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Uneven Access to Basic Household Amenities in North-East India: Spatial Inequalities, Rural–Urban Disparities and Health-Related Implications

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Uneven Access to Basic Household Amenities in North-East India: Spatial Inequalities, Rural–Urban Disparities and Health-Related Implications

Abstract: Basic household amenities are important indicators of living conditions and contribute to the wellbeing and development of households. However, their availability and distribution remain uneven across regions and between rural and urban areas. This study analyses spatial disparities in access to household level basic amenities across 86 districts of North East India using Census 2011 data. The study used eight indicators; concrete roofs, treated drinking water, electricity, toilet, bathroom, drainage, LPG/PNG, and kitchen facilities. A Composite Index was constructed using eight indicators after normalization. Location Quotient and Gini Coefficient were applied to assess concentration and inequality. A modified disparity index was used to assess rural urban differences, Pearson's correlation to examine associations among amenities, and GIS based mapping to identify spatial patterns. The finding reveals substantial spatial variation in access to household amenities across the region, with capital and relatively developed districts generally showing better access, while several remote, rural and peripheral districts experience greater infrastructural deficits. Concrete roofing records the highest overall inter district inequality (Gini=0.61), followed by drinking water (0.47), drainage (0.43) and LPG/PNG (0.43). The findings highlight the need for geographically targeted and integrated infrastructure planning to reduce spatial inequalities in household living conditions. Although health outcomes are not directly examined, improved access to safe water, sanitation, drainage and clean cooking energy may contribute to more health supportive household environment.

1. Introduction

Provision of basic household services, including access to safe drinking water, sanitation, electricity, and clean cooking fuel, is considered a fundamental aspect of human development and social equity (Montgomery et al. 2003). Provision of basic household services, including access to safe drinking water, sanitation, electricity, and clean cooking fuel, is considered a fundamental aspect of human development and social equity (Kumar, 2015). The health, education, productivity, and quality of life are determined by these basic amenities, which directly connect infrastructure access to development outcomes (Satterthwaite, 2016). Although the world is rapidly urbanising and technological advancements have been made, there are still notable differences between rural and urban populations in terms of access to and quality of household services (Tacoli, McGranahan, and Satterthwaite, 2015). In developing countries, access to better housing facilities is associated with higher economic and social status (Huang and Jiang, 2009; Ahmad, 2012). Like other developing countries, India is also experiencing inequality in housing and basic amenities (Kundu *et al.,* 1999; Srinivasan and Mohanty, 2004; Edelman and Mitra, 2006; Motkuri and Joe 2005; Pal et al. 2015; Kumar 2015). As per the Census of India 2011, the percentage of households with access to water, sanitation, and drainage in urban areas was 69.33%, 79%, and 44.5%, respectively, whereas only 25.51% had access to water, 27.63% to sanitation, and 5.75% to drainage in rural areas of India (Mahalingam et al., 2025).

Numerous studies have been conducted in India examining access to basic amenities among households across different rural and urban environments (Kumari, 2022; Pal et al., 2015; Rana, 2018). Studying the spatial distribution of household facilities can provide information on the presence of inclusion and exclusion in the development process. The problem of infrastructure inequality is a mirror of broader questions of governance, social justice, and state investment (Satterthwaite, 2016). The concentration and deprivation areas can be identified to support more equitable planning and resource distribution (Ravallion et al., 2007). Such a regional outlook is especially relevant in heterogeneous regions such as North East India, where aggregate statistics tend to hide internal variations (Hazarika, 2013). There has been a tendency in the extant literature on inequality in India to concentrate on income, consumption, and urbanisation, with comparatively less attention given to disparities in basic household infrastructure across districts (Kanbur & Venables, 2005). If it has been done, the studies focus more on national or state-wide comparisons, but sub-regional differences have not been fully explored (Kurian, 2000).

Access to basic household amenities is an important component of living conditions, human wellbeing, and regional development. Facilities such as adequate housing, treated drinking water, electricity, sanitation, drainage, bathroom facilities, clean cooking fuel, and kitchen facilities contribute to a healthy and secure household environment and reflect the extent to which the benefits of development reach households. However, access to these essential amenities is not evenly distributed across geographical areas, and such spatial inequalities can influence differences in living standards and the quality of the residential environment.

The north-East region of India has received comparatively limited academic attention in the spatial analysis of household amenities, despite their importance for development and human wellbeing (Baruah, 2007). Existing studies in India have examined disparities in access to basic

household amenities, but much of the literature has focused on national level or broad regional patterns. Such approaches may mask important variations within the North-East, a region characterised by diverse geographical settings, dispersed settlements, difficult terrain, infrastructural constraints, and considerable socio-economic and cultural diversity. Consequently, there is a need for a more focused and spatially disaggregated examination of household amenities within the region.

Furthermore, intra-regional disparities in access to household amenities remain insufficiently explored. Significant differences may exist not only between the eight states of North-East India but also between rural and urban areas and among individual districts. Examining these differences at the district level is particularly important because regional averages can conceal pockets of deprivation and areas of relatively better provision. In addition, existing studies often examine individual amenities separately, providing limited understanding of the combined condition of household infrastructure. A multidimensional assessment that considers several amenities simultaneously can therefore provide a more comprehensive picture of household living conditions and spatial inequality.

The importance of household amenities can also be understood through the Capability Approach proposed by Amartya Sen, which emphasises that development should be evaluated not only through income but also through people's access to essential capabilities and conditions necessary for achieving wellbeing (Sen, 1985; Sen, 1999). Access to drinking water, sanitation, electricity, adequate housing, and other basic household facilities forms an important part of these enabling conditions. From this perspective, differences in household amenities represent more than infrastructural disparities; they also reflect unequal opportunities to achieve improved living conditions and wellbeing (Nussbaum, 2000; UNDP, 2010). Several of these amenities, particularly water, sanitation, drainage, housing quality, and cooking energy, also have potential implications for the health supportive quality of the household environment. However, the present study does not directly measure health outcomes; rather, it considers household amenities as important environmental and infrastructural conditions with implications for health and quality of life.

The study is further informed by the Core-Periphery Model, which provides a spatial perspective for understanding uneven development and the concentration of infrastructure and services in relatively developed or central areas compared with peripheral and less developed areas (Friedmann, 1966; Krugman, 1991). This framework is useful for interpreting the geographical variation in household amenities across North-East India and for identifying spatial patterns of infrastructural advantage and deprivation. The spatial distribution of household facilities can therefore be viewed development (Smith, 1977; UN Habitat, 2016).

In this context, a district level analysis of household amenities is necessary to identity the geographical pattern and extent of spatial inequality in the region. Such an analysis can move beyond simply describing the availability of individual facilities by examining the overall level of household amenities, the concentration or deficit of specific facilities, spatial inequality, and rural urban differences. The identification of districts with relatively poor access to essential household amenities can provide an empirical basis for understanding areas of infrastructural deprivation and for informing policies aimed at more balanced and inclusive regional development (Kanbur & Venables, 2005).

Therefore, there is a clear need for a comprehensive spatial assessment of basic household amenities in North East India that considers multiple dimensions of household infrastructure at the district level. The present study addresses this gap by examining the spatial distribution and regional disparities in access to basic household amenities across districts of North East India, with particular attention to rural urban differences, spatial concentration, and inequality. By constructing a composite measure of household amenities and applying spatial and inequality-based approaches, the study seeks to identify relatively advantaged and deprived areas and contribute to a better understanding of uneven living conditions and their broader implications for human wellbeing in the region.

2. Database & Methodology

2.1.Study Area and Unit of Analysis

The study focuses on Northeast India, a region comprising eight states: Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, and Tripura. The region is marked by pronounced physiographic diversity, ranging from alluvial valleys to mountainous terrain, as well as substantial ethnic, cultural, and socio-economic heterogeneity (Meitei & Das, 2025). Persistent disparities in infrastructure development, urbanisation levels, and livelihood opportunities between hill and valley districts make Northeast India a particularly relevant context for examining spatially differentiated migration processes (Baruah, 2007). The district is adopted as the unit of analysis to achieve finer spatial resolution and capture inter-district interactions that are often obscured in state-level analyses. Based on the administrative boundaries defined in the Census of India 2011, the analysis covers 86 districts (Figure 1), allowing for a systematic assessment of household disparity across the region.

