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Original Article

Soil Characteristics, Spatial Distribution and Nutrient Status in South Sikkim: A Geographical Assessment

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Abstract

Soil characteristics in Sikkim are influenced by variations factors such as relief, parent material, climate, vegetation and land use. This paper highlights a geographical assessment of soil types and soil-quality found in South Sikkim, using the locality-level explanations and district-wise data contained found in the source document. The major soil groups found in south Sikkim including Pachic Haplumbrepts, Typic Hapludolls, Umbric Dystrochrepts, Typic Argudolls, Cumulic Hapludolls and Udorthents. It describes the sandy loam, clay loam and loam textures across localities and records soil characteristics in 15 Gram Panchayat Units (GPUs). Further, the district-wise dataset, 86.0% of the reported area of South Sikkim falls within the three listed acidic soil classes. The source records 80.2% in its high organic-carbon category, 82.3% in the high available-phosphorus category and 53.2% in the high available-potassium category. Comparative data of four districts i.e. North, East, South and West districts provide a broader state-level context. This analysis is based on secondary information provided by different sources from Agriculture Census and EARAS (2013–14), Krishi Vigyan Kendra, Namthang, and the National Bureau of Soil Survey and Land Use Planning. The study identifies spatial contrasts in soil properties but is constrained by the age and incomplete methodological documentation of the source data. In particular, the organic-carbon class interval requires verification.

Keywords: *South Sikkim, classification, soil acidity, organic carbon, phosphorus, potassium, soil mapping.*

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Introduction

Soil is endowed natural resource that mainly supports agriculture, forest ecosystems, hydrological processes and rural livelihoods. In mountainous regions, soil formation and distribution are closely associated with relief, slope, parent material, climate, vegetation and land-use practices. The aforesaid factors produce considerable local variation in soil depth, texture, drainage, acidity and nutrient status.

Sikkim reveals wide variations in climate, physiography, geology and vegetation. The source material reports that 78 soil families were identified and represented through 69 mapping units in the state. It classifies the soils into three orders, seven suborders, twelve great groups and twenty-six subgroups. Inceptisols are reported to occupy 42.84%, Entisols 42.52% and Mollisols 14.64% of the state's soil area (Sikkim Forest Department).

South Sikkim's soils are portrayed as being resulting from sandstone, phyllite, schist, gneiss and colluvial materials. The source characterises the soils as generally acidic to very acidic, with pH commonly between 5.0 and 6.0.

Objectives

1. To depict the major soil groups and soil-texture classes reported in South Sikkim.
2. To study district-wise variations in soil acidity, organic carbon, available phosphorus and available potassium.
3. To consider the geographical effects of the reported soil properties for land use and soil management in different location within south Sikkim.

Study Area

The study focuses on South Sikkim. The source map depicts the South District boundary, major settlements, drainage and mapped soil units. The physical setting is determined by mountainous terrain and variations in slope and parent material. The source identifies sandstone, phyllite, schist, gneiss and colluvial deposits as important parent materials.

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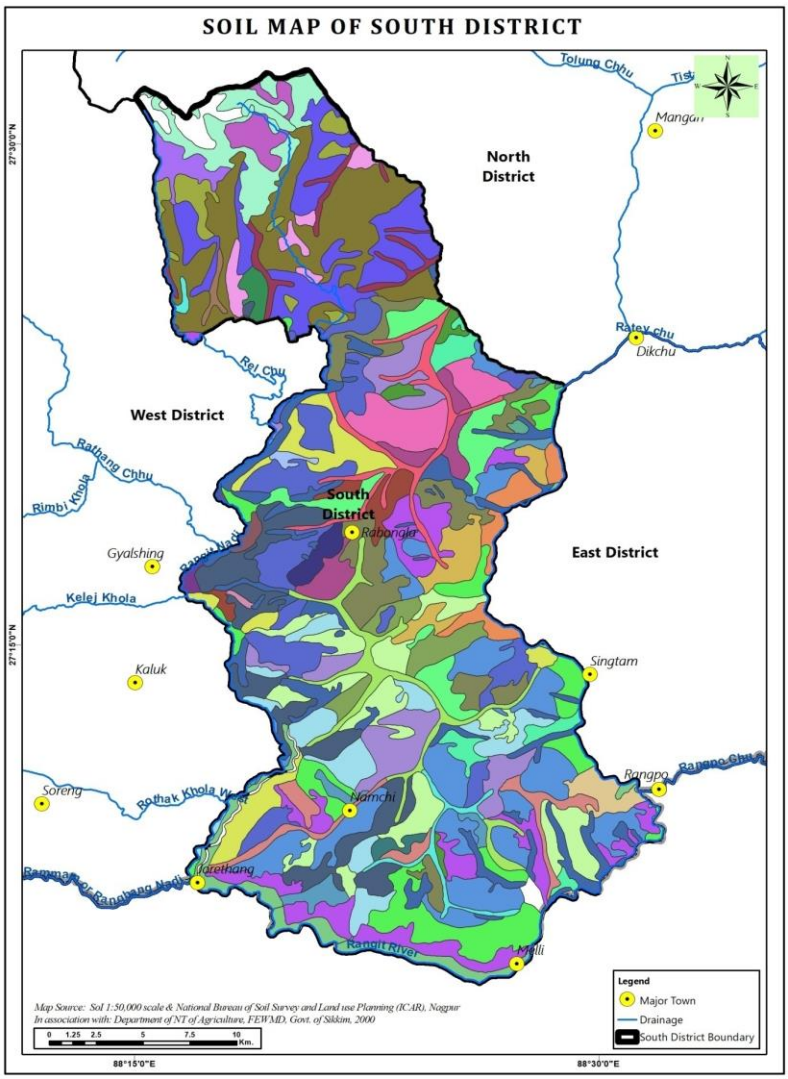

