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IMPACTS OF CLIMATE CHANGE ON THE LIVELIHOOD PRACTICES OF FARMERS IN THE BILATE WATERSHED, ETHIOPIA

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Abstract

Climate change poses significant challenges to agriculture in Ethiopia, particularly for smallholder farmers in regions like the Bilate watershed. This study investigates the impact of climate change on farmers' livelihood practices, focusing on adaptive strategies such as crop diversification, livestock rearing, mixed farming, and agroforestry. There is a notable gap in understanding how climate variability influences daily agricultural practices and farmers' adaptive responses in the Bilate watershed. The study aims to address this gap by analyzing how farmers adapt to climate change and identifying the most effective adaptive strategies. Data were collected through a household survey, employing a two-stage sampling technique across six kebeles (administrative subdivisions). In the first stage, six kebeles were selected from a total of 37 in the district using a simple random sampling method. The selected kebeles were Achamo, Balessa, Bonosha, Kulito, Handazo, and Battu Degaga. In the second stage, within each of the selected kebeles, a systematic random sampling technique was used to select 351 households. A probit regression model was used to analyze the likelihood of adopting adaptive practices in response to climatic variables such as rainfall variability and temperature increases. The findings reveal that 65% of farmers diversified their crops, influenced significantly by rainfall variability ($p < 0.05$), while 35% adopted agroforestry. Livestock rearing was strongly associated with temperature increases ($p < 0.01$). Mixed farming was negatively impacted by heatwave intensity ($p < 0.05$), showing that extreme temperatures reduce the likelihood of its adoption. Agroforestry adoption was significantly driven by loss of soil fertility ($p < 0.01$), as farmers sought to improve soil quality. The study found that climatic factors such as heatwave intensity and seasonal rainfall fluctuations negatively impact crop diversification, with increasing temperatures and erratic rainfall discouraging farmers from diversifying their crops. The analysis revealed that heatwaves adversely affect livestock rearing, leading to higher mortality rates and reduced productivity. The study demonstrates that climate change is significantly altering agricultural practices in the Bilate watershed. The findings suggest that promoting agroforestry and mixed farming systems can enhance resilience among smallholder farmers. The study recommends targeted interventions to support these adaptive strategies, offering valuable insights for policymakers aiming to improve agricultural resilience in Ethiopia's climate-vulnerable regions.

***Keywords**: Climate Change; Livelihood Practice; Probit Regression, Bilate Watershed*

1. Introduction

Climate change, driven primarily by the anthropogenic emission of greenhouse gases (GHGs) such as carbon dioxide and methane, is causing significant alterations in global weather patterns (Zhang et al. 2017; Yoro and Daramola, 2020). These changes are evidenced by rising global temperatures, melting ice caps, and more frequent extreme weather events like hurricanes, floods, and droughts (Walsh et al., 2020). The impacts of these changes are widespread, affecting ecosystems, human health, and socio-economic structures worldwide (Tachiiri et al., 2021). The global agricultural sector, which is highly sensitive to weather conditions, faces increased challenges such as shifting growing seasons, reduced water availability, and heightened pest and disease pressures (Cai et al., 2015).

Africa is exceptionally vulnerable to the impacts of climate change due to its heavy dependence on rain-fed agriculture, low adaptive capacity, and high levels of poverty (Ziervogel and Ericksen). Climate projections for the continent indicate increased temperatures, more frequent and severe droughts, and unpredictable rainfall patterns, which pose serious threats to food security and water resources (Collier et al. 2008). Ethiopia's economy is largely agrarian, with agriculture accounting for approximately 35% of the GDP and employing around 80% of the population (Chipeta et al. 2015). The country is highly susceptible to climate change due to its reliance on rain-fed agriculture, which makes it vulnerable to variations in rainfall and temperature (Gangadhara Bhat and Moges, 2021). Ethiopia has already experienced increased temperatures and more erratic rainfall patterns, leading to recurrent droughts and floods that significantly impact agricultural productivity and food security (Conway and Schipper). These climatic challenges are compounded by other issues such as soil degradation, deforestation, and population pressure, which further threaten the livelihoods of millions of Ethiopians (Bryan et al., 2009).

Numerous studies have documented the impacts of climate change on agriculture and livelihoods in Ethiopia. Tessema and Simane (2021) examined the perceptions and adaptation strategies of farmers in the Nile Basin, finding that climate variability has already led to reduced agricultural productivity, affecting both crop yields and livestock production. Similarly, Hadgu et al. (2015) reported that erratic rainfall and temperature changes are major constraints to agricultural productivity in northern Ethiopia. Adimassu and Kessler (2016) explored the adaptation strategies of smallholder farmers in the Central Rift Valley, noting that farmers employ various adaptive measures such as changing planting dates, using drought-resistant crop varieties, and practicing soil and water conservation techniques. However, the effectiveness of these strategies is often limited by factors such as lack of access to information, credit, and improved technologies. Tadesse (2010) highlighted that traditional knowledge and community-based adaptation practices play a crucial role in enhancing the resilience of farming communities to climate change.

The Bilate watershed in the Ethiopian Rift Valley Basin faces significant challenges due to climate change, particularly in water availability and hydrological dynamics. Studies indicate

a notable increase in temperature and variability in precipitation patterns, leading to decreased water availability (Orke and Li, 2022). These climatic changes result in reduced river flows and groundwater levels, exacerbating water scarcity during dry seasons and impacting agricultural productivity, which is heavily reliant on rain-fed systems (Edamo et al., 2022). Additionally, altered hydrometeorological patterns contribute to more frequent and severe droughts, further stressing the watershed's resources and the communities dependent on them (Tekleab et al., 2015). Local perceptions highlight these changes, with farmers observing shifts in planting seasons and increased difficulty in sustaining crop yields, prompting adaptations such as diversified crop choices and improved water conservation practices (Getahun et al., 2020). Moreover, the combined effects of climate change and land-use changes significantly alter the hydrological responses of the watershed, leading to increased runoff and soil erosion, which further degrade the land's agricultural potential (Kuma et al., 2021).

Despite extensive research on the impacts of climate change in the Bilate watershed, there is a notable gap in studies specifically focused on the impacts of climate change on the livelihood practices of farmers. While existing literature highlights changes in water availability, hydrological dynamics, increased frequency of droughts, and local perceptions and adaptations, there is limited empirical evidence on how these climatic changes directly influence farmers' day-to-day agricultural practices, income-generating activities, and overall socio-economic resilience. Therefore, this study was intended to analyze the impacts of climate change on the livelihood practices of local farmers in the Bilate watershed.

2. Method

2.1. Study Area

The Bilate River Basin is located in Ethiopia, originating from the Gurage Mountains and draining into the Lake Abaya-Chamo watershed. It covers 5625 square kilometers and spans from the Ethiopian Highlands to the Rift Valley lowlands. The altitude ranges from 1,146 to 3,393 meters above sea level. Geographically, its location extends from 6º 36'N 38º00'E to 8º05'N 38 º12'E (Figure 1).

2.2. Demographic characteristics

The demographic characteristics of the respondents reveal that the majority were male (84.9%), with only 15.1% being female. In terms of age distribution, most respondents fell between the ages of 30-45 years (35.04%), followed by those aged 45-60 years (29.06%), while a smaller proportion were over 60 years (17.09%) or between 18-30 years (18.8%). The vast majority of respondents were married (89.46%), with a small number being widowed (6.55%), divorced (2.85%), or single (1.14%). Family size varied, with the largest group having 8-10 members (32.19%), followed by those with 5-8 members (27.35%) and more than 10 members (23.36%). In terms of educational background, 40.17% of respondents could read and write, 39.89% were illiterate, and 14.25% had

reached secondary-level education. Only 4.27% had completed primary education, and 1.42% were college or university graduates.

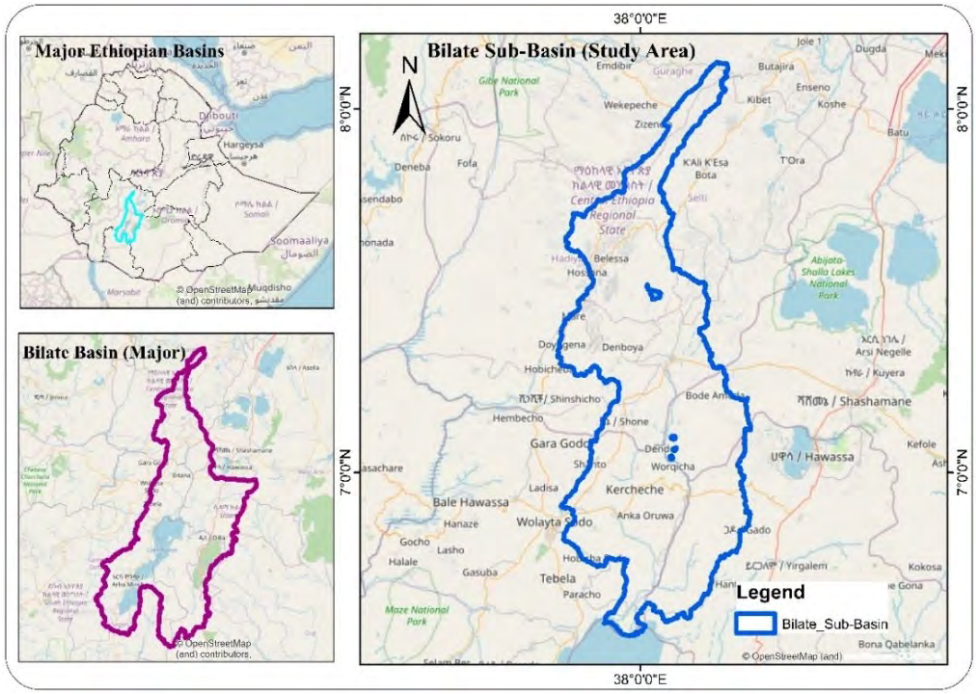

Figure 1: Location map of the study area

2.3. Research approach

In this study, a quantitative research approach was chosen to rigorously assess the impacts of climate change on the livelihood practices of farmers in the Bilate watershed, Ethiopia. This approach allows for objective measurement and statistical analysis of variables like crop diversification, livestock rearing, and adoption of agroforestry practices in response to climatic factors such as heatwaves, rainfall variability, and soil erosion rates. Through systematically quantifying these relationships, the study aims to provide robust insights into how climate change influences farmers' adaptive strategies and livelihood decisions in the Bilate watershed, contributing to evidence-based interventions and policy recommendations for enhancing agricultural resilience in similar contexts.

2.4. Data collection instruments

The research methodology employed a comprehensive and triangulated approach to gather data on climate change impacts and adaptation strategies among smallholder farmers in the Bilate watershed, Ethiopia. Utilizing a household questionnaire survey as the primary data collection tool ensured efficient gathering of information from a large and

dispersed population within a defined timeframe, leveraging both closed and open-ended questions to capture a wide range of insights.

Table 1: Demographic characteristics of the respondents

Variables	Categories	Frequency	Percent
Sex	Male	298	84.90
	Female	53	15.10
Age	<18	0	0.00
	18-30	66	18.80
	30-45	123	35.04
	45-60	102	29.06
	>60	60	17.09
Marital status	Single	4	1.14
	Married	314	89.46
	Widowed	23	6.55
	Divorced	10	2.85
Family size	3-5	60	17.09
	5-8	96	27.35
	8-10	113	32.19
	>10	82	23.36
Educational level	Read and write	141	40.17
	primary level	15	4.27
	Secondary level	50	14.25
	college/university graduate	5	1.42
	Illiterate	140	39.89

Source: Field survey, 2024

2.5. Sampling technique

In this study, a two-stage sampling technique was employed to ensure the selection of a representative sample. In the first stage, six kebeles (administrative subdivisions) were selected from a total of 37 in the district using a simple random sampling method. This was done to capture the district's diversity in terms of biophysical characteristics, agricultural practices, socio-economic statuses, and climate change adaptation strategies. The selected kebeles were Achamo, Balessa, Bonosha, Kulito, Handazo, and Battu Degaga. In the second stage, within each of the selected kebeles, a systematic random sampling technique was used to select households. This method ensured that every household had an equal chance of being selected, thereby reducing bias. The sample size for the households was determined using the statistical formula developed by Yemane (1967) to ensure adequate representation across the kebeles, accounting for variations in climate change impacts and adaptation practices among smallholder farmers. Additionally,

purposive sampling and snowball sampling were used to select knowledgeable key informants and participants for focus group discussions, adding depth to the qualitative aspects of the study by gathering rich insights into local climate impacts. In these processes, the statistical formula developed by Yemane (1967) was used to determine the sample size as follows:

$$n = \frac{N}{1 + N(e)} \quad \text{Equation (1)}$$

Where n is the sample size, N is the total number of households, and e is the error designating to be at a 0.05 significant level. According to the unpublished document obtained from BRB district administration, the total number of the households in the respective kebeles are Achamo (578), Balessa (407), Bonosha (524), Kulito (397), Handazo, (451), and Battu Degaga (519) making a total of 2876 households. Hence using Equation 2, the sample size was determined as follows:

$$n = \frac{2876}{1 + 2876(0.05)} \quad \text{Equation (2)}$$

$$n = 351 \quad \text{Equation (3)}$$

2.6. Method of data analysis

2.6.1. Econometric model

To analyze how climate change affects different farming practices, a probit regression model was used. This type of model helps us understand the likelihood of farmers adopting certain strategies like crop diversification, livestock rearing, mixed farming, or agroforestry when faced with changes in climate, such as temperature increases or rainfall variability. Essentially, the model estimates the probability of a farmer choosing a particular practice based on how these climate factors are affecting their environment. This approach allows us to see which climate changes are influencing specific farming decisions, providing insights into the best ways to support farmers in adapting to climate change (Habtemariam et al., 2016).

The dependent variables represent key livelihood practices of farmers within the Bilate watershed, impacted by climate change. These practices include:

Crop Diversification: These variables measure how farmers diversify their crop production as a response to climatic changes. It's treated as a binary variable, where diversification is coded as 1 and non-diversification as 0.

Livestock Rearing: This variable assesses the practice of raising livestock and how it's affected by climate factors like heatwaves and rainfall variability. It is also a binary variable, with 1 indicating engagement in livestock rearing and 0 otherwise.

Mixed Farming: This variable combines both crop cultivation and livestock rearing.

It evaluates how climatic conditions influence the integration of these practices. It's coded as 1 for mixed farming and 0 for single farming practices.

Agroforestry: This variable looks at the practice of integrating trees and shrubs into agricultural landscapes to enhance productivity and sustainability. It is treated as a binary variable, with 1 representing the adoption of agroforestry and 0 indicating non-adoption.

Table 2 summarizes the independent variables used in the study, detailing their descriptions and measurement scales. The variables include a range of climatic factors and their impacts on agricultural practices. For instance, the Intensity of Heatwaves (HV) and Seasonal Rainfall Fluctuation (RF) are measured on a continuous scale from 0 to 1, indicating the severity and variability of these events. Other variables like Heavy Amount of Annual Rainfall (HR) are measured in millimeters, while Loss of Pasture Land (LP) is quantified in hectares. Additionally, some variables are categorical, such as Livestock Health Issues and Drought Occurrences, which categorize the presence or severity of these conditions.

Table 2: Independent variables description for the impacts of climate change on the livelihood practices

Variable	Description	Measurement Scale
Intensity of Heatwaves (HV)	Measures the frequency and severity of heatwave events	Continuous (0 to 1 scale)
Seasonal Rainfall Fluctuation (RF)	Assesses variations in rainfall patterns over different seasons	Continuous (0 to 1 scale)
Heavy Amount of Annual Rainfall (HR)	Evaluates the total annual precipitation	Continuous (mm)
Crop Water Stress	Reflects the degree to which crops experience water deficiency	Continuous
Livestock Health Issues	Measures the prevalence of health problems in livestock	Categorical
Drought Occurrences	Tracks the frequency and severity of drought events	Categorical
Loss of Pasture Land (LP)	Assesses the reduction in available pasture land	Continuous (hectares)
Loss of Soil Fertility (LSF)	Evaluates the decline in soil quality and fertility	Continuous (0 to 1 scale)
Soil Erosion Rate (SE)	Measures the extent of soil erosion	Continuous (0 to 1 scale)
Farmers' Perceptions and Awareness of Climate Change	Assesses how farmers perceive and understand climate change	Categorical
Access to Climate Information	Evaluates access to information regarding climate patterns	Categorical

The Probit regression model employed in this study analyses the impacts of climate change on various livelihood practices. The model estimates the probability of adopting specific practices (such as crop diversification, livestock rearing, mixed farming, and agroforestry) in response to climatic variables. The general form of the Probit regression model can be expressed as:

$$P(Y_i = 1|X_i) = \Phi(X_i\beta) \quad \text{Equation (4)}$$

Where:

$P(Y_i = 1|X_i)$is the probability that the dependent variable (Yi) (representing the adoption of a specific livelihood practice) equals 1 given the independent variables (Xi). Φ is the cumulative distribution function of the standard normal distribution. (Xi) is a vector of independent variables. β is a vector of parameters to be estimated.

For each dependent variable (Yi), the Probit model estimates the probability of adoption based on the linear combination of the independent variables (Xi) weighted by the parameter vector β. The cumulative distribution function Φ then transforms this linear combination into a probability.

The specific Probit regression equation for each dependent variable (Yi) representing a particular livelihood practice can be written as:

$$P(Y_i = 1|X_i) = \Phi(X_i\beta) \quad \text{Equation (5)}$$

Where (Xi) includes the relevant independent variables for the particular livelihood practice being analyzed.

3. Results

3.1. Impacts of climate variability on crop diversification

The impact of various environmental factors on crop diversification in the Bilate watershed was explored using a probit regression model. While several coefficients suggested potential negative associations with crop diversification, most did not achieve statistical significance. Heatwaves showed a negative coefficient (-0.188), indicating a possible adverse effect on crop diversification, though it was not statistically significant ($p = 0.435$). Similarly, seasonal rainfall fluctuation, heavy annual rainfall, loss of soil fertility, loss of pasture land, crop yield reduction, and loss of livestock also exhibited coefficients suggesting negative impacts on crop diversification. Yet, none were statistically significant except for the loss of livestock (-1.962, $p < 0.05$). These findings align with existing literature emphasizing the complex relationship between climatic variables and agricultural practices in influencing crop diversity.

The practical implication of these findings is that while climate factors such as heatwaves and rainfall variability may exert pressure on farmers, livestock loss appears to

be a particularly critical issue. This suggests that interventions aimed at protecting livestock during climate extremes could have the additional benefit of enabling farmers to maintain or increase crop diversification, thereby improving their resilience to climate change. Supporting farmers with livestock insurance, veterinary services, or alternative income sources may help mitigate the negative impacts of livestock loss on crop diversification.

Probit Regression Results

	Livelihood Practices (Dependent variable):			
	Crop Diversification	Livestook rearing	Mixed Farming	Agroforestry
	(1)	(2)	(3)	(4)
Intensity of heatwaves	-0.188	-0.834*	-1.071**	-0.170
	(0.435)	(0.427)	(0.465)	(0.385)
Seasonal Rainfall flactuation	-0.116	-0.072	0.315	-0.140
	(0.482)	(0.534)	(0.706)	(0.425)
Heavy amount of annual rainfall	0.843	2.099***	-0.767	0.213
	(0.502)	(0.553)	(0.630)	(0.458)
High soil erosion rate	-0.187**	-0.018	-1.270**	-0.116
	(0.421)	(0.491)	(0.517)	(0.401)
Loss of soil fertility	-0.654	-0.761*	-0.905	1.499***
	(0.405)	(0.429)	(0.555)	(0.317)
Loss of pasture land	-0.481	1.966***	-0.534	0.677
	(0.532)	(0.468)	(0.624)	(0.450)
Crop yeild reducation	-0.114	-0.651	-3.013***	0.239
	(0.474)	(0.432)	(0.536)	(0.418)
Loss of Livestock	-1.962**	-0.024	0.035	-0.769*
	(0.544)	(0.537)	(0.586)	(0.432)
Constant	-0.322	-2.837**	1.886	-1.274
	(1.148)	(1.173)	(1.491)	(0.999)
Observations	351	351	351	351
Log Likelihood	-33.603	-34.385	-27.807	-64.293
Akaike Inf. Crit.	87.207	88.770	75.615	148.586

Note: *p<0.1; **p<0.05; ***p<0.01

Figure 2: Probit regression results

3.2. Impact on livestock rearing

The probit regression model was employed to assess the influence of various environmental factors on livestock rearing in the Bilate watershed. The analysis shows that heatwaves have a significant negative impact on livestock rearing (-0.834, $p < 0.1$), indicating that as heatwave intensity increases, the likelihood of farmers continuing to rear livestock declines. This suggests that heat stress directly threatens livestock health, water availability, and forage, all of which are essential for sustaining livestock production. In areas experiencing frequent heatwaves, farmers face higher livestock mortality rates or decreased productivity, leading to a reduction or abandonment of livestock rearing. In contrast, heavy annual rainfall had a significant positive effect on livestock rearing (2.099, $p < 0.01$), showing that more abundant rainfall improves water supply and pasture growth,

creating favorable conditions for livestock. This is crucial for pastoral and mixed farming communities that depend on consistent water sources and healthy grazing lands. The positive correlation indicates that areas with reliable rainfall maintain or expand livestock production. The model also found a significant positive association between loss of pasture land and livestock rearing (1.966, $p < 0.01$). This reflects a compensatory strategy, where farmers respond to pasture loss by intensifying their efforts to rear livestock, perhaps by investing more resources into feeding or managing their animals. Livestock remains a crucial economic asset, even in the face of environmental degradation, driving farmers to sustain production through alternative means. Factors like seasonal rainfall fluctuation, soil erosion, and loss of soil fertility showed non-significant negative effects on livestock rearing, indicating that these environmental changes reduce the availability and quality of pastureland, which diminishes livestock productivity over time. These findings highlight the need for targeted interventions to protect livestock from heat stress, such as improving access to water, shade, and veterinary care. Efforts to sustainably manage grazing lands and restore degraded pasture areas are essential to help farmers mitigate the adverse effects of climate change and maintain livestock as a vital part of their livelihoods.

3.3. Impact on mixed farming

The probit regression model analyzed the effects of environmental factors on mixed farming in the Bilate watershed, revealing several key challenges. Heatwave intensity had a significant negative impact on mixed farming (-1.071, $p < 0.05$), indicating that extreme heat reduces the likelihood of farmers engaging in both crop cultivation and livestock rearing, reflecting the difficulties of managing mixed farming systems under heat stress. Seasonal rainfall fluctuation showed a positive coefficient (0.315, $p = 0.706$), suggesting that diversified farming systems may help farmers cope with variable rainfall patterns, although this was not statistically significant. In contrast, heavy annual rainfall had a negative coefficient (-0.767, $p = 0.630$), indicating that excessive rainfall can disrupt mixed farming practices by causing flooding and waterlogging. High soil erosion rates demonstrated a significant negative association with mixed farming (-1.270, $p < 0.05$), highlighting that erosion degrades land quality and discourages mixed farming due to reduced productivity. Although loss of soil fertility (-0.905, $p = 0.555$) and loss of pasture land (-0.534, $p = 0.624$) were not statistically significant, their negative coefficients indicate challenges to the sustainability of mixed farming systems. Additionally, crop yield reduction had a significant negative effect (-3.013, $p < 0.01$), showing that lower crop yields reduce feed availability for livestock, directly impacting the viability of mixed farming. Conversely, loss of livestock showed a non-significant positive coefficient (0.035, $p = 0.586$), suggesting that farmers might adapt by integrating more crops into their systems to compensate for livestock losses. Overall, these findings underscore the need for interventions addressing land degradation, such as soil conservation and erosion control measures, as well as improvements in crop resilience and water resource management to support the viability of mixed farming systems in the face of climate change.

3.4. Impacts on agroforestry

In the Bilate watershed, the impact of environmental factors on agroforestry adoption was investigated using a probit regression model. The study found a non-significant negative association between the intensity of heat waves (-0.170, $p = 0.385$) and agroforestry, indicating potential challenges due to heat stress affecting tree growth and water availability. Similarly, seasonal rainfall fluctuation (-0.140, $p = 0.425$) showed a non-significant negative coefficient, suggesting difficulties in tree establishment amid variable rainfall. Conversely, heavy annual rainfall (0.213, $p = 0.458$) exhibited a non-significant positive coefficient, suggesting conducive conditions for agroforestry where adequate water supports tree productivity. A high soil erosion rate (-0.116, $p = 0.401$) presented a non-significant negative coefficient, implying potential challenges in maintaining soil stability critical for agroforestry. In contrast, loss of soil fertility (1.499, $p < 0.01$) showed a significant positive coefficient, indicating degraded soil conditions might incentivize agroforestry adoption for soil health improvement. Loss of pasture land (0.677, $p = 0.450$) displayed a non-significant positive coefficient, suggesting interest in agroforestry as an alternative land-use strategy. Crop yield reduction (0.239, $p = 0.418$) had a non-significant positive coefficient, indicating that regions with lower crop yields might consider agroforestry to enhance agricultural resilience. A significant negative association was found between loss of livestock (-0.769, $p < 0.1$) and agroforestry adoption, highlighting challenges due to reduced household resources and income. These findings underscore the intricate dynamics of environmental influences on agroforestry adoption, necessitating targeted interventions to promote sustainable agricultural practices in the Bilate watershed.