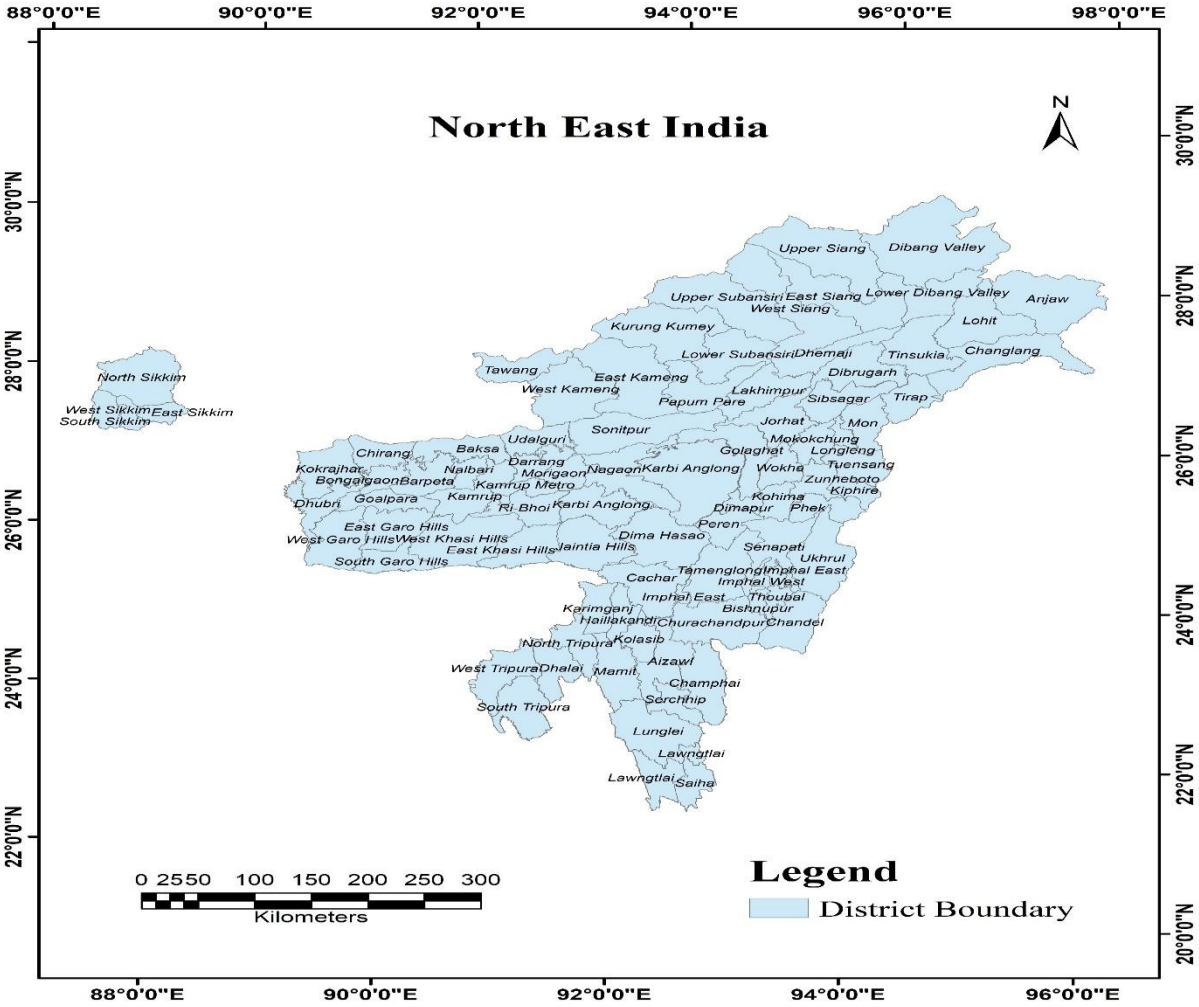


Figure 1: Study area Map (Meitei & Das, 2025)

2.2.Data Source and Study Unit

The present study examines the spatial distribution of basic household amenities in North East India at the district level using secondary data obtained from the Census of India 2011, Government of India. Census 2011 was selected because it provides comprehensive and spatially disaggregated information on household amenities across districts and rural-urban areas. Since the subsequent population Census has been delayed, census 2011 remains an important source for examining spatial inequalities in household living conditions across the region

The study covers the eight states of North East India. Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura and includes 85 districts for these states based on the administrative boundaries available in Census 2011, The district is considered the primary unit of spatial analysis, with rural and urban areas examined separately to identify differences in access to basic household amenities.

Eight indicators were selected to represent important dimensions of household living conditions: concrete roof, treated drinking water, electricity, toilet facility, closed drainage,

bathroom facility, LPG/PNG cooking fuels, and kitchen facility. These indicators collectively reflect housing quality, access to essential services, sanitation, hygiene related infrastructure and household energy. Adequate access to such facilities is not only an indicator of improved living standards but also contributes to a healthier household environment. Inadequate water, sanitation, drainage, housing and cooking facilities may increase exposure to environment health risks and thereby have implications for household health and wellbeing (Sen, 1999; World Bank, 2009; UNDP, 2016).

Thus, the study does not directly measure health outcomes; rather, household amenities are considered basic environment and infrastructural conditions that may influence health and quality of life. This provides a health-related perspective for interpreting spatial inequalities in household amenities without making direct causal assessment of health outcomes

2.3.Selection of Household Amenity Indicators

The eight selected indicators represent different aspects of household infrastructure and living conditions.

1) Concrete roof: The percentage of households having a concrete roof was used as an indicator of relatively durable housing construction. A durable roof can provide better protecting from rain, heat and other environment conditions, thereby contributing to a healthier residential environment.
2) Treated drinking water: The percentage of households obtaining drinking water from tap water supplied through treated sources was used as an indicator of access to improved drinking water conditions. Adequate access to treated water is important for maintaining household hygiene and reducing potential exposure to water related health risks.
3) Electricity: The percentage of households using electricity as the primary source of lighting was used as an indicator of household infrastructure. Access to electricity contributes to improved household conditions and facilities related activities related to hygiene, education, communication and access to information.
4) Toilet facility: The percentage of households having a latrine/toilet facility within the premises was used as an indicator of sanitation. Adequate sanitation is an important component of a healthy living environment because poor sanitation can contribute to environmental contamination and the transmission of infectious diseases.
5) Closed drainage: The percentage of households having a closed drainage system was used as the drainage indicator. Proper drainage can help reduce stagnant wastewater and associated environment and sanitation problems.
6) Bathroom facility: The percentage of households having a bathroom facility within the premises was used as an indicator of household's hygiene infrastructure. The availability of a bathroom facilities personal hygiene and contributes to improved household living conditions.
7) LPG/PNG cooking fuel: The percentage of households using LPG/PNG was used as an indicator of access to relatively cleaner households cooking energy. Greater use of LPG/PNG may reduce household exposure to smoke associated with traditional solid

fuels and therefore has potential implications for respiratory and indoor environment health.

8) Kitchen facility: The percentage of households having a kitchen facility for cooking withing the premises was used as an indicator of household infrastructure and living conditions. The availability of an appropriate cooking space can support better organisation and hygiene within the household.

All eight indicators were treated as positive indicators, where higher values represent better access to household amenities and relatively improved living conditions.

2.4.Household Amenities Index

To obtain an overall measure of household amenities, a composite Household Amenities Index (HAI) was constructed from the eight selected indicators. The index provides a relative measure of the level of household infrastructure and living conditions across districts. The indicators were normalised using a min-max dimension index approach

$$\text{Dimension Index} = \frac{Observed\ value - Minimum\ value}{Maximum\ value - Minimum\ value}$$

The normalised value ranges from 0 to 1, with higher values representing better access to the respective amenity. The overall Household Amenities Index was calculated as the arithmetic mean of the eight normalised indicators:

$$\text{Composite Index} = \frac{X1+X2.....X_n}{n}$$

A higher HAI therefore represents better overall access to basic household amenities and comparatively better household living conditions. Since water, sanitation, drainage, housing and cooking energy conditions are closely associated with the quality of the residential environment, the HAI can also be interpreted as an indicator of potential health supportive living conditions, although it is not a direct measure of health status.

2.5.Rural-Urban Disparity

To examine differences in household amenities between rural and urban areas, a Rural-Urban Disparity Index based on the modified formulation of Kundu and Rao (1983) was applied. The rural and urban index values were used to assess the extent of inequality in access to household amenities.

$$DI = \log\left(\frac{X_U}{X_R}\right) + \log\left(\frac{200 - X_R}{200 - X_U}\right)$$

where $X_R$is the rural index and $X_U$is the urban index for a district. In this study, the original dimensionless index values (ranging from 0 to 1) were first converted to percentages by multiplying by 100.

The first term, $\log(X_U/X_R)$, represents the proportional difference between urban and rural indices, and the second term, $\log((200 - X_R)/(200 - X_U))$, adjusts for the overall level of the indices. A higher DI value indicates a larger disparity between rural and urban areas in a district. The index provides an indication of the extent to which rural and urban populations differ in their access to basic household infrastructure. Higher disparity values indicate greater rural urban differences, while lower values indicate relatively similar levels of access.

The rural urban analysis is particularly relevant from a health perspective because unequal access to water, sanitation, drainage, housing and cleaner cooking energy may result in differences in the quality of the residential environmental and consequently in potential exposure to environmental health risks.

