

Demographic Shift and Settlement Pattern of East Sikkim District, India: A Spatial and Hierarchical Assessment for Regional Planning

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Abstract: *The spatial distribution of population and the hierarchy of settlements are fundamental determinants of balanced regional development, particularly in mountainous regions where physical constraints strongly influence demographic concentration and accessibility to infrastructure. East Sikkim, despite occupying only about 954 km² of the state's geographical area, accommodates the largest share of Sikkim's population and functions as its principal administrative, commercial and institutional centre. This study examines the demographic characteristics and settlement pattern of East Sikkim District through a comprehensive assessment of Census 2011 data supported by decadal census records, district census publications and spatial datasets. The methodology integrates comparative demographic analysis at state, district and sub-district levels with spatial mapping of settlements and an institutional scalogram technique to establish settlement hierarchy based on infrastructural availability. Demographic indicators including population size, density, literacy, sex ratio, Scheduled Caste and Scheduled Tribe population, fertility rate, urban-rural composition and decadal growth have been analysed to understand regional variations and demographic transition. Settlement distribution has been examined with respect to physiography, transportation corridors and administrative divisions, while weighted infrastructural indices have been employed to classify settlements into Regional Service Centres, Sub-Regional Service Centres, Central Villages and Service Villages. The analysis indicates that East Sikkim exhibits the highest population density, literacy rate and degree of urbanisation within the state, primarily owing to the concentration of Gangtok and other urban centres. Settlement distribution demonstrates a pronounced linear concentration along major transportation corridors, whereas higher elevation regions remain sparsely populated. The hierarchy established through institutional scalogram analysis identifies significant disparities in infrastructural distribution and highlights the need for strengthening lower-order settlements to achieve balanced regional development. The study provides an empirical framework for regional planning by integrating demographic assessment with spatial settlement analysis for infrastructure planning in mountainous regions.*

Keywords: Demography, Settlement Pattern, Institutional Scalogram, Settlement Hierarchy, Spatial Analysis

1. Introduction

Demographic structure and settlement organisation constitute two of the most significant components influencing regional planning and territorial development. Population characteristics determine the demand for infrastructure, public services, housing, education, healthcare and employment, whereas settlement distribution reflects the spatial manifestation of economic opportunities, accessibility and administrative functions. In mountainous regions, these relationships become considerably more complex because topography, elevation, climatic conditions and transportation constraints directly affect the concentration and growth of settlements. Consequently, understanding demographic trends together with settlement hierarchy provides an essential basis for developing balanced regional planning strategies capable of reducing spatial inequalities while improving service accessibility. Sikkim represents one of India's most distinctive Himalayan states where physical geography exerts a dominant influence on patterns of human habitation. Although the state occupies only approximately 7,096 km², its terrain varies considerably from low river valleys to high Himalayan mountain ranges, resulting in substantial variations in settlement density and accessibility. Administrative divisions within Sikkim comprise four districts—East, West, North and South—which exhibit marked differences in demographic composition, urbanisation levels and infrastructure distribution. Among these, East Sikkim assumes exceptional significance because it accommodates the state capital, Gangtok, and functions as the principal administrative, commercial, educational and

tourism centre. Consequently, demographic concentration and infrastructural development within East Sikkim substantially exceed those of the remaining districts, creating a distinctive regional development pattern. Rapid urbanisation experienced during recent decades has further transformed the demographic landscape of East Sikkim. Migration towards Gangtok and adjoining urban settlements has accelerated population concentration, altered rural-urban composition and increased demand for physical and social infrastructure. Simultaneously, several rural settlements continue to experience relatively slow demographic growth due to limited employment opportunities and comparatively lower accessibility to higher-order services. These demographic processes have produced an increasingly hierarchical settlement system characterised by a limited number of highly developed urban centres serving an extensive network of rural settlements. Understanding this evolving hierarchy is essential for identifying service deficiencies and determining appropriate infrastructure investments within different categories of settlements.

Regional planning increasingly emphasises functional settlement hierarchy rather than administrative classification alone. Settlement hierarchy identifies centres according to their demographic significance, infrastructural availability and service functions, enabling planners to distribute public facilities efficiently while reducing regional disparities. Institutional scalogram analysis has emerged as one of the most effective quantitative approaches for establishing such hierarchies because it evaluates settlements on the basis of infrastructure availability through weighted scoring systems.

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When integrated with demographic indicators and spatial mapping, the approach provides an objective framework for identifying regional service centres, intermediate settlements and lower-order villages requiring infrastructural intervention. The present study investigates the demographic characteristics and settlement pattern of East Sikkim District through a multi-scalar analytical framework. The assessment begins with a comparison of Sikkim's demographic characteristics with other Himalayan states, namely Himachal Pradesh and Uttarakhand, thereby placing East Sikkim within a broader regional context. Subsequently, demographic variations among the four districts of Sikkim are examined to identify the distinctive characteristics of East Sikkim. Temporal demographic changes between 1991 and 2011 are analysed to understand demographic transition, urbanisation and changing settlement dynamics. Further analysis at the subdivision level examines demographic variations within Gangtok, Pakyong and Rongli subdivisions. Finally, spatial settlement distribution and institutional scalogram analysis are employed to establish settlement hierarchy and identify infrastructural disparities across settlements.

2. Literature Review

(Kumar Routray, 1993) argues that despite the introduction of urban and regional planning in post-Independence India, the planning system has largely remained fragmented, with limited integration across administrative and spatial levels. The author highlights several persistent shortcomings, including the lack of a comprehensive national urbanisation policy, inadequate institutional coordination, inefficient urban land management practices, and weak integration between urban and regional planning frameworks. The study further observes that planning efforts have predominantly concentrated on the provision of physical infrastructure while giving insufficient attention to regional economic development, environmental sustainability, and the promotion of balanced spatial growth. Accordingly, ineffective implementation, weak information and monitoring systems, financial limitations, and poor inter-agency coordination have significantly constrained the success of planning initiatives. The paper concludes that addressing these deficiencies requires a more integrated, decentralised, and regionally coordinated planning approach that reinforces rural urban linkages, strengthens institutional capacity, and promotes sustainable and balanced regional development. (Jain & Jehling, 2020) contend that significant deficiencies remain in the way regional planning is conceptualised and implemented within India's rapidly expanding urban regions. The authors observe that existing urban growth models largely overlook the integration of socio-economic and infrastructure variables, reducing their effectiveness in supporting informed planning and policy decisions. They further point to persistent challenges such as the limited availability of harmonised spatial and demographic data, inadequate coordination between rural and urban planning systems, and weak institutional arrangements for managing regional development across administrative boundaries. Additionally, the study notes that planning policies continue to underestimate the strategic role of small and intermediate cities, despite their increasing contribution to future urban growth. The authors also recognise methodological constraints arising from inconsistent administrative