4. Discussion

In Ethiopia, various studies have shown that climate change significantly affects crop diversification. For example, Deressa et al. (2009) noted that climate variability, including increasing temperatures and changing rainfall patterns, adversely affects agricultural production. Specifically, the intensity of heat waves negatively impacts crop yields and thus the diversity of crops that farmers can grow. The findings from the Bilate watershed, where the coefficient for the intensity of heat waves on crop diversification aligns with this broader trend. Furthermore, Kassie (2018) highlighted that rainfall variability, particularly fluctuations in seasonal rainfall, leads to decreased agricultural productivity and crop diversification. This finding is consistent with the Bilate watershed results, where seasonal rainfall fluctuation shows a negative coefficient for crop diversification, though also not statistically significant. These studies collectively suggest that managing rainfall variability is crucial for maintaining crop diversity in Ethiopia's agricultural systems.

Livestock rearing in Ethiopia is highly susceptible to climate change impacts, particularly heatwaves and droughts. The significant negative association between the intensity of heatwaves and livestock rearing in the Bilate watershed study (-0.834, $p < 0.1$) reflects this vulnerability. Research by Yilma et al. (2009) confirms that heat stress significantly reduces livestock productivity by affecting feed and water availability, leading to

higher mortality rates. Similarly, Bogale and Erena (2022) documented that recurrent droughts and heat waves reduce livestock numbers and productivity, impacting farmers' income and food security. The loss of livestock itself is a critical issue in Ethiopia. The significant negative association found in the Bilate watershed mirrors findings by Aklilu et al. (2002), who noted that livestock losses due to climate-related events force farmers to abandon livestock rearing, further compromising their livelihoods.

The mixed farming systems in Ethiopia, which integrate crop and livestock farming, are particularly vulnerable to climate change. The significant negative impact of heat waves on mixed farming (-1.071, $p < 0.05$) observed in the Bilate watershed is echoed by studies such as those by Kassaye et al. (2021). They reported that climate stressors like heatwaves disrupt both crop and livestock productivity, making mixed farming less viable. The combined stresses on crops and livestock due to extreme weather events reduce the effectiveness of mixed farming as a livelihood strategy. Agroforestry practices in Ethiopia, while recognized for their potential to enhance resilience against climate change, also face challenges. The significant negative association between loss of livestock and agroforestry (-0.769, $p < 0.1$) in the Bilate watershed indicates that livestock losses undermine the capacity of farmers to engage in and benefit from agroforestry. This finding is supported by studies like that of Mbow et al. (2014), who found that livestock provide essential resources such as manure and draft power, which are critical for maintaining productive agroforestry systems. The loss of these resources due to climate-induced livestock mortality severely limits the ability of farmers to practice agroforestry effectively.

Farmers could enhance their resilience by adopting climate-resilient crop varieties that are better suited to withstand extreme temperatures and fluctuating rainfall patterns. Additionally, implementing rainwater harvesting and irrigation systems could help mitigate the effects of rainfall variability, ensuring more consistent water availability for crops. Training programs focused on sustainable agricultural practices could also empower farmers to diversify their planting schedules and choose crops that thrive under variable climatic conditions. To address livestock rearing vulnerabilities, farmers can implement shaded areas for livestock to reduce heat stress and improve water management practices to ensure that livestock have access to adequate hydration. Additionally, creating supplementary feeding programs during drought periods can help sustain livestock health and productivity. The establishment of community-based animal health programs can also enhance the capacity of farmers to manage livestock effectively, particularly during extreme weather events. Policymakers should consider promoting agroforestry and mixed farming as part of broader climate adaptation strategies, encouraging practices that enhance ecosystem services. Initiatives that support livestock health and productivity are essential to maintain the complementary relationship between crop and livestock farming, thereby strengthening overall resilience to climate change.

While this study provides valuable insights into the impacts of climate change on agricultural practices in the Bilate watershed, it has limitations. The analysis focused on specific environmental factors and may not encompass all variables affecting farming

systems, such as socio-economic factors or local governance structures. Future research could explore the interplay between these factors and climate adaptation strategies to provide a more comprehensive understanding of how farmers can effectively respond to climate challenges. Longitudinal studies assessing the long-term effects of climate change on agriculture in various regions of Ethiopia could yield important data for developing adaptive strategies. Additionally, research that evaluates the effectiveness of implemented adaptation practices will help refine approaches that enhance resilience in Ethiopian agriculture.

5. Conclusion

The study found that climatic factors such as the intensity of heatwaves and seasonal rainfall fluctuations negatively impact crop diversification, although these impacts were not statistically significant. This suggests that increased temperatures and unpredictable rainfall patterns discourage farmers from diversifying their crops, which can threaten food security and income stability. The significant negative impact of heatwaves on livestock rearing highlights the vulnerability of livestock to rising temperatures, leading to higher mortality rates and reduced productivity. The findings indicate that extreme heat disrupts the balance required for successful mixed farming practices, adversely affecting both crop yields and livestock health. Moreover, agroforestry practices are also influenced by climate change, particularly through the loss of livestock, which diminishes critical resources such as manure and draft power essential for maintaining agroforestry systems. The results from the Bilate watershed align with broader research findings across Ethiopia, confirming that climate change poses substantial threats to agricultural livelihoods. These insights underscore the urgent need for comprehensive climate adaptation strategies. Policymakers should focus on developing and promoting climate-resilient agricultural practices that enhance crop diversification and improve livestock management. Specific interventions could include investing in research and development of heat-resistant crop varieties, implementing community-based training programs for farmers on sustainable practices, and providing financial support for irrigation systems to cope with rainfall variability. Furthermore, agricultural extension services must prioritize education on effective livestock management during extreme weather events, including the provision of shaded areas and supplementary feeding programs to mitigate heat stress. Farmers are encouraged to diversify their income sources, integrate agroforestry practices, and adopt water conservation techniques to enhance resilience. Future research should explore the long-term effects of climate change on agricultural practices in different regions of Ethiopia, considering socio-economic factors and local governance structures. By understanding these dynamics, stakeholders can refine their approaches to building resilience against climate change, ensuring sustainable agricultural systems that support the livelihoods of smallholder farmers.

Declarations

Conflict of interest: There is no potential conflict of interest by the authors.

Data availability statement: The required data could be available from the corresponding author if there is a request.

Ethics Statement

The study complies with all regulations and confirms that informed consent was obtained from the participants in collecting data.

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RELEVANCE OF THE CHICAGO CLASSICAL MODELS IN URBAN MORPHOLOGY OF THE GURUGRAM-MANESAR URBAN COMPLEX, INDIA

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Abstract

The urbanisation rate in Gurugram has dramatically increased over the decades. The expansion of Gurugram fits well with the Chicago School's traditional urban models. Gurugram's urban morphology has been transformed significantly, which can be observed in various phases. This study incorporates data from several sources to map the morphological changes of the city. The study is based on a descriptive and evidence-based investigation of the urban morphological transformation in Gurugram within the general theoretical framework of the classical models of the Chicago School. In Gurugram, the concentric nature of urban expansion stayed intact until 2000, and thereafter, these concentric belts started to deform. Since then, the expansion of Gurugram began to be observed in sectors, within which some patches started emerging as new urban centers. This study intends to predict the morphological patterns of the city based on the classical urban models and current urban processes.

Keywords: Urban Morphology, Chicago School, Gurugram

1. Introduction

Urban morphology refers to 'urban form'; it explains how cities physically evolve over time, and how the various elements of the urban fabric come to exist, interact, and transform. It is noted that urban morphology is multidisciplinary and multi-scalar. Geography, history, architecture, urban studies, economics, and other disciplines contribute theoretically and empirically to understanding urban forms. Urban morphology is instrumental in addressing perpetually relevant issues such as growth, planning, urbanisation, and related issues (Chiaradia, 2019).

The Chicago School of Sociology has contributed significantly to understanding urban morphology. In their attempt to understand urban spaces and the spatiality of social processes, the Chicago School has put forth widely acknowledged and studied models of city shapes and city spaces (Knox & Pinch, 2010). Any research undertaken in the field of urban morphology has found invariable references to the Chicago School models. However, owing to their American bias, deterministic perspective, and congruence with

laws of the natural sciences, these models have also received significant criticism through the behavioral, welfare, and post-modern paradigms in social sciences.

Nevertheless, during the recent decades, increasing relevance has been identified with cities of developing economies like Beijing, where significant road networks, ring roads, and radial outers form a complex network and is thus a good example of the concentric zone theory by Ernst Burgess (1925) (Tian *et al.,* 2010). Mapping land use through remote sensing and GIS, China's Xinjiang City exhibits how the expansion through time can be delineated into concentric zones (Seifolddini & Mansourian, 2014). The Nigerian city of Ibadan can be separated into Old Ibadan and New Ibadan through various eras. In the early 20th century, New Ibadan City grew in concentric semicircular zones, with commercial areas to the north, west, and east (Splansky, 1966). The city of Benin in Nigeria's urban expansion does not adhere to any Chicago classical theory. However, it simultaneously exhibits the characteristics of concentric zone theory, sector model, and multi-nuclei (Odjugo et al. 172).

The zones of land use that Burgess had created are evident in Bangalore City, an Indian metropolis, which has grown spatially in a concentric manner. This city's transport infrastructure also follows a radial plan (Sen, 2013). Based on functional land use and morphogenetic type of plans, five separate geographical zones were identified: Inner, Inner fringe belt, Intermediate, Outer, and Suburban Zone in Ahmedabad (Jha *et al.,* 2019).

In this study, an attempt has therefore been made to re-acknowledge the relevance of these almost century-old models owing to their resemblances to urban expansions in developing economies like India. Gurugram, a post-global Indian city, has experienced fairly steady development, and there has been a noticeable rise in factors and phenomena that sum up to what is broadly identified as 'urbanisation'. Its physical growth may be separated into two primary components: Old Gurugram and New Gurugram, both of which have developed rather quickly. The Gurugram-Manesar Urban Complex has come to exist due to the expansion and emergence of New Gurugram and its consequent intrusion into Manesar. This brand-new, growing metropolis is built on the outcomes of liberalisation, globalisation, industrialisation, and the emergence of the corporate sector. Although the city is newly developing within a developing nation, its developmental pace and resultant first-world-looking spaces are comparable to Western cities, and this is possibly an important reason for its physical formations and transformations being effectively explained by models of the Chicago School. Thus, the primary objective of the study is to understand the developing morphology of the Gurugram-Manesar Urban Complex and explain the same using the classical models of the Chicago School.

2. Theoretical Framework: The Chicago School

Rapid population growth, immigration, and industrialisation in the first decades of the 20th century significantly impacted the structure and operation of American cities. The term 'Chicago School' describes a particular group of sociologists who worked at the University of Chicago in the early 20th century. The main idea of the Chicago School was to

study urban and social phenomena using the human ecological approach based on naturalistic observations (Sibley, 1990). The eminent scholars (Figure 1) from the school built a strong foundation for urban research. Two distinct eras can be distinguished within the Chicago School. Early Chicago school refers to the years between 1894 and 1940, whilst Post-World War II Chicago school is the years between 1945 and 1960 (Hart, 2010) (Figure 2).

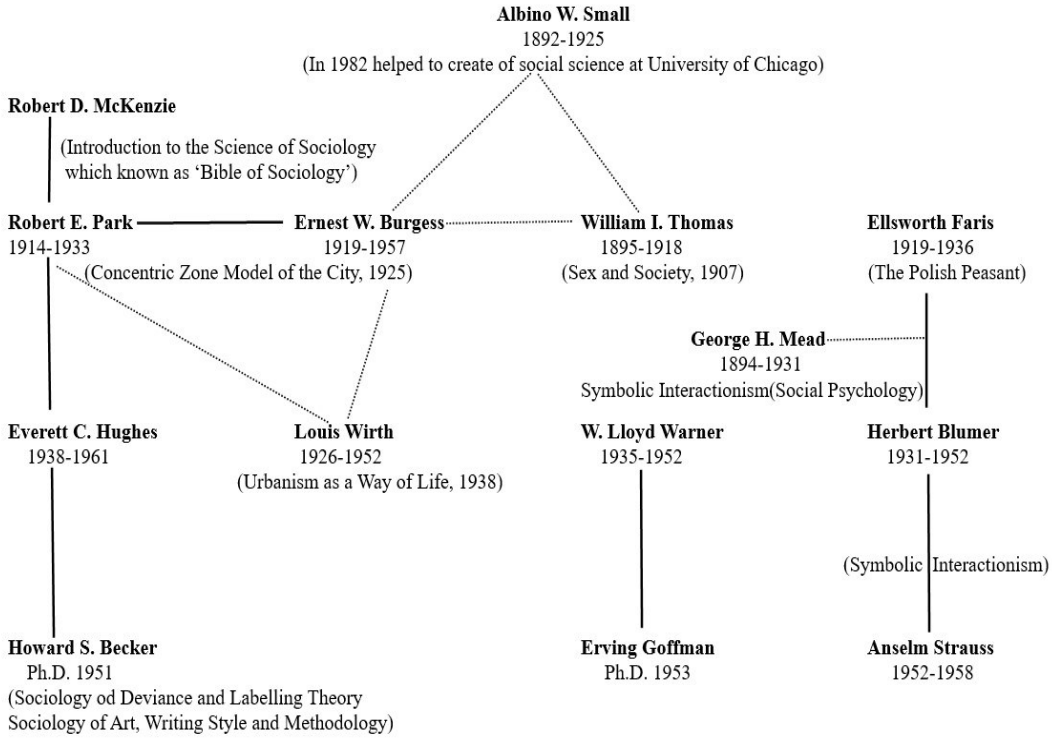

Figure 1: The relationships between the important researchers from the Chicago School are depicted in the diagram. A straight line denotes relationships between advisors and students, whereas a dotted line denotes additional potent connections (Wayne & Ackerman, 1996)

The Chicago School's academics were the first to present an urban growth model and to divide the city into various zones according to a few predetermined criteria. After conducting a thorough analysis of the city of Chicago, Ernest Burgess proposed the Concentric Zone Model in 1925. The city's Central Business District (CBD), Zone of Transition, Zone of Independent Workers Homes, Zone of Better Residences, and Commuter's Zone are the five distinct zones identified by the model. Hoyt (1939) developed the Sector Theory after researching 142 American cities. Six zones of a city were defined under the Multiple Nuclei Theory proposed by Harris & Ullman (1945). In 1964, Vance proposed the Urban Realm paradigm and expanded the Multiple Nuclei paradigm. He

suggested four domains: the CBD, the New Downtown, the Commercial Centers, and the Suburban Downtown. A model provided by Mann (1965) identifies four distinct zones in a city. According to White (1987), modification of the Burgess Model, urban centers can be classified into the core, zone of stagnation, pockets of poverty and minorities, elite enclaves, the diffused middle class, industrial anchors, epicenters, and corridors.

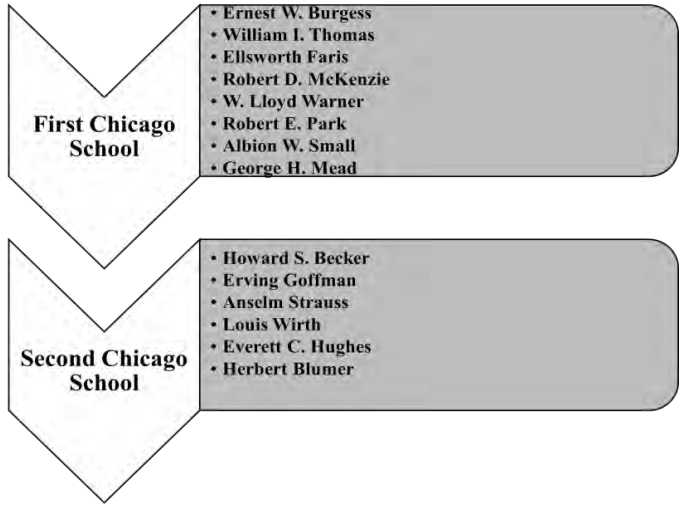

Figure 2: List of Scholars in the First and Second Schools of Chicago (Lutters & Ackerman, 1996)

The Chicago study gained significant depth and richness from its anthropological proximity. Later on, the school's most outstanding liability was its over-dependence on qualitative techniques at the expense of sound quantitative metrics (Lutters & Ackerman, 1996). The Chicago School's impact years lasted from the beginning of the twentieth century to the late 1950s, with its peak years occurring between the First World War and the conclusion of the Great Depression, both of which saw significant growth and change. The increasing population transfer from the rural, homogeneous, agrarian community to the large, heterogeneous, industrial city was one notable trend during this time. At this time, Chicago became an 'instant' city, one of many American cities undergoing rapid growth.

3. Database and Methods

The Chicago Classical Models have been used to analyze the changes in morphology, as these models are reflected in morphological changes observed within the Gurugram-Manesar Urban Complex (GMUC). The study included both descriptive and evidence-based analysis. Using descriptive analysis, this study, based on the socioeconomic conditions of the cities, which were observed in the Chicago School models, as well as the commonalities among the numerous studies of GMUC, has been analyzed (Elets, 2019). The Central Business District (CBD) of Gurugram has been determined

based on the similarity of characteristics found in a CBD with published research papers (Murphy & Vance, 1954). Google Earth imagery has been used in this research paper to understand the process of morphological changes through urban built-up areas in the GMUC. The morphological changes have been analysed from 1985 to 2000 and from 2000 to 2021, when the National Capital Region (NCR) planning was declared.

4. Results and Discussion

4.1 Changing urban morphology of Gurugram

A city's good and seamless development is determined by its organic and orderly spatial expansions. However, some Indian cities have developed quickly in response to the globalisation policies, causing them to reach their peak at unexpected times. This is best illustrated by Gurugram, whose development peaked as a result of the National Capital Region Policy and rising foreign investment. Thus, the urban morphology of Gurugram has undergone a fast but orderly transformation.

4.2 Phase-1 (1985-2000): Concentric Zones

In his theory, Burgess believed that five zones make up any urban ecology; thus, he developed the concentric zone plan, which was undoubtedly not intended to be exclusive to Chicago (Figure 3). Concentric rings of growth became visible in Gurugram City between the years 1980 and 2000. Delhi Lease and Finance (DLF) and Ansal Properties began purchasing land in Gurugram at this time and began constructing large-scale private enclaves. DLF began acquiring property for commercial use in addition to residential areas, providing incentives for the city to grow outwardly. These observations are similar to the quick expansion of Chicago's industries and retail sectors in the early 20th century (William, 1992).

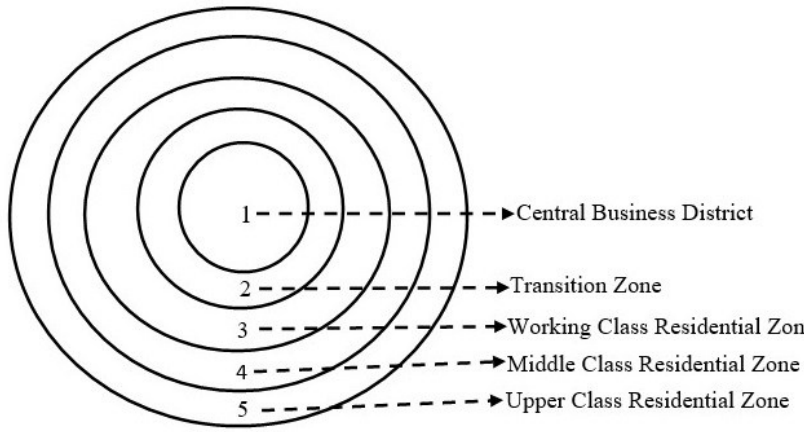

Figure 3: Concentric Rings are given by Park & Burgess (1925)

During the initial phase, Gurugram city was transformed into a suburb of Delhi, with manufacturing and residential areas (Bedi & Mahavir, 2022). The city's growth was moderate during this time. Businesses significantly influenced the growth of Gurugram in the auto parts, telecommunications, and clothing industries. Honda and Hero Motors established a motorbike manufacturing facility here in 1980. Maruti-Suzuki Automobile Plant, an Indo-Japanese joint venture, was also founded in Gurugram in 1982, along with its subsidiary factories. General Electric also began working with Indian businesses in 1989. During this phase, India started pursuing a liberalisation strategy in 1991, in which private businesses were attracted by liberalisation.

In 1985, Gurugram expanded around Sadar Bazar. During the period, it served as the primary trading hub, resulting in the concretisation of concentric zonation. Until 2000, Gurugram only experienced concentric growth, which is illustrated in Figure 4. The construction of Palam Vihar was just starting at the time, whereas the DLF Phase had grown to a vast area. Sikandarpur, the urban transmission was being done at the time. As seen in the concentric zone model, till 1985-2000, Sadar Bazar was a single urban market in Gurugram with further urban expansion around it. This is similar to the post-World War I immigration from non-European regions to Chicago (Holli & Jones, 1995). The city was also in its early stages of growth at the time. Consequently, new luxurious high-rise apartments were built, attracting some of the wealthiest residents. Simultaneously, Chicago was experiencing a high level of crime and violence at this time, and there was an increasing number of domestic homicides. Additionally, some family homicides and murders of immigrants were observed at a higher level (Adler, 2003), causing significant segregation within the city. Observing these characteristics, sociologist Burgess developed his theory of concentric zonation by analyzing Chicago's social urban structure and the circumstances present at that time.

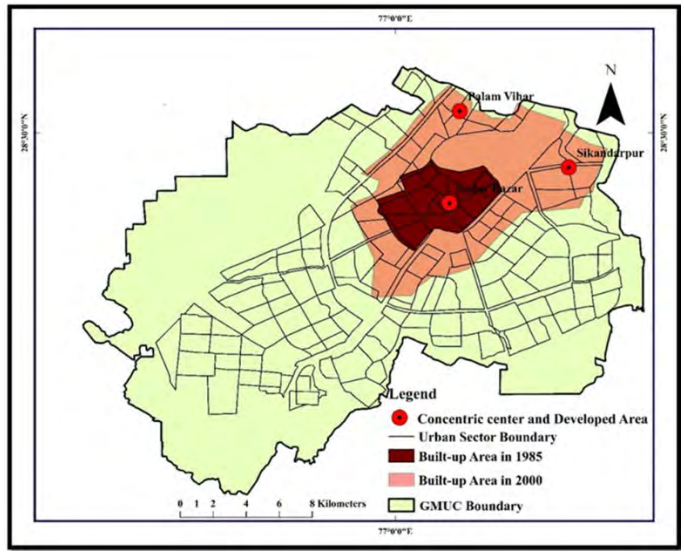

Figure 4: Concentric Expansion of Gurugram City (1985-2000)

4.3 Phase-2 (2000 to present): Sectors

In Gurugram, the concentric nature of urban expansion stayed intact until 2000, and thereafter, these concentric belts started to deform. Since then, the expansion of Gurugram began to be observed in sectors, within which some patches started emerging as new urban centers, similar to Homer Hoyt's (1939) sector model (Figure 5).

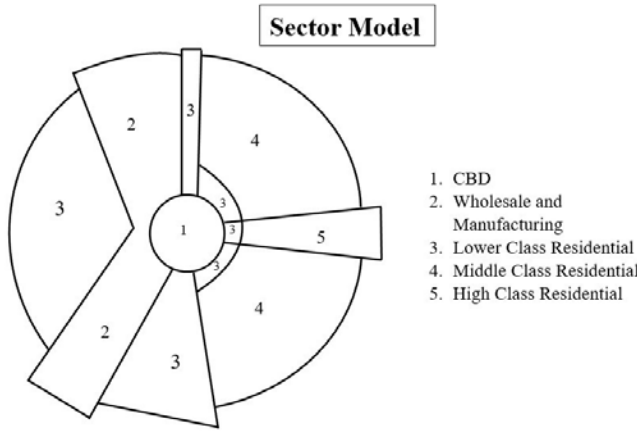

Figure 5: Graphical Representation of Sector Model by Hoyt (1939)

Chicago experienced rapid growth during the 20th century. In 1925, 700,000 inhabitants were added, with roughly 5,000 apartment structures and 9,400 single-family homes constructed (Beauregard, 2016). Hoyt endured significant losses due to the 1929 stock market crash in Chicago, which was a significant economic event at that time. Hoyt examined a connection between business cycles and real estate. At that time, Burgess's concentric ring model of Chicago was highly accepted, but because of the city's then-current development and strategic location for investors, a form of land that would provide greater profit and lower risk to investors, developers, banks, and real estate firms was desired. As these processes expanded and became more prominent, Hoyt created a method for it. This gave birth to the sector model in urban morphology.

Similarly, General Electronics established call centers in Gurugram in 1997. Business process outsourcing firms were founded, including American Express, EXL, IBM, Microsoft, Ericsson, and others (Elets, 2019). Multi-national businesses like Siemens, Coca-Cola, Pepsi, Hyundai, and Honda were established. National Highways have significantly influenced the construction of new nuclei in Gurugram, and as a result, urban expansions have happened towards the south and southwest. The National Highway 48 (NH 48) runs from Delhi to Gurugram in the southwest and has been built as an Expressway up to Kherki Daula. When NH 48 was built, Manesar (a satellite town of

Gurugram till then) ceased to exist as a separate town and amalgamated with Gurugram, becoming the Gurugram-Manesar Urban Complex. IMT (Industrial Model Township) Manesar emerged as an alternate nucleus in Gurugram's urban expansion. Eastern Gurugram experienced urban sprawl when South City and DLF were built (Yadav and Sengupta, 2021). To the southeast of here, Wazirabad and adjacent villages have undergone urbanisation. Gurugram has grown from Kherki Daula through Panchgaon to IMT Manesar in the southwest.