2.6.Location Quotient

The location Quotient (LQ) was used to identify districts with relatively high or low concentrations of individual household amenities compared with the regional average of North east India.

$$\text{Location Quotient (L.Q): } \frac{(ei/p)}{(\frac{Ei}{P})}$$

Where,

e_i denotes the number of households of particular facility 'i in a given district, p denotes the total household of the concerned district, Ei denotes the number of households of particular facility 'I' in North East India and P denotes the total household of North East India.

If L.Q.>1, indicate that the concentration of facilities is high in the district compared to the districts of the state as a whole. If L. Q <1, it indicates a lack of facilities in the district compared to the state as a whole. Districts with lower concentrations of sanitation, treated drinking water, closed drainage and cleaner cooking fuel may therefore be considered areas of comparatively greater potential environmental and health vulnerability, although health outcomes are not directly measured in the present study.

2.7.Gini coefficient

The Gini coefficient was used to measure spatial inequality in the distribution of household amenities across districts. District level values of each amenity were arranged in ascending order, and the Gini coefficient was calculated using the standard formulation.

$$G=\frac{2\sum_{i=1}^{n} ixi}{n\sum_{i=1}^{n} xi}-\frac{n+1}{n}$$

Where, xi denotes the household asset value of the i^{th} district, i denotes the rank of the i^{th} district, and n denotes the total number of districts.

The coefficient ranges from 0 to 1, with values closer to 0 indicating greater equality and higher values indicating greater spatial inequality. The Gini coefficient therefore helps identify which household amenities show the greatest geographical inequality across North East India.

2.8.Spatial Analysis

The spatial distribution of the Household Amenities Index, individual amenities, Location Quotients and rural urban disparities was examined using GIS techniques. The results were represented spatially through thematic maps using ArcGIS.

Choropleth maps were prepared to visualise the spatial variation in household amenities and the composite index across districts. The equal interval classification methods were used to represent the spatial distribution of the index and disparity values.

The spatial analysis provides a geographical understanding of areas with relatively better or poorer household living conditions. In particular, areas characterised by low access to water, sanitation, drainage, durable housing and cleaner cooking energy can be identified as locations where potential environmental health vulnerabilities may be greater.

Data processing, coding, index construction and statistical calculations were performed using IBM SPSS Statistics Version 20.

3. Results

3.1.State-wise Profile of Household Living Conditions.

From Table 1, the percentage of concrete roofs shows noticeable variation across states in housing quality and access to durable construction materials. Sikkim has the highest share (23.11%), indicating relatively better housing conditions and greater adoption of permanent roofing materials. This is followed by Mizoram (13.35%) and Meghalaya (10.25%), which also reflect moderate availability of stone-roofed houses. On the one hand, Assam contributes only 2.86, which shows a very low proportion, suggesting a predominance of temporary or semi-permanent roofing materials and comparatively poorer household amenities.

For lighting access varies widely among the states of North East India. Sikkim has the highest coverage (92.54%), followed by Mizoram and Nagaland, indicating strong electricity infrastructure, while Assam has the lowest coverage (37.05%), indicating a major deficiency in electricity supply. The other villages fall in a moderate range (60–69%). Overall, the data highlights uneven development and suggests a need to prioritise improvement in poorly lit villages, especially in Assam.

Access to drinking water is generally low across the states, ranging from 6.08% in Nagaland and 9.15% in Assam to 39.44% in Mizoram, indicating a clear shortage of drinking water facilities. In contrast, toilet facility availability is much higher in all states of North East India, with Mizoram (91.91%), Manipur and Sikkim (87.2%), and Tripura (86.04%) performing particularly well. Even the lowest toilet facility coverage (62% in Arunachal Pradesh) is far above most drinking water levels. Overall, the pattern suggests that sanitation initiatives have achieved wider reach than housing quality, clean energy adoption, or piped water access. This aligns with broader national findings that while toilet construction expanded rapidly under government programmes, complementary amenities such as drainage, kitchens, and clean cooking fuel remain unevenly distributed (Government of India, 2020).

Drainage facilities are extremely limited in most states of North East India, ranging from 3–6% in Assam, Manipur, Tripura, and others, with only Mizoram (13.12%) and Sikkim (14.62%) showing relatively better coverage. Bathroom facilities, however, are more available, though still uneven: Mizoram and Sikkim lead at 65.18% and 35.06 %, while Tripura (18.91%) and Assam (24.47%) lag far behind. LPG/PNG use varies widely across provinces, from only 11.85% in Meghalaya and 17.64–19.96 % in Tripura and Nagaland to a high of 52.55% in Mizoram and 41.26% in Sikkim, indicating unequal access to clean cooking fuel.

In contrast, kitchen availability is generally high in all states, ranging from 65.66% in Sikkim to 88.62% in Nagaland. This suggests that while most households have kitchen space, many still lack access to clean cooking fuel, highlighting a gap between physical infrastructure and clean energy adoption that development programs may need to address. Studies on rural housing and amenities also note that North-Eastern states exhibit sharp internal disparities due to terrain, settlement patterns, and economic constraints, which slow uniform infrastructure expansion (IIPS & ICF, 2021; Bhagat, 2013).

Table 1 Household living condition by states of North East India

State	Concrete Roof	Electricity	Drinking Water	Toilet	Drainage	Bathroom	LPG/PNG	Kitchen
Sikkim	23.11	92.54	29.20	87.20	14.62	65.06	41.26	65.66
Mizoram	13.65	84.20	39.44	91.91	13.12	65.18	52.55	83.13
Manipur	4.42	69.32	24.71	87.03	3.98	31.12	27.60	85.68
Nagaland	5.60	81.61	6.08	76.52	4.81	52.37	19.96	88.62
Arunachal	3.93	65.68	26.42	61.97	5.95	29.02	29.22	85.84
Tripura	4.21	68.44	20.31	86.04	3.68	18.91	17.64	77.83
Meghalaya	10.25	60.92	27.81	62.91	5.70	33.27	11.85	71.71
Assam	2.86	37.05	9.15	64.89	3.61	24.47	18.95	70.27

Source: Census of India, 2011

3.2.Gaps in Access to Basic Household Amenities

Table 2 shows a considerable difference in inter-sectoral disparity in household facilities between urban and rural regions in the north-eastern states of India, with significant differences across selected states and various attributes that show uneven trends in infrastructural development**.**

The gap in concrete roof housing remains relatively low to moderate in most states, indicating partial diffusion of durable building roof materials in rural areas; however, the difference is significant in Sikkim (44.28) and Meghalaya (28.69), indicating a high degree of urban bias in permanent concrete roof structures. Conversely, Arunachal Pradesh and Tripura are recording lower gaps, indicating a more balanced distribution of roof structures.

Access to drinking water reveals one of the most pronounced and uneven disparities. States such as Sikkim (56.64), Meghalaya (51.43), and Mizoram (47.23) show very high urban–rural gaps, indicating severe deficits in rural water infrastructure. Interestingly, Nagaland registers a slightly negative gap (–1.08), which can be either a position of relative equality or actually slightly better rural accessibility as compared to urban areas, which is an exception to the overall trend.

The gap in electricity access is exceptionally high in Assam (55.72) and remains substantial in Arunachal Pradesh and Meghalaya, reflecting the persistent exclusion of rural households from reliable energy sources. Conversely, Sikkim records a very low gap (8.55), indicating either limited overall access or a more uniform distribution across rural and urban areas.

Toilet indicators show mixed but concerning patterns. The toilet facility gap is particularly high in Mizoram (42.88) and Arunachal Pradesh (37.82), underscoring acute rural sanitation deprivation. Similarly, the bathroom facility gap remains consistently high across almost all states, exceeding 50 in Assam, Arunachal Pradesh, and Manipur, highlighting toilets as a critical dimension of urban–rural inequality.

Disparities in access to improved drinking water and sanitation facilities are well documented; a recent analysis based on NFHS-5 data for Northeast India finds that factors such as household wealth, education and residence type significantly influence access to water and sanitation, highlighting entrenched inequalities within and between states (Tirkey et al. 2025).

In terms of drainage, the gaps are generally lower than those for other amenities. However, Sikkim again stands out with a substantially high gap (34.55), pointing towards concentrated urban or peri-urban drainage facilities. Research on sanitation further corroborates these disparities: socio-economic studies of Indian households reveal significant variation in access to improved sanitation across states, driven by income, education and infrastructure deficits — factors likely contributing to the low toilet and drainage percentages observed in some Northeast states (Kumar, Hasan & Rajak, 2024).

The disparity in clean cooking fuel (LPG/PNG) is among the highest across all attributes, with extremely large gaps in Arunachal Pradesh (65.58), Mizoram (66.87), and Sikkim (61.82). This reflects a persistent rural reliance on traditional fuels and highlights energy transition as a major challenge in rural areas. In the context of clean cooking fuels like LPG/PNG, national studies have also shown that policy interventions such as the Pradhan Mantri Ujjwala Yojana have had differential impacts across regions, with the North-East experiencing comparatively smaller gains in clean fuel adoption, underscoring persistent regional and community-specific disparities in energy access (Asharaf & Tol, 2024). Finally, the gap in kitchen facility is moderate overall but significantly higher in Sikkim (30.24) and Meghalaya (19.65), indicating pronounced urban–rural contrasts in kitchen facility conditions. In contrast, Nagaland shows near parity (0.48), suggesting relatively balanced kitchen standards.