boundaries, the absence of comprehensive long-term spatial datasets, and the limited incorporation of contemporary factors such as digitalisation into urban growth analyses. Collectively, these issues highlight the necessity for integrated, evidence-based, and institutionally robust regional planning frameworks that can effectively reduce spatial inequalities and support balanced and sustainable regional development. (Ghosh & De, 2005) contend that substantial gaps persist in explaining how infrastructure influences regional economic development across Indian states. The authors observe that earlier research has generally focused on a narrow range of infrastructure variables and shorter periods of analysis, thereby limiting a comprehensive understanding of long-term regional inequality and development trajectories. They further emphasise the lack of holistic frameworks that simultaneously account for both economic and social infrastructure, along with the unavailability of consistent and reliable state-level data on infrastructure investments. The study also points to institutional shortcomings, such as inefficient distribution of public resources and the continued existence of regional disparities despite decades of planned development. Additionally, the authors recognise methodological limitations associated with fragmented datasets and the challenges of accurately assessing infrastructure quality across regions. Collectively, these deficiencies highlight the importance of developing comprehensive infrastructure indices, strengthening long-term data systems, and adopting region-specific planning strategies to support balanced regional development and minimise spatial inequalities in India.

(Moulik et al., 2000) argue that conventional national planning strategies are often insufficient to accommodate the wide variations in regional development patterns, resource availability, and socio-economic conditions across India, thereby constraining the successful implementation of development policies. The authors point to several critical shortcomings, including the absence of robust region-specific planning models, weak coordination between regional and national planning systems, and the limited availability of disaggregated data necessary for analysing regional differences in energy demand and resource potential. They also acknowledge methodological constraints arising from inadequate state-level databases, uncertainties in forecasting future technological advancements and costs, and the reliance on assumptions where regional information is incomplete. Furthermore, the study observes that centralised planning mechanisms frequently fail to incorporate local and regional priorities, diminishing the effectiveness of policy outcomes. Collectively, these deficiencies highlight the importance of adopting decentralised, evidence-based, and regionally responsive planning frameworks that enhance national policy formulation while effectively addressing regional disparities and local development needs. (Ortman & Cooper, 2021) argue that traditional approaches to settlement pattern research exhibit several methodological shortcomings, particularly in the reconstruction of historical populations from archaeological data. The authors note that previous estimation techniques generally relied on the assumption of a direct linear relationship between artifact density and population size, which often produced biased population estimates by undervaluing smaller settlements while inflating those of larger ones. They also identify a lack of comprehensive

theoretical frameworks that effectively integrate settlement size, demographic characteristics, and socioeconomic processes within a single analytical model. Furthermore, the study recognises challenges associated with incomplete archaeological records, inconsistencies in artifact preservation, uncertainties in determining occupation durations, and inadequate methods for quantifying settlement-level uncertainty. The authors further stress the importance of validating settlement scaling theory across diverse cultural and geographical settings to enhance its broader applicability. Collectively, these limitations highlight the need for theoretically robust, nonlinear, and empirically tested methodologies that can generate more reliable demographic estimates and advance the understanding of long-term settlement evolution and spatial development. (Bhaker, 2014) underscore the relatively underexplored nature of research concerning the institutional functioning and operational effectiveness of NGOs involved in rural development in India. Their study suggests that previous investigations have devoted limited attention to key dimensions such as organisational management, stakeholder involvement, institutional sustainability, and the actual outcomes of grassroots development initiatives. The authors further contend that the lack of a comprehensive conceptual framework, coupled with a heavy dependence on conventional survey-based methodologies, constrains a holistic evaluation of NGO performance and community participation. In addition, the predominance of donor-oriented, project-specific interventions tends to divert attention from locally determined priorities, thereby weakening participatory development processes. The paper also points out that insufficient emphasis on community ownership and institutional continuity diminishes the lasting benefits of development programmes. Collectively, these observations demonstrate the need for more inclusive, context-responsive, and multidimensional research approaches that can improve NGO accountability, strengthen community participation, and ensure the long-term sustainability of rural development efforts.

(Paul & Sen, 2018) emphasise that significant conceptual and methodological limitations continue to exist in the assessment of metropolitan livability, particularly in the rapidly urbanising context of Indian cities. The study suggests that previous investigations have primarily concentrated on the physical and environmental attributes of livability, with relatively little consideration given to the social factors that shape community wellbeing. It further indicates that existing assessment approaches lack comprehensive analytical frameworks capable of explaining the complex relationship between urban geographic characteristics and spatial differences in liveability within metropolitan regions. In addition, prevailing evaluation methods are largely dependent on isolated indicators, restricting a holistic understanding of intra-metropolitan inequalities. The authors also recognise methodological limitations arising from the use of a restricted set of Integrated Urban Geographic Factors (IUGFs) and the reliance on expert-based judgement in cluster formation. Taken together, these shortcomings underline the importance of developing more holistic, multidimensional, and empirically robust assessment frameworks that incorporate physical, social, and economic dimensions to facilitate evidence-based urban planning and promote sustainable

metropolitan development. (Li & Song, 2020) contribute significantly to the understanding of rural settlement evolution, yet their research exposes several areas that require further scholarly attention. The investigation is confined to Jizhou District, making it difficult to generalise the findings to other regions with distinct geographical, socio-economic, and developmental contexts. Although the CLUE-S model demonstrates strong capability in projecting future land-use patterns, its analytical framework relies largely on physical landscape attributes and accessibility indicators, with relatively limited consideration of socio-economic conditions, institutional arrangements, and governance processes that substantially influence settlement dynamics. In addition, the projected development scenarios are founded on predetermined assumptions, which may affect the reliability of long-term predictions. The study also provides relatively limited insight into the role of policy interventions, institutional coordination, and stakeholder engagement in guiding rural settlement transformation. Collectively, these limitations underscore the importance of developing more holistic, interdisciplinary, and adaptable modelling frameworks that integrate spatial, socio-economic, institutional, and governance perspectives to facilitate sustainable rural and regional development. (Sharapov, 2020) evaluates the reliability of prevailing archaeological survey methods employed in regional settlement pattern studies and reveals several methodological constraints that hinder precise demographic and spatial interpretations. The study suggests that widely adopted techniques, such as surface surveys, aerial photographic analysis, and extensive test-pit excavations, frequently fail to identify smaller or sparsely occupied settlements, especially in landscapes characterised by poor surface visibility. It further demonstrates that inconsistencies in site detection probabilities, insufficient sampling density, and the dependence on a single survey approach may lead to distorted assessments of settlement hierarchy, population size, and spatial organisation. The research additionally draws attention to operational challenges, including the considerable labour demands of field investigations, the need to survey extensive geographical areas, and the restricted applicability of existing methods across different environmental contexts. Collectively, these findings highlight the necessity for adaptive, multi-scale, and rigorously tested survey methodologies that can enhance site discovery, improve demographic reconstruction, and strengthen regional settlement pattern analyses across diverse archaeological settings.