Gurugram's growth has been further accelerated by the construction of the Delhi Metro and its proximity to the Indira Gandhi International Airport. This way, industrial and infrastructural development became key reasons for developing sectors (Figure 6).

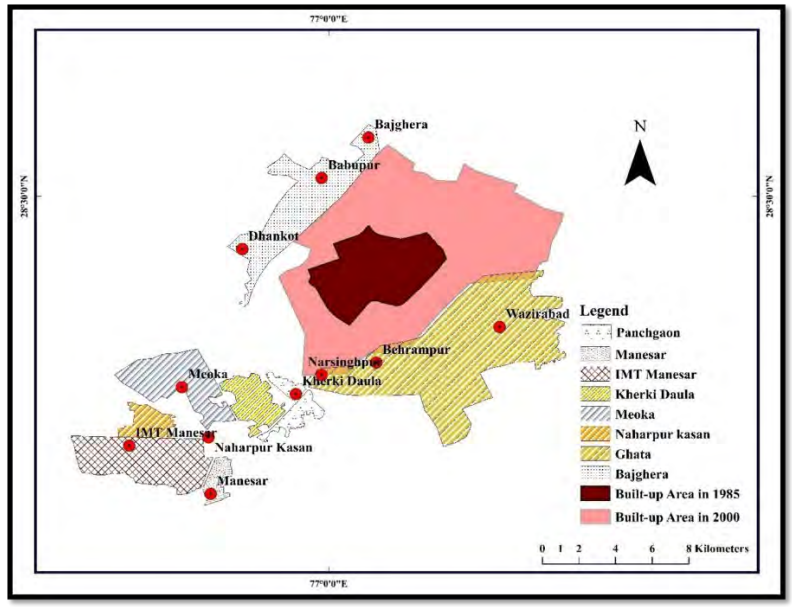

Figure 6: Urban Expansion of Gurugram-Manesar Urban Complex, 2000-2021

According to Hoyt (1939), as a city grows, its urban area begins to expand, and activities that once took place within the city now extend outside of it. In Gurugram, industries were established along important railroads and roadsides in the South, Southwest, and Northwest. With the adoption of the National Capital Region Policy, liberalization, and globalisation, extensive agricultural land was acquired in and around Gurugram, which eventually led to the expansion of core-like activities and lifestyle, developing sectors rather than zones, for reasons as explained by Hoyt for Chicago.

4.4 Present scenario of Gurugram city's development

Unlike Burgess and Hoyt's models, horizontal expansion did not continue organically and singularly in Gurugram because of its location in the Aravalli foothills. In

addition, privatised real estate markets, extremely uneven geographical development, farmer protests, and so on, make vertical expansion a simultaneous process in the city.

Gurugram's morphological structure shows horizontal expansion along National Highway 48, which is simultaneously vertical (Figure 7). Vertical cities are common and desired in the twenty-first century. It is thought to be the finest method for creating master plans for the growth of new cities and skyscrapers (Novikov & Gimazutdinova, 2021). Liberal economic policies and globalisation have significantly influenced the swift development of Gurugram and its changing urban morphology in the last few decades. In recent years, Gurugram has been developed under a predefined plan in which the development policies of the National Capital Region (NCR), along with Udyog Vihar and IMT Manesar, developed by HSIIDC, have given a new shape to the development of the city. The Master Plan-2031 for the city is also prepared by the state government, considering the city's prospects.

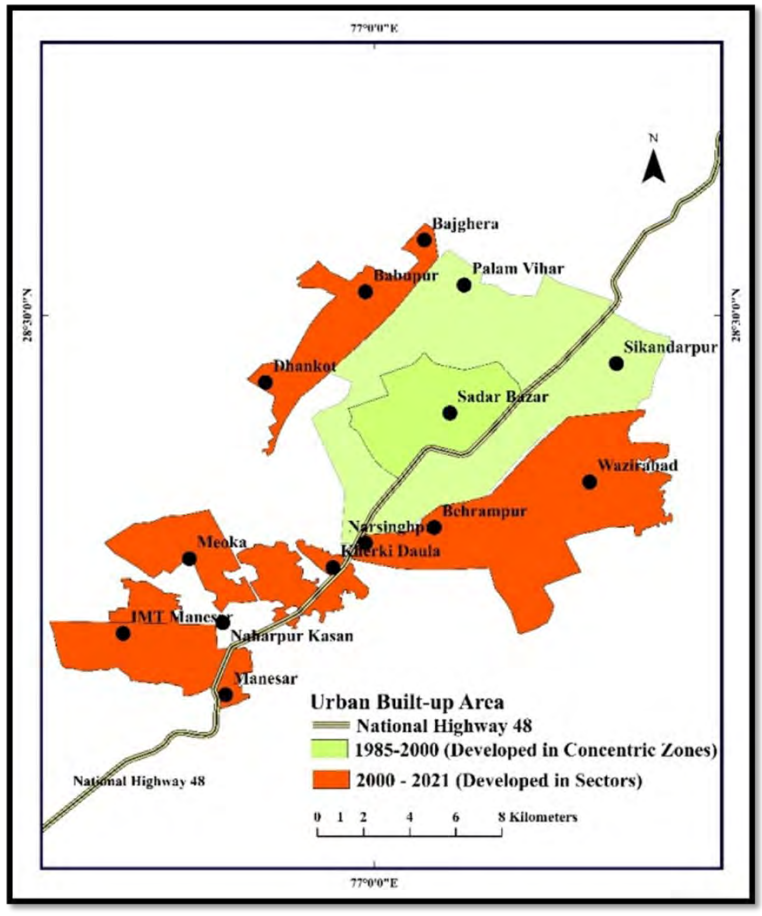

Figure 7: Morphological Changes and Expansion of Gurugram-Manesar Urban Complex (1985-2021)

As high-resolution images have not been available for some areas of GMUC for certain years, the accuracy of built-up delineation, especially in 1985, is limited.

Conclusion

There have been many morphological changes in the development of Gurugram from 1985 to 2021, similar to the models of the Chicago Schools. Gurugram expanded like Chicago in its initial phase, but the physical structure and various government policies affected its development. The recent industrial development of IMT Manesar and its connectivity with National Highway 48 has given a vertical form to the urban expansion of Gurugram, and it is emerging as a new center of urban attraction. Metro and Rapid Metro projects have provided rapid growth to the city, which has led to the expansion of real estate, top retailers, and high-rise buildings. Aravalli Hills, National Park, lakes, agricultural land, greenfield areas, government policies and plans, and transportation networks have all played an important role in the urban morphological structure of Gurugram. The problems of land scarcity, ecological issues, such as degradation of wetlands, illegal tree cutting, illegal construction, and lack of infrastructure owing to population expansions, are the major developmental concerns of the city.

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DECODING THE SPATIAL VARIATION OF CLIMATE VULNERABILITY IN ODISHA, INDIA

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Abstract

Coastal states in India face various climate-related challenges, including cyclones, floods, rising sea levels, heat waves, droughts, and changing precipitation patterns, which pose a significant barrier to alleviating poverty, improving health, and advancing development. In the Indian context, various studies have explored such issues by assessing vulnerability, but only limited studies have downscaled to micro-spatial units. This paper constructs a district-level climate vulnerability index and maps the spatial heterogeneity for Odisha, India. Using the site-specific indicators, the composite vulnerability index reflecting sensitivity, exposure, and adaptive capacity is framed for each spatial unit. The aggregate vulnerability index varies from 0 to 1, denoting lower to higher vulnerability. The southern and central districts are naturally vulnerable due to their spatial dimensions, but higher sensitivity and lower adaptation capacity make the situation worse for these districts. Districts like Baleshwar and Bhadrak with high exposure to climate vulnerability can be addressed by enhancing the adaptive capacity indices like forest area, television satellite connections, and concrete houses, and reducing the sensitivity due to population density, muddy houses, and non-working population. Results highlight the inter-district variations among components of vulnerability, indicating the importance of local-scale policy-making for better management of climate-induced vulnerability.

Keywords: Spatial variation; Vulnerability; Exposure; Adaptive capacity; Sensitivity; Climate Change

1. Introduction

Natural disasters are significant events that can wreak havoc on populations and economies. They can hinder development regardless of whether a country is developed or developing. India is often referred to as one of the most disaster-prone countries in the world and faces numerous challenges due to its vast population and limited landmass (GoI, 2014). India has experienced frequent calamities and has 40 million hectares of land vulnerable to floods, a long coastline prone to cyclones, and 68% of its agricultural land susceptible to drought (Patel et al., 2020). India is subject to many natural and artificial disasters, which can happen differently; over 40 million hectares are at risk of flooding and river erosion; of the 7,516 km of coastline, close to 5,700 km are at risk of cyclones and

tsunamis; 68% of the land that can be farmed is at risk of drought, and hilly areas are at risk of landslides and avalanches (GoI, 2014). More than 3 out of 10 of the world's poor live in India; 70% of its population works in agriculture; 40 million ha are at risk from flooding; 68% of its agricultural land is at risk from drought; the country's coastal regions are vulnerable to cyclones; and the country's annual mean temperature is rising, making it one of the most vulnerable nations in the world (Radhakrishnan et al., 2017).

Natural catastrophes frequently hit Odisha due to its location and climatic conditions, hence it is considered as the most disaster-prone state in India. The state is frequently hit by cyclones and has a tropical climate with heavy monsoon rains, leading to frequent flooding. Low-lying coastal plains and hilly regions are susceptible to floods, storm surges, and landslides (Sharma, 2016). Among the natural calamities that strike and devastate the state, occurrences of floods, droughts, cyclones, and heatwaves are almost a regular feature, befalling more than once in some years, and those of hailstorms, whirlwinds, tornadoes, and landslides are occasional (OES, 2015). The environment of Odisha can be described as tropical, with warm temperatures and high humidity year-round, moderate to heavy rainfall, and pleasant winters. Odisha has been hit by extreme weather fluctuations that have had devastating consequences on agricultural output, raising the dangers of food insecurity and malnutrition. Odisha is one of India's most risky states regarding climate change and the frequency with which natural disasters like floods, cyclones, droughts, and heatwaves occur (Patel, 2019). These disasters, in particular, and climate change, in general, negatively influence agriculture and other economic sub-sectors; therefore, appropriate action needs to be taken in response to this problem (OES, 2015).

The state is frequently plagued by floods, which impede development, and occasionally hit by cyclones, which, while less common than floods, threaten public safety and property, particularly in the state's coastal regions (SDMP, 2013). Heatwaves have become more frequent and severe due to the structure of economic activity in Odisha, negatively influencing the quality of life of many people, particularly those whose jobs require them to work outside (Patel et al., 2019). Each year, the industrial sector and coal-fired plants release 164 million tonnes of carbon gases, comparable to 3% of the expected growth in human greenhouse gases globally. They are therefore blamed for the rising temperature and intensity of heatwaves in Odisha. Deforestation rates in mining areas have risen over time, and the industry has exacerbated this trend. Moreover, this has also added to the disruption of irregular rainfall patterns and rising temperatures that impact Odisha's coastal agricultural production (D. Mishra & Sahu, 2014). According to Das (2016), Odisha is a fascinating example of natural disaster-led underdevelopment due to its frequent and repeated calamities and economic backwardness.

Climate change-related natural disasters and meteorological disruptions threaten most coastal regions. The impact of recurrent exposure events on the socioeconomic characteristics of the population in the coastal system creates vulnerability, which varies depending on coping capacity (Yadav & Barve, 2017). Demographic, socioeconomic, and

hazardous physical and environmental surroundings are the leading causes of vulnerability, according to Wisner et al. (2003). Vulnerability affects different populations' resource distribution, livelihood possibilities, social rights, and institutional access. The people or communities waiting for aid to re-establish their livelihoods after a disaster are equally vulnerable to subsequent calamities. Cutter et al., (2003) classify vulnerability as exposure, social condition, integration of prospective directions, and societal resilience, focusing on places or regions. The IPCC, (2007) defines vulnerability holistically, covering economic, social, and environmental variables of an area or population at risk. Communities in rural areas with low infrastructure, social systems, illiteracy, and unemployment are more prone to frequent disasters and fewer preventive actions.

According to Cutter et al. (2003), vulnerability is closely linked to a household or community's socioeconomic condition, and their contribution must be measured to minimize their negative impact and identify appropriate actions. Such an assessment can explain why specific communities suffer more from hazard events. Cutter et al. (2003) found social vulnerability variables like resource scarcity, political power, representation, social capital, social networks and relationships, beliefs and conventions, and infrastructure and lifeline density. Birkmann (2013) believed that social vulnerability should include income, age, and gender inequality. According to Brouwer et al. (2007), households with lower incomes and fewer natural assets are more vulnerable to disasters. Balica et al. (2012) stated that socioeconomic parameters strongly influence a human system's crisis response. Recurrent hazards, insufficient adaptive capacity, and weak institutional backing are the leading causes of social vulnerability (Chakraborty et al., 2005). Demography, agriculture, and economic capability increase socioeconomic vulnerability (Bahinipati, 2014).

IPCC, (2007) outlines vulnerability as “the degree to which a system is susceptible to or is unable to cope with adverse effects of climate change including climate variability and extremes, and it is the function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity and adaptive capacity.” So, the IPCC, (2007) categorized vulnerability into three dimensions: Adaptive capacity, exposure, and sensitivity. Vulnerability, thus, results from the interaction of socioeconomic status, physical condition, and exposure to potential danger. When these factors are considered, regional vulnerability can be assessed. Numerous global vulnerability assessments have focused on areas and communities most at risk from natural disasters (Acharya & Das, 2020). Despite its considerable exposure to weather-related disasters, India scores poorly in susceptibility estimates using socioeconomic indicators. Analysis of vulnerability in Indian context studies has typically focused on physical characteristics rather than social markers (Mazumdar & Paul, 2016).

Climate change and climate-related disasters pose a significant barrier to alleviating poverty (Jain & Jain,2016), improving health, and advancing development in many developing countries, including India. Odisha’s geological position on the eastern coast of India and its meteorological situation have caused the state to be highly susceptible to climate change and many disasters, especially cyclones, floods, and

droughts. Therefore, assessing all dimensions of vulnerabilities and their spatial distribution across the state is crucial to prioritizing climate risk reduction strategies for the state. So, the present study aims to assess climate-induced vulnerability by constructing a composite vulnerability index based on the IPCC (2007) framework to address Odisha's vulnerability progression due to climate change.

2. Data and Methodology

The study is based on secondary data district statistical handbook, statistical abstract reports of the Government of Odisha, the census of India, and the annual report on natural catastrophes of Odisha database. Since the census data is required for a secondary vulnerability analysis, this study is based on 2011 data for all 30 districts. Microsoft Excel and SPSS-25 (Statistical Package for Social Sciences) have been used for data analysis, and QGIS (Quantum Geographic Information System) software for spatial analysis.

2.1 Study Site

Odisha has been split into five distinct morphological regions based on factors such as geographic location, degree of continuity, and degree of homogeneity. The Odisha Coastal Range in the east, the Central Mountainous and Highlands Area, the Central plateaus, the western undulating uplands, and the significant flood plains comprise this region's topographical features. Odisha has been divided into three revenue divisions known as the Central region (Puri, Cuttack, Jajapur, Jagatsinghapur, Kendrapara, Bhadrak, Baleshwar, Khordha, Nayagarh, and Mayurbhanj), Northern region (Anugul, Sambalpur, Jharsuguda, Kendujhar, Dhenkanal, Debagarh, Bargarh, Balangir, Subarnapur, and Sundergarh) and Southern region (Baudh, Nuapada, Gajapati, Ganjam, Kalahandi, Kandhamal, Rayagada, Nabarangpur, Koraput, and Malkangiri). This study uses the three revenue divisions.

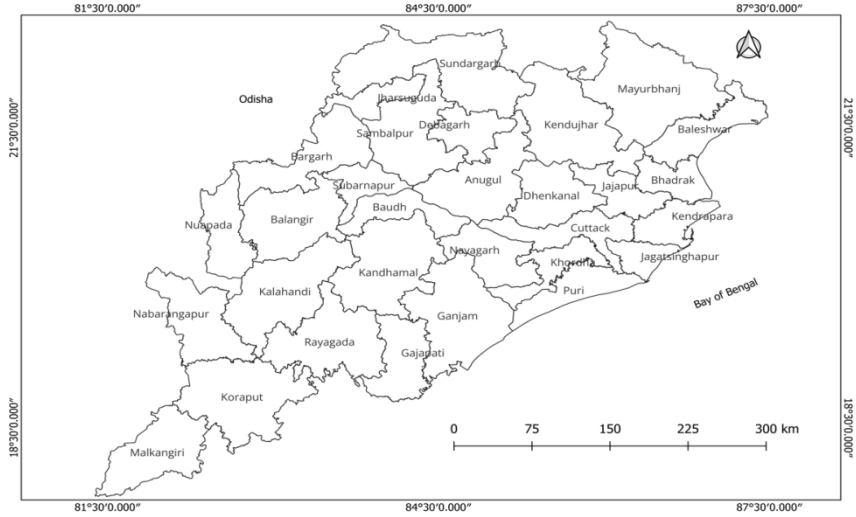

Fig. 1 Study Area (Odisha) with district administrative boundaries

2.2 Components of Vulnerability

To capture the three components of the vulnerability index, exposure, sensitivity, and adaptive capacity, 27 indicators have been selected.

Table 1. Major Components of Vulnerability Index and its Indicators.

Components	Indicators	Rational	References
Exposure	Number of cyclones in the last decades (C)	The greater the number of storms, the greater the risk.	(Rehman et al., 2021; Yadav & Barve, 2017)
	Number of floods in the last ten years (F)	High occurrence of floods leads to exposure.	(Rehman et al., 2021)
	Annual average rainfall in the last ten years (R)	Higher rainfall leads to exposure.	(Rehman et al., 2021)
	Occurrence of heatwave in the last ten years (H)	Heat waves can exacerbate existing vulnerabilities.	(Patel et al.,2019)
	Number of droughts in the last ten years (D)	Droughts can increase vulnerability.	(Patel et al., 2019)
Sensitivity	Illiterate population (IL) (%)	The consequences of catastrophes are more on these people.	(Yadav & Barve, 2017)
	Female population (FP) (%)	Natural disasters have a longer-term impact on women.	(Rehman et al., 2021)
	Decadal population growth (GR) (%)	More people mean more pressure.	(Rehman et al., 2021)
	Population Density (PD) (%)	High-population cities may take longer to escape and cause significant damage in natural catastrophes.	(Rehman et al., 2021)
	Scheduled castes and Scheduled tribes (SC & ST) (%)	They represent society's most deprived group.	(Rehman et al., 2017)
	Dependent Population (DP) (%)	Higher children and elderly people mean more vulnerability to catastrophes.	(Mazumdar & Paul, 2016)
	Agricultural laborer to Main workers (AL) (%)	Workers in the agricultural sector who are paid daily to perform tasks on other people's farms are not guaranteed a stable income.	(Yadav & Barve, 2017)

	Cultivators (CV) (%)	Farmers are more vulnerable due to hazards.	(Paltasingh & Goyari, 2015)
	Non-Worker (NW) (%)	Non-working populations are more vulnerable.	(Mudasser et al., 2020)
	Marginal worker (MW) (%)	Marginal workers are vulnerable due to seasonal hazards.	(Mudasser et al., 2020)
	Dilapidated house (DH) (%)	These homes are more likely to be damaged by natural disasters.	(Rehman et al., 2021)
	Muddy houses (MH) (%)	These homes are more likely to be damaged by natural disasters.	(Rehman et al., 2021)
Adaption	Forest percentage of GA (FA) (%)	Well-established forestry may help provide some physical protection against the effects of natural disasters.	(Rehman et al., 2021)
	Female Literacy (FL) (%)	Women who are educated and able to read and write can help raise disaster awareness.	(Rehman et al., 2021)
	Mean Road density (RD)	Emergency evacuation may be faster with better road infrastructure.	(Rehman et al., 2021)
	Literacy Rate (LR) (%)	Literate people may be more aware of and equipped for climate change adjustments.	(Yadav & Brave, 2017)
	Concrete house (CH) (%)	These homes will be less likely to be damaged or destroyed.	(Ahsan & Warner, 2014)
	Electricity facility (EF) (%)	Electricity may improve adaptability.	(Mazumdar & Paul, 2016)
	Drinking water facility (DW) (%)	Clean drinking water may improve adaptability.	(Mazumdar & Paul, 2016)
	Television connection (TV) (%)	Areas with communication may have better adaptability.	(Yadav & Brave, 2017)
	Main Worker (Ma.W) (%)	Higher percentage of workers means high adaptive capacity.	(Mudasser et al., 2020)
	Banking facility (BF) (%)	Money saved can be used to offset disaster losses.	(Yadav & Barve, 2017)

2.3 Measurements of Composite Vulnerability Index

A combined indicator-based approach has been used to develop the Composite Vulnerability Index (CVI); its primary characteristics are adaptability, exposure, and sensitivity (Ahsan & Waner, 2014). Given that each indicator has been measured using a unique unit of measurement, a normalizing approach can be used to derive a single, non-unit-specific value, as demonstrated by the equation (I) below

$$(\text{Index } X_i)i = \frac{(X_i - Min\ X)}{\text{Max } X_i - \text{Min } X_i} \quad \text{(I)}$$

Where (Index X_i)i represents the normalized indicator score of District I, and the value of the normalized indicators lies between 0 and 1. X_i is the value of the i^{th} indicator. Min X_i and Max X_i stand for the minimum and maximum value of the i^{th} indicator among all the districts.

After standardizing each indicator, average the indicators using the equation below to calculating the final components.

$$M_i = \sum_{j=1}^{n} Index\ X_i / n \quad \text{(II)}$$

Where M_i shows the three major components of district i, the major components comprise sensitivity, exposure, and adaptive capacity. N represents the number of indicators for a particular major component used in this study. The CVI was then determined using the composite indicator structure technique.

$$CVI_i = \frac{(\text{Exposure})i + (\text{Sensitivity})i + (1 - \text{Adaptive capacity})i}{3} \quad \text{(III)}$$

Here, CVI_i (Table 5) represents the Composite vulnerability index of the i^{th} district, '1- Adaptive capacity' shows lack of adaptive capacity.

After analysing exposure, sensitivity, and lack of adaptive capacity components and composite vulnerability, spatial variability has been depicted through mapping.

3. Results and Discussion

3.1 Exposure

Extreme weather occurrences are becoming more common and severe, which depicts the exposure components' vulnerability. As a result of climate change, communities worldwide have adapted coping mechanisms towards extreme weather events (Table 2) such as hurricanes, cyclones, heatwaves, and droughts. Due to rising sea levels, homes, livelihoods, and entire civilizations are in danger of submersion in coastal locations. Floods or parched landscapes caused by unpredictable rainfall threaten agricultural output and water supply in inland regions. Hence, to find out the level of exposure of all 30 districts, we considered five indicators.

Baleshwar, Bhadrak, Cuttack, and Kendrapara are among the districts with higher exposure to floods, and Debagarh, Jharsuguda, Koraput, Malkangiri, Nuapada, and Sundargarh have lower exposure scores (Table 5). Baleshwar, Bhadrak, Ganjam, Kendrapara, and Puri are among the districts with higher exposure to cyclones due to frequent cyclones. Cuttack, Mayurbhanj, and Kendrapara are among the districts with the highest exposure to heavy rainfall, and Bolangir and Kendujhar exhibit relatively lower exposure. Districts like Anugul, Sambalpur, and Sundargarh have relatively higher exposure, and Baudh, Gajapati, Koraput, Malkangiri, Nabarangapur, and Nuapada have lower heatwaves. Exposure to droughts also varies among the districts; Malkangiri, Nabarangapur, and Rayagada exhibit higher exposure, and Baudh, Jajapur, Kalahandi, and Nuapada have relatively lower exposure to droughts.