Table 2 Gap in basic amenities in household in North Eastern India

State / Attributes (%)	Assam	Arunachal Pradesh	Manipur	Meghalaya	Mizoram	Nagaland	Sikkim	Tripura
Concrete roof	14.49	10.85	9.2	28.69	23.25	14.24	44.28	12.82
Drinking water	21.62	26.83	37.84	51.43	47.23	-0.08	56.64	32.12
Electricity	55.72	40.56	18.9	43.36	29.33	22.2	8.55	32.09
Toilet	34.14	36.81	12.65	41.87	13.94	25.38	11.08	16.44
Bathroom	55.93	51.09	25.38	52.22	38.95	39.86	33.96	38.33
Drainage	14.01	12.98	2.98	15.54	15.42	5.38	34.55	4.95
LPG/PNG	58.08	64.57	41.68	43.09	65.86	46.03	60.81	44.42
Kitchen facility	18.96	5.61	10.37	19.65	8.32	0.47	30.24	17.75

Source: Census of India, 2011

3.3. Inter-district variations in Access to Basic amenities (based on concentration index)

From Figure 2(a), the relative positions of the districts to the state regarding household facility availability can also be gauged. It was prepared with the help of Location Quotient values. It shows that 25 districts have an LQ value greater than 1 for a Concrete roof. This means these districts performed better than the state average on this measure. Districts like East Sikkim have the highest LQ, indicating a very strong concentration. Baksa of Assam; Dibang Valley, and Kurung Kumey of Arunachal Pradesh have limited adoption of concrete roofing due to rurality, terrain, or lower infrastructure development for concrete-roof housing compared to the reference average. Other notably high districts include Aizawl of Mizoram, East Khasi Hills of Meghalaya, and Kamrup Metropolitan of Assam**,** reflecting urbanised or relatively developed housing conditions.

The spatial pattern of LQ for electricity shows that most districts in the southern and eastern parts of the region, including most of Manipur, Mizoram, and Nagaland, as well as some districts in the northern part of Arunachal Pradesh, exhibit a high concentration of electricity as a source of Energy**.** Aizawl records the highest LQ, followed closely by Papum Pare, Kolasib, and East Khasi Hills, suggesting a relatively strong concentration of electricity access in these districts. On the other hand, the central and western parts are largely under represented, with many districts including Barpeta, Dhubri, Goalpara, Baksa, Dhemaji, and Wokha.

Considering tap water from treated sources, most districts in the southern, eastern, and select northern parts of the Northeast, including the states of Arunachal Pradesh and Mizoram, and parts of Meghalaya, exhibit higher concentrations. Districts like Papum Pare, West Kameng, East Khasi Hills, Aizawl, Kolasib, Imphal West, and West Kameng show very high LQ values, while central and western belts, especially in Assam and Nagaland, including Manipur, lag behind.

The distribution of latrine facilities appears more balanced, with 44 districts recording LQ values above 1 and 42 districts below 1**.** Districts exhibiting higher LQ values are predominantly clustered in Mizoram, Manipur, Sikkim, Tripura, and select urban districts of Assam and Nagaland which include the district of certain state of North east India such as Aizawl, Serchhip, Kolasib, Imphal West, Imphal East, Kamrup Metropolitan, Dimapur, Mokokchung, and East District (Sikkim) display very high LQ values, highlighting shows household toilet coverage. While districts such as Anjaw, Kurung Kumey, East Kameng of Arunachal Pradesh, Baksa, Chirang, Kokrajhar, Dhemaji of Assam exhibit comparatively poor sanitation coverage.

From Figure 2(b), shows the Location Quotient pattern in Northeast India shows a sharp regional inequality in bathroom facility concentration: districts with LQ > 1, clustered in Mizoram, Nagaland, Sikkim, parts of Arunachal Pradesh, Meghalaya urban hills, and Imphal valley of Manipur indicate above-regional average household bathroom access, suggesting relatively better infrastructure and urban influence, while LQ < 1 districts (large parts of Assam, Tripura, interior Meghalaya, and remote Arunachal belts like Kurung Kumey and Anjaw) reveal facility deficit zones linked to rural isolation, tribal hill terrain, and weaker service delivery; the extreme contrast such as Papum Pare, Aizawl, and East Khasi Hills versus South Garo Hills and Dhalai, highlights a clear core–periphery development structure, where capital districts and administrative hubs act as sanitation cores while border and interior tribal districts

remain lagging, indicating a need for spatially targeted sanitation planning rather than uniform policy distribution.

LPG/PNG shows extreme spatial inequality, with very high concentration in urban and capital districts such as Papum Pare, Kamrup Metropolitan, Aizawl, Dimapur, Imphal West, and East District of Sikkim, while many interior tribal and hill districts of Nagaland, Meghalaya, Manipur, and parts of Assam record severe deficits, indicating limited LPG penetration.

For Kitchen LQ is relatively balanced and mostly around or above 1, especially across Arunachal Pradesh, Nagaland, Mizoram, and Manipur, suggesting that basic kitchen space exists even where clean fuel access is low, thereby highlighting a structural gap between physical housing infrastructure and access to modern energy sources, with urban centres functioning as energy cores and remote border districts remaining energy-deficit peripheries.

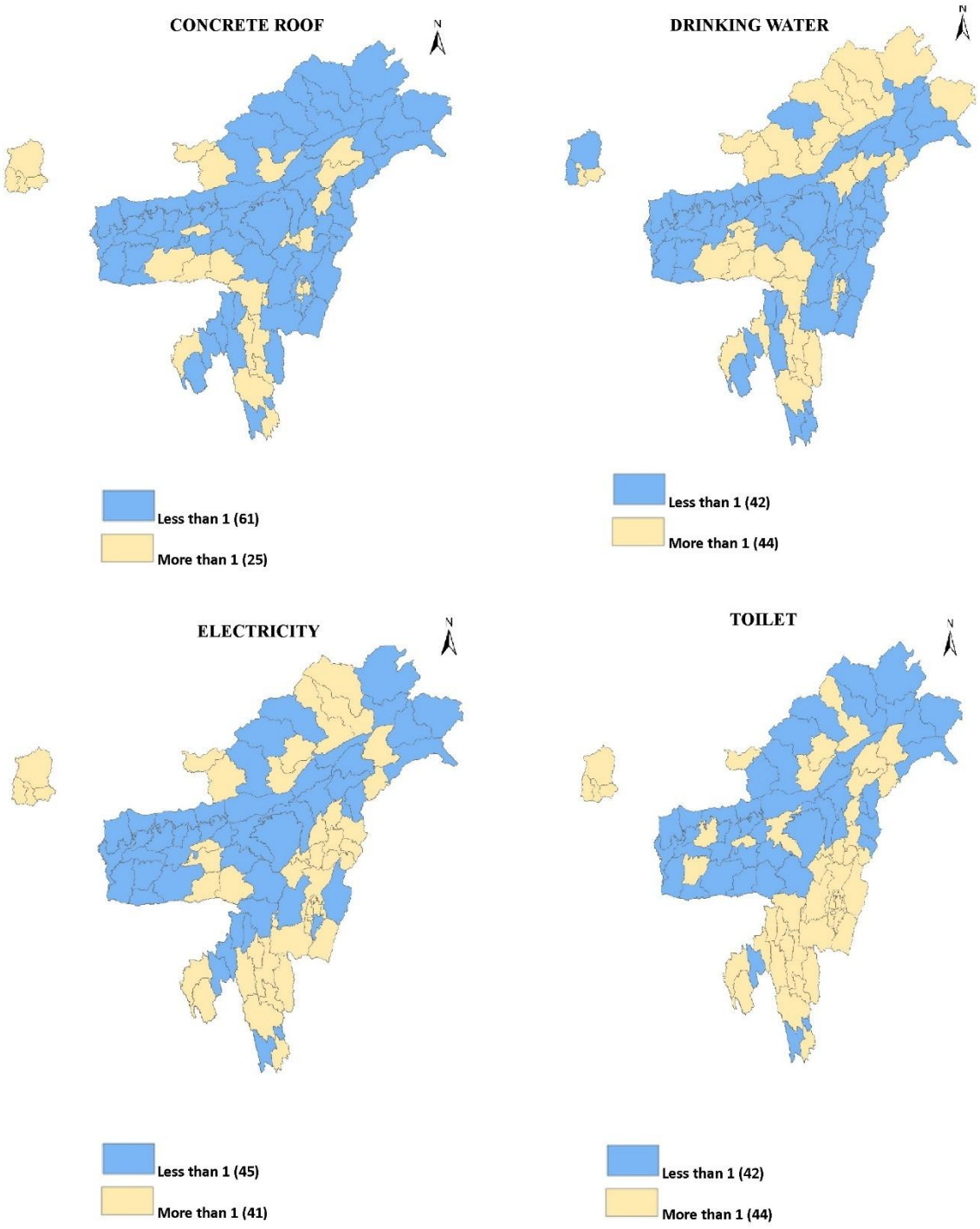

CONCRETE ROOF
N
Less than 1 (61)
More than 1 (25)
DRINKING WATER
N
Less than 1 (42)
More than 1 (44)
ELECTRICITY
N
Less than 1 (45)
More than 1 (41)
TOILET
N
Less than 1 (42)
More than 1 (44)