Figure 1. Soil map of South District



Data Sources and Methodology

This paper is based on secondary data and descriptive information contained in the supplied source document. The material includes a soil map and legend; descriptions of soil groups in relation to slope and land use; district-wise percentages for pH classes, organic carbon, available phosphorus and available potassium; and locality-level descriptions for 15 GPUs. The district-wise tables attribute their data to Agriculture Census and EARAS (2013–14). The local soil information is attributed to Krishi Vigyan Kendra (KVK), Namthang, South Sikkim.

The data were recorded into comparable tables and interpreted descriptively. The original values and class labels have been retained. Comparative bar charts have been redrawn from the supplied values for presentation.

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The source does not specify the sampling design, sample size, sampling dates, laboratory procedures, geographic coordinates or uncertainty estimates. The organic-carbon table labels the high class as ">0.75–1.5%," which overlaps the medium class (0.75–1.5%); this has been flagged rather than silently corrected. Percentages in the pH table do not total 100%, and the source does not explain the residual area.

Soil Groups and Landscape Characteristics

The dominant soil groups reported for South Sikkim include Pachic Haplumbrepts, Typic Hapludolls, Umbric Dystrochrepts, Typic Argudolls, Entic Haplumbrepts, Cumulic Hapludolls, Typic Cryorthents and Lithic Udorthents. The source associates these soil groups with contrasting slope positions, drainage conditions, soil depths and land uses.

Table 1. Soil types and characteristics reported for South Sikkim

No.	Soil type(s)	Characteristics described in source
1	Haplumbrepts and Pachic Haplumbrepts	Ridges around 30% slope; deep, somewhat excessively drained, fine-loamy soils; slight stoniness and moderate erosion; under forest, paddy and limited maize; acidic and erosion-prone.
2	Typic Hapludolls and Umbric Dystrochrepts	Ridges on 15–30% slopes; deep, excessively drained, coarse- to fine-loamy soils; slight stoniness and moderate erosion; moderately acidic and humus-rich; forest, paddy and maize.
3	Cumulic Hapludolls and Pachic Haplumbrepts	Slopes below 15%; deep, well-drained, fine-loamy soils with loamy surface; slight stoniness and moderate erosion; paddy cultivation and some temperate forest.
4	Cumulic Hapludolls, Typic Hapludolls and related groups	Steep hill sides around 30–50%; moderately shallow to deep, well-drained silty to fine-loamy soils; slight stoniness and moderate erosion; acidic, largely under temperate/alpine forest with some cereal cultivation.

Source: kvkeastsikkim.nic

The descriptions suggest that slope position is an important organising factor in the local soil landscape. Lower-gradient areas are associated with deep, well-drained soils and paddy cultivation, while steep slopes are described as having variable soil depth, stoniness and forest cover. The source also records moderate erosion in the described landscape settings.

District-wise Soil Acidity

The pH table indicates that strongly acidic soils are most extensive in East Sikkim (73.0%), followed by North (62.4%), West (43.9%) and South (37.0%). South Sikkim has the highest share of slightly acidic soils (18.2%), while West Sikkim records the highest moderately acidic share (38.9%). The combined percentage of the three listed acidic classes is 86.0% in South, 93.3% in North, 97.8% in East and 97.0% in West.