Table 2. Indicator values of exposure components

Districts	Heatwave	Droughts	Rainfalls	Floods	Cyclones
Anugul	0.60	0.40	0.76	0.47	0.00
Baleshwar	0.40	0.30	0.95	0.93	0.67
Bargarh	0.53	0.40	0.70	0.27	0.00
Bhadrak	0.40	0.30	0.82	0.93	0.60
Bolangir	0.33	0.40	0.76	0.53	0.00
Baudh	0.07	0.30	0.80	0.47	0.00
Cuttack	0.40	0.30	0.99	0.67	0.13
Debagarh	0.13	0.40	0.68	0.13	0.00
Dhenkanal	0.53	0.40	0.76	0.20	0.00
Gajapati	0.07	0.30	0.71	0.60	0.13
Ganjam	0.53	0.50	0.71	0.33	0.47
Jagatsinghapur	0.53	0.40	0.84	0.67	0.40
Jajapur	0.27	0.20	0.90	0.93	0.13
Jharsuguda	0.40	0.50	0.74	0.13	0.00
Kalahandi	0.20	0.40	0.97	0.47	0.00
Kandhamal	0.13	0.30	0.99	0.47	0.00
Kendrapara	0.40	0.40	0.87	0.93	0.53
Kendujhar	0.40	0.20	0.78	0.33	0.00
Khordha	0.47	0.20	0.80	0.67	0.20
Koraput	0.07	0.30	0.80	0.33	0.00
Malkangiri	0.07	0.50	0.83	0.20	0.00
Mayurbhanj	0.40	0.40	0.84	0.47	0.07
Nabarangapur	0.07	0.50	0.98	0.33	0.00
Nayagarh	0.40	0.20	0.82	0.60	0.13
Nuapada	0.20	0.40	0.63	0.33	0.00
Puri	0.27	0.30	0.87	0.67	0.60
Rayagada	0.13	0.40	0.75	0.60	0.00
Sambalpur	0.60	0.40	0.85	0.40	0.00
Subarnapur	0.27	0.30	0.79	0.47	0.00
Sundargarh	0.53	0.50	0.71	0.27	0.00

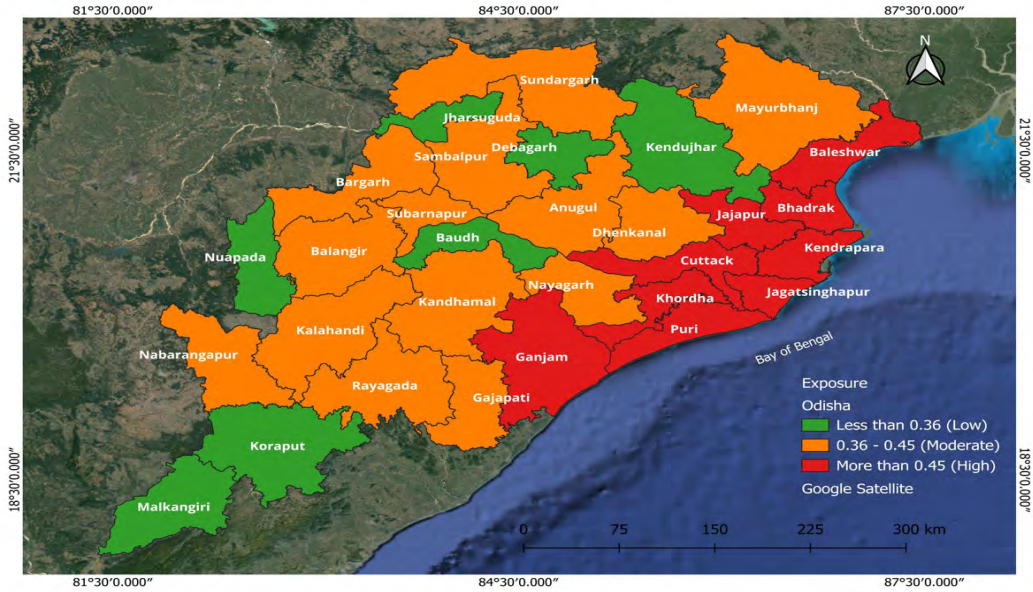

Fig. 2 Spatial Variation in Exposure Map of Different Districts of Odisha

Higher exposure scores (Fig.2 & Fig.5) are witnessed in districts like Baleshwar, Bhadrak, Kendrapara, Puri, Jagatsinghapur, Cuttack, and Ganjam because these districts face different types of natural hazards like cyclones and floods. Also, these districts face drought due to unpredictable rainfalls (Table 4). Southern and Northern region districts have lower exposure scores like Koraput, Kandhamal, Debagarh, Sundargarh, Jharsuguda, and Kendujhar because these districts face only heatwaves, droughts, and floods in some regions.

3.2 Sensitivity

Sensitivity assesses the extent to which districts are affected by climate change, making it an essential factor in vulnerability assessments because it indicates tolerance within a social structure. Hence, the sensitivity aspects of 30 districts are evaluated by taking 12 indicators into account to ascertain the level of vulnerability. Analysing the decadal population growth proves valuable in assessing the population-related stress across various districts. Factors such as the percentage of the prevalence of dilapidated houses and the extent of agricultural land play a pivotal role in gauging the sensitivity of different districts. A higher proportion of dilapidated houses signifies increased vulnerability. Those involved in agrarian pursuits face heightened susceptibility to the impacts of disasters. Notably, the female population, as well as the Scheduled Caste (SC) and Scheduled Tribe (ST) populations, emerge as the most vulnerable and sensitive groups to disasters.

Population density is critical in central districts like Khordha, Cuttack, Jagatsinghapur, Jajapur, and Baleshwar, making them sensitive to natural hazards.

Districts like Bolangir, Malkangiri, and Rayagada experience rapid population increases. Illiteracy rates were higher in the southern and northern regions, making these region more sensitive. Housing conditions of the southern and northern regions districts like Debagarh, Koraput, Malkangiri, Gajapati, Rayagada, Nabarangapur, Kalahandi, and Mayurbhanj have made them sensitive to different types of hazards, in terms of more muddy and dilapidated houses. Southern districts like Malkangiri, Nabarangapur, Kandhamal, Koraput, Nuapada, and Rayagada are more sensitive due to the higher percentage of non-working and dependent populations (Table 3).

Table 3. Indicator values of Sensitivity components

Districts	IL	FP	GR	PD	SC&ST	DP	AL	CV	NW	MW	DH	MH
Anugul	0.23	0.49	0.12	0.2	0.33	0.37	0.33	0.2	0.59	0.4	0.19	0.49
Baleshwar	0.2	0.49	0.15	0.61	0.33	0.38	0.38	0.31	0.6	0.34	0.14	0.6
Bargarh	0.25	0.49	0.1	0.25	0.39	0.36	0.47	0.28	0.49	0.38	0.11	0.67
Bhadrak	0.17	0.5	0.13	0.6	0.24	0.38	0.48	0.33	0.69	0.44	0.11	0.68
Bolangir	0.35	0.5	0.23	0.25	0.39	0.4	0.32	0.23	0.56	0.3	0.09	0.55
Baudh	0.28	0.5	0.18	0.14	0.36	0.42	0.45	0.29	0.5	0.44	0.07	0.73
Cuttack	0.15	0.48	0.12	0.67	0.23	0.35	0.27	0.15	0.64	0.26	0.14	0.34
Debagarh	0.27	0.49	0.14	0.11	0.52	0.39	0.5	0.26	0.47	0.5	0.2	0.39
Dhenkanal	0.21	0.49	0.12	0.27	0.33	0.37	0.38	0.16	0.64	0.36	0.16	0.58
Gajapati	0.47	0.51	0.11	0.13	0.61	0.42	0.52	0.22	0.49	0.42	0.08	0.35
Ganjam	0.29	0.5	0.12	0.43	0.23	0.38	0.38	0.19	0.57	0.4	0.13	0.25
Jagatsinghapur	0.13	0.49	0.08	0.68	0.23	0.35	0.27	0.28	0.65	0.28	0.08	0.36
Jajapur	0.2	0.49	0.13	0.63	0.32	0.37	0.34	0.22	0.7	0.26	0.2	0.52
Jharsuguda	0.21	0.49	0.13	0.27	0.49	0.35	0.23	0.17	0.57	0.31	0.09	0.62
Kalahandi	0.41	0.5	0.18	0.2	0.47	0.41	0.58	0.19	0.52	0.5	0.1	0.41
Kandhamal	0.36	0.51	0.13	0.09	0.69	0.43	0.46	0.22	0.52	0.53	0.09	0.44
Kendrapara	0.15	0.5	0.11	0.55	0.22	0.35	0.31	0.32	0.68	0.31	0.1	0.65
Kendujhar	0.32	0.5	0.15	0.22	0.57	0.39	0.41	0.26	0.58	0.42	0.1	0.68
Khordha	0.13	0.48	0.2	0.8	0.18	0.34	0.15	0.12	0.65	0.2	0.1	0.34
Koraput	0.51	0.51	0.17	0.16	0.65	0.43	0.42	0.3	0.5	0.43	0.07	0.57
Malkangiri	0.52	0.5	0.22	0.11	0.8	0.45	0.34	0.49	0.49	0.42	0.09	0.54
Mayurbhanj	0.37	0.5	0.13	0.24	0.66	0.4	0.47	0.2	0.51	0.55	0.13	0.68
Nabarangapur	0.54	0.5	0.19	0.23	0.7	0.44	0.54	0.28	0.5	0.54	0.06	0.68
Nayagarh	0.2	0.48	0.11	0.25	0.2	0.38	0.35	0.24	0.64	0.33	0.17	0.39
Nuapada	0.43	0.51	0.15	0.16	0.47	0.43	0.49	0.31	0.5	0.5	0.06	0.58
Puri	0.15	0.49	0.13	0.49	0.2	0.36	0.26	0.28	0.63	0.28	0.16	0.44
Rayagada	0.5	0.51	0.17	0.14	0.7	0.42	0.53	0.21	0.52	0.51	0.08	0.48
Sambalpur	0.24	0.49	0.12	0.16	0.53	0.36	0.32	0.17	0.51	0.33	0.1	0.56
Subarnapur	0.26	0.49	0.13	0.28	0.35	0.38	0.49	0.26	0.53	0.41	0.09	0.71
Sundargarh	0.27	0.49	0.14	0.21	0.6	0.37	0.29	0.21	0.58	0.39	0.08	0.5

Thus, the sensitivity component (Fig. 3 & Fig. 5) of the southern districts of the state is relatively higher than the others, such as Nabarangapur, Rayagada, Koraput, Malkangiri, Rayagada, Nuapada, and Kandhamal, as they are mostly Schedule Caste and

Schedule Tribe dominated, and also, they have a higher percentage of illiterate populations (Table 3). These also have higher decadal population growth and muddy or dilapidated houses. The sensitivity component scores of the central and northern regions of the state sensitivity scores are mostly the same.

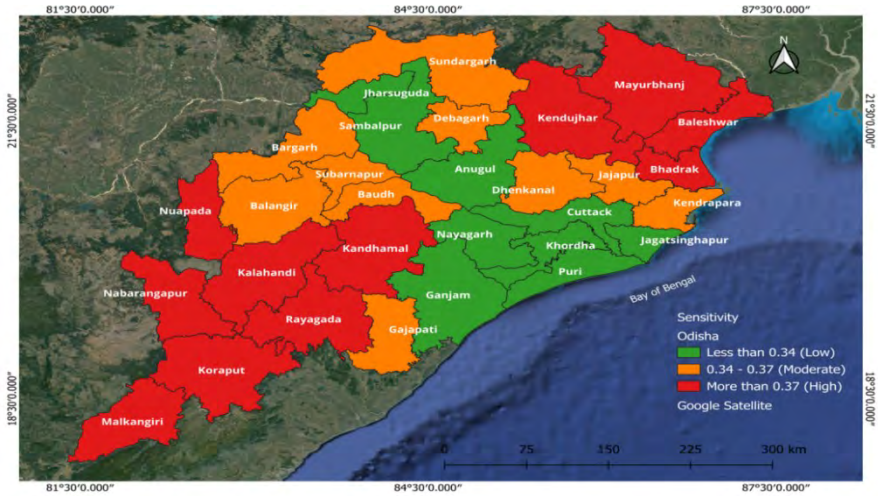

Fig. 3 Spatial Variation in Sensitivity Map of Different Districts of Odisha

3.3 Lack of Adaptive Capacity

Adaptation refers to the human capacity to adjust to disasters induced by climate change. It aligns with individuals' ability to respond and acclimate to such catastrophic events. Communities having access to facilities such as potable water, electricity, paved roads, mobile connectivity, and cement houses have a greater ability for adaptation. Literacy rates, particularly among females, act as useful community readiness and resilience measures. In estimating the composite vulnerability index, the lack of adaptive capacity is used instead of adaptive capacity. Therefore, a lower value means higher adaptive capacity and vice versa. Initially, adaptive capacity measures were defined using ten indicators.

Districts like Khordha, Jagatsinghapur, Cuttack, Kendrapara, and Puri demonstrate higher adaptive capacities that can respond effectively to various environmental and socio-economic challenges. These districts are primarily coastal districts. Factors like female literacy, household access to electricity, mean road density, and availability of banking facilities increase their adaptive capacity (Table 4). Southern region districts of the state have low scores in adaptive capacity (Fig.4 and Fig.5), which means these districts lack adaptive capacity. Districts like Nabarangapur, Koraput, Kandhamal, Malkangiri, Rayagada, Kalahandi, and Nuapada lack adaptive capacity due to lower literacy rates, lower female literacy, availability of electricity, banking facilities, and mean road density (Table 4). Dhenkanal, Debagarh, Bolangir, Mayurbhanj, and Subarnapur lack adaptive capacity

compared to other northern districts. However, Sambalpur and Bargarh districts have high adaptive capacity because these districts have high literacy rates, banking facilities, and mean road density (Table 4).

Table 4. Indicator values of Adaptive capacity components

Districts	FA	FL	EF	BF	TV	DW	RD	Ma.W	LR	CH
Anugul	0.42	0.69	0.45	0.37	0.15	0.94	0.26	0.60	0.78	0.01
Baleshwar	0.08	0.72	0.56	0.38	0.21	0.96	0.40	0.66	0.80	0.01
Bargarh	0.15	0.65	0.45	0.26	0.20	0.98	0.27	0.62	0.75	0.03
Bhadrak	0.01	0.76	0.53	0.32	0.16	0.98	0.54	0.56	0.83	0.01
Bolangir	0.14	0.54	0.29	0.28	0.15	0.96	0.11	0.70	0.65	0.04
Baudh	0.41	0.60	0.18	0.36	0.07	0.97	0.37	0.56	0.72	0.00
Cuttack	0.17	0.80	0.62	0.43	0.27	0.98	0.33	0.74	0.86	0.01
Debagarh	0.46	0.63	0.03	0.34	0.08	0.94	0.31	0.50	0.73	0.00
Dhenkanal	0.30	0.71	0.42	0.29	0.11	0.93	0.24	0.64	0.79	0.00
Gajapati	0.58	0.43	0.49	0.44	0.22	0.89	0.30	0.58	0.54	0.02
Ganjam	0.24	0.61	0.54	0.38	0.19	0.95	0.33	0.60	0.71	0.01
Jagatsinghapur	0.01	0.81	0.53	0.50	0.23	0.97	0.43	0.72	0.87	0.01
Jajapur	0.09	0.73	0.47	0.31	0.12	0.94	0.42	0.74	0.80	0.00
Jharsuguda	0.14	0.71	0.61	0.47	0.34	0.98	0.43	0.69	0.79	0.02
Kalahandi	0.29	0.47	0.23	0.26	0.12	0.95	0.37	0.50	0.59	0.02
Kandhamal	0.07	0.52	0.17	0.52	0.09	0.81	0.23	0.47	0.64	0.01
Kendrapara	0.39	0.79	0.53	0.51	0.18	0.99	0.37	0.69	0.85	0.00
Kendujhar	0.68	0.58	0.30	0.44	0.17	0.89	0.15	0.58	0.68	0.01
Khordha	0.14	0.82	0.72	0.38	0.37	0.98	0.45	0.80	0.87	0.02
Koraput	0.19	0.39	0.25	0.33	0.17	0.88	0.20	0.57	0.49	0.01
Malkangiri	0.38	0.38	0.18	0.39	0.22	0.91	0.18	0.58	0.49	0.01
Mayurbhanj	0.38	0.53	0.24	0.48	0.16	0.94	0.27	0.45	0.63	0.01
Nabarangapur	0.32	0.36	0.13	0.28	0.12	0.97	0.23	0.46	0.46	0.01
Nayagarh	0.22	0.72	0.54	0.26	0.13	0.97	0.26	0.67	0.80	0.01
Nuapada	0.43	0.45	0.28	0.26	0.26	0.95	0.34	0.50	0.57	0.01
Puri	0.03	0.78	0.55	0.38	0.20	0.93	0.63	0.72	0.85	0.01
Rayagada	0.44	0.39	0.27	0.43	0.16	0.91	0.23	0.49	0.50	0.01
Sambalpur	0.50	0.68	0.51	0.42	0.32	0.96	0.33	0.67	0.76	0.04
Subarnapur	0.14	0.64	0.33	0.28	0.13	0.96	0.34	0.59	0.74	0.02
Sundargarh	0.42	0.66	0.47	0.52	0.37	0.96	0.28	0.61	0.73	0.02

3.4 Composite Vulnerability Index

The overall vulnerability (Fig.6) shows that some central districts, like Baleshwar, Bhadrak, Jagatsinghapur, Jajapur, Mayurbhanj, and Kendrapara, are highly vulnerable because of the high exposure to natural hazards and climate change. But districts like Puri,

Cuttack, and Nayagarh are moderately vulnerable because of lower sensitivity and better adaptive capacity. Southern districts like Ganjam, Nabarangapur, Rayagada, Kandhamal, and Kalahandi are highly vulnerable because these districts are comparatively higher in sensitivity components and lack adaptive capacity but are low on exposure. However, the southern districts like Malkangiri and Koraput were moderately vulnerable even if they have more sensitivity (Fig.2) and less adaptive capacity (Fig.3) because these districts have lower exposure components in terms of natural hazards. Northern districts like Bargarh, Subarnapur, Anugul, and Kendujhar are moderately vulnerable because of the average score in three components of the vulnerability index. However, Bolangir district is highly vulnerable due to higher sensitivity and lack of adaptive capacity. However, northern districts like Sambalpur, Jharsuguda, Sundargarh, and Baudh are less vulnerable because of less exposure.

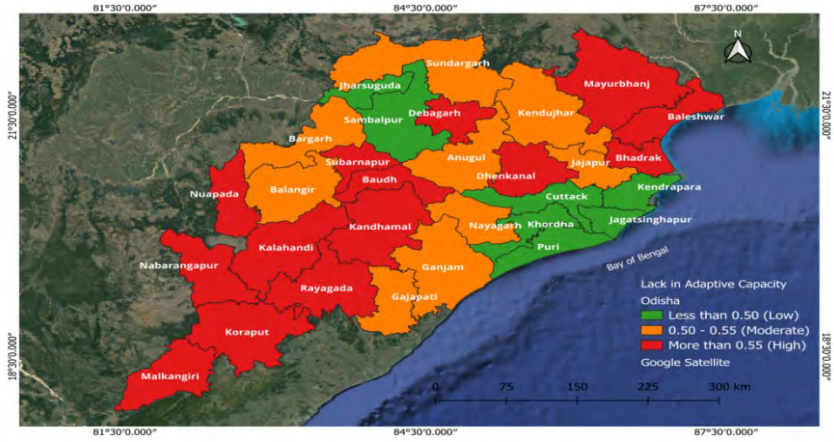

Fig. 4 Spatial Variation in Lack of Adaptive Capacity Map of Different Districts of Odisha

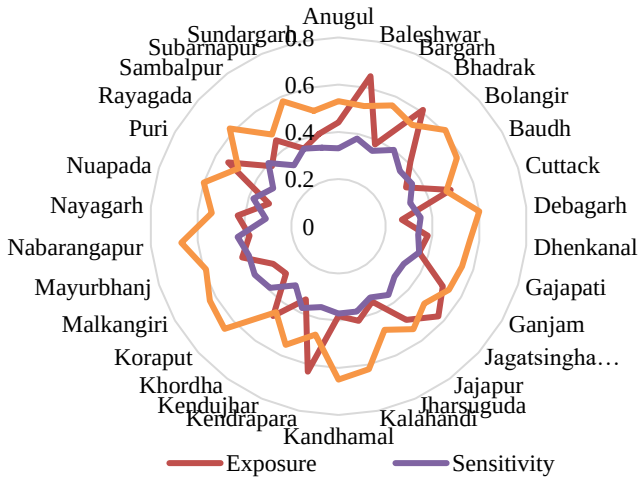

Fig. 5 Three Components Score of Vulnerability Index

Table 5. Components score of Vulnerability index

Districts	Exposure	Sensitivity	Adaptive capacity	1-Adaptive capacity	CVI
Anugul	0.44	0.33	0.47	0.53	0.44
Baleshwar	0.65	0.38	0.48	0.52	0.52
Bargarh	0.38	0.35	0.44	0.56	0.43
Bhadrak	0.61	0.40	0.47	0.53	0.51
Bolangir	0.41	0.35	0.39	0.61	0.46
Baudh	0.33	0.36	0.42	0.58	0.42
Cuttack	0.50	0.32	0.52	0.48	0.43
Debagarh	0.27	0.35	0.40	0.60	0.41
Dhenkanal	0.38	0.34	0.44	0.56	0.42
Gajapati	0.36	0.36	0.45	0.55	0.43
Ganjam	0.51	0.32	0.46	0.54	0.46
Jagatsinghapur	0.57	0.32	0.51	0.49	0.46
Jajapur	0.49	0.36	0.46	0.54	0.46
Jharsuguda	0.35	0.33	0.52	0.48	0.39
Kalahandi	0.41	0.37	0.38	0.62	0.47
Kandhamal	0.38	0.37	0.35	0.65	0.47
Kendrapara	0.63	0.35	0.53	0.47	0.48
Kendujhar	0.34	0.38	0.45	0.55	0.43
Khordha	0.47	0.31	0.55	0.45	0.41
Koraput	0.30	0.39	0.35	0.65	0.45
Malkangiri	0.32	0.41	0.37	0.63	0.45
Mayurbhanj	0.43	0.40	0.41	0.59	0.48
Nabarangapur	0.38	0.43	0.33	0.67	0.49
Nayagarh	0.43	0.31	0.46	0.54	0.43
Nuapada	0.31	0.38	0.40	0.60	0.43
Puri	0.54	0.32	0.51	0.49	0.45
Rayagada	0.38	0.40	0.38	0.62	0.46
Sambalpur	0.45	0.32	0.52	0.48	0.42
Subarnapur	0.36	0.36	0.42	0.58	0.44
Sundargarh	0.40	0.34	0.50	0.50	0.41
Coefficient of Variation (C.V.)	23.26	9.17	13.38	10.70	6.84

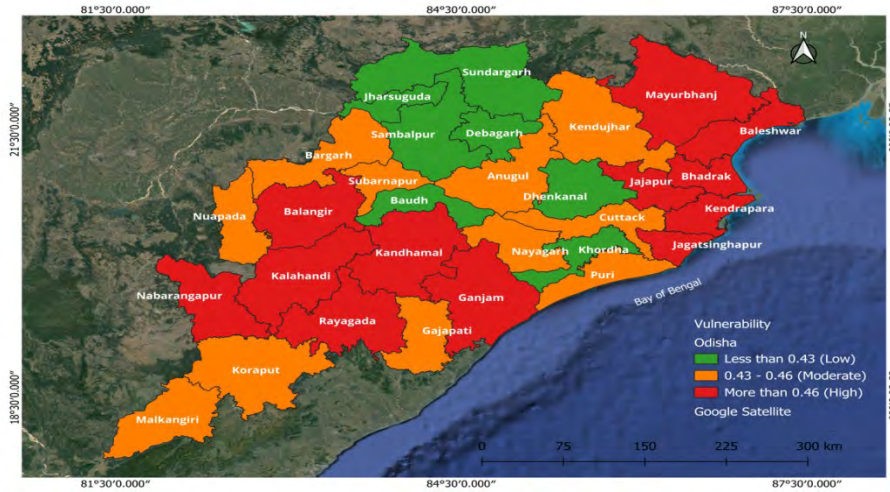

Fig. 6 Spatial Variation in Vulnerability Map of Different Districts of Odisha

4. Conclusion

The composite vulnerability index has been evaluated for 30 districts in Odisha by evaluating three components: exposure, sensitivity, and adaptive capacity, incorporating 27 indicators. A very high degree of exposure was found in Odisha's central districts because these districts face different types of natural hazards due to climate change; cyclones and floods are the most critical disasters affecting coastal districts, making them more sensitive due to these hazards, even if their adaptive capacity is higher than other state districts. Thus, the central districts like Baleshwar, Bhadrak, Jagatsinghapur, Jajapur, Mayurbhanj, and Kendrapara are highly vulnerable due to high exposure and sensitivity coupled with inadequate adaptive capacity. The southern part of the state has more backward districts with poor adaptive capacity and high sensitivity components. So, southern districts like Ganjam, Nabarangapur, Rayagada, Kandhamal, and Kalahandi are also highly vulnerable due to their high sensitivity and lack of adaptive capacity despite having lower exposure to natural hazards. The Northern region of the state is relatively less vulnerable because these regions have lower exposure scores to climate disasters and are moderate in sensitivity and adaptive components.

The research reveals that reducing vulnerability would require working on sensitivity and adaptive capacity components, as exposure is natural and cannot be reduced. Reforms in education, improving housing conditions, and offering employment can help reduce sensitivity and adaptive components. Educational institutions, local businesses, and transportation infrastructure can turn rural places into semi-urban hubs to decrease vulnerability in the central districts. Drinking water, power, toilets, and a low-interest credit facility for building permanent housing should be provided to increase the adaptive capacity in the backward districts of the state. The inter-district spatial variations on vulnerability components indicate the importance of local-scale policy-making for better management of climate-induced vulnerability.