Figure 2 (a)

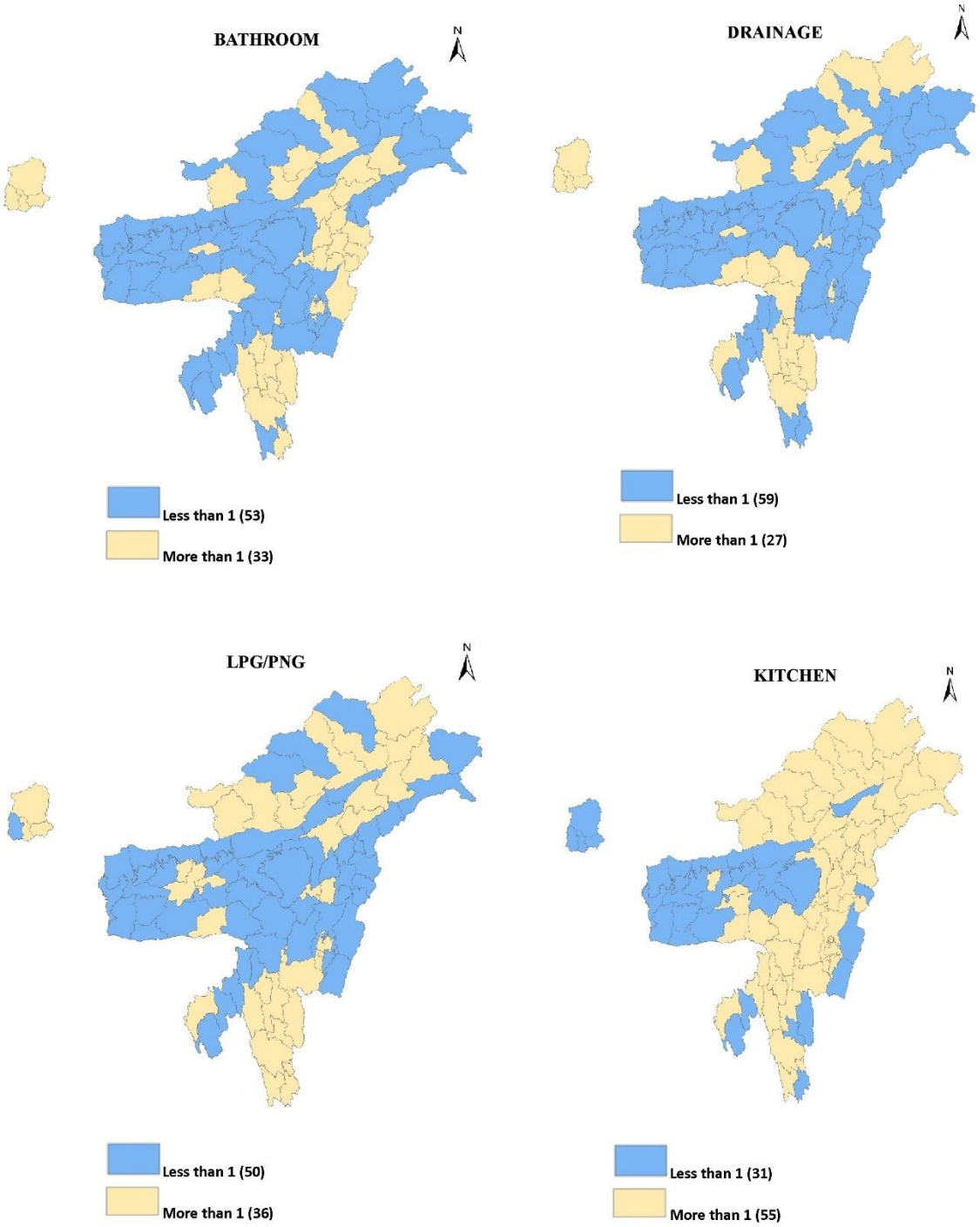


Figure 2 (b)

Figure 2 (a & b): Location Quotient (LQ) Showing the Relative Position of Different Districts of North East India in Access to Relative Household Amenities

3.4. District-wise Composite Index of Urban and Rural Household Amenities & Assessing Household Amenities Disparity Between Rural and Urban Areas in North-East India

The map (Figure 3) shows the spatial distribution of the Composite Index of Rural Household Amenities and Urban Household Amenities in the north-eastern part of India. It gives the substantial inter-district disparities in the availability of basic household amenities. The composite score ranges from 0.0 to 1.0. The spatial pattern of rural areas highlights that districts in the western parts of Assam, including Dhubri, Kokrajhar, Chirang, and Darrang, and for the urban areas, the northern and western plains, shown in lighter shades, reveal significantly lower composite scores, including the districts such as Dhubri, Goalpara, Chirang of Assam, Longleng of Nagaland, South Garo Hills of Meghalaya, which represent regions with poor access to Urban household amenities.

The southern and central parts of rural areas of north east India exhibit relatively higher composite scores, including the districts, such as East Sikkim, Aizawl, Serchhip, and Champhai in Mizoram, and Papum Pare in Arunachal Pradesh and the Urban districts in the central and southern hill regions of North East India exhibit the highest composite scores, which are represented in darker shades. Districts such as: Jaintia Hills of Meghalaya, East District of Sikkim, Aizawl of Mizoram, Tawang, West Siang, Lower Subansiri, Papum Pare of Arunachal Pradesh shows high standards of urban amenities, including well-developed bathing and sanitation systems, widespread use of electricity and LPG/PNG, and durable concrete housing structures.

The majority of the rural districts fall within the 0.2–0.4 composite score range, representing moderate access to amenities, including Kohima in Nagaland, Sivasagar in Assam, Bishnupur in Manipur, and West Tripura. A large number of urban districts fall into the 0.4–0.6 range, reflecting moderate urban development. These include Cachar and Dima Hasao in Assam, Churachandpur in Manipur, and Kohima, Dimapur, and Phek in Nagaland.

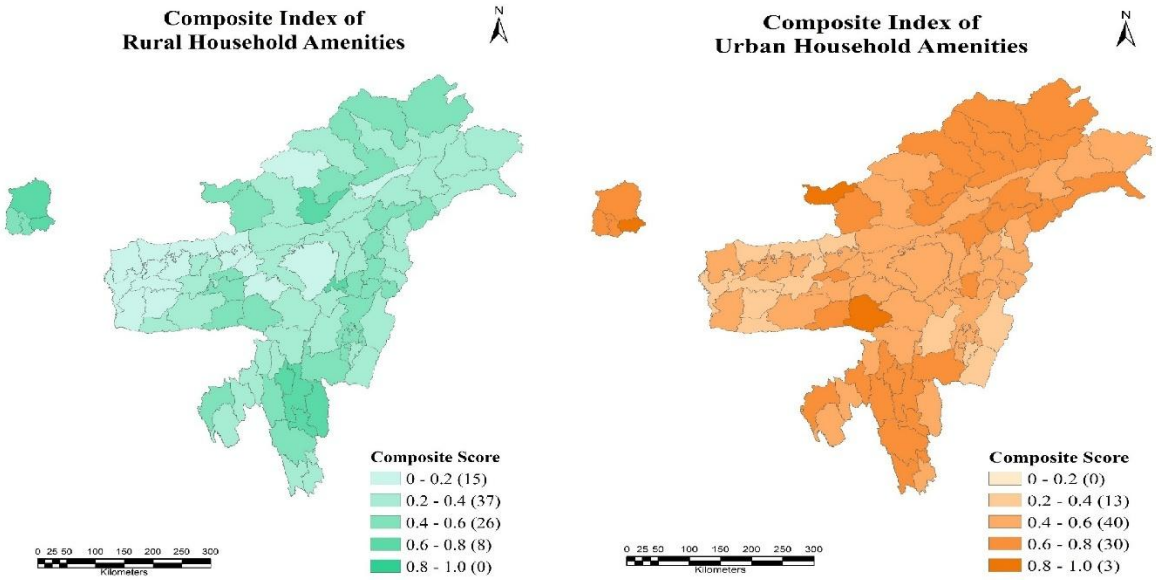


Figure 3 District Wise Composite Index of Urban and Rural Household Amenities

Figure 4 also illustrates the disparity in household amenities across districts of North East India, measured using a disparity index ranging from “Very Low” to “Very High.” Districts with very low disparity indicate nearly equal access to amenities between rural and urban households,

observed in 8 districts, such as Imphal West, Bishnupur, Thoubal, and Ukhrul of Manipur, Mon, and Dimapur of Nagaland, and Champhai, and Kolasib of Mizoram reflecting effective local policies or minimal urban-rural gaps.