(Tian & Mao, 2022) offer important insights into the interplay between regional integration and urban sprawl, while simultaneously exposing several areas that merit further investigation. The research is centred on the Yangtze River Delta (YRD), which constrains the broader applicability of its findings to urban agglomerations characterised by different socio-economic conditions, institutional structures, and environmental contexts. Although the mechanical equilibrium model successfully integrates urban expansion, socioeconomic development, and urban functions, it places comparatively less emphasis on critical determinants such as governance effectiveness, land-use policies, institutional arrangements, and environmental management, all of which significantly influence urban growth. Furthermore, regional integration is evaluated primarily through simulated

population mobility, which may not adequately capture the wider spectrum of economic linkages, technological interactions, and institutional cooperation among cities. The study also recognises limitations associated with data availability, the use of administrative units as the principal analytical scale, and the restricted temporal coverage of POI datasets. Collectively, these limitations emphasise the need for more holistic, multi-level, and empirically robust analytical frameworks capable of explaining the intricate relationship between regional integration and sustainable urban development across diverse regional settings. (Hrynkevych, 2023) provide important insights into the challenges of forecasting human resource requirements for regional development while also revealing several limitations in existing planning practices. The study indicates that workforce planning in Ukraine continues to rely predominantly on normative approaches and formal agreements with employers, which are insufficient to reflect evolving labour market conditions and the diverse priorities of regional stakeholders. It further illustrates the lack of a comprehensive methodological framework capable of systematically combining demographic forecasts, employer expectations, labour market analyses, and educational planning into an integrated decision-making process. In addition, the authors recognise several practical constraints, including inadequate data systems, limited stakeholder engagement, institutional and financial limitations, and the growing uncertainty caused by migration trends and geopolitical instability. Collectively, these concerns emphasise the importance of developing coordinated, data-driven, and participatory forecasting models that can support more effective regional planning, strengthen workforce development, and improve the long-term resilience of regional economies. (Constanta, 2013) examines several conceptual and practical challenges associated with fostering active European citizenship through local and regional governance structures. The study demonstrates that, despite the existence of a well-defined legal framework protecting electoral rights within the European Union, considerable differences remain between statutory provisions and their effective implementation across Member States. It further illustrates that prevailing governance mechanisms have not been sufficiently effective in bridging the gap between European institutions and citizens, as reflected in persistently low levels of electoral participation. The paper also draws attention to inadequate public awareness, ineffective communication strategies, and limited citizen involvement, all of which continue to hinder meaningful civic participation. Although the study promotes a multi-level governance model as a potential solution, it provides relatively limited empirical validation of its effectiveness across diverse regional settings. Collectively, these observations emphasise the need for more comparative, evidence-based, and participatory governance frameworks that can enhance institutional coordination, strengthen citizen engagement, and promote more effective democratic participation at local and regional scales.

(Hnatkovych & Smolinska, 2023) provide a comprehensive assessment of the shortcomings within contemporary regional development management, with particular emphasis on Ukraine's decentralisation process and the challenges associated with post-war recovery. The study demonstrates that existing governance arrangements are constrained by

weak institutional coordination, inefficient administrative decision-making, insufficient information and monitoring systems, and inadequate fiscal and managerial independence at the regional level. It also indicates that current regional development strategies have yet to effectively incorporate strategic planning, digital transformation, and data-driven governance practices necessary for addressing long-standing regional inequalities. While the authors recommend a series of legal, institutional, organisational, and technological reforms based on European governance models, these proposals are predominantly normative and are supported by limited empirical evidence across varying regional contexts. Furthermore, the framework places relatively little emphasis on stakeholder engagement and the diverse governance needs of individual regions. Collectively, these observations highlight the necessity for more evidence-based, integrated, and flexible regional development frameworks that enhance institutional effectiveness, strengthen policy execution, and foster balanced and sustainable regional growth. (Sun et al., 2024) make a significant contribution to understanding the interactions between regional economic development and land use change, while also exposing several areas that warrant further investigation. The research is limited to Shaanxi Province and Xi'an City, thereby restricting the generalisability of its findings to regions characterised by different physical, socio-economic, and institutional conditions. While the application of nonlinear regression provides valuable insights into the association between economic development and land use dynamics, the analytical framework offers only limited capacity to quantitatively evaluate the economic outcomes of individual land use policies because of methodological and data-related constraints. The study also recognises that its analysis is confined to provincial and municipal scales, leaving finer spatial variations at the county and local levels largely unexplored. In addition, accurately measuring the long-term economic returns of land conversion and sustainable land management practices remains a persistent challenge. Taken together, these limitations underscore the need for more comprehensive, multi-level, and interdisciplinary research frameworks that integrate spatial, economic, policy, and governance dimensions to strengthen sustainable land use planning and regional development strategies.

3. Study Area and Background

East Sikkim District is situated in the eastern part of the Himalayan State of Sikkim and occupies an area of approximately 954 km², making it the third largest district in terms of geographical extent. Despite its relatively moderate area, the district accommodates the highest population among the four districts of the state, reflecting its strategic administrative and economic importance. East Sikkim is bounded by North Sikkim to the north, Bhutan to the east, West Bengal to the south and South and West Sikkim towards the west. The district occupies a physiographically diverse landscape characterised by rugged mountain slopes, deeply incised river valleys and varying elevations that significantly influence settlement distribution and transportation networks. The district derives its regional importance primarily from the presence of Gangtok, the capital city of Sikkim, which functions as the state's administrative headquarters and its principal centre for commerce, education, healthcare, tourism

and public administration. Besides Gangtok, East Sikkim contains important urban centres including Singtam and Rangpo, while Rhenock functions as a Census Town. These urban centres collectively form the primary growth corridor of the district and exert considerable influence over surrounding rural settlements through employment generation, educational facilities, commercial activities and administrative services. The concentration of higher-order institutions within these centres has encouraged continuous migration from rural settlements, contributing significantly to demographic concentration and urban expansion.