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SPATIO-TEMPORAL ANALYSIS OF AGRICULTURAL DEVELOPMENT IN DIMAPUR DISTRICT, NAGALAND

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Abstract

This study explores the spatio-temporal aspects of agricultural development, focusing on the dynamic interchange between space and time in shaping agricultural practices and outcomes, utilizing diverse datasets and methodological approaches to discern patterns and trends in the Dimapur district of Nagaland. Highlighting a multidisciplinary approach, it examines how geographical factors, such as land availability, area, production and productivity interact with temporal variables, including economic fluctuations and demographic changes, to influence agricultural development. Through a combination of spatial and temporal analysis, the study investigates patterns of agricultural productivity, land use dynamics, consumption and production patterns, and livelihoods across different regions and periods of the Dimapur district. The study is based on both a primary survey of 125 respondents and secondary data. The analysis suggests that there has been an improvement in agricultural development from 2010 to 2019, with annual variability. The production cluster in the district is mainly comprised of pineapple, banana, paddy, cashew and oil seeds. The crop production data shows that cereals saw a 62% increase in production and a 53% rise in productivity, despite a 5% decrease in cultivated area. The strong correlation between area and production (.913) suggests that the area under production is a key factor in the overall production. Land Use / Land Cover mapping for 2017 and 2023 demonstrates a notable change in land use categories. Despite the built-up areas increasing significantly (3.96%), agricultural productivity showed notable improvements from 2010 to 2019. This study aids in understanding agricultural trends, challenges, and opportunities in Dimapur and offers comprehensive insights that potentially guide future agricultural development and resource management strategies.

Keywords: Spatio-Temporal, Agricultural Development, LULC, Production, Productivity

1. Introduction

Over the past several decades, global agricultural production has witnessed remarkable growth, driven by technological advancements, improved farming practices, and supportive policies. According to the Food and Agriculture Organization (FAO, 2021), Global cereal production increased from 876 million tonnes in 1961 to 2,990 million tonnes in 2019. Meat production rose from 71 million tonnes in 1961 to 337 million tonnes in 2019. Milk production more than doubled from 344 million tonnes in 1961 to 883 million tonnes in 2019. This substantial increase in agricultural output has been crucial in meeting the food demands of a growing global population, which increased from 3.1 billion in 1961 to 7.7 billion in 2019. The Green Revolution, beginning in the 1960s, played a pivotal role in this agricultural transformation. However, this impressive growth has not been without challenges. The intensive agricultural practices associated with the Green Revolution have led to environmental concerns, including soil degradation, water pollution, and loss of biodiversity (Pingali, 2012). Additionally, climate change poses a significant threat to global food security, with changing weather patterns and extreme events affecting crop yields and agricultural productivity (Lobell et al., 2011).

In India, agriculture remains a cornerstone of the economy and society, contributing 18% to the Gross Domestic Product (GDP) and employing 50% of the country's workforce (NITI Aayog, 2017). The sector has undergone significant transformations since independence, with the country moving from food scarcity to food surplus. According to the Ministry of Agriculture and Farmers Welfare (2022), India's food grain production has seen a remarkable increase, rising from approximately 51 million tonnes in 1950-51 to over 305 million tonnes in 2020-21. This growth has been accompanied by diversification in crop production, with notable increases in the cultivation of horticultural crops, oilseeds, pulses, and cash crops like cotton and sugarcane (Indian Council of Agricultural Research, 2022).

The northeastern region of India, comprising seven states including Nagaland, presents a unique agricultural scenario. The region is characterized by hilly terrain, high rainfall, rich biodiversity, and a prevalence of traditional farming methods (Bujarbaruah and Bhatt, 2006). One of the most prominent agricultural practices in the region is shifting cultivation, locally known as jhum. This traditional method involves clearing forest areas, cultivating for a short period, and then allowing the land to regenerate (Ramakrishnan, 2015). While culturally significant, jhum cultivation has been associated with soil erosion, deforestation, and declining productivity due to shortened fallow periods (Grogan et al., 2012).

Dimapur, the largest city in Nagaland, presents a microcosm of the agricultural challenges and opportunities in the northeastern region. With approximately 70% of its population engaged in agriculture, the sector plays a crucial role in the local economy and food security (Government of Nagaland, 2021). However, agricultural practices in Dimapur are predominantly rain-fed, making crop production highly dependent on monsoon patterns (Murry and Das, 2021). Economic growth, rising earnings and urbanization have impacted

Dimapur's dietary patterns. There is expanded demand for more variety assortment in food decisions, and people of Dimapur are turning out to be more worried about food quality and well-being (Jaiswal et al., 2023). The agricultural landscape of Dimapur is characterized by a mix of traditional and modern farming practices. While rice remains the primary crop, there has been a gradual shift towards cash crops and horticultural produce in recent years (Mondalb, 2014).

While extensive research exists on global and national agricultural trends, there is a significant gap in understanding the localized agricultural dynamics in Dimapur, Nagaland. Few studies have examined the spatio-temporal changes in agricultural practices, land use patterns, and food security challenges specific to this region. The unique geographical, climatic, and socio-economic conditions of Dimapur necessitate a focused study to inform targeted agricultural policies and interventions (Singh et. al, 2020). Provides a comprehensive analysis of the spatio-temporal changes in agricultural land use in Dimapur over the past decades, considering the impact of urbanization and changing farming practices. Investigates the impact of changing dietary patterns and urban food demands on local agricultural production and farmer livelihoods (Kuotsuo et. al, 2014). Explores sustainable agricultural strategies that are tailored to Dimapur's unique context, balancing productivity, environmental conservation, and socio-economic development (Briassoulis, 2020). Thus, the study aims to analyse the spatio-temporal changes in agricultural land use in Dimapur over the past decades.

2. Materials and Methods

2.1 Study Area

Dimapur district, often referred to as the 'rice bowl of Nagaland', is situated in the southwestern part of Nagaland state, India. The district lies between 25° 48' and 26° 00' North latitude and 93° 30' and 93° 53' East longitude (Government of Nagaland, 2022). It shares borders with Kohima district to the East, Peren district to the South, and Assam state to the North and West (Directorate of Economics and Statistics, 2021). Dimapur experiences a subtropical monsoon climate, characterized by distinct seasons. The average annual rainfall is approximately 1,500 mm, with about 80% occurring during the monsoon season from June to September (Indian Meteorological Department, 2021). Temperature ranges from 12°C to 36°C throughout the year, with relative humidity fluctuating between 60% and 90% (Directorate of Economics and Statistics, 2021).

2.2 Data Sources

This study is based on both secondary and primary data. The Primary data was collected from 125 respondents, which comprised households and families living in Dimapur, both in urban and rural areas. The collection of data was done through simple random sampling and the snowball technique. The secondary datasets such as area, production and productivity, consumption of fertilizers, land use, distribution of work,

workforce participation, production and requirement of crops etc. are drawn from numerous data sources including Statistical Abstract of Nagaland, Indiastat.com, Reports of Agriculture District office, Department of agriculture and family welfare, ICAR, Nagaland, and District agricultural office, Nagaland. Land use/land cover (LULC) changes from 2017 to 2023 were assessed using images derived from Sentinel-2 with 10-meter resolution. The administration boundary of the study area is extracted from the Survey of India, which was further converted into a digital format using ArcGIS, with the projection set to Universal Transverse Mercator (UTM).

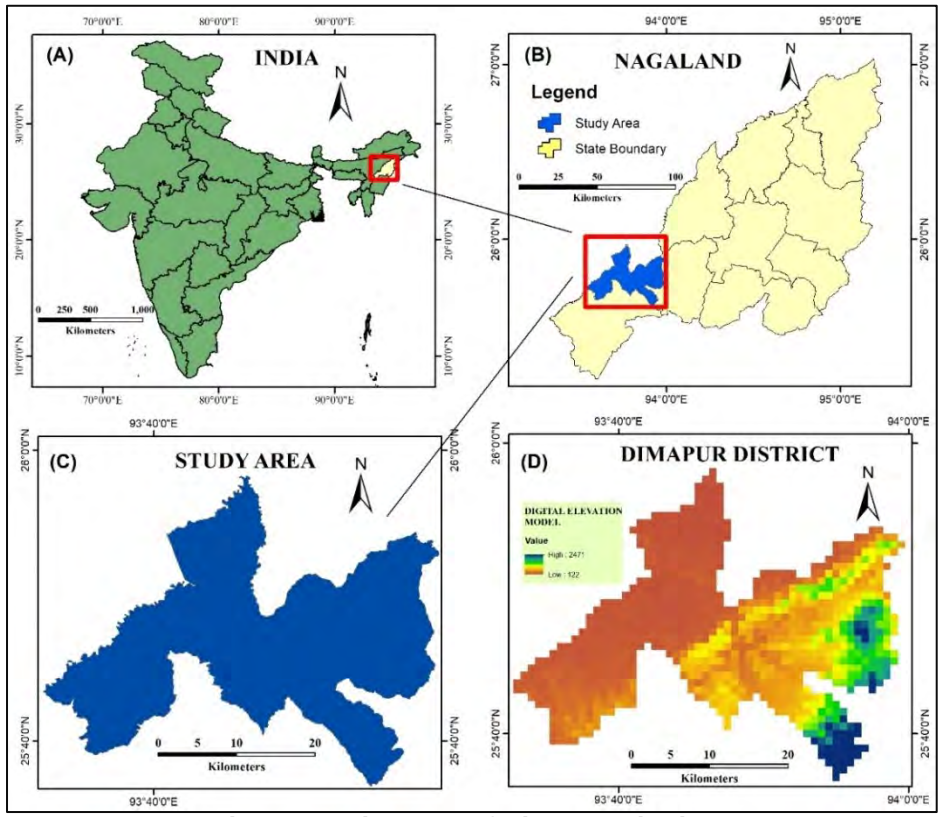

Fig: 1 Location Map of Dimapur District

Source: Census of India and Digital Elevation, 2021

2.3 Land use/land cover (LULC) changes

Land Use / Land Cover maps for 2017 and 2023 were prepared using a supervised classification technique (Fig. 2). An accuracy assessment for LULC classification was done in ArcGIS using the random points, ensuring representation for each LULC class. The overall accuracy, producer's and user's accuracies, and the Kappa coefficient were computed separately for 2017 and 2023. The overall Kappa accuracy for 2017 was 87 per cent and 96 per cent for 2023.

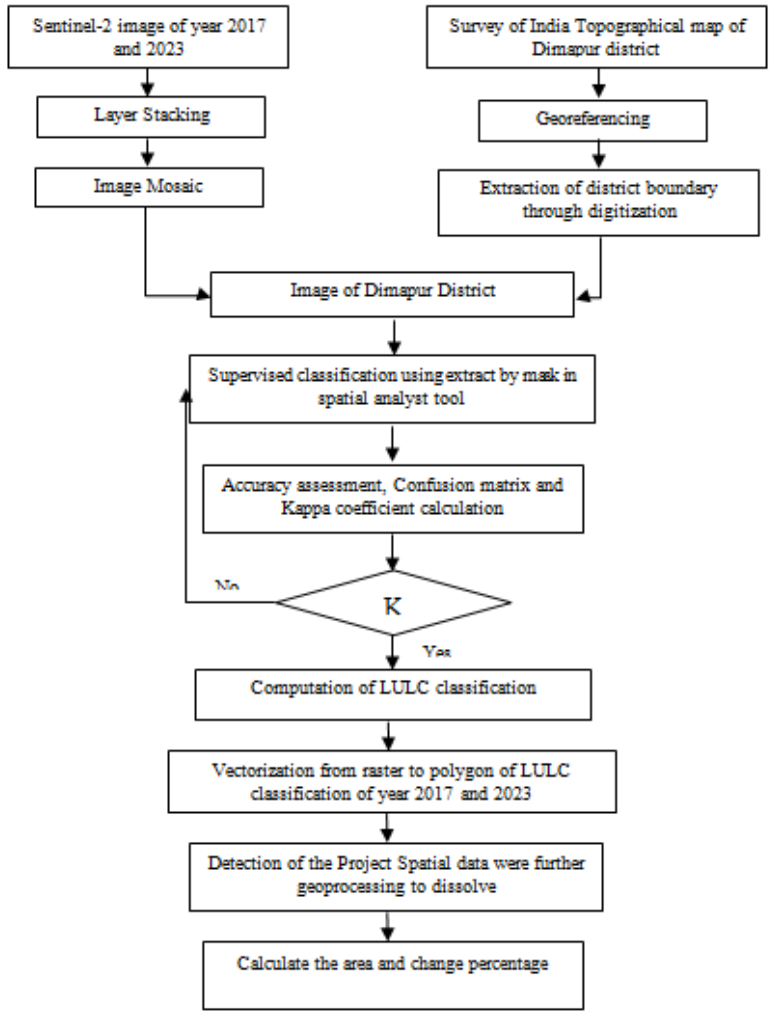

Fig: 2 Methodology Flowchart for LULC Mapping

2.4 Statistical analysis

The secondary data were analyzed using simple averages, ratios, correlation, two-tail tests, correlation and percentage change methods. The percentage change for area, production and productivity for crops from 2010 to 2019 was calculated. Correlation measures were used to understand the strength and direction of the linear relationship between two variables. The formula for Pearson correlation coefficient (*r*) is as follows:

$$r = \frac{\sum (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum (x_i - \bar{x})^2 \sum (y_i - \bar{y})^2}}$$

Where

r is the Pearson correlation coefficient.
x_i and y_i are the individual data points of the two variables.
x and $\overline{y}$ are the means of the two variables, respectively.
n is the total number of data points.

A paired sample test, also known as a paired sample t-test, is used to compare the means of two related groups. In the context of agriculture, a paired sample test compares the means of two related variables, such as area, production and productivity, before and after an intervention, or in two different conditions.

Calculated the standard deviation of the differences. This represents the variability of the differences around the mean.

$$\bar{d} = \frac{\sum_{i=1}^{n} d_i}{n}$$

$$s_d = \sqrt{\frac{\sum_{i=1}^{n}(d_i - \bar{d})^2}{n-1}}$$

Where

s_d is the standard deviation of differences.
di is the difference for each pair of observations.
$\overline{d}$ is the mean difference.
n is the number of pairs.

Calculated the t-statistic using the mean difference and standard deviation of differences:

$$t = \frac{\bar{d}}{s_d/\sqrt{n}}$$

Where

t is the t-statistic.
$\overline{d}$ is the mean difference.
s_d is the standard deviation of differences.
n is the number of pairs.

The critical value of the t-distribution for the desired significance level and degrees of freedom (which is *n*−1). Compare the calculated t-statistic to the critical value to determine whether to reject/accept the null hypothesis.

If $|t| > t_{\alpha/2}$, reject the null hypothesis.

If $|t| \leq t_{\alpha/2}$, fail to reject the null hypothesis.

3. Results and Discussion

The study examines spatial patterns of land use, distribution of workforce participation, crop production disparities, and household consumption patterns.

3.1 Spatial pattern of Land use and agricultural productivity

Understanding cropping patterns provides insights into agricultural practices, seasonal variations, and crop rotation strategies (Shah et al., 2021). Assessing land management practices such as irrigation, fertilization, pest control, and soil conservation techniques is crucial for optimizing agricultural productivity and sustainability in Dimapur (Mozhui and Sharma, 2020).

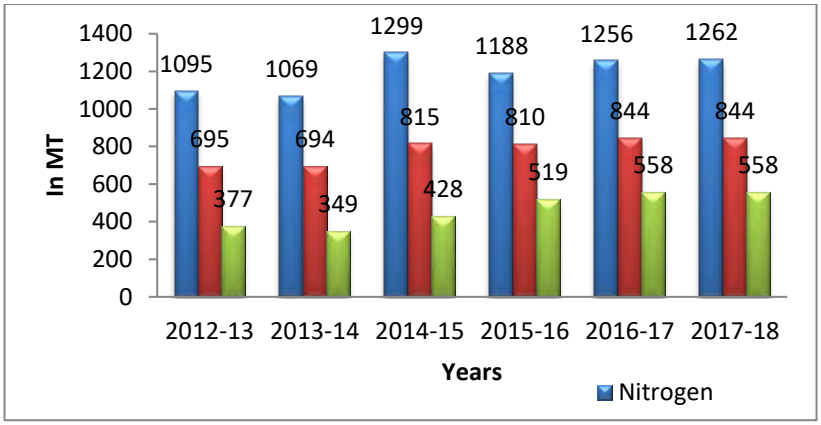

Fig: 3 Consumption of Fertilizers

Source: Directorate of Agriculture, Nagaland, 2018

The consumption of fertilisers in Nagaland, where the average consumption of Nitrogen (N) is around 1000 MT, has fluctuated quite significantly over the years. The highest consumption was 1299 MT in 2014-15, and 1062 MT in 2017-18 was the lowest. Phosphorus (P) consumption is increasing substantially, with 694 MT and 844 MT in the years 2013-14 and 2016-17, as the highest and lowest, respectively. While in Potassium (K), from 2012-13 onwards, the consumption increased from 349 MT to 558 MT(Fig.3).

Table: 1 Land Use Status (preceding average of 5 years from 2013-18) (Area in Ha.)

Districts	Geographical Area	Land under NonAgri use	Tree/ Forest Area	Rainfed area under		Land under tree groves and crops	Current fallow	Other fallow	Net Sown area	Net area sown more than once	Net irrigated area	Gross cropped area
				Cultivated	Cultivable waste							
Dimapur (Percentage)	92700	8200	42200	18470	13910	5850	1670	2400	18470	2234	14635	20704
	5.59%	14.64%	5.50%	10.44%	6.89%	71.10%	1.34%	0.74%	10.44%	97.64%	23.93%	11.55%
Nagaland	1657900	56022	767733	176949	201873	8228	124361	322736	176949	2288	61152	179237

Source: Directorate of Agriculture, Nagaland, 2019

Even though all the net sown region isn't utilized for the production of food, the weighted net sown region shows the accessibility of land that can be utilized for food processing and production. The land use statistics, based on average preceding of 5 years from 2013-18, in Dimapur is presented in Table 1. About 5.59 per cent of Nagaland's geographical area is in Dimapur with 42,200 ha under total forest area, around 12 per cent under gross cropped area. The production cluster in Dimapur is mainly comprised of pineapple, banana, paddy, cashew and oil seeds. The processing cluster is dependent on the raw material for the final products. The major processing clusters in Nagaland are paddy, sugarcane, tea, milk and meat. Apart from the major processing, the minor processing clusters are also there with very small quantities which can't be processed in the clusters (Krishna, 2020).

The Land Use / Land Cover data from 2017 to 2023 demonstrates notable changes in land use categories (Figure 4 and Table 2). The area covered by water decreased from 5.08 km² to 2.82 km², a reduction of 2.26 km², equating to a 0.30 per cent decrease. Tree cover reduced from 501.25 km² to 476.81 km², a loss of 24.44 km², or 3.21 per cent. This decline results from deforestation for agriculture, urban expansion and logging activities. The reduction in tree cover is concerning due to its implications for biodiversity, carbon sequestration, and ecosystem health. The area used for crops decreased from 140.91 km² to 130.85 km², a reduction of 10.06 km², or 1.32 per cent. This could reflect shifts in agricultural practices, urban sprawl into farming areas, or changes in crop viability due to environmental factors. There was a substantial increase in built-up areas from 106.16 km² to 136.35 km², an addition of 30.19 km², or 3.96 per cent. This growth highlights significant urban expansion, likely driven by population growth, economic development, and infrastructure projects. The bare ground almost disappeared, decreasing from 0.06 km² to virtually zero. This reduction suggests that previously bare areas have been repurposed, possibly for development or reforestation.

Table: 2 Dimapur Land Use Land Cover Change from 2017 to 2023

Category	Land Use Land Cover 2017		Land Use Land Cover 2023		Change in LULC	
	2017 (in Km²)	In Per cent	2023 (in Km²)	In Per cent	Change from 2017 to 2023 (in Km²)	Per cent change
Water	5.08	0.67	2.82	0.37	-2.26	-0.30
Trees	501.25	65.75	476.81	62.55	-24.44	-3.21
Flooded Vegetation	0.04	0.01	0.13	0.02	0.09	0.01
Crops	140.91	18.48	130.85	17.17	-10.06	-1.32
Built-Up Areas	106.16	13.93	136.35	17.89	30.19	3.96
Bare Ground	0.06	0.01	0.00	0.00	-0.05	-0.01
Rangeland	8.81	1.16	15.35	2.01	6.54	0.86
Total	762.31	100.00	762.31	100.00		

3.2 Distribution of workforce participation

The workforce participation rate in 2011, at all Indian levels, for males and females was 53.26 and 25.51 per cent, respectively. The distribution of category-wise workers in Dimapur is presented in Table 3. It is observed that the overall main workers are around

1,22,358, which is 16.51 per cent of Nagaland. The total cultivators in the district is around 20,000, which is about 5 per cent of Nagaland. The total agricultural labourers in Dimapur are around 19.96 per cent, of which 21.27 per cent are male and 18.23 per cent are female.

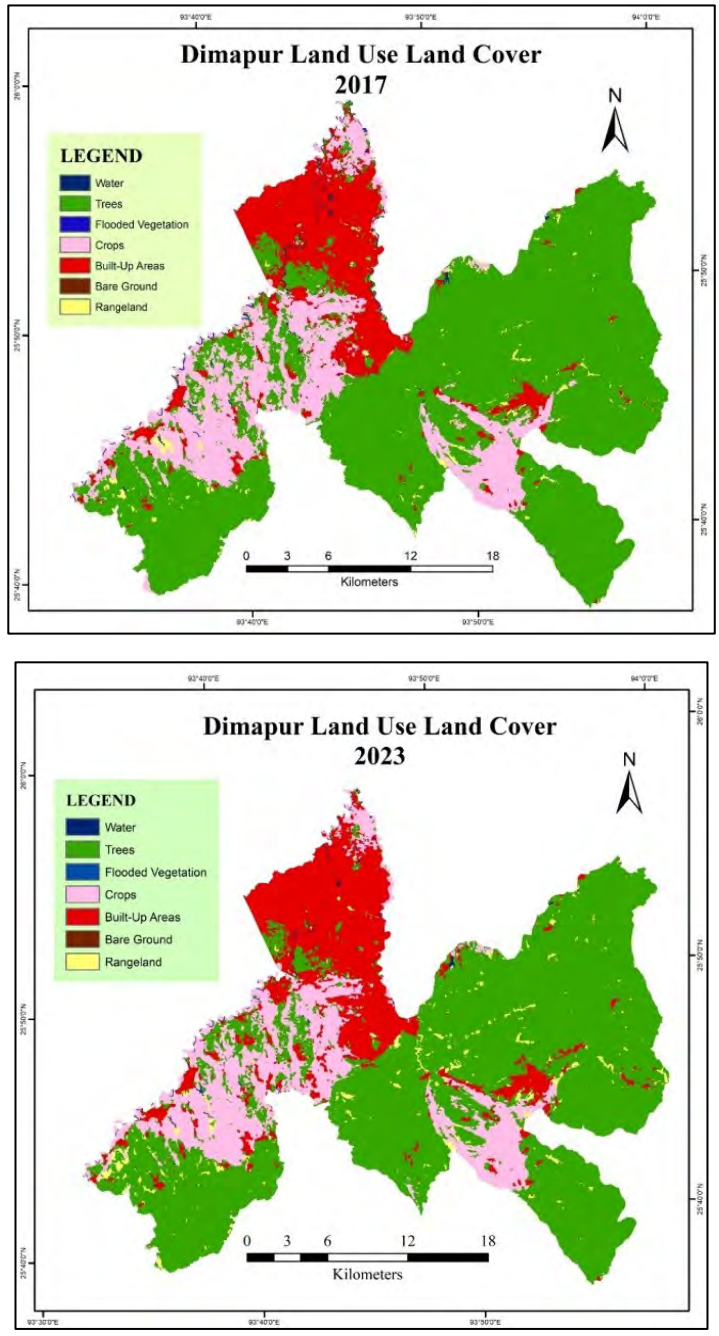

Fig. 4: Dimapur Land Use Land Cover (2017 and 2023)

Table 3: Distribution of Workers

State/District	Agricultural Labourers			Cultivators			Other workers			Grand Total		
	Male	Female	Person	Male	Female	Person	Male	Female	Person	Male	Female	Person
Dimapur	2743	1763	4506	12140	8451	20591	73172	24089	97261	88055	34303	122358
(%)	21.27%	18.23%	19.96%	5.83%	3.98%	4.90%	33.10%	31.23%	32.61%	19.91%	11.47%	16.51%
Nagaland	12899	9672	22571	208221	212158	420379	221084	77145	298229	442204	298975	741179

Source: Directorate of Census Operations, 2011

The work participation rate in 2011 in Dimapur was 40 per cent, which is lower than Nagaland's participation rate. The distribution of total population, main workers, marginal workers and work participation rate for Dimapur and Nagaland is presented in Table 4.

Table 4: Work Participation Rate in 2011

State/ District	Total Population	Total Workers	Marginal Workers	Main Workers	Work Participation Rate
Dimapur	378811	151350	28992	122358	40
(Per cent)	19.15%	15.54%	12.45%	16.51%	-
Nagaland	1978502	974122	232943	741179	49

3.3 Crop production patterns

There are two kinds of cereal production frameworks engaged in the study area: 1) wet rice culture - both HYV and traditional varieties used in irrigated and rain-fed conditions in terraces, plains and fields, and 2) shifting (Jhum) cultivation of traditional varieties in rain-fed conditions of slope/hill areas (Baruah et al., 2014). The traditional Jhum cultivation is a unique agricultural practice in the study area. In this method, a mixed cropping pattern is practised by joining grains, pulses, oilseeds, crops and spices utilising local cultivators, which are natural or organic (Pratap, 2011).