Low disparity covers 43 districts, where urban households have slightly better access to amenities, consistent with gradual rural development, especially in the northern, central and southern part of North east India. Moderate disparity, observed in 30 districts, highlights noticeable urban-rural differences, likely due to uneven infrastructure and socio-economic variations. Only 4 districts show high disparity, indicating significant gaps such as Bongaigaon, Chirang, Kokrajhar, and Darrang, while Dhubri (0.878) represents extreme disparity, where rural households have very limited access compared to urban households**.**

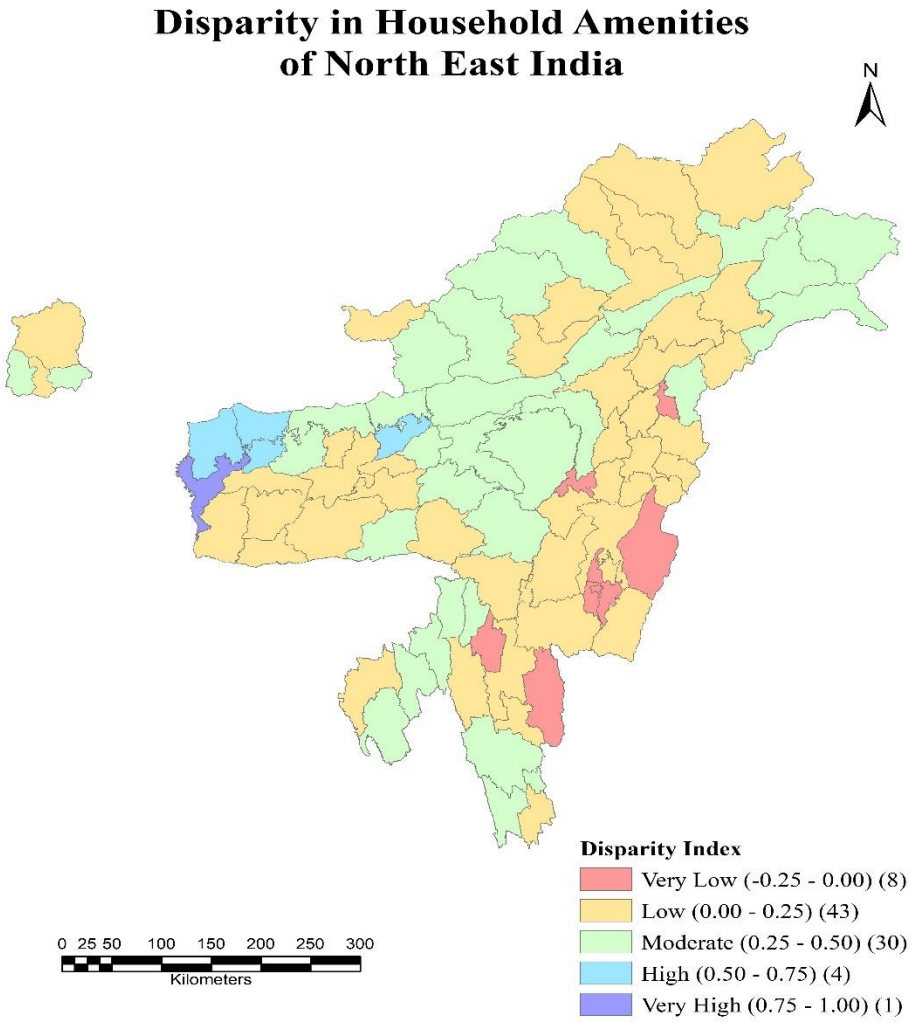


Figure 4 District Wise Disparity Index of Urban and Rural Household Amenities

3.5.Measures of Inequality at the District Level & Relationship between Household Amenities: A correlation analysis

From Table 3, the state-level Gini coefficients for North East India reveal substantial spatial disparities in the distribution of household amenities across rural and urban areas. Inequality in housing quality, as reflected by concrete roof, is relatively high, with a Gini value of 0.49 in rural areas and an even higher value of 0.63 in urban areas, resulting in a total Gini of 0.61.

This suggests substantial disparity in housing conditions, particularly within urban areas. High levels of inequality in housing quality (concrete roof) and access to clean cooking fuel (LPG/PNG) suggest that these facilities remain concentrated among relatively advantaged households, pointing to persistent socio-economic and infrastructural gaps.

Access to drinking water shows moderately high inequality across both rural and urban regions, with identical Gini values of 0.46, leading to an overall Gini of 0.47. This indicates that unequal access to water is a widespread issue affecting both settlement types, rather than being confined to rural areas alone.

In contrast, inequality in access to electricity and toilet facilities is comparatively low in rural areas, with Gini values of 0.06 and 0.03, respectively. However, the higher urban Gini values for these amenities (0.27 for electricity and 0.17 for toilet) point towards growing disparities within urban settlements. The relatively lower inequality in electricity aligns with evidence from national electrification programs, which Kumar (2015) found to be more uniformly distributed due to centralized policy delivery.–This reflects uneven access linked to socio-economic stratification rather than absolute lack. In contrast, the low levels of inequality observed in electricity and toilet facilities, particularly in rural areas, imply that public interventions in these sectors have been relatively successful in achieving wider and more equitable coverage.

The bathroom facility exhibits moderate inequality, particularly in urban areas where the Gini coefficient reaches 0.38, compared to 0.16 in rural areas. This highlights income-related disparities and differences in living standards, more pronounced in urban contexts.

Drainage facilities show a high level of inequality at the overall level (0.43), with rural and urban Gini values of 0.38 and 0.36, respectively. The near-similar values indicate that drainage-related disparities are prevalent across both rural and urban areas. Similarly, LPG/PNG records substantial inequality, especially in urban areas (0.46), compared to rural areas (0.24), resulting in a total Gini of 0.43. This reflects uneven access to transport-related assets and income differentials. However, the continued disparity in sanitation and drainage supports findings by Montgomery et al. (2003), who argued that water and sanitation improvements lag behind energy expansion because they require localized governance capacity and sustained maintenance.–Lastly, there is a lower disparity in access to the Kitchen facility in both rural (0.06) and urban (0.10) regions, indicating that this facility is distributed more evenly across the state.

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Table 3 Measures of Inequality at the District Level

Attributes	Rural Gini Index	Urban Gini Index	Total Gini Index
Concrete Roof	0.49	0.63	0.61
Drinking water	0.46	0.46	0.47
Electricity	0.06	0.27	0.23
Toilet	0.03	0.17	0.14
Bathroom	0.16	0.38	0.33
Drainage	0.38	0.36	0.43
LPG/PNG	0.24	0.46	0.43
Kitchen	0.06	0.10	0.10

Source: Computed by the author

Table 4 gives the correlation matrix of different household amenities. The table clearly shows that households with concrete roofs are positively associated with drinking water, electricity, toilet facilities, bathrooms, drainage, and LPG/PNG. Similarly, all other amenities, such as drinking water, electricity, toilets, bathrooms, drainage facilities, LPG/PNG, and kitchen facilities, are positively correlated with each other. Moreover, a positive relationship means that if one amenity is available in the household, there is a possibility that other amenities will also be available. The presence of a house with a concrete roof is not significantly related to the kitchen facility in the household.

Table 4 Correlations matrix of Household Amenities (Total), North East India (2011)

Variables	Concrete roof	Drinking water	Electricity	Toilet	Bathroom	Drainage	LPG/PNG	Kitchen
Concrete roof	1							
Drinking water	.564**	1						
Electricity	.569**	.553**	1					
Toilet	.408**	.320**	.610**	1				
Bathroom	.725**	.430**	.752**	.534**	1			
Drainage	.833**	.619**	.572**	.456**	.724**	1		
LPG/PNG	.727**	.638**	.553**	.490**	.670**	.797**	1	
Kitchen	.190	.329**	.416**	.249*	.342**	.274*	.297**	1

Source: Computed by the author

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

4. Discussion

Household living conditions in the states of North East India shows that the most vulnerable states, based on the overall pattern of limited access to multiple basic amenities, are Assam, Tripura, Arunachal Pradesh, and Manipur. These states show vulnerability because challenges are not confined to a single sector but extend across housing quality, water access, energy use, and sanitation-related infrastructure. The issues are interconnected; limited infrastructure development, economic constraints, and difficult terrain collectively restrict improvements in living conditions.