Administratively, East Sikkim comprises three subdivisions—Gangtok, Pakyong and Rongli—which are further organised into block administration centres and Gram Panchayat Units (GPUs). The district contains eight development blocks and forty-two Gram Panchayat Units, reflecting a relatively decentralised administrative structure for managing dispersed rural settlements. While Gangtok subdivision accommodates the majority of urban population, Pakyong and Rongli continue to be characterised by predominantly rural settlement patterns with comparatively lower levels of urban development. This variation provides an appropriate basis for analysing demographic contrasts and settlement hierarchy within the district. The transportation network of East Sikkim plays a decisive role in shaping settlement distribution. National highways connecting Gangtok with Rangpo, Singtam and neighbouring regions constitute the principal development corridors where both urban and rural settlements are concentrated. Conversely, higher elevation regions located in the eastern part of the district exhibit sparse settlement distribution owing to difficult terrain, lower accessibility and environmental constraints. The spatial organisation of settlements therefore demonstrates a strong relationship between transportation accessibility and demographic concentration, a characteristic commonly observed in mountainous regions. According to Census 2011, East Sikkim recorded the highest district population of 283,583, the highest literacy rate of 83.85%, and the largest Scheduled Caste and Scheduled Tribe populations among all districts of Sikkim. The district also

exhibits the highest population density within the state, reflecting the combined influence of administrative concentration, economic opportunities and urbanisation. These demographic characteristics distinguish East Sikkim as the state's primary regional growth centre while simultaneously creating increasing pressure on urban infrastructure and public services. The coexistence of highly developed urban settlements and dispersed rural villages makes the district particularly suitable for analysing settlement hierarchy from a regional planning perspective.

4. Methodology

The present study adopts a quantitative and spatial analytical approach to investigate demographic characteristics and settlement patterns in East Sikkim District. The methodological framework combines comparative demographic assessment, temporal trend analysis, spatial mapping and institutional scalogram analysis to establish settlement hierarchy (Mukhopadhyay, 2026) and identify regional planning implications. The study is primarily based on secondary data obtained from the Census of India (1991, 2001 and 2011), District Census Handbook (2011), Rural Management and Development Department, Government of Sikkim, and administrative maps of East Sikkim. These datasets provide demographic indicators, administrative boundaries, settlement characteristics and infrastructure information required for comprehensive analysis.

The methodology was implemented in four sequential stages.

Stage I focused on district-level comparison within Sikkim. East Sikkim was analysed against North, South and West districts using the same demographic indicators to identify its relative demographic dominance and urban characteristics. The analysis further incorporated historical Census data from 1991, 2001 and 2011 to evaluate demographic transition over two decades, enabling the identification of changes in population growth, literacy, urbanisation, fertility and population density.

SIKKIM DISTRICTS					
S. NO.	DEMOGRAPHIC ATTRIBUTES	EAST	NORTH	SOUTH	WEST
1	POPULATION				
	MALE	1,50,260	24,513	76,663	70,225
	FEMALE	1,31,033	18,841	70,079	66,074
	TOTAL	2,81,293	43,354	1,46,742	1,36,299
2	SEX RATIO				
	ADULT	872	769	914	941
	CHILD	946	897	948	950
3	CHILD POPULATION				
	MALE	13,651	2,361	7,737	7,669
	FEMALE	12,920	2,118	7,333	7,288
	TOTAL	26,571	4,479	15,070	14,957
4	LITERACY RATE (%)				
	MALE	89.22	83.03	87.06	84.47
	FEMALE	79.41	69.92	76.58	72.12
	TOTAL	84.67	77.39	82.07	78.69
5	POPULATION DENSITY (per/sq.km)				
	POPULATION	295	10	196	117
6	POPULATION				
	URBAN (%)	43.19	10.62	14.44	3.85
	RURAL (%)	56.81	89.38	85.56	96.15
7	CASTE WISE POPULATION				
	SCHEDULED CASTES	15,305	982	6,053	5,935
	SCHEDULED TRIBES	78,436	38,715	41,392	57,817
8	CASTE WISE POPULATION (%)				
	SCHEDULED CASTES	5.4	2.25	4.12	4.35
	SCHEDULED TRIBES	27.66	65.7	28.19	42.38
9	GROWTH RATE (%)				
	URBAN	128.47	272.44	434.44	187.23
	RURAL	-16.47	-2.70	-1.51	7.93
	TOTAL	14.80	5.67	11.57	10.59

EAST SIKKIM DISTRICT				
S. NO.	DEMOGRAPHIC ATTRIBUTES	1991	2001	2011
1	TOTAL POPULATION			
	MALE	95,980	1,32,917	1,50,260
	FEMALE	82,466	1,12,123	1,31,033
	TOTAL	1,78,452	2,45,040	2,81,293
2	SEX RATIO			
	ADULT	859	844	872
	CHILD	941	950	946
3	LITERACY RATE (%)			
	MALE	73.1	81.20	89.22
	FEMALE	55.56	66.81	79.41
	TOTAL	65.13	74.68	84.67
4	POPULATION DENSITY (per/sq.km)			
	POPULATION	187	256	295
5	POPULATION			
	URBAN (%)	17.86	21.57	43.19
	RURAL (%)	82.14	78.43	56.81
6	CASTE WISE POPULATION			
	SCHEDULED CASTES	12,473	14,277	15,305
	SCHEDULED TRIBES	39,241	45,321	78,436
7	CASTE WISE POPULATION (%)			
	SCHEDULED CASTES	6.99	5.8	5.4
	SCHEDULED TRIBES	21.99	18.5	27.66
8	FERTILITY RATE			
	POPULATION	2.5	2.4	1.6
9	GROWTH RATE (%)			
	TOTAL	28.6	37.3	14.80

Figure 1: Demographic Attributes of 4 Districts of Sikkim, **Figure 2:** Decadal Growth Rate of East Sikkim District (Source: DCHB 2011)

Stage II examined demographic variations among the three subdivisions of East Sikkim- Gangtok, Pakyong and Rongli.

Comparative assessment included rural and urban population, decadal growth, urbanisation level, literacy, sex ratio and

child sex ratio to understand demographic differentiation within the district and identify spatial concentration of development.