Table 5: Percentage change in area, production and productivity in 2010 and 2019

Crops	2010			2019			Per Cent Change (%)		
	Area (ha)	Prod. (MT)	Productivity	Area (ha)	Prod. (MT)	Productivity	Area (ha)	Prod. (MT)	Productivity
Cereals	22708	31791	1.4	21477	51540	2.14	-5%	62%	53%
Pulses	1880	1880	1	2012	2989	1.3	7%	59%	30%
Oil seeds	10185	8454	0.83	11204	13444	1.2	10%	59%	45%
Vegetables	2945	10308	3.5	3178	22092	6.8	8%	114%	94%
Fruits	2800	9800	3.5	3166	16448	5.3	13%	68%	51%

Source: Department of Agriculture and allied departments, Govt of Nagaland (2020)

There is an upward trend in cereals production from 31,791 MT in 2010 to 51,540 MT in 2019. Although the cereals area has decreased by 5 per cent, production and productivity have increased by 62 and 53 per cent, respectively. Likewise, the production of

pulses, oilseeds, vegetables and fruits in Dimapur has increased considerably in Dimapur district (Table 5). The vegetable production saw a maximum growth of 114 per cent. This could suggest that farmers preferred more diverse crops to meet the local market demands.

There was a strong positive correlation between area and production (0.913), indicating that as area increased, production also increased. A negative correlation is noted between area and productivity (-0.438), suggesting that increases in area and production do not necessarily correlate with productivity improvements (Tables 6 and 7).

Table 6: Correlation Between Area, Production and Productivity in 2010

		Area	Production	Productivity
Area	Pearson Correlation	1	.913*	-0.436
	Sig. (2-tailed)		0.03	0.463
Production	Pearson Correlation	.913*	1	-0.058
	Sig. (2-tailed)	0.03		0.926
Productivity	Pearson Correlation	-0.436	-0.058	1
	Sig. (2-tailed)	0.463	0.926	
*. Correlation is significant at the 0.05 level (2-tailed).				

Table 7: Correlation Between Area, Production and Productivity in 2019

		Area	Production	Productivity
Area	Pearson Correlation	1	0.846	-0.438
	Sig. (2-tailed)		0.071	0.461
Production	Pearson Correlation	0.846	1	0.06
	Sig. (2-tailed)	0.071		0.924
Productivity	Pearson Correlation	-0.438	0.06	1
	Sig. (2-tailed)	0.461	0.924	

The two-tailed tests comparing 2010 to 2019 data for area, production, and productivity show that the changes in area are not statistically significant (p = 0.8), suggesting that the slight increase in area may not have a meaningful impact overall (Table 8).

Table 8: Two-tailed tests between Area, Production and Productivity 2010 and 2019

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Area (2010) Area (2019)	-103.8	822.4	367.8	-1125	917.4	-0.3	4	0.8
Production (2010) Production (2019)	-8856	7194.9	3217.7	-17789.7	77.7	-2.8	4	0.1
Productivity (2010-11) Productivity (2019)	-1.3	1.3	0.6	-2.9	0.3	-2.3	4	0.1

3.4 Consumption Pattern

The socio-economic conditions of the surveyed respondents are presented in Table 9. In this study, it was observed that the size of the families is mainly small to medium. It was observed that households' status and the preferences for food products are variable (Yepthomi, 2016).

The consumption of onions, potatoes, vegetables, legumes, and fruits shows varied patterns as presented in Table 10. Consumption patterns reflect both traditional preferences and changing lifestyles. For instance, most of the surveyed households consume more vegetables monthly, which creates market demand that drives the changes in agricultural cropping patterns considerably in the study area.

Table 9: Socio-Economic Status of Dimapur District

Category	Responses (N=125)
Gender	
Male	62
Female	63
Prefer not to say	0
Education level of household head	
Illiterate	06
5 Years of schooling (Primary)	06
8 Years of schooling (Middle)	08
10 years of schooling (High)	09
12 years of schooling	24
Graduation	43
Masters	26
Others (Diploma, etc.)	03
Household Income (Annually)	
Below 1 Lakh	22
1-3 Lakhs	18
3-5 Lakhs	22
5-8 Lakhs	27
8-10 Lakhs	16
Above 10 Lakhs	20
Household family size	
Small (≤4)	67
Medium (5-7)	41
Large (≥8)	17
Tenancy Status of the household	
Owner	57
Tenant	51
Others	17
Residency history of the household	
By Birth	49
Less than 10 Years	24
Between 10 and 20 years	23
Between 20 and 30 years	19
More than 30 Years	10

Table 10: Consumption pattern of households

	Zero Consumption	2 Kg	4 Kg	6 Kg	8 Kg and Above
Vegetables and fruits Consumption in the last 30 days (in %)					
Onion	3	22	31	17	26
Potato	3	17	38	17	25
Vegetable	2	13	33	27	26
Legumes	14	34	27	16	13
Fruits	5	17	38	18	23
Dairy Product consumption in the last 30 days					
Milk	5	20	30	11	33
Curd	15	38	22	11	14
Cheese	28	34	22	11	4
Bread consumption in the last 30 days					
Barley	30	38	17	11	5
Rice	2	21	34	18	26
Wheat grain flour	7	27	33	16	17
Food-related Consumption in the last 30 days					
	Zero Consumption	1/2 Kg	2 Kg	3 Kg	4 Kg and Above
Garam Masala	17	67	13	1	2
Butter	22	46	27	4	2
Oil	6	41	30	7	13
Sugar/Jaggery	7	40	31	7	14

Source: Based on primary survey, 2021

4. Conclusion

The study of the agricultural development of Dimapur reveals a complex landscape of challenges and opportunities, characterised by significant changes in land use, agricultural productivity, and consumption patterns. Between 2017 and 2023, the district experienced a 3.21% decrease in tree cover and a 1.32% reduction in cropland, while built-up areas expanded by 3.96%. Despite this urbanisation trend, agricultural productivity notably improved from 2010 to 2019. Crop production data illustrate that cereals saw a 62% increase in production and a 53% rise in productivity, despite a 5% decrease in cultivated area. Vegetables demonstrated the most dramatic growth, with a 114% increase in production and a 94% boost in productivity. Workforce participation in Dimapur (40%) lags behind the overall rate for Nagaland (49%). The study recommends implementing sustainable land use policies to expand agricultural lands and increase workforce participation in the agricultural sector. Investing in agricultural research and technology, particularly promoting crop diversification and value-added vegetable production industries, is essential for the study area. Developing targeted workforce training programs to address the gap in work participation rate and strengthening market linkages to support farmers and contribute to improving food security are also to be considered while planning for sustainable agricultural development in the Dimapur district of Nagaland.

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INTER-STATE MARRIAGE MIGRATION AND SOCIO-CULTURAL VALUE SYSTEM IN ROHTAK DISTRICT, HARYANA, INDIA: EVIDENCES FROM THE FIELD

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Abstract

Females contribute to streams of migration mainly for marriage purposes. Rural-to-rural migration forms a large proportion of such migration. Marriage migration depends upon socioeconomic, religious and cultural set-ups. Interstate marriage migration is essentially female-selective and is widespread in areas with low sex ratios. In Haryana, with an extremely low sex ratio of 893 females per 1000 males (National Family Health Survey-5 (NFHS) Report, 2019-2021) the pressure of continuing the family tree is so enormous that people, who are not in a position to find a suitable bride locally or within the same state, create a network of contacts in other states and bring brides from different parts of India. Though the phenomenon of such marriages is not new in Haryana (as Jats from Haryana have long been bringing brides from neighbouring states like Utter Pradesh, Rajasthan and distant states like Assam, Jharkhand, Bihar, Orissa, Chhattisgarh, Himachal Pradesh, Uttarakhand, West Bengal and Maharashtra) yet the implications of present-day long distance, inter-caste and inter-culture marriages are noteworthy in the social context. It is in this context that it seems important to examine such marriages which are not only a product of inter-culture and inter-religion allowances but have also been an outcome of mutual understanding and emotional bonding due to love affairs. This paper thus examines inter-state marriage migration in the context of socio-economic set-up and cultural value system in the state. Qualitative research methods consisting of in-depth interviews, focus groups, note-taking, participant observation etc. were employed in 15 villages out of a total of 147 villages in the district of Rohtak, selected based on purposive sampling for this work. In the interview schedule, both open and close-ended questions were included to avoid subjectivity and ascertain the reality and validity of the data. This study reveals that socio-economic attributes like unemployment, landlessness or possession of small-sized landholding, negligible or no inherited assets, physical deformity, low income, low literacy level etc. of grooms in Rohtak district pose hurdles in arranging matrimonial alliances at the local level or with brides of neighbouring states/districts. Besides these socio-economic factors, cultural value systems and norms like adherence to the rules of khap panchayats; non-acceptance of inter-caste marriages; absence of marriage barter system; and addiction to hukkah or drugs, alcohol etc. prevalent in Rohtak district also determine the marriage institution and make it extremely difficult for the local grooms to arrange brides within the state and therefore compel them to bring brides from the other near/distant states.

Keywords: Marriage Migration, Khap Panchayat, Inter-caste Marriage, Size of landholding

1. Introduction

Empirical studies indicate that the determinants of migration and migration intentions differ for men and women. Typically, men are seen as the primary income earners, while women are expected to contribute to family and parental support (Jong, 2000). Integrating gender into theoretical models of international migration involves more than merely adding a sex variable; it requires a nuanced understanding of how gender roles and expectations influence migration intentions and behaviours (Ellis et al., 1996). This comprehensive approach reveals the complexities of migration within the broader context of marriage and family dynamics, highlighting the interplay between social capital, economic aspirations, and gender-specific roles and expectations. This geographical separation, resulting from historical patterns of migration and non-migration, shapes the social fabric of communities and the capacity for intergenerational support. The implications are profound, affecting not only immediate care needs but also long-term social cohesion and the sustainability of local communities. As migration continues to shape demographic landscapes, understanding these regional variations becomes essential for planning social services and support systems that accommodate the needs of both older and younger populations. Regional disparities in family networks influence the availability of familial support and care, which is crucial for ageing populations. In areas where family members are more dispersed due to migration, the burden of care may fall more heavily on institutional services or specific individuals within the family who remain local. Conversely, regions with denser family networks may experience more robust informal support systems, easing the care responsibilities of individual family members and potentially enhancing the living conditions for all generations. The relationship between marriage and family is often assumed to be straightforward, but with the increasing diversity of family forms in the 21st century, it warrants reevaluation. The expansion of networks contributes to the development of a "culture of migration." Social capital, which includes networks, connections, information, trust, and norms of reciprocity shared by connected groups (Wacquant & Bourdieu 1992; Brisson & Usher, 2005; Woolcock, 1998), plays a crucial role in this culture. In this context, migration is viewed as an accepted and desirable method for achieving social and economic mobility, higher income, or improved lifestyle goals that are often unattainable solely through local resources. Regional variations in access to local family networks have significant implications for future care burdens and the living conditions of both older and younger generations (Lundholm, 2015).

The geographical distance between family members is a long-term consequence of accumulated migration and non-migration by individuals and their relatives. The analysis of early marriage reveals significant negative consequences, driven by factors such as illiteracy, entrenched traditional social structures, poverty, and economic instability. These factors collectively create devastating impacts on the social, physiological, and psychological well-being of individuals, families, and society at large. Nour (2006) has extensively studied the impact of early marriage, particularly in developing countries, noting

that it often leads to poor health outcomes for young girls, limited educational opportunities, and social isolation. Mathur, Greene, and Malhotra (2003) have also discussed how early marriage affects girls' personal development, restricting their autonomy and perpetuating cycles of poverty. Additionally, Jensen and Thornton (2003) emphasize that early marriage often leads to diminished life prospects, as it is typically associated with low levels of education and increased exposure to domestic violence. These studies underline how early marriage, compounded by socio-economic and cultural factors, has far-reaching effects on the individual's well-being and perpetuates a cycle of disadvantage within the community. Moreover, the incongruous gender relations within marriage migration contexts are examined to understand how these disparities manifest and affect women's lived experiences. Inter-caste and inter-religion marriages in India face significant social challenges and stigmas, making such unions difficult for couples to navigate. Traditionally, marriages within the same caste and religion have been the societal norm, and deviation from these norms often attracts social disapproval. However, the processes of modernization, westernization, democratization, and development have begun to bring about positive changes in Indian society, slowly altering perceptions and practices related to marriage.

The decision to migrate is often influenced by the existence of and participation in social networks that connect people across different geographical locations (Phizacklea, 1999). Migration is a complex process driven by a combination of economic, social, political, cultural, and personal factors (Halfacree, 2004). As Indian society continues to evolve, the increasing influence of global cultural trends and internal socio-economic developments are expected to further challenge and transform traditional marriage practices. This ongoing transformation reflects broader changes in societal attitudes towards caste, religion, and the acceptance of diverse family structures. Endogamy, or marrying within one's caste, is often seen as a way to preserve caste purity and maintain the social order. It is argued that endogamy protects women from the discrimination they might face in inter-caste marriages, where they are often not fully accepted and treated differently. The Indian marriage system is deeply rooted in lineage and identity markers, such as individual names, family names, village names, and gotras (clans).

These identifiers are designed to maintain social structures and avoid issues such as congenital diseases by preventing close-knit marriages. Marrying outside of one’s caste in India involves several social and cultural implications, particularly for women. Traditionally, women who marry outside their caste are expected to adopt their husband’s surname and, consequently, their husband’s caste identity. This shift means that women are often seen as leaving their original caste, and their children are typically considered part of the father’s caste, following the patrilineal norm. As a result, women do not contribute to the growth or continuation of their birth community, leading to concerns about the erosion of caste identities. However, these traditions have been changing, especially over the past few centuries. Modernization, globalization, and changing social attitudes have started to challenge the rigid caste boundaries and the associated practices. The deterioration of strict

caste- based traditions reflects a broader societal shift towards more inclusive and egalitarian values. In contemporary India, there is a growing recognition of the need to move beyond caste-based discrimination and to foster a more inclusive society. While traditional practices still hold sway in many areas, the increasing acceptance of inter-caste marriages signals a slow but ongoing transformation. This shift is driven by factors such as education, urbanization, and increased social mobility, which are gradually changing the rigid caste-based social fabric. The traditional Indian caste system imposes significant social and cultural constraints on inter-caste marriages, especially for women, ongoing societal changes are challenging these norms. The movement towards greater acceptance of inter-caste marriages represents a significant shift in the cultural and social landscape, promoting a more inclusive and egalitarian society.

It is in this context that the present study examines the role of socio-economic status and cultural value system in inter-state marriages in Rohtak district with special reference to the villages chosen for this purpose by highlighting the deterrents of local matrimonial alliances and factors promoting inter-state marriage migration in the study area.

2. Methodology and Sources of Data

This paper draws upon a larger study of inter-state marriages in Rohtak district, Haryana. Qualitative research methods, consisting of in-depth interviews, focus groups, note-making, and participant observation (the researcher stayed with the group of target women for a certain period) were employed in 15 villages in the district of Rohtak. A sample of 15 villages, representing 10 per cent of the total number of villages in Rohtak district (147), was taken for sampling purposes. The number of villages in Rohtak, Meham, Sampla, and Kalanaur tehsils is 59, 37, 24, and 27, respectively. These four tehsils constitute 40, 25, 17, and 18 per cent of the total number of villages, respectively.

Thus, the sample was taken in the same proportion, i.e., 6 villages (40 per cent) from Rohtak, 4 villages (25 per cent) from Meham, 3 villages (17 per cent) from Sampla, and 2 villages (18 per cent) from Kalanaur. Six hundred households identified through the snowball technique were visited for data collection from these villages. In the interview schedule, both open and close-ended questions were included to avoid subjectivity and to ascertain the reliability and validity of the information. The sampled population which has been covered through the interview schedule included 600 inter-state migrant brides and their husbands. The relevant sets of data related to the various socio-economic and cultural aspects like nature of employment, size of land holding, level of education, caste, the prevalence of inter-caste marriage, influence of khap panchayats etc. have been collected from the migrant brides and grooms; anganwadi workers; Accredited Social Health Activists (ASHA) and members of concerned village panchayats.

3. Results and Discussions

As far as the traditional values are concerned, Haryana with a deep-rooted

connection to its rural and agricultural heritage, continues to attach great importance to its culture, though it is fast changing in the modern-day context. Traditional values such as respect for elders; a joint family system; strong work ethics etc. are highly valued. As agriculture plays a significant role in the state's economy, the farming way of life has shaped many of these values. Haryana's socio-cultural value system is thus a blend of traditional values and modernization and is influenced by its agricultural heritage, religious diversity, and growing urban population. It is important to note that Haryana, like other parts of India, faces social challenges such as caste-based discrimination and unequal access to resources.

Efforts are, no doubt, being made to address these issues through policies and awareness campaigns. Marriage is a sacred institution that reflects the socio-cultural value of the generations of both the bride and the groom. In the Indian state of Haryana, the institution of marriage is significantly affected by the value system and socio-cultural aspects. Caste panchayats (Chowdhry, 2004) are traditional panchayats, which are patriarchal and revivalist in nature; though they have no legal base, they reinforce traditions and norms, especially in marriage practices in rural Haryana. In Haryana, marriages are strictly marked by caste endogamy and gotra exogamy and there are prescribed rules regarding social and spatial distances. Inter-caste and intra-gotra marriages are not only ridiculed and boycotted but sometimes also end with the elimination of both the boy and the girl involved in such an affair. Some of the aspects of the socio-cultural value system and marriage practices in Rohtak include: the prevalence of domestic violence against women; low sex ratio; female feticide; dominance of caste-specific marriage norms etc.

The analysis of the primary data reveals that there are many aspects of socioeconomic status and cultural value systems which affect the institution of marriage in Haryana. Following is a brief discussion of the attributes of socio-economic status and dimensions of cultural value systems which significantly affect the process of such matrimonial alliances in the selected villages.

3.1 Socio-economic Status and Inter-State Marriage Migration

Nature of Employment

In Haryana, employment plays a significant role in shaping marriage dynamics, influenced by socioeconomic, cultural, and gender norms. The interplay between work opportunities, income security and marriage decisions is deeply rooted in both traditional expectations and evolving economic realities. Poor economic conditions, such as landlessness or small-sized landholdings, unemployment, lack of good government or private jobs, and negligible ancestral/inherited property/assets, significantly affect marriage relations. Moreover, these challenges were exemplified by the fact that Haryana, in December 2022, had the highest unemployment rate of 37.4 per cent in India. (Manav, The Print, 11 January, 2023, CMIE, 2023). These factors contributed to the complexities within marriage relations and underscored the importance of addressing economic disparities to

improve the well-being and stability of inter-state migrant brides This is also evident from the primary data collected through the field survey. It was found that 94.66 per cent of the groom respondents who did not get married in Rohtak/Haryana itself and got married in other states were unemployed. 568 out of 600 such respondents cited lack of employment as the reason for their inter-state marriage. Since employment and job security are one of the major criteria for marriage in Haryana, the unemployed respondents got married in other state/s.

Table 1 Surveyed Respondents (Grooms): Socio-economic Status and Inter-State Marriage Migration

Sr. No	Indicators of Socio-economic Status	Number of Respondents	Per cent
1	Unemployment	568	94.66
2	Landlessness or Small-Sized Landholding	551	91.83
3	No Inherited Assets	558	93
4	Low Level of Education (Up to High School)	449	74.83
5	Age Factor (30+)	475	79.16
6	Physical Deformity	121	20.16
7	Low Level of Income	403	67

Source: Based on Field Survey (October 2023-April 2024)

In the study area, traditional and economic factors converge to create barriers in the local marriage market. Unemployment, lack of land and inherited assets, low level of education, delayed marriage etc. are the most dominant factors driving individuals toward inter-state marriages, reflecting the importance of financial stability, social status, and education in marriage decisions (Table 1). Families and individuals who face difficulty in finding local matches due to the above-mentioned reasons are often pushed to seek alliances across state borders, where expectations may differ. It is important to mention here that many of the respondents were affected by more than one factor which compelled them to marry outside the state.

Size of Landholding

Haryana is predominantly an agrarian society where land ownership is a crucial indicator of wealth and status. Families with no land or small-sized landholding face significant challenges in securing marriages within the state, as land ownership is often linked to financial stability. 91.83 per cent (Table1) of the groom respondents indicated this as a key factor, suggesting that families with no or limited agricultural assets are more likely to turn to inter-state marriages, where the bride's family may not consider the ownership of land as an essential criterion for marriage purposes.

Inherited Assets

In Haryana's traditional society, inherited assets provide long-term financial security, making men with such assets more desirable in the marriage market. Without inherited assets men are often seen as less stable, pushing families to seek alliances outside the state, where poorer families might be contacted for matrimonial alliance. The absence of inherited assets, such as inherited property or wealth, affected 93 per cent (Table1) of the groom respondents' ability to find marriage partners locally.

Level of Education

In Haryana, where educational qualifications are becoming increasingly important for both jobs and social status, men with low levels of education struggle to find suitable local brides. Inter-state marriages, often with families in less economically developed regions, might offer more flexible expectations regarding education. The primary data revealed that a low level of educational attainment, particularly when limited to high school or below, affected 74.83 per cent (Table 1) of groom respondents and persuaded them to inter-state marriages. Education plays a critical role in employment opportunities and socio-economic mobility.

Age Factor

In Haryana, as in many parts of India, there is a cultural preference for younger grooms, and men who delay marriage, often due to late employment or educational pursuits, may find themselves with fewer local options. Inter-state marriages become a viable alternative for older men, where age may not be as critical a criterion for marriage. In the present study, 79.16 per cent (Table1) of groom respondents in 30-plus age group highlighted the challenges in finding local marriage partners.

Physical Fitness

Physical appearance and good health are traditionally considered important in the marriage market and men with physical deformities may face rejection from local families. While this factor is not as dominant as unemployment or small-sized landholding, it still drives some families to seek inter-state marriages where expectations might be more flexible or influenced by other compensating factors like personality or income. The respondents in the present study who cited physical deformity as a factor were suffering from low levels of physical deformities like broken limbs, short height, etc. They did not get any marriage offer locally and opted to get married outside the state. Though physical deformity was a less notable factor, affecting only 20 per cent (Table 1) of the respondents in the present study.

Level of Income

Income is a key determinant of marriage suitability, especially in regions where

dowry and economic contributions are a major consideration. Families with low incomes struggle to find local marriage prospects, as they might not be able to meet the financial expectations associated with such marriages. This drives individuals to seek alliances outside the state, where financial expectations might be less rigid. Income disparities in Haryana, compounded by rising costs of living and dowry demands, make it difficult for families with lower incomes to secure local marriages. Inter-state marriages can provide more accessible alternatives for these families. In the present study, 67 per cent (Table 1) of the groom respondents revealed that their annual income was less than Rs one lakh which became a major hindrance in arranging brides from the local area and they were forced to get married in another state.

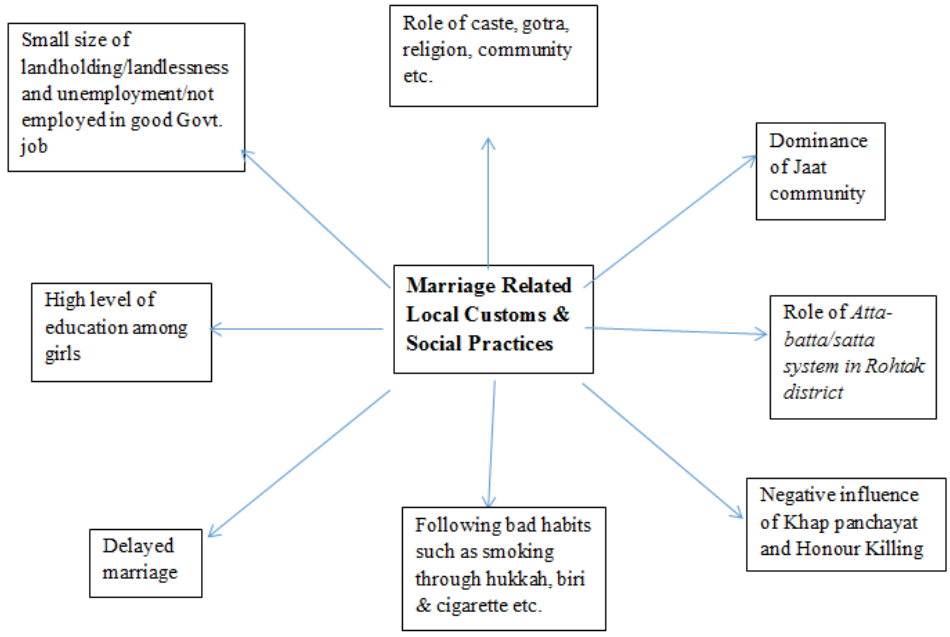

Figure 1 Surveyed Respondents: Factors Affecting Socio-economic Status and Inter-State Marriage Migration

Source: Based on Field Survey (October 2023-April 2024)

3.2 Cultural Value System and Inter-State Marriage Migration

Kaur (2012) observed that there are two reasons: poverty and dowry, for a cross-regional bride to migrate for marriage from Bengal or other such states. Data shows that most women married out are from poor rural or urban working-class families. They are frequently forced into marriage with less prosperous males who may also have personal shortcomings and family disadvantages, such as being older, having previously been married, being alcoholics, being widowers with numerous children, or having some sort of physical impairment. Haryana stands as an epitome of gender inequality and patriarchy,

with a cultural fixation on honour, often culminating in diverse forms of violence against women, both within as well as outside the home (Gill, 2017). Another important form of violence against women is the purchase of women from other states. The brides who are brought from other states find it very difficult to acclimatize themselves in a new socio-cultural setup (Dheer, Deccan Herald,2019). Some studies also indicate that such brides also become the victim of domestic violence and exploitation (Bajwa, The New Indian Express, 9 September 2019). The sex-ratio scenario in Haryana shows disturbing trends. Daughter aversion and son preference are expressed through the rampant use of sex-selective technologies leading to abortions, neglect of female children, and female infanticide (Sudha and Rajan 1999; Ahlawat 2013). The aversion for daughters could also be linked to inheritance rights of property, as the dominant landowning caste groups are strictly against girls' share in property (Ahlawat 2012).