The vulnerability of Assam is well documented in literature, particularly due to recurrent flooding and riverbank erosion in the Brahmaputra valley. Studies highlight that the region is “prone to frequent and severe floods,” which damage infrastructure, livelihoods, and basic services, while erosion displaces populations and creates long-term developmental challenges (Gogoi, Das & Narah, 2025). Assam remains highly flood-susceptible, affecting socio-

economic conditions and service accessibility (Choudhury & Dutta, 2026). Assam is a geographically diverse area, with its population, natural boundary, ethnicity, and more, even its religion, and most of the ethnic group's customs, habits, and social behaviours are diverse, which drastically influence their socio-economic behaviour. Further, the area is drastically suffering from migration, where pressure the existing population (Das, 2017). For Tripura, research indicates that flood risks and infrastructure limitations remain key concerns, particularly in rural areas, where development projects struggle to achieve effective implementation and resilience (Hazari, Das & Kalita, 2025). The state's landlocked geography, surrounded by Bangladesh on three sides, limits its connectivity with the rest of India. Poor infrastructure, high transportation costs, and lack of large-scale industries remain major hurdles. Additionally, unemployment, poverty, and migration of educated youth to other states pose socio-economic challenges (Mandal, 2023). The vulnerability of Arunachal Pradesh and Manipur is supported by regional studies emphasize the predominance of mountainous terrain and dispersed populations across the North-East. Around 90-95% of the region is hilly, making infrastructure development, service delivery, and connectivity significantly more difficult and costly. This reinforces the idea that structural and regional inequalities affect basic amenities across states like Manipur and Arunachal Pradesh.

The interstate variation in household amenities across the states of Northeast India reflects significant disparities in infrastructure development and service delivery, shaped by a combination of geographical, socio-economic, and administrative factors. States such as Sikkim, Mizoram, and Meghalaya generally perform better across several indicators. In contrast, states like Manipur, Nagaland, and parts of Assam continue to lag in multiple dimensions, highlighting persistent developmental imbalances.

A key feature emerging from the data is the presence of sectoral disparities in amenity provision. While access to electricity and LPG/PNG is relatively higher in many states, other essential services such as sanitation, drainage, and kitchen facilities remain inadequately developed. This suggests that progress has been uneven across sectors, with certain amenities benefiting from targeted policy interventions and others receiving comparatively less attention. Such partial development limits overall improvements in living standards, as the absence of complementary facilities reduces the effectiveness of gains in individual sectors. Geographical conditions play a critical role in influencing these patterns. The region is characterized by hilly terrain, dispersed rural settlements, and limited connectivity, which pose substantial challenges to the expansion of infrastructure and public services.

States like Arunachal Pradesh and Nagaland, despite showing moderate progress in selected indicators, continue to face difficulties in extending water supply systems, sanitation infrastructure, and drainage networks to remote and inaccessible areas. These physical constraints increase the cost and complexity of development, contributing to slower progress in certain regions. In addition to geographical factors, socio-economic conditions and levels of urbanization significantly affect the availability of household amenities. States with higher urban concentration and better economic conditions tend to have improved access to infrastructure and services, whereas predominantly rural and economically weaker states tend

to have lower levels of amenity provision. This indicates that disparities are not only spatial but also closely linked to economic capacity and settlement patterns.

The spatial pattern of Location Quotient values strongly supports the core periphery structure of regional development. Urban centres and administrative hubs such as Aizawl, Imphal West, and Kamrup Metropolitan exhibit consistently high LQ values across multiple indicators, functioning as "cores" with better infrastructure, service delivery, and economic opportunities. In contrast, remote, hilly, and tribal dominated districts, particularly in Arunachal Pradesh, western Assam, and parts of Nagaland remain "peripheries," characterised by infrastructural deficits and limited accessibility. The variation across indicators also reveals sector-specific inequalities. For instance, while kitchen availability is relatively widespread, access to LPG/PNG and electricity remains highly uneven, indicating a disconnect between physical housing infrastructure and access to modern energy services. Similarly, sanitation and bathroom facilities show clustered development patterns, reflecting the influence of targeted government programmes but also uneven implementation across regions.

The spatial distribution of the Composite Index demonstrates considerable inter-district variation in access to basic household amenities across North-East India. The concentration of relatively lower composite scores in parts of Assam, particularly in the western districts, indicates that household infrastructure remains unevenly distributed across the region. The spatial pattern is also different between rural and urban areas, suggesting that geographical location and settlement characteristics influence access to basic household facilities. The concentration of higher composite scores in several districts of Sikkim, Mizoram and Arunachal Pradesh indicates comparatively better household infrastructure conditions in these areas.

The relatively low composite scores observed in several districts may be associated with the geographical and infrastructural challenges characteristics of the North-East. Remote settlements, difficult terrain, dispersed populations, limited connectivity and the high cost of extending infrastructure can constrain the provision of basic household services. In parts of Assam, environmental and geographical conditions may further complicate infrastructure provision. However, the present stud does not directly measure these factors; therefore, they should be understood as possible contextual explanations rather than direct determinants established by the analysis. The spatial pattern is particularly important from a health and wellbeing perspective. Household amenities constitute an important part of the physical environment in which people live and ca influence exposure to environment health risks. Access to treated drinking water, toilets, bathrooms and appropriate drainage contributes to improved hygiene and sanitation conditions, including durable roofing, can provide greater protection from adverse environmental conditions. Therefore, districts with low composite levels may represents areas where households are potentially more exposed to health-related environment vulnerabilities. Access to LPG/PNG is also relevant from a health perspective because cooking energy is closely associated with the quality of the household indoor environment. Greater dependence on cleaner cooking fuels can reduce exposure to smoke generated by traditional solid fuels. Consequently, the spatial disparities observed in LPG/PNG access may have implications for household environment health, particularly where other basic

amenities are also limited. Nevertheless, because the present study does not include information on indoor air pollution, respiratory illness or other health outcomes, the relationship should be interpreted as a potential health implication rather than a causal finding.

This uneven distribution of amenities underscores the need for targeted rural development programs and balanced infrastructural investment to reduce spatial inequality in basic amenities (Kumar & Singh, 2021). Studies on infrastructure inequality show that development tends to cluster in administratively strong and economically connected regions, while remote districts remain structurally disadvantaged (Sen, 1999; World Bank, 2009). Similar patterns have been reported in states such as Bihar, Odisha, and parts of Madhya Pradesh, where rural districts lag significantly behind urban centres in sanitation, housing quality, and energy access (Kundu, 2003).

The rural urban disparity results provide further evidence of uneven development within the region. Most districts fall within the low to moderate disparity categories, indicating that substantial differences between rural and urban household amenities are not universal across North east India. The presence of very low disparity in districts such as Imphal West, Bishnupur, Thoubal and Ukhrul in Manipur, Mon and Dimapur in Nagaland, and Champhai and Kolasib in Mizoram suggests relatively smaller rural urban differences in the distribution of household amenities. These patterns may reflect closer rural urban linkages, settlement structures and relatively similar access to selected household facilities. However, the present analysis cannot determine which specific factor is responsible for the lower disparity in these districts. The relatively low disparity between urban and rural areas in the Imphal Valley and some part of Mizoram and Nagaland is due to its compact geography, integrated rural-urban economy, widespread access to infrastructure and services, and productive agriculture, which together enable rural households to achieve living standards closer to urban populations (Devi & Devi, 2023; Dimapur Online, 2023).

In contrast, the high disparity observed in Bongaigaon, Chirang, Kokrajhar and Darrang, and particularly the very high disparity recorded in Dhubri, indicates substantial differences between rural and urban household infrastructure. Dhubri, with a disparity index of 0.878, represents the most pronounced rural urban gap in the study. Such disparities are important because differences in access to water, sanitation, drainage, housing and clean cooking energy can translate into differences in the quality of the household environment and consequently contribute to unequal health related living conditions. The educational achievement and work participation gap between males and females is very high in the district of Dhubri as compared to the other districts of Assam, because of various factors such as socio-cultural background of the communities, limited access to high quality education, school environment, lack of awareness, etc. (Mushahary & Basumatary, 2020). In addition to these, Dhubri faces challenges such as frequent flooding, inadequate infrastructure, and limited industrialization (Tiwari, 2024).

The relationship between the composite index and health should therefore be understood through the concept of social and environment determinants of health. Household infrastructure does not represent health itself; rather, it forms part of the material conditions that can support or constrain healthy living. A household with adequate water, sanitation, drainage, housing and

clean cooking energy is generally better positioned to maintain a healthier domestic environment than a household lacking several of these facilities. The findings also support the idea of cumulative disadvantage. When several amenities are simultaneously deficient, households may face multiple environment disadvantages. For example, inadequate drinking water combined with poor sanitation and drainage may increase exposure to environmental health risks, while poor housing and limited access to clean cooking fuel may add further vulnerabilities. Thus, spatial deprivation in household amenities may have implications beyond individual facilities and should be considered as a multidimensional issue.