Table 2. District-wise soil pH classes (area in percent)

District	Strongly acidic	Moderately acidic	Slightly acidic	Total listed
North	62.4	24.4	6.5	93.3
East	73.0	18.3	6.5	97.8
South	37.0	30.8	18.2	86.0
West	43.9	38.9	14.2	97.0

Source: Agriculture Census and EARAS, 2013–14, as cited in the supplied document.

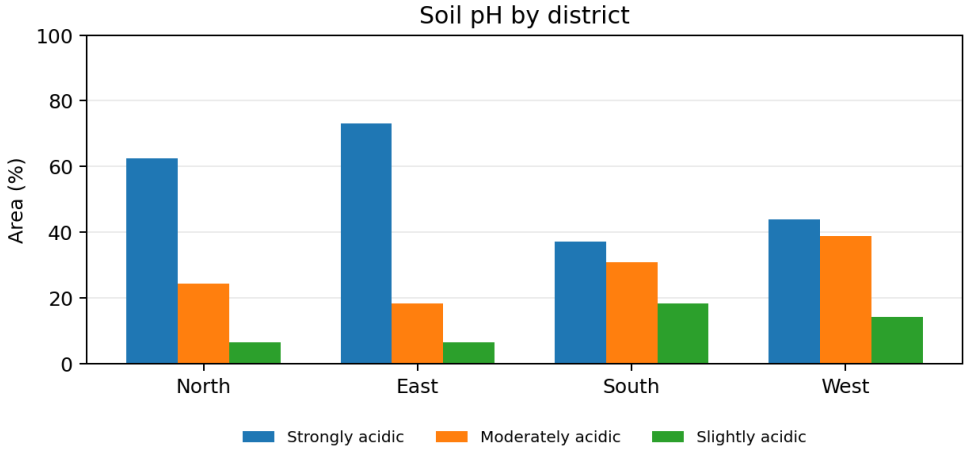

Figure 2. District-wise distribution of reported soil pH classes.

The data show that acidity is widespread across the four districts represented in the original dataset. South Sikkim has the lowest combined proportion across the three listed acidic classes, although the figure remains substantial. The unaccounted percentages should not be assigned to another pH class without checking the original dataset.

Soil Organic Carbon

The source table records the high organic-carbon category as the largest class in all four districts. The reported values are 84.6% in North, 86.8% in East, 80.2% in South and 86.0% in West. South Sikkim has the highest medium-category share (12.6%) and a low-category share of 7.2%.

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Table 3. District-wise organic-carbon classes (area in percent)

District	Low (<0.75%)	Medium (0.75–1.5%)	High (as printed)
North	7.7	7.7	84.6
East	3.4	9.8	86.8
South	7.2	12.6	80.2
West	4.4	9.6	86.0

Source: Agriculture Census and EARAS, 2013–14, as cited in the supplied document.

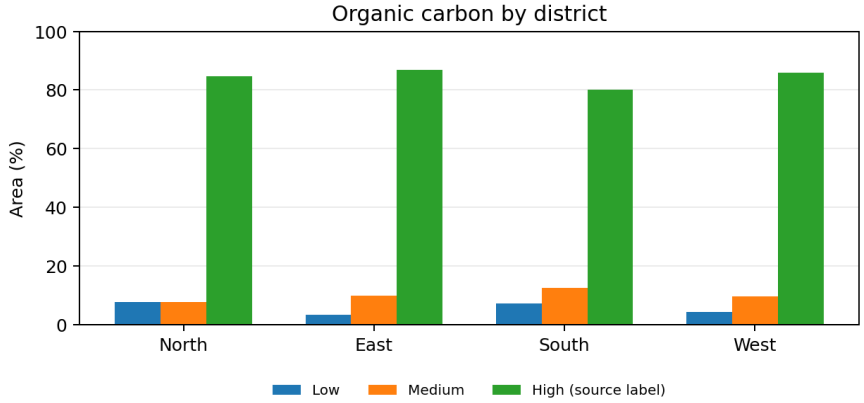

Figure 3. District-wise distribution of organic-carbon classes.

The large reported share in the high category may indicate generally favourable organic-carbon status in the source dataset. However, the printed high-class interval (“>0.75–1.5%”) overlaps the medium interval. This classification must be checked against the original report before the values are interpreted as a definitive measure of high organic carbon.