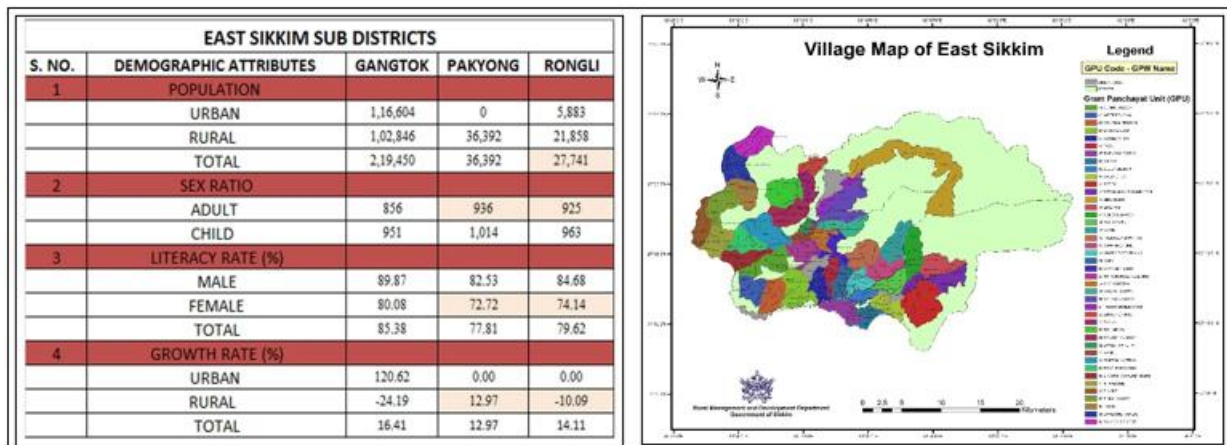


Figure 3: Demographic Attributes of 3 Sub Districts, East Sikkim, **Figure 4:** Village and Block Maps of East Sikkim District (Source: DCHB 2011, Rural Management and Development Department, Govt. of Sikkim)

Stage III comprised spatial analysis of settlement distribution. Administrative maps, village maps and transportation networks were integrated to examine relationships between settlements, topography and accessibility. Settlement concentration, distribution along

transport corridors, elevation characteristics and administrative organisation through subdivisions, blocks and Gram Panchayat Units were interpreted to explain regional settlement morphology.

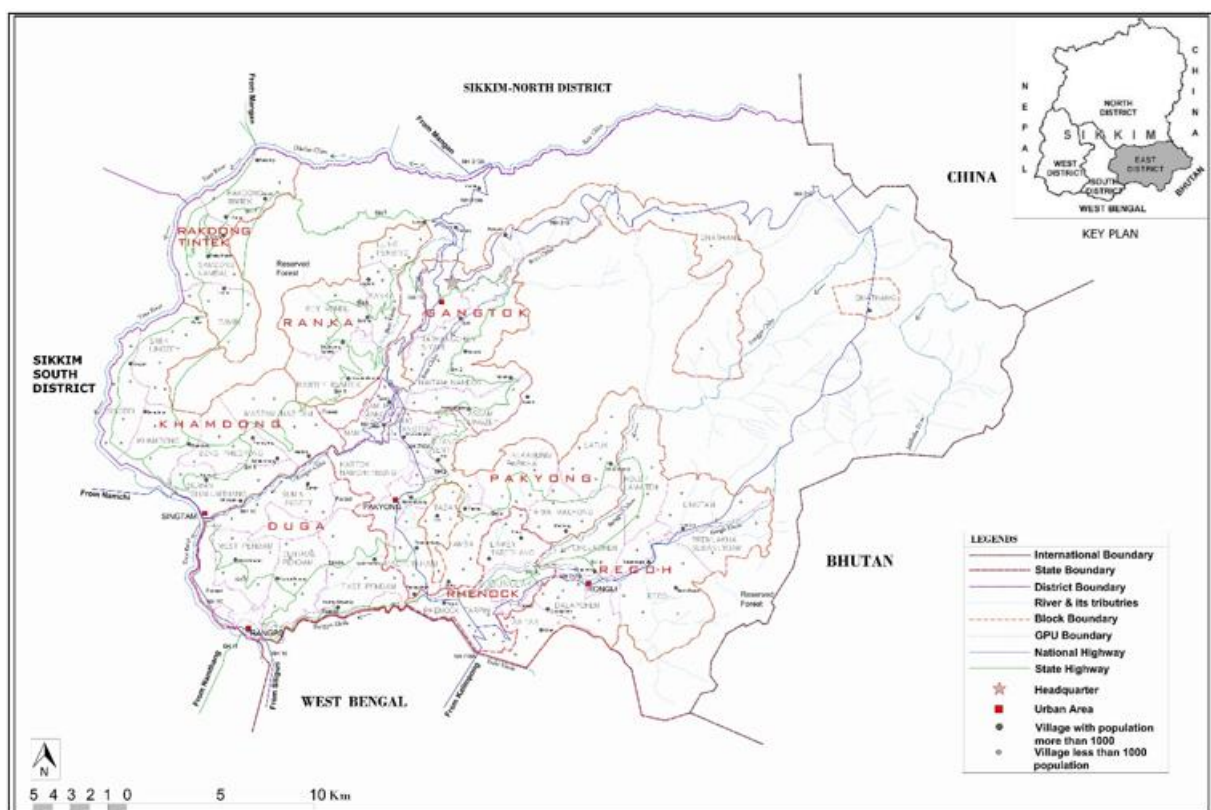


Figure 5: Existing Settlement Map, East Sikkim District (Source: Census 2011)

Stage IV employed an Institutional Scalogram Analysis to establish settlement hierarchy. Infrastructure and public facilities available within identified settlements were inventoried and assigned weights according to their frequency of occurrence. Rare and higher-order facilities received greater weight, while commonly available facilities received comparatively lower weights. The cumulative weighted score

represented the infrastructural strength of each settlement. Based on these composite scores, settlements were ranked and classified into four hierarchical categories:

- Order I – Regional Service Centres
- Order II – Sub-Regional Service Centres
- Order III – Central Villages
- Order IV – Service Villages

This classification enabled identification of service concentration, infrastructural disparities and potential growth centres for future regional planning. The hierarchy was subsequently represented spatially to evaluate the geographical distribution of higher-order and lower-order settlements across East Sikkim.

5. Results and Discussion

Sub-District Level Demographic Analysis

Significant demographic variations are evident among the three subdivisions of Gangtok, Pakyong and Rongli. Gangtok subdivision overwhelmingly dominates the demographic structure of East Sikkim owing to the presence of the state capital and associated urban centres. The subdivision accommodates the highest urban population, highest literacy levels and greatest concentration of administrative and institutional infrastructure. Pakyong subdivision remains predominantly rural despite experiencing gradual demographic growth. Unlike Gangtok and Rongli, Pakyong exhibits negligible urban growth because no major statutory

urban centre existed within the subdivision during the period analysed. Consequently, demographic characteristics continue to be strongly influenced by agricultural activities and dispersed rural settlement patterns.

Rongli subdivision occupies an intermediate position between Gangtok and Pakyong. The presence of Rhenock as a Census Town has encouraged moderate urban development while maintaining substantial rural characteristics. Urbanisation within Rongli has therefore progressed more rapidly than Pakyong but remains considerably below the level observed in Gangtok subdivision. Comparison of rural and urban growth rates reveals pronounced demographic concentration within Gangtok subdivision. Rural population growth has declined significantly because of migration towards Gangtok city and associated urban settlements where employment opportunities, educational institutions, healthcare services and administrative facilities are concentrated. This pattern demonstrates the growing dominance of Gangtok as the primary demographic and economic growth pole within East Sikkim.