The Gini coefficient findings reveal that the inequality cannot be overlooked, especially in rural areas. Although access to basic facilities is usually better in urban areas, the uneven distribution in rural areas contributes substantially to overall inequality. The relatively high inequality observed for concrete roofing, drinking water, drainage and LPG/PNG suggest that improvements in household infrastructure have not been distributed uniformly across the region. The particularly high urban inequality in concrete roofing, bathroom facilities and LPG/PNG indicate that urban areas, despite generally having better infrastructure than rural areas, may also contain substantial differences between better served and poorly served districts.

These spatial differences can be related to the distinctive geographical and infrastructural conditions of North East India. Difficult terrain, dispersed settlements, limited accessibility and high costs of infrastructure provision can create challenges for extending basic services across the region. At the same time, differences in household economic capacity may influence the ability to improve housing quality and adopt facilities such as concrete roofing and LPG/PNG. The results therefore indicate that regional averages alone may conceal substantial spatial inequalities.

Household amenities such as treated drinking water, toilet facilities, drainage and bathroom facilities are important components of a healthy residential environment. Inadequate water and sanitation can increase exposure to environmental contamination, while inadequate drainage can contribute to unhygienic surroundings and stagnant wastewater. Similarly, housing quality provides protection from environmental conditions, while access to LPG/PNG may reduce household exposure to smoke associated with traditional solid cooking fuels. Thus, districts experiencing deficiencies across several of these amenities may potentially face greater environment health vulnerabilities.

The correlation results provide further evidence that household amenities tend to form an interconnected system rather than functioning as isolated facilities. The strong association between concrete roofing and drainage, concrete roofing and LPG/PNG suggest that better performing districts in one dimension of household infrastructure often perform better in another dimension as well. This pattern is consistent with the broader understanding that household living conditions are multidimensional and that infrastructure improvements frequently occur together.

The relationship between water, sanitation, bathroom and drainage facilities is particularly relevant to household environmental health. These facilities jointly contribute to hygiene,

wastewater management and protection from environmental contamination. Therefore, the spatial co-occurrence of these amenities suggests that deprivation may also be cumulative: districts with relatively poor access to one facility may experience deficits in several complementary aspects of household's infrastructure. Such cumulative disadvantage can potentially limit the ability of households to maintain healthy living environments.

The strong positive association between LPG/PNG and several other amenities further indicates that access to cleaner cooking energy is associated with broader household amenities. Greater access to cleaner cooking fuel is potentially important because reduced dependence on traditional solid fuels can improve indoor environmental conditions. In a related study, Kumar and Singh (2021) examined the unified distribution of basic services across rural and urban India and reported significant associations between water supply infrastructure and sanitation facilities. Studies on the adoption of clean cooking fuels in India indicate that LPG availability is highly correlated with household socio-economic status and the quality of household infrastructure (Madubansi & Shackleton, 2007). The association between LPG/PNG and other household amenities identified in this analysis is positive and consistent with these results, indicating that contemporary access to energy is an indirect indicator of greater development. For instance, Tiwari (2024) found that basic household amenities in Nepalese villages exhibited strong positive interrelationships, indicating that improvements in one dimension often coincide with advancements in sanitation and energy services.

The relatively low inequality in electricity, toilet and kitchen facilities, particularly in rural areas, may indicate more widespread distribution of these amenities compared with other indicators. This pattern may partly reflect the reach of public infrastructure programmes and government interventions. However, the presence of relatively low inequality does not necessarily mean that all districts have achieved complete or adequate coverage. Equality in distribution and adequacy of provision are different concepts; a facility can have a low Gini coefficient while still having a relatively low overall level of access.

5. Conclusion

The present study highlights pronounced spatial and regional disparities in access to household-level basic amenities across the states of North East India. While certain states, such as Mizoram and Sikkim, demonstrate relatively better performance in multiple indicators, large sections of Assam, Meghalaya, and Arunachal Pradesh continue to experience infrastructural deficits. The composite index and Location Quotient analysis clearly reveal a core–periphery pattern of development, where capital districts and administratively stronger regions concentrate higher levels of amenities, whereas remote, rural, and border districts remain structurally disadvantaged. Although toilet coverage and electricity access show comparatively wider diffusion, significant inequalities persist in housing quality, drainage, bathroom facilities, and especially clean cooking fuel (LPG/PNG). Most districts in North East India exhibit low to moderate urban-rural disparities in household amenities, while districts like Dhubri and Bongaigaon require targeted interventions to reduce significant inequalities. The Gini coefficients further confirm that disparities are not only rural–urban but also intra-urban and

inter-district in nature. The strong positive correlations among amenities indicate that improvements in one dimension of infrastructure are closely associated with progress in others, reinforcing the need for integrated development planning. Overall, the findings underscore that balanced regional development in North East India requires spatially targeted, inclusive, and multi-sectoral policy interventions that address structural, geographic, and socio-economic constraints to ensure equitable access to basic household amenities. Policymakers should prioritise targeted investments in high-deficit rural districts, strengthen clean energy access, and promote integrated infrastructure planning that simultaneously addresses water, sanitation, housing, and energy. A combination of quantitative spatial analysis and field-based validation would further improve understanding and support more inclusive regional development strategies. The spatial inequalities identified in household amenities have implications for health supportive living conditions, particularly where deficiencies in drinking water, sanitation, drainage and clean cooking energy coexist. Improved access to these basic amenities may therefore contribute to healthier household environments and improved wellbeing.

6. Limitation

The study has some limitations that should be acknowledged. It relies on Census 2011 secondary data, which may not fully reflect recent improvements in household infrastructure following major government interventions, thereby capturing past rather than present disparities. Although the census is conducted every ten years, the 2021 round has not yet been released. Despite this, Census 2011 remains widely used due to its reliability and detailed coverage, and is still relevant for analysing long-term regional disparities in access to basic amenities. The analysis is restricted to a limited set of indicators and district-level aggregates, which may mask intra-district inequalities and overlook other important dimensions of household well-being.

7. Implication and Future research

The findings suggest that improving household living conditions in North-East India requires a comprehensive and coordinated approach rather than isolated interventions. Since amenities are closely interrelated, development efforts should focus on simultaneous improvement of multiple basic services, including water, sanitation, housing, and energy. There is also a need for area-specific planning, where strategies are adapted to local geographical conditions such as flood-prone areas and hilly terrains. Strengthening infrastructure in remote and rural regions should be prioritized to reduce accessibility barriers and improve service delivery.

The very high disparity observed in Dhubri, along with high disparity in Bongaigaon, Chirang, Kokrajhar and Darrang, indicates the need to strengthen rural household infrastructure in areas where rural populations lag substantially behind urban populations. Planning should focus on reducing rural urban gaps rather than concentrating investment only in urban centres. Improved access to treated drinking water, toilets, bathrooms and adequate drainage can contribute to better hygiene and sanitation conditions and may reduce environmental health risks.

Targeted attention should be given to highly vulnerable states and districts, particularly those with persistent deficits across multiple indicators. Enhancing rural infrastructure, improving connectivity, and ensuring better implementation of existing programmes can help reduce disparities. Further, development strategies should aim for balanced regional growth, ensuring that benefits are not concentrated only in urban centres but are extended to peripheral and rural areas. Finally, incorporating local socio-cultural contexts into planning can improve the adoption and effectiveness of certain amenities, especially in rural and tribal regions. Together, these measures can contribute to reducing inequality and improving overall living standards across the region.

Future studies can focus on micro-level analysis (village/household level) in states like Assam and Manipur to capture local disparities. Research can also examine the impact of amenities on health and quality of life, and analyse how socio-economic factors such as income, education, and gender influence access. There is scope for time-based studies to assess changes and policy effectiveness, along with urban–rural comparative analysis in regions like Imphal Valley. Additionally, GIS-based spatial analysis and qualitative studies on socio-cultural practices can help better understand persistent inequalities in household amenities.

Declarations

Funding: The authors received no specific funding for this study.

Ethics Approval: This study used publicly available, aggregated secondary data from the Census of India 2011. The study did not involve direct recruitment, interaction, or intervention with human participants. Therefore, ethical approval was not required for this study.

Clinical trial number: not applicable.

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Author Contributions

Lourembam Bipin Singh: Conceptualization, methodology, formal analysis, interpretation of results, writing—original draft, and visualization.

Dr. Biswajit Das: Supervision, methodological guidance, critical review of the manuscript, interpretation of findings, and final approval of the manuscript.

All authors read and approved the final manuscript.

Competing Interests

The authors declare that they have no competing financial or non-financial interests in relation to this work.

Data Availability

The data used in this study are publicly available from the Census of India 2011, Office of the Registrar General & Census Commissioner, India.

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The manuscript has not been published previously and is not currently under consideration for publication elsewhere.

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All authors have read and approved the manuscript and agree with its submission to *Discover Social Science and Health*. All authors accept responsibility for their respective contributions to the work.

Permission to Use Third-Party Material

All tables, figures, maps, and other materials presented in this manuscript were prepared by the authors based on the Census of India 2011 data. No previously published third-party figures or other copyrighted materials requiring permission have been used.

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