Available Phosphorus

Available phosphorus is reported predominantly in the high category in all four districts. South Sikkim records the highest share (82.3%), closely followed by East (82.1%), West (78.4%) and North (70.7%). The low category ranges from 0.0% in North to 5.8% in East.

Table 4. District-wise available phosphorus classes (area in percent)

District	Low (<34 kg/ha)	Medium (34–68 kg/ha)	High (>68 kg/ha)
North	0.0	29.3	70.7
East	5.8	12.1	82.1
South	5.1	12.6	82.3
West	3.7	17.9	78.4

Source: Agriculture Census and EARAS, 2013–14, as cited in the supplied document.

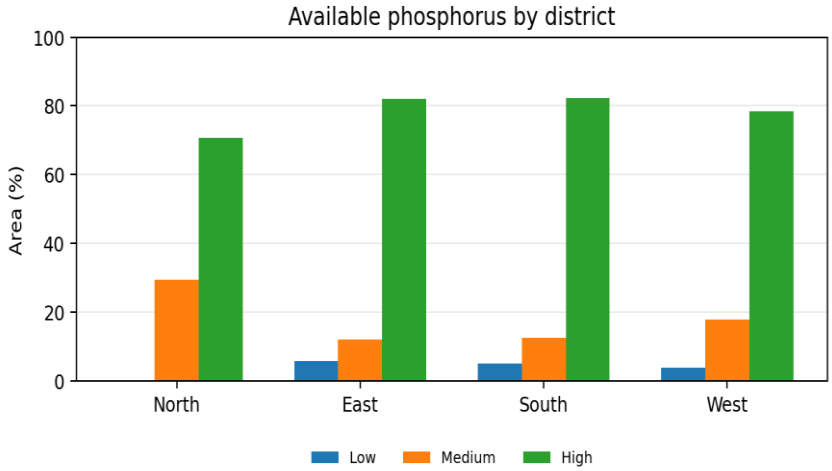

Figure 4. District-wise distribution of available phosphorus classes.

The high-category share is particularly prominent in South and East Sikkim. These figures are area percentages from a secondary source and do not provide crop-response data or field-specific fertiliser requirements. Nutrient recommendations should therefore be based on current soil testing.

Available Potassium

The high available-potassium category accounts for more than half of the reported area in each district. West Sikkim records the highest share (67.3%), followed by East (63.9%), South (53.2%) and North (53.1%). South Sikkim has the highest medium-category share (37.1%) and the highest low-category share (9.7%).

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Table 5. District-wise available potassium classes (area in percent)

District	Low (<135 kg/ha)	Medium (135–335 kg/ha)	High (>335 kg/ha)
North	7.6	39.3	53.1
East	8.3	27.8	63.9
South	9.7	37.1	53.2
West	5.6	28.1	67.3

Source: Agriculture Census and EARAS, 2013–14, as cited in the supplied document.

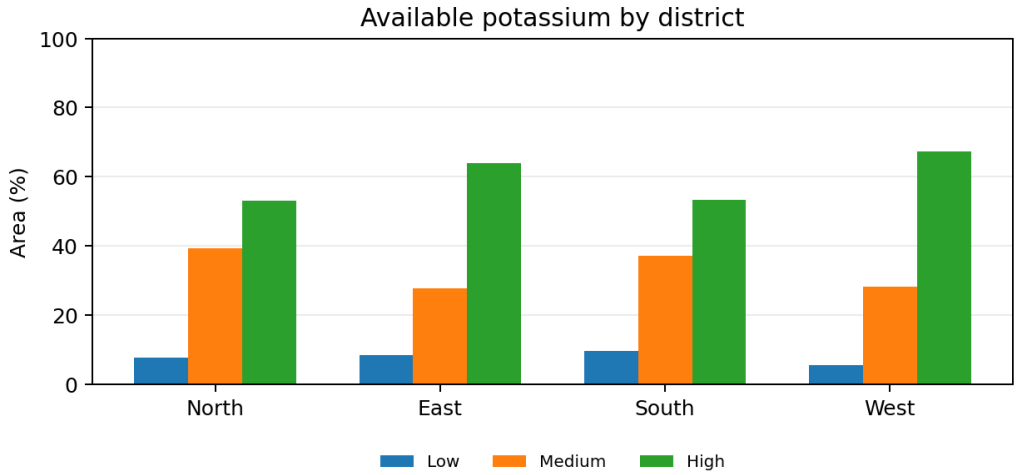

Figure 5. District-wise distribution of available potassium classes.