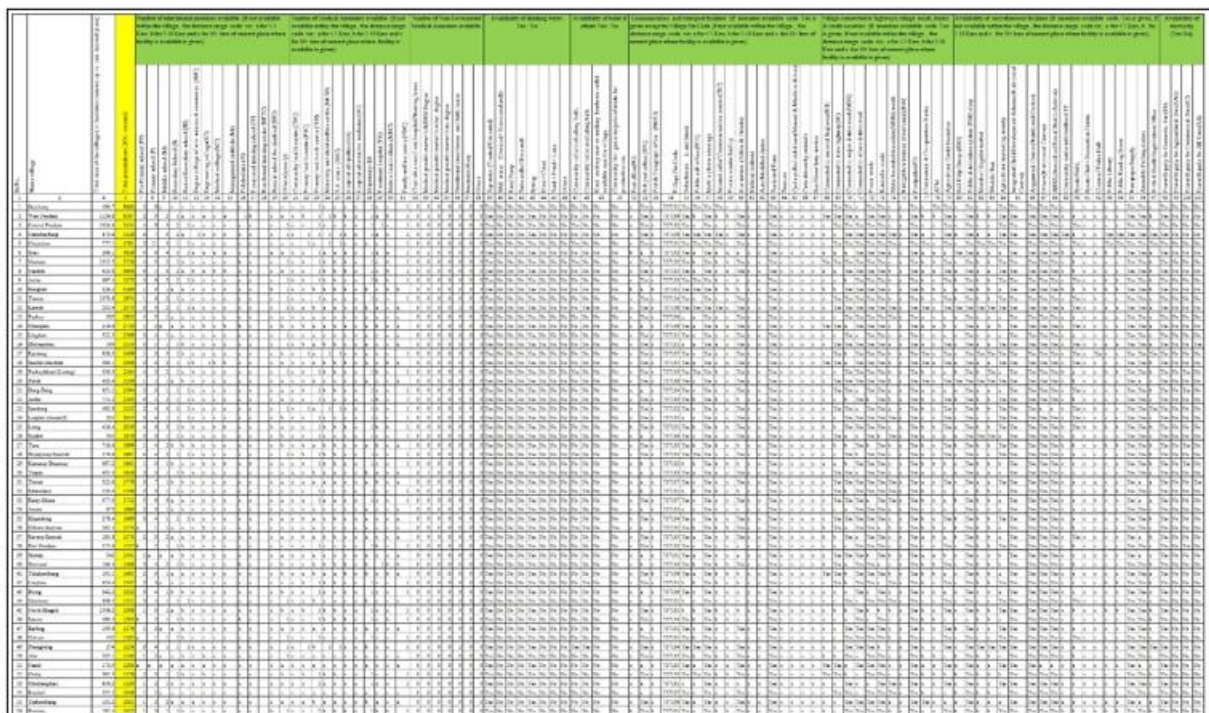


Figure 6: Scalogram Model with 56 Settlements above 1000 Population and Infrastructural Weightage in Descending Order, East Sikkim District (Source: Author)

Spatial Distribution of Settlements

Spatial analysis demonstrates that settlement distribution in East Sikkim is strongly controlled by topography and transportation accessibility. Settlements exhibit a pronounced linear pattern along the National Highway and major State Highways, indicating the critical role of transportation corridors in determining habitation patterns within mountainous environments. Most rural settlements also maintain close proximity to these transportation routes, facilitating access to administrative centres and public services. Settlement concentration is particularly evident in the south-western part of the district adjoining West Bengal. This region possesses comparatively favourable terrain, improved accessibility and stronger economic linkages with

neighbouring regions. In contrast, eastern high-altitude areas contain relatively few permanent settlements owing to rugged terrain, steep slopes and environmental constraints. Gnathang represents one of the few significant settlements within these higher elevation zones.

Administrative organisation further contributes to settlement distribution. East Sikkim comprises three subdivisions, eight development blocks and forty-two Gram Panchayat Units encompassing numerous villages and four urban settlements. Such administrative decentralisation facilitates local governance; however, higher-order public facilities remain concentrated within a limited number of settlements, reinforcing regional disparities in service accessibility.

