classes under good management are capable of producing adapted plants, such as forest trees and common cultivated field crops and pastures. Soils in class V, VI and VII are suited to use of adapted native plants. Some soils in classes V and VI are also capable of producing specific and crops such as certain fruits and ornamentals with soil and water conservation measures.

The soil characteristics of land capability classes are given below:

Class 1 - Soils have few limitations that restrict their use.

Class II - Soils have some limitations that reduce the choice of plants or require moderate conservation practices.

Class III - Soils have severe limitations that reduce the choice of plants or require special conservation practices, or both.

Class IV - Soils have very severe limitations that restrict the choice of plants or require very careful management, or both.

Class V - Soils have little or no erosion hazard but have other limitations impractical to remove; limiting use to pasture, woodland or wildlife food and cover.

Class VI - Soils have severe limitations making them unsuited to cultivation and limit their use largely to pasture, woodland or wildlife food and cover.

Class VII - Soils have severe limitations making them unsuited to cultivation and restrict their use to grazing, woodland or wildlife.

Class VIII- Soils have limitations that preclude their use for arable or non-arable crops and restrict their use to recreation, wildlife or water supply or to aesthetic purposes.

Further, these land capability classes are given weightage according to the kind of limitation, which are as follows :

- Risk of erosion - designated by symbol 'e'
- Wetness, drainage, or overflow -designated by symbol 'w'
- Root-zone limitations -designated by symbol 's'
- Climatic limitations -designated by symbol 'c'

CONCLUSIONS

A critical analysis of the soils of the study area revealed that most of the 12 Soil Series associations and miscellaneous landforms fall under Class VII category, though a few individual soil sites fall under other land capability classes, viz. Class III, Class VI, and Class VIII. These land capability classes have been shown in Figure 2, and given below in Table 6.

Table 6. Land Capability Classes in Itanagar Capital Complex

Land Capability Class	Map Symbol	Soil Series Association	Subclass
III	4 - 12	Dokhoso - Sonajuli	IIIe3s
VI	6 - 11 - 9	Itanagar - Papu - Karjuli	Vies
VII	5 - 9	Gohpur - Karjuli	VIIe6s
	8 - 11 - 4	Julie - Papu - Dokhoso	VIIe5
	10 - 2	Pachin - Budhibeta	VIIe3
	3 - 7	Chimpu - Jolang	VIIe4
VIII	13 - 1	Gullied land - Banderdewa	VIIIe6

Land Capability Class III: The land capability class III is associated with the soils occurring in the valleys with a slope ranging from very gentle to moderate in weathered sandstone landscapes. However, some landscapes have moderately sloping soils with eroded phase also in this capability subclass grouping. These are the small patches of agricultural lands in the study area, which are used for paddy cultivation. These soils are shallow to moderately deep, with sandy clay loam texture, and non-calcareous. Most of these soils have aquic moisture regimes as can be judged from the mottles in the horizons except the associated soils in the forest. The soils are that of Dokhosa Series (Typic Endoaquept), and Sonajuli Series (Typic Udorthent).

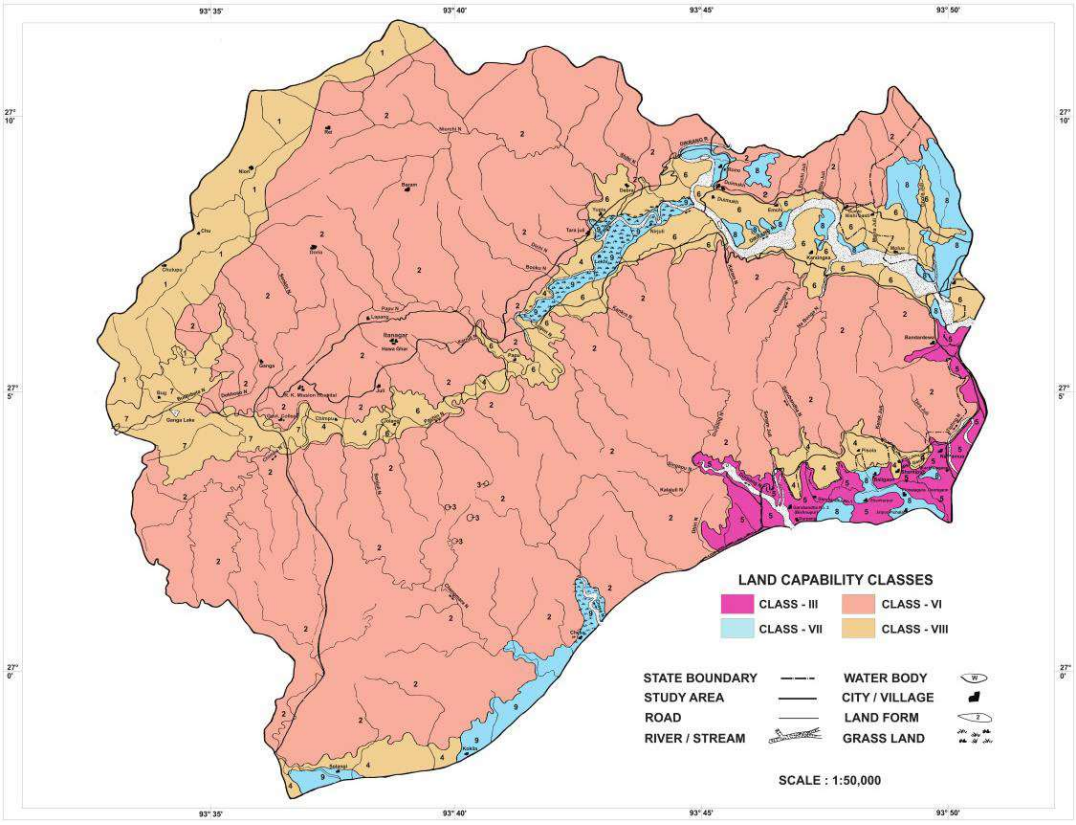

Figure 2: Map showing Land Capability Classes

Land Capability Class VI: Here soils are associated with sandstone and granite gneissic landscape with moderately steep to steeply sloping low hills. The soils are shallow to moderately deep, sandy loam to clay loam soils. The soils are that of Itanagar Series (Typic Udorthent), Papu Series (Typic Kanhaplohumult) and Karjuli Series (Typic Udorthent).

Land Capability Class VII: The soils covers nearly 75% of the total area. These are associated with sandstone and granite-gneissic landscape with steeply to very steeply sloping hills. The soils are shallow to moderately deep, sandy loam to clay loamy soils. The soils belong to Gohpur Series (Typic Udorthent), Karjuli Series (Typic Udorthent), Julie Series (Typic Kanhaplohumult), Papu Series (Typic Kanhaplohumult), Dhokosa Series (Typic Endoaquept), Pachin Series (Humic Dystrudept), Budhibeta Series (Typic Kanhaplohumult), Chimpu Series (Typic Kanhaplohumult), and Jolang Series (Humic Dystrudept).

Land Capability Class VIII: Here soils are associated with sandstone and granite-gneissic landscape with moderately to strongly sloping hills, hill slopes and foothills. The soils are highly degraded due to gullied landform. The soils are in association with Banderdewa Series (Typic Kanhaplohumult).

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