The reported distribution indicates that high potassium is widespread, but South Sikkim has a comparatively larger medium and low share than East and West. This variation points to the value of local soil testing and site-specific nutrient management.

Local Soil Texture and GPU-level Variation

The source material attributes local soil observations to Krishi Vigyan Kendra (KVK), Namthang. Three broad textural classes are reported: sandy loam, clay loam and loam. Sandy loam is reported at Namthang, Rateypani, Melli and Jorethang; clay loam at Damthang, Temi, Rabong and Kewzing; and loam at Yangyang and Lingmoo. The area is described as having moderately acidic to acidic soils.

Table 6. Soil types reported across 15 Gram Panchayat Units

GPU / locality	Soil types, colours or textures reported
Namphing	Red, black and grey
Legship	Sandy, black, red and loam
Rong-Bul	Grey mixed with stones, red and black
Tarku	Black
Turung–Mamring	Loam and black
Sadam–Suntaley	Sandy and black
Tinik–Chisopani	Brown and black
Namthang–Maneydara	Sandy loam
Assangthang	Black and red
Wok–Omchu	Red, sandy and black
Borong–Phamthang	Clay, black and red
Barfung–Zarung	Sandy, black and red
Paiyong	Sandy, brown and red
Tinkitam–Rayong	Black, clay and red
Perbing–Dovan	Yellow, red and sandy

Source: Village Action Plan 2011

These locality descriptions indicate considerable variation in soil colour and texture. They are qualitative observations and should not be treated as substitutes for standardised particle-size analysis or laboratory-based soil classification. A detailed field survey could relate these observations to elevation, slope, parent material and land use.

The reported soil pattern reflects the influence of mountainous relief and varied parent materials in South Sikkim. Differences in slope position correspond with contrasts in soil depth, drainage, stoniness and reported land use. The association of deeper soils on gentler slopes with paddy cultivation, and forest cover on steeper terrain, highlights the relationship between physical landscape conditions and land-use practices.

The four-district comparison shows widespread acidity, with South Sikkim displaying the lowest combined percentage across the three acidic classes listed. The nutrient tables indicate a high share of available phosphorus and potassium in the upper reported categories. The organic-carbon results also show a large share in the source-defined high category, but that result

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remains uncertain because of the overlapping class interval. These patterns should be treated as broad regional indicators, not as a basis for uniform fertiliser prescriptions.

The original district comparison uses the North, East, South and West administrative units represented in the 2013–14 dataset. It should not be read as a current six-district comparison. The lack of sampling details and georeferenced observations also restricts spatial analysis and the ability to assess changes over time.

Major Findings

- South Sikkim is reported to contain several soil groups, including Haplumbrepts, Hapludolls, Dystrochrepts, Argudolls and Udorthents.
- Sandy loam, clay loam and loam are the principal textural classes reported for the localities described.
- The three listed acidic pH classes together account for 86.0% of South Sikkim in the 2013–14 dataset.
- The source reports 80.2% of South Sikkim in its high organic-carbon category, but the class threshold requires verification.
- High available phosphorus is reported for 82.3% of South Sikkim.
- High available potassium is reported for 53.2% of South Sikkim, with 37.1% in the medium category.
- The 15-GPU descriptions indicate local variation in soil colour and texture that merits detailed field-based investigation.

Conclusion

The study documents a varied soil landscape in South Sikkim shaped by mountainous relief, parent materials and contrasting land-use settings. The source material identifies several soil groups and textural classes and describes differences in soil depth, drainage, stoniness and erosion across slope positions. The district-level data indicate widespread soil acidity and substantial proportions of area in the reported high categories for organic carbon, available phosphorus and available potassium. South Sikkim has a lower combined share across the three listed acidic pH classes than the other districts in the original comparison, and the highest reported share of high available phosphorus.

These findings must be interpreted in light of the secondary and historical nature of the data. The organic-carbon class interval, unexplained residual percentages in the pH table and absence of detailed sampling and laboratory methods require verification. A contemporary georeferenced soil survey integrating profile descriptions, laboratory analysis, slope, elevation, parent material and land use would provide a stronger basis for soil conservation, crop planning and nutrient management in South Sikkim.

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Conflicts of interest

The authors declare that there are no conflicts of interest regarding the publication of thesis paper.

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