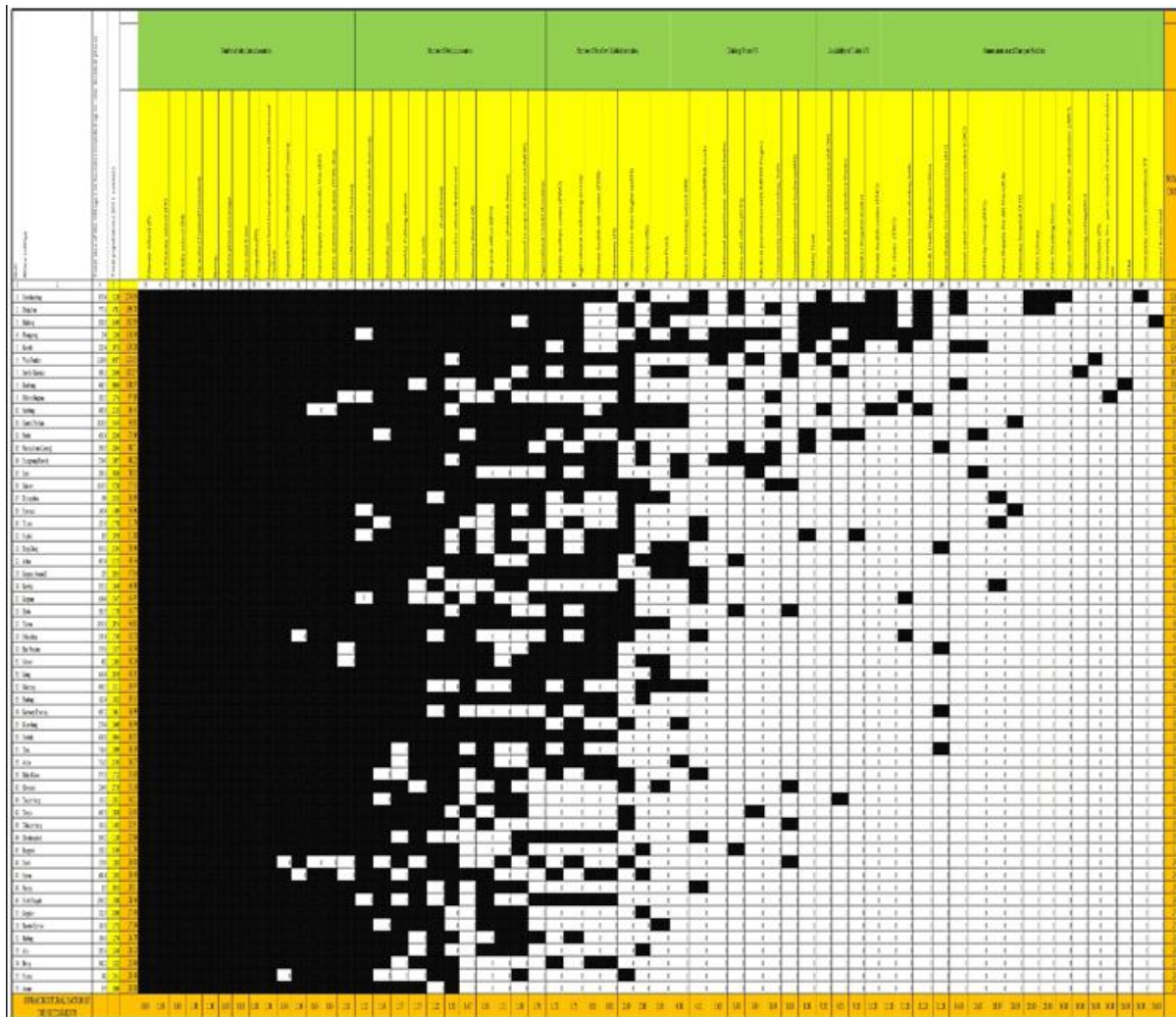


Figure 7: Scalogram Model Showing Distribution Pattern of the listed Infrastructures and Ranking of Settlements, East Sikkim District (Source: Author)

Institutional Scalogram and Settlement Hierarchy

The institutional scalogram analysis provides a systematic quantitative framework for evaluating settlement hierarchy based on infrastructure availability rather than population size alone. Individual physical, social and miscellaneous infrastructure facilities were assigned weighted values according to their frequency of occurrence among identified settlements. Facilities that occurred infrequently received higher weights because they represented higher-order services, whereas commonly available facilities received lower weights. Composite infrastructure scores were subsequently calculated by summing the weighted values for each settlement. The resulting hierarchy classified settlements into four functional categories: Regional Service Centres (Order I), Sub-Regional Service Centres (Order II), Central Villages (Order III) and Service Villages (Order IV). This

hierarchy reflects the degree of infrastructural concentration and service provision available within each settlement. Gangtok emerged as the dominant Regional Service Centre with the highest infrastructural score, followed by other major urban settlements including Singtam, Rangpo and Rhenock. These settlements collectively function as the primary service centres for the district, accommodating higher educational institutions, healthcare facilities, banking services, commercial establishments, administrative offices and transportation infrastructure. Several larger rural settlements such as Namcheybung also demonstrated relatively high infrastructural scores, indicating their emerging role as intermediate service centres. The hierarchy further reveals that many settlements possessing moderate or relatively large populations continue to function as lower-order settlements because of inadequate infrastructure availability.

S.NO	SETTLEMENT CATEGORIES	NAME OF SETTLEMENT	POPULATION	PROPOSED FACILITIES AND AMMENITIES IN A SETTLEMENT	TOTAL POINTS : SCALOGRAM
1	ORDER - 1 REGIONAL SERVICE CENTRE	Gangtok (Urban Centre)	1,80,281	Traditional practitioner and faith healer . Public call office (PCO) Medical practitioner with MBBS Degree Community toilet including bath. Connected to national highway(NH) Weekly Haat Maternity and child welfare centre (MCW) Commercial & Co-operative Banks Mandis / Regular market Primary health centre (PHC) T.B. clinic (TBC) Community toilet excluding bath. Birth & Death Registration Office Power Supply for Commercial Use (EC) Internet cafes/ Common service centre (CSC) Self-Help Group (SHG) Power Supply for All Uses (EA) Veterinary hospital (VH) Public Library Public Reading Room Degree college of arts science & commerce (ASC) Engineering college(EC) Polytechnic (PT) Community bio-gas or recycle of waste for productive use. ATM	274.19
		Singtam (Urban Centre)	1,368		
		Rangpo (Urban Centre)	15,450		
		Rhenock (Urban Town)	1,881		
		Namchi (Urban Town)	1,138		
		Rubing	2,409		162.19
2	ORDER - 2 SUB REGIONAL SERVICE CENTRE	Phongrong	1,176	Power Supply for Commercial Use (EC) Internet cafes/ Common service centre (CSC) Self-Help Group (SHG) Power Supply for All Uses (EA) Veterinary hospital (VH) Public Library Public Reading Room Degree college of arts science & commerce (ASC) Engineering college(EC) Polytechnic (PT) Community bio-gas or recycle of waste for productive use. ATM Community centre with/without TV Cinema / Video Hall	136.04
		Kaluk	1,051		129.28
		West Mowfun	1,180		123.15
		South Mowfun	1,196		112.17
		Chudang	1,190		108.67
3	ORDER - 3 DISTRICT TOWN	Chakirang	1,141	Water bounded macadam(WBM) roads Traditional practitioner and faith healer . Public call office (PCO) Medical practitioner with MBBS Degree Community toilet including bath. Connected to national highway(NH) Weekly Haat Maternity and child welfare centre (MCW) Commercial & Co-operative Banks Mandis / Regular market Primary health centre (PHC) T.B. clinic (TBC) Community toilet excluding bath. Birth & Death Registration Office Power Supply for Commercial Use (EC) Internet cafes/ Common service centre (CSC) Self-Help Group (SHG) Power Supply for All Uses (EA) Veterinary hospital (VH) Public Library Public Reading Room Degree college of arts science & commerce (ASC) Engineering college(EC) Polytechnic (PT) Community bio-gas or recycle of waste for productive use. ATM Community centre with/without TV Cinema / Video Hall	91.88
		Chudang	1,121		90.43
		Chudang	1,121		90.83
		Chudang	1,121		75.68
4	ORDER - 4 SERVICE VILLAGE	Phokhrang (Living)	2,104	Maternity and child welfare centre (MCW) Commercial & Co-operative Banks Mandis / Regular market Primary health centre (PHC) T.B. clinic (TBC) Community toilet excluding bath. Birth & Death Registration Office Power Supply for Commercial Use (EC) Internet cafes/ Common service centre (CSC) Self-Help Group (SHG) Power Supply for All Uses (EA) Veterinary hospital (VH) Public Library Public Reading Room Degree college of arts science & commerce (ASC) Engineering college(EC) Polytechnic (PT) Community bio-gas or recycle of waste for productive use. ATM Community centre with/without TV Cinema / Video Hall	68.71
		Phokhrang (Living)	1,887		68.22
		Phokhrang (Living)	1,887		58.15
		Phokhrang (Living)	1,887		57.35
		Phokhrang (Living)	1,887		56.69
		Phokhrang (Living)	1,887		54.96
		Phokhrang (Living)	1,887		51.79
		Phokhrang (Living)	1,887		51.18
		Phokhrang (Living)	1,887		50.96
		Phokhrang (Living)	1,887		49.34
		Phokhrang (Living)	1,887		47.14
		Phokhrang (Living)	1,887		46.98
		Phokhrang (Living)	1,887		45.97
		Phokhrang (Living)	1,887		45.77