Numerous cases are being reported in print and electronic media about young couples who have eloped or sought police protection committed suicide or were killed in the name of 'family honour' and, in extreme cases, asked to tie a rakhi (holy thread) and enter into sibling relationships. In such a situation, where the universality of marriage is the norm, restrictions on marriage and marriage squeeze become increasingly significant resulting in a limited choice of mate selection.

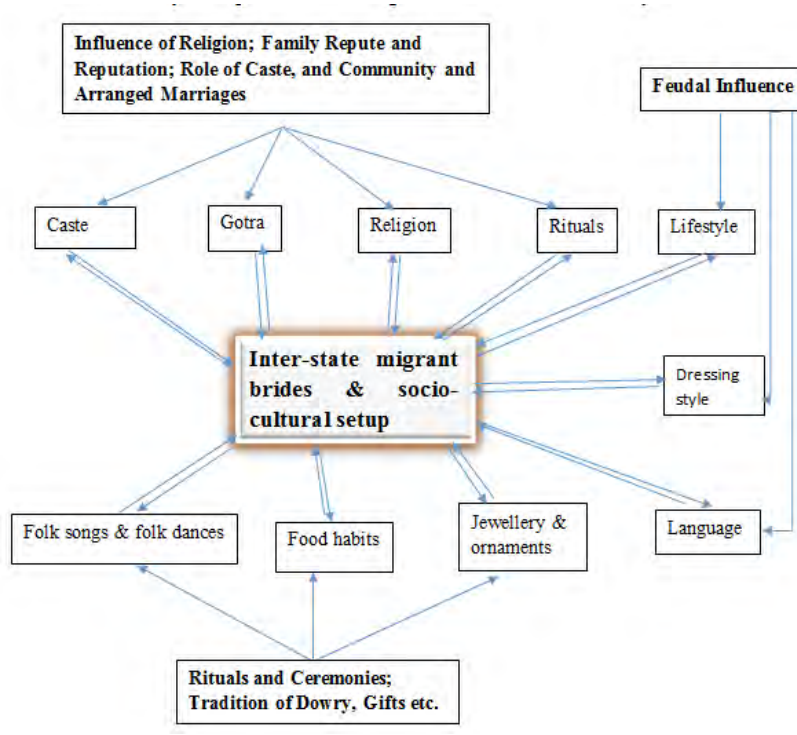

Figure 2 Surveyed Respondents: Marriage and Socio-Cultural Value System

Source: Based on Field Survey (October 2023-April 2024)

The prevalence of social practices can vary significantly from one region to another and is influenced by a wide range of factors, including culture, tradition, religion, and socio-economic conditions. Social practices can also change over time due to evolving societal norms and government policies. Here are some examples of prevalent social practices in Rohtak: like behaviour of local people, local customs; honour killings; the role of khap panchyat; *atta-batta/satta system* (barter system) in marriages; drug addiction; delayed marriages etc (Figure 3).

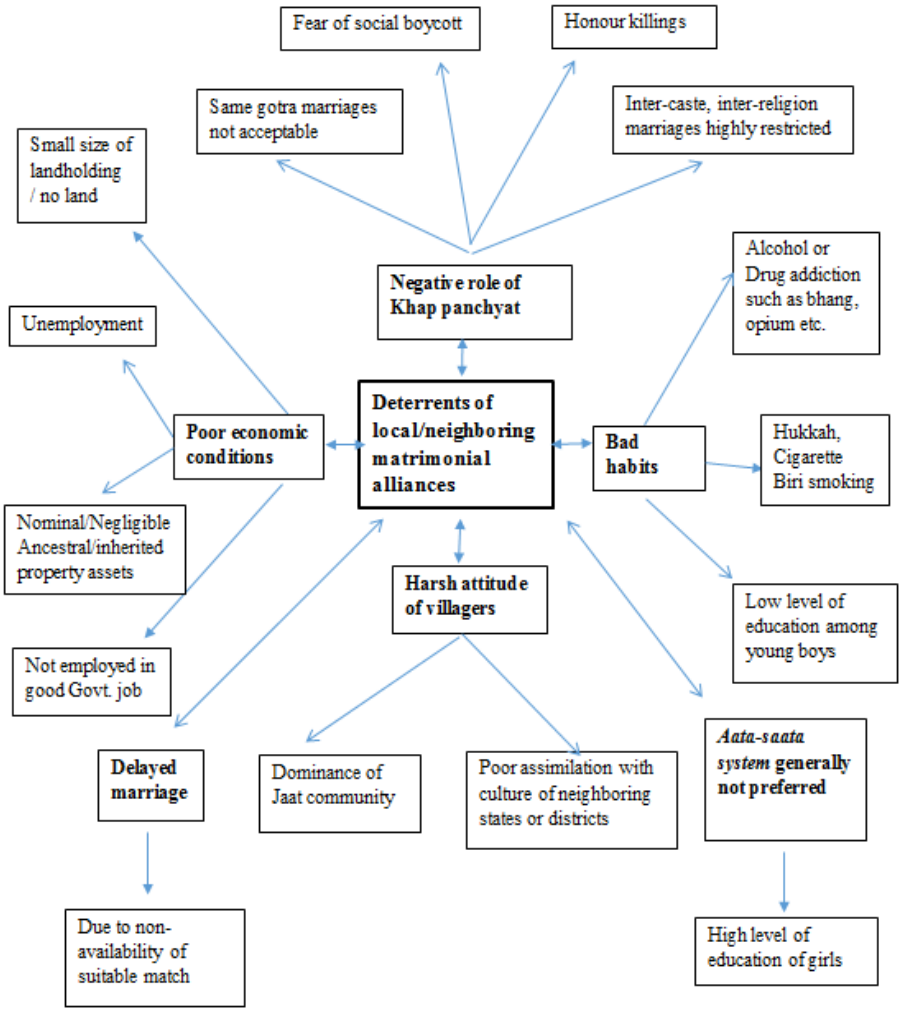

Figure 3 Surveyed Respondents: Deterrents of Local/Neighboring Matrimonial Alliances

Source: Based on Field Survey (October 2023-April 2024)

The state of Haryana is endowed with cultural richness and is undergoing social changes, with an emphasis on education, gender equality, and economic development. Rohtak, a district in the state of Haryana, has a cultural value system and marriage-related practices that reflect the broader culture of the state. This section discusses the inter-state marriages in Rohtak district in the light of the cultural value system.

3.3 Reputation of the Family Khap Panchayats and Regulation of Marriages

Marriages are often seen as a reflection of the family's social standing and there is a desire to maintain a positive image in the community. Caste continues to be a significant factor in marriage decisions in Rohtak. Generally speaking, families prefer arranged marriages within their caste or community, adhering to traditional social hierarchies. Inter-caste marriages, however, becoming more common, especially in urban areas, may face societal resistance in some cases. The religion of the families involved plays a significant role in marriage-related practices. Hindu, Sikh, and Muslim wedding ceremonies in Rohtak, follow, to a large extent, their respective religious customs and traditions. Same-caste marriages in Haryana are deeply entrenched in the region's cultural and social fabric, where maintaining caste purity and upholding family honour is paramount. These marriages are driven by the tradition of endogamy, which ensures that families marry within their caste to preserve their social status, lineage, and cultural values. Khap Panchayats, influential caste councils in rural Haryana, play a significant role in enforcing same-caste marriages and often oppose inter-caste unions, sometimes using social sanctions or even violence to maintain these norms.

Khap Panchayats, a type of caste council in Haryana, exemplify the powerful and discriminatory cultural norms prevalent in the state. The term "Khap" refers to the territorial divisions within the Jat caste, organized into exogamous patrilineal clans (gotras). Members of the same gotra are considered united by ties of putative consanguinity and a sense of brotherhood (bhaichara). Historically, Khaps were formed by male elders of the village community and continue to command universal respect, basing their judgments on life experiences and accumulated wisdom (Chowdhry, 2007). These Panchayats regulate marriages in villages based on caste, gotra, and the village of the marrying couples. Marriages that violate the norms set by the Panchayats incur the wrath of these councils, impacting both the couples and their families. This practice also highlights a violation of constitutional norms, including the fundamental right to life and liberty. 85 per cent of the total respondents from the field survey admitted the supremacy of Khap panchayats. They were not willing to overrule the dominance and norms of khap panchayat and to marry in other castes within the same state. That is why inter-caste marriages with brides from other states are more prevalent in Rohtak than in other parts of the state.

3.4 The dominance of the Jaat Community and the Denial of Inter-Caste Marriages

Historically, the Jat community in Rohtak has had a significant presence and influence, especially in rural areas. Some remnants of the feudal system, where landlords

wielded power and influence over the local population, can still be observed in certain regions. The socio-cultural value system and marriage-related practices in Rohtak reflect a mix of tradition and modernity. While arranged marriages and traditional customs remain significant, there is also a noticeable shift towards more individual autonomy and choice in marriage decisions, particularly among the younger generation influenced by changing social and economic dynamics. Some of these values are inherent in the old. Some of these socio-cultural values may include caste, gotra, religion, lifestyle, and rituals (Figure 3). Arranged marriages are prevalent in Rohtak, as they are in many parts of India. In these marriages, families play a significant role in selecting a suitable partner for their children. Compatibility in terms of caste, religion, social status, and family background is often given considerable importance. Mutual understanding, personal rapport and affinity among the partners (spouses) are seldom considered. Rohtak is one such district in the state which is dominated by the Jaat community and is set apart due to their harsh vocal expression (*Lathmare*). A commonly used local proverb*, Ek Rohtaki 100 kotaki barber hai* (meaning one person of Rohtak equals one hundred persons with sticks in their hands), testifies to the harsh attitude of the dominating Jaat community and thus hinders the establishment of marriage relations with the other castes or religions. In the present study, 97 per cent of the respondents belonging to the Jaat community opted to follow the local norm and not to get married in another caste within the state. This is one of the major socio-cultural value systems or norms which leads to inter-state marriages in Rohtak district.

3.5 Aata Saata or Marriage Barter System

Traditional Gender Roles continue to influence marriage practices in Rohtak. Generally speaking, the custom is that the bride will move into the groom's family and accept all household responsibilities. However, these roles are gradually evolving, especially in urban areas, with more women pursuing education and careers, even after their marriage. *Aata Saata* (matrimonial barter system) involving the exchange of brides is followed, in some districts such as Kaithal Karnal, Jind, Kurukshetra, Sirsa, Fatehabad of Haryana. Aata Satta is more than just an exchange of women from two families or clans; it rather establishes the shadow of mutual threat across marriages. This system of marriage, however, is not prevalent in Rohtak district, because in Rohtak, the female enrolment ratio in higher education is higher as compared to the males. In 2019-2020, the female enrolment ratio in Rohtak was 107.37 per cent while it was 89.15 per cent for males (All India Survey on Higher Education (AISHE) Report, 2019-2020). As more females pursue higher education than males, in Rohtak they tend to avoid the *Aata Saata* system because of the mismatch of educational qualifications of prospective brides and grooms. 52 per cent of respondents in the study area also admitted the avoiding the atta satta system because of social reasons.

One of the respondents, aged 37 years, belonging to the Jaat community revealed the situation of *Atta-Satta* in the following words:

"Though there was a girl in my close family who could have been a potential match for me my family members decided not to accept this arrangement as the practice of marriage barter is not prevalent in this area. My family argued that such an arrangement would lead to negative comments and a loss of social respect in both the village and society. Such an argument led to the decision to seek a bride from Bihar, a distant state to avoid potential backlash from the community." This reflects the strong influence of social expectations and reputation in determining marriage decisions in traditional settings.

3.6 Nonacceptance of Smokers and Alcoholics as Grooms

Haryana is one of the top 10 states using intoxicating substances (Govt. of India, 2019). A large number of young boys in Haryana are into the bad habit of smoking (through hukkah, biri cigarettes etc). Are not considered suitable for matrimonial alliances. Alcohol addiction is another factor responsible for not letting young boys get married within the state. Men who get addicted to alcohol, smoking and other types of intoxicating substances, thus, lose the opportunity to get married within the same state or locally as the family members of marriageable girls usually take care of such things before marrying their daughter. As it becomes difficult to find suitable matches locally or from neighbouring states or districts for men who are addicted to alcohol, smoking and/or other types of intoxication; agents /families from distant states are contacted to identify suitable brides for such young men. Primary data collected in the present study revealed that 58 per cent of the total groom respondents were regular smokers and/or drug addicts and were, therefore, married to brides belonging to other states.

4. Conclusion

This paper attempts to identify and analyse inter-state marriage migration in light of socioeconomic status and cultural value systems in selected villages in Rohtak district in Haryana. The findings reveal that socio-economic factors like unemployment, landlessness or small-sized landholdings, non-availability of inherited assets, physical deformity, low income and low level of education are noteworthy deterrents in arranging brides locally or from neighbouring states for prospective grooms in Rohtak district. Similarly, value systems and norms including adherence to the rules of Khap Panchayats, non-acceptance of inter-caste marriages, absence of marriage barter system and addiction to drugs and alcohol, prevalent in the district, also determine the marriage institution and force many young boys to get married in other states. Socioeconomic status and cultural value system of Haryana in general and Rohtak in particular thus hinder inter-caste marriages within the state and at the same time it does offer opportunities to explore marriage options beyond the boundaries of the state. The implications of such inter-state, inter-caste and sometimes inter-religion marriages need to be explored further to understand the living conditions and health status of such inter-state migrant brides who might be facing challenges about adjustment and assimilation in the new socio-economic and cultural set-up.

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NEWS AND NOTES

Archives - 1

from The Indian Geographical Journal Formerly Known as The Journal of The Madras Geographical Association

(Volume XX(4), 1945, p - 168)

Letters to the Editor

Geography and the Indian Science Congress

The Baroda session of the Indian Science Congress in January 1942, saw the last of the separate Geography section and thus we have lost the only existing body that could bring Indian Geographers together. Now it struggles as a mere annexure to geology. We are, however, thankful for sparing us this short spell of individual honourable existence.

This step-motherly treatment with such an important Human Science as Geography merely shows the narrowness of the outlook of those who are responsible for it. This unwise step is a clear illustration that we in this country have not yet fully understood the great importance and practical utility of geography – a subject which has been defined as a 'Pivotal subject' by eminent educators of modern times. I only hope and pray that we may soon realise what an unjustified 'butchery' has been committed by a body that claims within its fold the cream of Indian scientists and educationists. We have not yet forgotten at what an unearthly hour and under what circumstances, the Geography section was voted to be closed down at Benares in 1941.

It was perhaps simply a gesture of good will to the British Geographers who visited the Calcutta session of the congress in 1938 that a temporary Geography section was so triumphantly started. The British visitors took a wise step in passing a resolution for the permanency of the section and it was somehow, decided to make the section a permanent feature. The section had hardly begun to settle down when in 1940 a proposal for its re-amalgamation with Geology was put forward at Madras. Then in 1941 the work was done and it was voted to be closed down. This 'mortal' anxiety on the part of some, lays bare their insincerety and narrow mindedness. Window dressing against the visitor is perhaps inherent in us. I wish I could know what are the reactions of the British geographers to this.

Geography needs no charity or patronage for its existence. I, or any of my fellow 'students of geography' have no intention of begging the delegates to the next sessions to graciously reconsider the whole situation. I, on the other hand challenge those who are responsible for it, to justify their action. To me and to all sensible and progress-loving persons, Geography is a subject of utility and great promise-and it is only the shrouded imagination of the foggy-headed conservative that may refuse to believe it. Its importance

and great popularity is already established in our schools and intermediate colleges and it has also made a triumphant entry into some of our Universities. Much useful research work has already been effected and much is in progress. As such, Geography deserves all encouragement and due nourishment to grow to a grand maturity. Such unwise and uncalled for actions may only hinder its useful progress.

Geography is not envious of Geology or Anthropology-subjects that are as yet so uncommon in our colleges and yet nobody ever thinks of amalgamating them with something else. It only hopes that people in this country will someday wake up to its great importance as a 'human science' and restore it to its proper place in the realm of Indian Education.

V. S. Mathur

Archives - 2

from The Indian Geographical Journal Formerly Known as The Journal of The Madras Geographical Association

(Volume XXI, 1946, pp.124-128)

Geography in Indian Universities: with the march of time

Kedar Nath Srivastava, M.A., B.T.
Teachers Training College, Vidya Bhavan, Udaipur

It is indeed a pleasure for us to record the fruit of our appeal through the Monograph 'Geographical Education in Indian Universities" to the Universities of India to enhance the cause of Geography as a subject of University education. We congratulate the authorities of the Allahabad and Agra universities for having started M.A., classes in geography since July 1946 It is highly satisfying to see that some of the universities which have till date been neglecting the subject have now realized the importance of geographical studies in their future programme of educational planning and expansion.

Allahabad University. – This University, since July 1946, has started geography in M.A. only. No provision has been made for M.Sc., course. Naturally it would take some time to make provision for research, but we trust that the authorities will do their utmost to develop the department soon into a research centre. I learnt that no addition has been made in the staff and that Dr. R.N. Dubey, M.A. D.Litt , continues to be the Head of the Department . It is good as far as the new Department has to function under Dr. Dubey, but, I wonder his visualizations are likely to be poorly or insufficiently realized without a good and extended team of professors. I therefore strongly urge the academic council to make immediate additions to the stuff, which at present consists of only two members including the Head of the Department.

The number of students admitted to the M.A. previous class this year is 25, and the enrolment to the same class is expected to be 25 to 30 next years and the following years.

It may also be maintained here that the number of students who offered geography in the juniors B.A., class in 1946 was 72 as compared to 50 in 1944, showing an increase of 50% in two years.

Agra University, - It was reported in my monograph that geography had been included in M.A., courses of the Agra University but no affiliated college was recognized for M.A. It is now pleasing to note that St, John's College, Agra which had been teaching geography upto B.A. classes for a dozen years nearly, has begun M.A. classes in geography since July, 1946. The number of students admitted to this college is 8. A great number of students had to be refused admission on grounds of 'No Vacancy'. But this smallness in number is likely to be compensated by a contingent of private teacher candidates from the United Provinces and Rajputana who are to appear at the first M.A., previous examination of the University in 1947. The strength of the private candidates may be estimated to be not less than 100, judging from the number of candidates, from Udaipur, alone (seven) who will be taking their examination this year.

Mr, N.M.Ghose, M.A, (Hons.), assisted by two lecturers, is the Head of the Department of Geography at the College. Geography has been included in only M.A., courses as in the Allahabad University, It is hoped that the other colleges affiliated to the University will follow suit in the near future so to make geographical instructions in these classes available to a wider area. The private examination system in the subject, however, in my opinion, has to be discouraged, directly or indirectly. India needs today trained geographers who have a thorough understanding of the aims and methods of geographical research and who have had inspirational education under a regular College staff.

Bombay University, -- In my Monograph befitting reference could not be made about the contributions of the Bombay University towards the progress of this science in India under the person of Dr, Maneck B, Pithawalla, D,Sc., B.A., F.G.S., L.C.P., University teacher in geography for postgraduates research. The University is fortune in having a scholar like him. It is expected that the University will recognize his services very soon and start M.A., classes under his chairmanship. Dr, Pithawalla, Who happens to be one of the Vice-Presidents of the Society, has been doing pioneer work in the field of geographical research in this country. He has over 50 research papers and seventeen publications to his credit. He was the first Doctor of Science in Geography in India of the Bombay University. He received training in the methods of research at the University of London under Professor E.G.R. Taylor and was awarded the Research Certificate in Geography by the same University, He conducted a regional survey of the Lower Indus Basin. This thesis consisting of 17 papers published in various scientific journals of India, was awarded the Moos Gold Medal, the highest Science award by the University of Bombay in 1942, for the best thesis for the year.

At present some Ph.D, students are working under him for the Ph.D. Degree on the following problems.

1. A Regional geography of the Upper Ganges Basin.
2. A Geography of Sind during the Arab occupation of the region (711 A.D. to 1200 A.D).
3. A Geography of Sind with special reference to animal life.
4. Parsee settlements on the West Coast of India.

Review

The Progress of Geographical Education in Indian Universities

Mr. Srivastava has placed all those interested in the progress of geography lastingly in his debt by preparing a very careful and detailed statement showing the present position of geographical studies in Indian Universities, He not only deals in general terms with geography as a University subject, but goes on to indicate the rapid growth in popularity of the subject amongst undergraduate students. He estimates the total strength of students pursuing studies in geography in degree classes at approximately 1,000, with a total teaching staff of 74. He summarizes the position by saying, however, “The progress of geographical studies in India has been very poor. We started late and still the onward march is unsatisfactory slow.” As he rightly says, geography was introduced into the Universities of Europe at a relatively late stage compared with many other subjects. It gained an important position in Germany and later in France and although geography has been taught in Oxford since 1887 and in Cambridge since 1888, it was really not until the first World War that the importance of geographical studies became so obvious that Honours Schools were set up in practically all the Universities of the British Isles. As he rightly says, therefore, the positions in India is simply that there is a lag of a few decades.

The development to date has been very different in different parts of India. A special mention must be made of the pioneering work of the Department of Geography of the Muslim University at Aligarh, and this University stands in the forefront. Very important progress has been made at Calcutta and there are now important developments at madras and Bombay and in the Punjab. Details are also given of University work in geography at Agra, Allahabad, Mysore and Patna.

Mr, Srivastava describes the work of the Indian geographical Society, Calcutta Geographical Society, and mentions the Punjab Geographical Review.

When the Indian Science Congress celebrated its coming-of-age in 1937 -38 and about one hundred delegates came from the British Association for the Advancement of Science, the old established section E (Geography) of the British Association was naturally represented by a strong continent of University geographers , including Professor H.J.Fleure, F.R.S., Professor C.B.Fawcett, Professor A.G.Ogilvie, Professor L.Dudley Stamp, Mr. R. H.Kinvig, and Professor W.T.Gordon, all of whom are, or were then Heads of Departments of Geography in British Universities. The delegates included others who had contributed to geographical research. The meetings of the special Section of Geography which was established that year for the first time were well attended and it is tragic to have

to record that the separate Section of Geography of the Indian Science Congress has since been remerged with Geology. It is clear, therefore, that a fresh start must be made and the author of this monograph sets out in some detail proposals for a Central Institute of Geographical Research.

He introduces his proposals by some very wise remarks. He points out that the geography which has been taught in India has very naturally been introduced by those whose training has been in Europe, or elsewhere abroad. As he says, the student has tended to learn more of the geography of other countries and continents than he has of his own country, and that the vast field of research into Indian geography remains unexplored. There is at the present time no adequate account of the geography of India in any language and the regional studies which play such an important part in work in other parts of the world have only recently begun. There is no doubt that the great need in India is for those who have a thorough training in the aims and methods of geographical research to turn their attention to the problems of their own country. He proposes, therefore, a Central Institutes of Geographical Research. Rather naturally the University of Aligarh is suggested as a possible Centre as being one of the few places in India where advanced geography is taught and where there is a considerable library. Form Aligarh there is reasonable access to the Imperial records at Delhi and reasonable communications to most parts of the country.

He goes further and suggests the personnel of the governing body and here there seems a danger in introducing at the outset, too much rigidity. The recent development in Britain whereby the Government has made available a large sum for research in the Social Sciences, some of which is being used to further the objects of such Central Institutes, might well be taken as a model by the Indian Government at a time when there can be few if any more pressing problems than those which fall within the purview of the Social Sciences. Among the Social Sciences, geography takes a fundamental place in its study of the physical environment of man. Surely such an Institute should be under a Director of quite unimpeachable academic status, and well provided with funds to be used for the furtherance of geographical research along the lines that would be done in India, that the allocation of definite regions for primary study to the University Departments which is further suggested has some advantages, but there are many problems of central research which the Institute itself might undertake with the help of Research Fellowships.

Just as the first World War resulted directly in the realization that the countries of the world knew little about their own background and still less about one another and led therefore to the establishment in Britain, America and elsewhere of many University Departments of Geography, so the second World War has led to a very real appreciation of the importance of trained geographers and geographical studies,. The Intelligence Departments of the Allies were staffed to a very considerable extent by those whose University training had been in geography. The operations off the fighting services depended very largely on geographical information collected for and supplied to them by trained geographers. At the same time, those who were engaged on the work of reconstruction came more and more to rely upon detailed surveys, such as surveys of land

use, carried out by teams of geographers. There is a realisation that all physical planning is in essence the determination of the right use of land in the national interest and in accordance with international co-operation, and such surveys involve essentially a geographical training and the representation of the data on series of maps. The greatest difficulty at the present time is a lack of well-trained first-class personnel to carry out the surveys. There is no doubt that the author's plea for a Central Institute and its adequate equipment is well founded, and judging by what is happening in other countries where geographers are finding their rightful place in many spheres of Government and private activity, there is no lack of opportunities for those who look upon their geographical training as leading to other careers than that of the teacher, important as that remains.