Figure 8: Derived List of Order of Settlements with Proposal of Amenities and Infrastructural Facilities (Source: Author)

Conversely, certain settlements with comparatively modest populations occupy higher hierarchical positions due to the presence of specialised public facilities. This finding confirms that settlement hierarchy is determined primarily by functional infrastructure rather than demographic size alone. The spatial representation of the hierarchy indicates considerable concentration of higher-order settlements around major transportation corridors and urban centres, while peripheral settlements remain categorised as Service Villages. Such disparities highlight the necessity for targeted infrastructure investment to strengthen intermediate settlements and reduce excessive dependence upon Gangtok. Overall, the institutional scalogram effectively identifies regional growth centres and provides a rational basis for phased infrastructure planning, service allocation and balanced regional development across East Sikkim.

The present study demonstrates that demographic characteristics and settlement organisation in East Sikkim are

closely interrelated and collectively define the district's regional development trajectory. Comparative demographic analysis establishes East Sikkim as the most urbanised and socio-economically advanced district of Sikkim, characterised by the highest population, literacy rate, population density and concentration of higher-order infrastructure. These demographic advantages are primarily associated with the presence of Gangtok as the state capital, together with other important urban centres such as Singtam, Rangpo and Rhenock, which function as major administrative, commercial and service centres. Simultaneously, the district exhibits declining rural population growth resulting from sustained migration towards urban settlements, indicating an ongoing demographic transition driven predominantly by economic opportunities and improved public services. Spatial analysis further reveals that settlement distribution is strongly influenced by physiography and transportation accessibility.

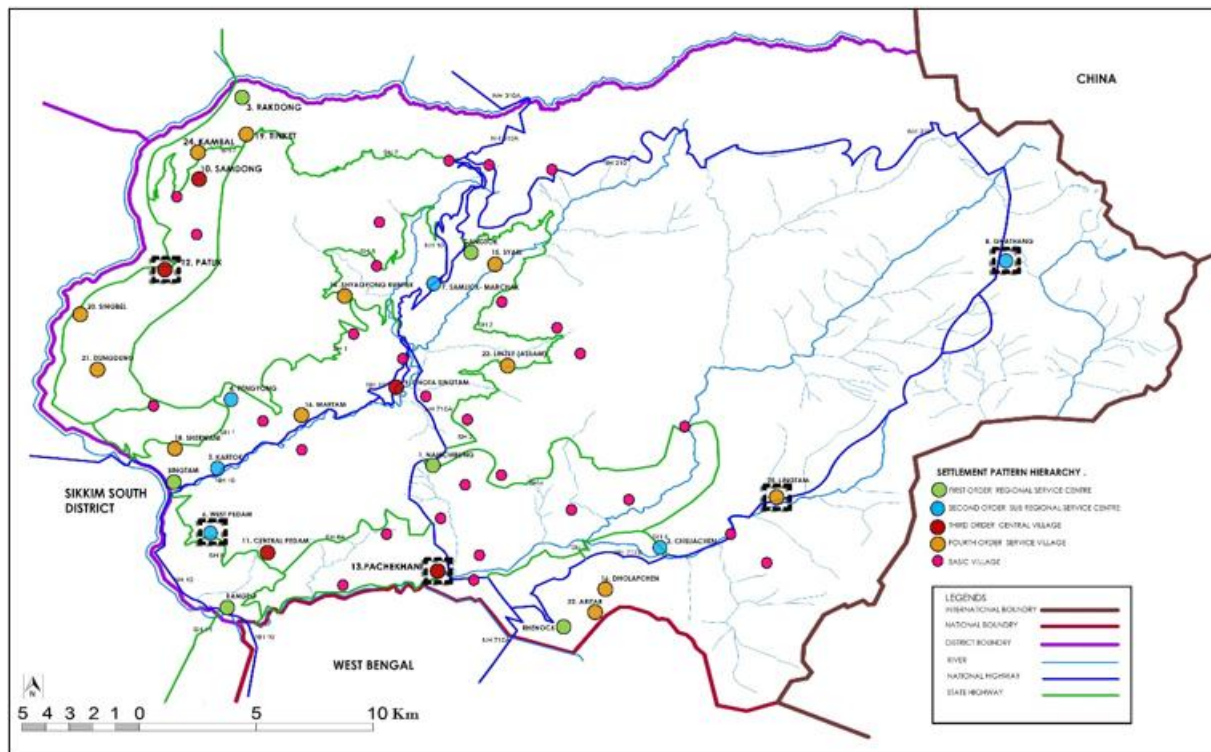


Figure 9: Derived List of Order of Settlements Mapped, Showcasing Geographical Position and Proximity to Physical Infrastructures (Source: Author)

6. Conclusion

The concentration of settlements along National Highways and State Highways demonstrates the decisive role of transport infrastructure in shaping habitation patterns within mountainous regions, while higher elevation areas remain comparatively sparsely populated because of topographic constraints. This spatial imbalance has contributed to increasing concentration of population and infrastructure within a limited number of urban centres. The institutional scalogram analysis provides a robust framework for evaluating functional settlement hierarchy by integrating demographic characteristics with infrastructure availability. The classification of settlements into Regional Service Centres, Sub-Regional Service Centres, Central Villages and Service Villages clearly demonstrates considerable variation in service provision across the district. Higher-order settlements possess a comprehensive range of physical, social and commercial infrastructure, whereas numerous lower-order settlements continue to depend upon these centres for essential services. Consequently, strengthening intermediate settlements through phased infrastructure development would reduce excessive spatial concentration, improve accessibility for rural populations and promote a more balanced regional settlement structure.

Overall, the study establishes that demographic dynamics, transportation accessibility and infrastructure distribution collectively determine the hierarchy of settlements in East Sikkim. The integrated analytical framework adopted in this research provides an objective basis for identifying regional growth centres and prioritising infrastructure investment according to settlement order. Such an approach offers valuable guidance for regional planning in Himalayan environments by facilitating equitable service distribution,

strengthening rural service centres and supporting sustainable spatial development while reducing regional disparities across the district.

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