L.D. STAMP.

THE INDIAN GEOGRAPHICAL SOCIETY

Department of Geography, University of Madras, Chennai - 600 025

14th IGS Online Talent Test – 2024

Date: 05.01.2024 Time: 11.00 a.m. - 12.00 Noon

WINNERS

Young Geographer (Under Graduate Programme)

The IGS Founder Prof. N. Subrahmanyam Award

Total Participated: 839

Name of the Student	Name of the Institution	Marks Scored	Rank
Gokhila Annapoorani B	Dept. of Geography, Tourism & Travel Management, Madras Christian College (Auto), Chennai-600 059	67/75	**I**
Anusha S	Department of Geography, Government Arts and Science College, Amaikulam, Gudalur - 643 212	64/75	**II**
Jesslit Sebastian	Department of Geography, Presidency College (Autonomous), Chennai – 600 005	64/75	**II**
Karthikeyan.S	Department of Geography, Government Arts College (Autonomous), Kumbakonam - 612 002	64/75	**II**
Preetam Pathak	Dept. of Geography, Tourism & Travel Management, Madras Christian College (Auto), Chennai-600 059	63/75	**III**
Aadithya J	Dept. of Geography, Tourism & Travel Management, Madras Christian College (Auto), Chennai-600 059	63/75	**III**
Elakkiya E	Department of Geography, Bharathi Women's College (Autonomous), Chennai - 600 108	63/75	**III**
Nivetha R	Department of Geography, Bharathi Women's College (Autonomous), Chennai - 600 108	63/75	**III**
Dhanush Ram R	Department of Geography, Government Arts College (Autonomous), Coimbatore - 641 018	63/75	**III**
Jayagowri L	Department of Geography, Sri Meenakshi Government Arts College for Women (Auto), Madurai – 624 002	63/75	**III**

Young Geographer (Post Graduate Programme)
Prof. A. Ramesh Award

Total Participated: 234

Name of the Student	Name of the Institution	Marks Scored	Rank
Aishwarya Lakshmi R J	Department of Geography, Central University of Tamil Nadu, Thiruvarur – 610 005	68/75	**I**
Suvankar Dey	Department of Geography, Bharathidasan University, Tiruchirappalli - 620 024	64/75	**II**
Shalini S	Department. of Geography, Kundavai Nachiar Govt. Arts College for Women (Autonomous), Thanjavur - 613 007	64/75	**II**
Abisha P	Department of Geography, University of Madras 600 025	64/75	**II**
Shyamaladevi B M	Department of Geography, Central University of Tamil Nadu, Thiruvarur – 610 005	64/75	**II**
Gunavathi. G	Department of Geography, Presidency College (Autonomous), Chennai – 600 005	62/75	**III**
Varsha R	Department of Geography, Kundavai Nachiar Govt. Arts College for Women (Autonomous), Thanjavur - 613 007	62/75	**III**
Bharathi S	Department of Geography, Sri Meenakshi Government Arts College for Women (Auto), Madurai – 624 002	62/75	**III**
Harish R	Department of Geography, Government Arts College (Autonomous), Coimbatore – 641 018	62/75	**III**

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EMERGENCE OF SMALL TEA PLANTATIONS IN UDALGURI DISTRICT OF BODOLAND AREAS IN ASSAM (INDIA): EXAMINING THE CHALLENGES OF SMALL TEA GROWERS

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Abstract

Though small tea farms started considerably late in the Bodoland Areas in Assam, Udalguri district has emerged as the core of the entire Bodo region given its historical legacy of large tea plantations and growing awareness among the Bodo and other dominant communities of the district about higher returns from tea cultivation compared to rice-dominant traditional farming system. The rapid expansion of Small Tea Growers (STGs) highlights the improvement in local livelihoods, especially among landless labourers and unemployed youth. However, STGs face challenges such as high initial costs, market uncertainties, limited financial support and poor infrastructure, which hinder sustainable development. Thus, an attempt is made to analyse the emergence of small tea plantations in the Udalguri district, examining their spatial distribution, land use/land cover (LULC) changes, as well as the challenges faced by small tea growers based on primary data and remote sensing (LANDSAT) from 1991 to 2021. Understanding these multifaceted issues, a multiple linear regression methodology has been employed to investigate the impact of socio-economic factors on the income of Small Tea Growers. Primary data was collected with the help of a structured questionnaire from 234 STGs through purposive sampling. The research problem focuses on understanding what factors influence the income of STGs who play an important role in the tea industry, as these growers earn different income levels depending on different factors. The dependent variables were income (Rs/ha), years of schooling, age of growers, family size, years of experience, production (kg/ha) and area under tea (ha). Data was analysed to determine the strength of relationships between variables and income, with the model fit assessed using R and R^2. The results show that socio-economic factors significantly influence the income of STGs. The model exhibits a strong correlation (R=0.998). ANOVA results validate the model's reliability with a highly significant F-statistic. Overall, the results highlight the pivotal role of plantation size, productivity and family size in enhancing the profitability of STGs while other factors contribute minimally.

Keywords: small tea plantations, small tea growers, land use and land cover change, bought-leaf factories, Bodoland.

1. Introduction

The tea industry of India is very old and has been significantly contributing to the agrarian economy of the country since 1840 in the British colonial period (Behal, 2014). This industry has made a notable contribution towards production, marketing, consumption, and employment generation, where thousands of unemployed skilled and unskilled labourers are engaged in different parts of the tea-growing regions of rural India. Due to the prevalence of favourable environmental conditions concerning terrain, soil, rainfall, and temperature, in addition to an adequate labour supply, the Assam tea industry has become the biggest tea producer compared to other tea-growing regions of the country (Guha, 1977). However, in recent years the emerging significant challenges have led to the declining competitiveness of some large tea estates, attributed to factors, such as demand and supply imbalances, ageing bushes and failing replantation, maintenance neglect, quality deterioration, insufficient investment, high production costs, rising social expenses (including healthcare, education and housing) and labour shortage. On the other hand, some successful estates were interested in expanding their area under tea, but they were restricted as the government granted each plantation a certain and constrained amount of land. Peasants were therefore urged to intervene and ensure the sustainability of tea production. Small farmers surrounding tea estates have been converted to grow tea to supply the major plantations and their processing facilities with green leaves. At the beginning of the 1960s, the agricultural extension programmes of the country progressively extended to South Indian areas in Tamil Nadu's Nilgiris district (Reddy & Bhowmik, 1989).

The cultivation of tea in small holdings began initially in upper Assam, particularly in Golaghat, Sibsagar and Jorhat districts. Small-scale tea growing was explicitly suggested in 1978 by the late Soneswar Bora, the minister of cooperatives and agriculture. Given its higher economic return and sustainability compared to other traditional rice-based agriculture, the practice of small tea plantations (STP) has been widely spread from the upper Assam region (the core area of tea plantations in Assam) to most other parts of the state in recent times. As a result, a distinct group of tea farmers, comprising diverse ethno-religious communities called small tea growers (STG), are involved in tea growing and have become more popular on a local scale (Saikia, 2017). In the Draft Eighth Plan, the Tea Board of India (TBI) has prioritised promoting small tea producers to inspire young unemployed and landless people to start tea production in Assam and other tea-flourishing areas in India (Bhowmik, 1991). According to TBI, tea growing on small land holdings not exceeding 75 Bighas (approximately 25 acres or 10.12 hectares) is categorised as Small Tea Plantation. However, the Assam government classifies STPs as those which are having farm areas not exceeding 4.28 hectares or 32 bighas. In contrast, the All-Assam Small Tea Growers Association (AASTGA) identifies small tea growers as individuals with land holdings of less than 250 bighas or 33.44 hectares (Borah, 2013). The growth of STP in Assam has reached such a stage that its tea production of 334.15 million kg constitutes 48 per cent of the total tea production (696.67 million kg) in the state (TBI, 2022-23). Moreover, the state of Assam, constituting 50.72% of India's total production of tea, is the

biggest producer of tea in the country. Although tea cultivation started in upper Assam in the form of large-scale plantations during the British colonial period, small-holding tea cultivation has expanded tremendously across the state in the form of small tea plantations, largely since the 1980s, among individual farmers. Its growth in Assam has become such that currently it accounts for 24.33 per cent of the nation's total tea production. Assam currently has 1,22,415 small tea producers, which is against the country's 2,29,526, and around 1.5 million households in the state depend on small tea plantations (TBI, 2023). So far, the growth of small tea cultivation in lower Assam is primarily concentrated in the Udalguri district of the Bodoland areas, where it started in the early 1990s. This paper examines the origin and trend of the expansion of small tea plantations (STP) in the district and how the agricultural sector adapts to land use changes and other associated issues. It also analyses the impact of increased local producers' participation in the tea sector and the rise of bought-leaf factories on local livelihoods.

2. Database and Methodology

The study is primarily based on field data due to the lack of secondary data, which have been collected through a household survey of 234 small tea growers in No. 2 Rajagarh through purposive sampling, as this village is highly concentrated with STGs and where STPs are the primary occupation. The data obtained from the household survey have been interpreted in simple percentages. To understand the relation of STGs with bought leaf factories (BLFs) and estate factories (EFs) and the roles of factories in the expansion of STP, including their production systems, marketing strategies and related socio-economic impacts, interviews were conducted at 5 BLFs (Bodoland Tea Company, Suklai Tea Factory, Rajajuli TF, Nalapara TF, Phung TF) and 2 EFs (Boregajuli EF, Dimakuchi EF). To analyse the spatial expansion of STPs from 1991 to 2021 in Udalguri district, the data were extracted from Google Earth (12/1991) and (2/2021), which have been prepared using the software ArcGIS 10.8 and QGIS 3.28.6. The data obtained from the spatial distribution of STP of block growth of the area of STP (1991-2021) is shown in Table 2. Additionally, regarding changes in Land Use and Land Cover of Udalguri district, two satellite images from LANDSAT for the years 1991 and 2021 have been downloaded from USGS Earth Explorer, which are shown in Table 1, and a supervised classification method has been used using ArcGIS 10.8 and analysed by the Maximum Likelihood Algorithm. Again, to analyse LULC maps for 2010 and 2021 of No.2 Rajagarh village of Udalguri district, the data were extracted from Google Earth (11/04/2010 and 17/01/2021) and mapped by using the Software ArcGIS 10.8 and QGIS 3.28.6 and area change has been shown in percentage as well as area in ha (table 4). The secondary data about the distribution and growth of small tea growers and associated production patterns have been obtained from the Tea Board of India and various government reports.

Understanding these multifaceted issues, a multiple linear regression methodology has been employed to investigate the impact of socio-economic factors on the income of STGs. The research problem focuses on understanding what factors influence the income of STGs who play an important role in the tea industry, as these growers earn different

levels of income depending on different factors. The dependent variables were income (Rs/ha), years of schooling, age of growers, family size, years of experience, production (kg/ha) and area under tea (ha). Data was analysed to determine the strength of relationships between variables and income, with the model fit assessed using R and R^2.

Table 1: Details of Satellite Data Used

Sensor	PATH	ROW	Date of Acquisition	Scale/Resolution	No. of Bands
LANDSAT8 (LULC, 2021)	138	042	2021/3/2	30 Meter	7
	137	041	2021/1/28	30 Meter	7
LANDSAT 4-5 TM C2L1 (LULC, 1991)	136	041	1991/12/5	30 Meter	7
	136	042	1991/12/5	30 Meter	7
	137	041	1991/12/12	30 Meter	7

Data Source: USGS Earth Explorer

3. Study Area

The study area, i.e. Udalguri district, one of the five districts of Bodoland Territorial Region (BTR) in Assam, is located on the north bank of the Brahmaputra valley, covering an area of 2013.40 sq. km and lying between 26°39'45"N - 26°55'0"N latitude and 92°12'45"E - 91°57'30"E longitude (Fig. 1).

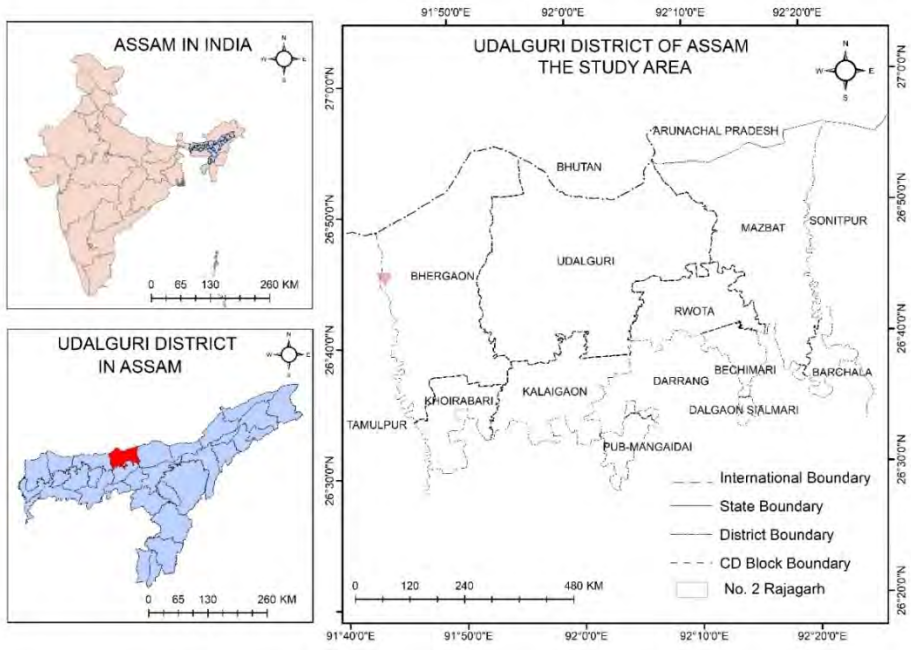

Fig. 1: Location Map of the Study Area (Udalguri District)

Source: Prepared by the author using the Software ArcGIS 10.8 based on a map from the District Census Handbook, Udalguri District, Census of India, Assam, 2011.

The district is bounded by Bhutan and Arunachal Pradesh in the north; the river Pachnoi in the east; Darrang district in the south; and Tamulpur district in the west. With a population of 831,668 (As per the 2011 Census), the district is characterised by diverse ethno-linguistic and religious composition. Besides the population of the Bodo community (31.76%), it is largely inhabited by non-tribal Assamese, Bengali and Nepali people. The Adivasi community, traditionally involved in tea plantations, also forms another important segment of the population in the district. The rural economy dominates Udalguri district. The urban areas comprising the towns of Udalguri (district headquarters) and Tangla constitute merely 3.90% of the district's total population. Udalguri district, being the core area of tea plantations in Bodoland, has twenty-five tea estates, which were established during the British period in the 1850s. Among them, Hattigarh Tea Estate, Majuli Tea Estate, Budlapara Tea Estate, Dhansiri Tea Estate and Mazbat Tea Estate are pretty big in their area and production. The district encompasses diverse soil types such as brown, red, yellow, bhabar, terai, shallow black and older alluvial soils. Udalguri district has a sub-tropical climate, which experiences high precipitation and temperature during the monsoonal season (April-October), which is ideal for tea cultivation. The district receives its highest temperature of about 38°C during the June-July months and the highest precipitation with 250-300 cm annual rainfall during the monsoonal season. In the district, a total of 7519 STGs are actively engaged in the STP sector, collectively occupying 8548.74 ha of land (TBI & Statistical Handbook of Assam, 2021).

4. Results and Discussion

4.1 Emergence of Small Tea Plantations in Udalguri District

The TBI pioneered small tea plantation expansion involving landless labourers and unemployed youth across the state of Assam. A similar approach can also be observed in the Udalguri district. Numerous small-scale tea farms were set up across the district with support from both TBI and large tea estates forming three major belts, viz. Dimakuchi, Udalguri and Mazbat from west to east (Bhobora, 2008; Barpujari, 2018). The first small tea plantation (STP) emerged in the Amjuli village area in the Udalguri belt in 1991, and simultaneously, almost in the same year, in the Dimakuchi and Mazbat belts. The initiation approach, however, varied across three belts. It was a collective effort primarily led by Bodo community entrepreneurs in Udalguri and Mazbat, while in Dimakuchi, individuals from multiple communities were involved in establishing the small tea plantations. Those involved in the process were largely enthusiastic peasants comprising educated unemployed youths, teachers engaged in venture schools, and some having abundant land but without technical efficiency for the modernisation of agriculture (Goni, 2015). Historically, though the concept of small tea plantations was mooted during the 1970s in upper Assam, the idea of small-scale tea cultivation came late in the Udalguri district (Bora, 2008; Borgohain, 2008). The STP in Udalguri district began as a Society in 1991 when Pronoy Basumatary, a former Assistant Manager of Bahi-Pukuri Tea Estate, and ten other Bodo youths established *Mwider Bagan* (Elephant herd) for tea cultivation on 6.5 hectares in Amjuli village under Udalguri belt, which was previously inhabited by some Bihari people

close to the Indo-Bhutan border and Corramore Tea Estate. Initially, the said land was non-cadastral, and this *tauzi* land belonged to the government. Most of the land was purchased from the Bihari people, which was identified as a 'ceiling surplus' (The Assam Fixation of Ceiling Act, 1956 as amended became effective on 15th February 1958, across all the plain districts of Assam. The ceiling limit was set at 49.05 acres, with an additional allowance of up to 9 acres for orchards. Later on, it was transformed into the *Myadi Patta* land. The Corramore Tea Estate under Williamson Magor & Co. Ltd. helped the *Mwider* Bagan Society's tea plantation. Subsequently, it expanded the plantation area to around 130 hectares by acquiring land from nearby areas, thereby establishing the Mwider Co-operative Tea Industry. After the demise of some of the founding members, the remaining stakeholders struggled to sustain operations collectively for some more time. However, in the later part of the 2010s, they ceased production and opted to divide the lands evenly among the individual shareholders. Similarly, within the same belt, *Jwnglari* Small Tea Garden was established in 1993 and is operated by small cooperatives through partnership arrangements (Daimary, 2024).

Pronoy Basumatary pioneered small-scale tea cultivation among Bodo youngsters in the Mazbat belt to combat unemployment (Basumatary, 2019). In 1991, he formed two groups, Badari and Rwdwmsri, organising 40 members and starting a nursery with clones from Lamabari, Bahi-Pukhuri, and Bettybari tea estates. Despite land allocation issues and opposition from Bodo farmers, they eventually found land in Paharpur, but were later dispossessed. In 1993, Badari members established an STP at Naoherua High School using their cultivated saplings (Basumatary, 2014). In the Suklai area, Kamala Bora and Gagan Dutta led the tea cultivation efforts. Bora brought seeds from Tinsukia in 1991, while Dutta, a High School teacher, started his garden with saplings from Atterighat Tea Estate in 1993, receiving technical support from the estate manager. In the Dimakuchi belt, pioneers like Davidson Daimari, Kogen Boro and others used their contract work experience to establish nurseries with cuttings from nearby estates.

4.2 Spatial Expansion of Small Tea Plantations (STPs) in Udalguri District

The growth and distribution of tea plantations in the Udalguri district are intricately linked with its climatic elements, such as rainfall and temperature, topographical characteristics like elevation, slopes, aspects and relief and soil characteristics. The first tea estate, Dimakuchi Tea Estate, was established in 1850 in the colonial era, and presently it is managed by McLeod Russel India Ltd., employing 603 permanent labourers and around 1300 contractual workers (As per the 2014 record), covering an area of 337 hectares (Baro, 2021). Large estates and STPs increasingly dominate the landscape of Bhergaon and Udalguri CD Blocks in Udalguri district. With over 7,519 registered STGs, plantation areas cover 8,549.74 ha compared to 12,640.57 ha of total tea estate area (Statistical Handbook of Assam, 2022). Bhergaon CD Block, with a higher concentration of STPs, shows the availability of suitable land and accessibility to manufacturers, driven by the concentration of small-scale tea farmers.

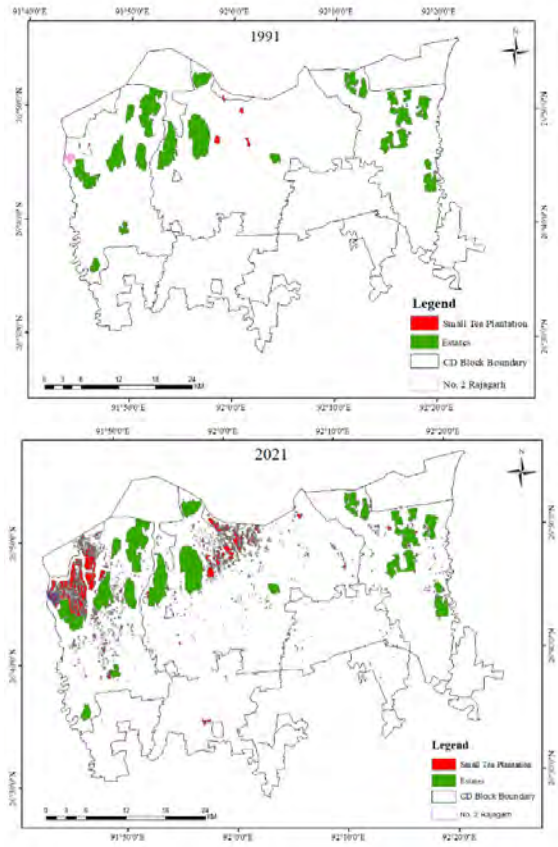

Fig. 2: Spatial Distribution of Tea Estate and Small Tea Plantations in Udalguri District, 1991 and 2021

Table 2: Block-wise Growth of Area of Small Tea Plantations of Udalguri District (CD Block having tea plantation), 1991 and 2021

CD Block	Total Area (ha) of CD Block, Udalguri	Area Under STP (ha)		% of STP Area to District's total STP Area	
		1991	2021	1991	2021
Bhergaon	50,279	38.34	10,994.27	15.04	56.13
Udalguri	57,900	216.48	7,511.4	84.96	38.34
Mazbat	32,900	-	709.06	-	3.62
Rowta	15,684	-	258.42	-	1.32
Kalaigaon	16,600	-	29.98	-	0.15
Khoirabari	17,100	-	80.33	-	0.41
Dalgaon Sialmari(Pt)	5,900	-	5.81	-	0.03
Total	**196,363**	**254.83**	**19,589.35**	**100**	**100**

The block-wise growth of STP in the district from 1991 to 2021 shows significant regional disparities and trends in land utilisation (Table 2). In Bhergaon CD Block, there is a substantial increase in STP area growing from 38.34 ha in 1991 to 10,994.27 ha in 2021 which constitutes over 56% of the district's total STP area (Fig. 2). Udalguri Block, despite having a smaller total area under STP in 1991 (216.48 ha), experienced significant expansion reaching 7,511.4 ha in 2021 (38.34%). The other CD Blocks like Mazbat, Rwota, Kalaigaon and Khoirabari showed minimal growth or no STP area in 1991, with only slight increases by 2021. Overall, the district's total area under STP grew substantially, with Bhergaon and Udalguri emerging as the dominant contributors to the expansion.

4.3 Implications of Small Tea Growers on their Livelihoods

The rapid growth of small tea plantations in the Udalguri district during the last three decades raises questions about the potential contribution of small tea plantations to improving the local livelihoods of farmers. The shift away from traditional crops towards tea cultivation originated from its higher profitability compared to traditionally grown food crops, including paddy, and has brought about marked changes in the agricultural landscape in the district as in other parts of the state (Sharma & Barua, 2017). Initially, small tea growers (STGs) in the district cultivated conventional crops like straw thatch, ragi millets, and mustard. However, they later shifted to sugarcane, areca nut, and pulses due to market demand. However, market uncertainty and unreliable weather led to low prices of such traditional agricultural products. Finally, the transition took off in the 1990s, particularly among the marginal farmers, who found tea cultivation more lucrative, because the daily income after 3-4 years of investment became much higher compared to other traditional food crops. In this way, many farmers in the district were attracted to the high economic returns of small tea growers through planned utilisation of unused or under-used fallow land, grazing land, wasteland and even kitchen gardens for the purpose (Saha, 2018). However, tea farming, which requires significant initial and continuous investment, becomes a hurdle for numerous small-scale farmers. Hence, access to institutional financial support is vital for their advancement. While India's Tea Board provides subsidies and banks extend loans, numerous small growers encounter difficulties due to the absence of permanent land titles, a requirement for accessing these resources (Deka, 2010). Therefore, the pioneers sold assets like land and livestock to invest in STP. Another advantage of small tea plantations is that tea growers can plant additional commercial trees like areca nut, agarwood, betel leaf, black pepper, etc., within the tea plantation area, which augments their income. According to the interlocutors, many small tea growers have already experienced success with the plantation of these crops in generating sufficient income. The small-scale tea plantation has been regarded as a major source of employment and income generation among the rural inhabitants of the district. It is well-known that many labourers are required to nurture tea plants, pluck, prune, and so forth (Das, 2012; Das & Das, 2020). Before the emergence of small tea plantations, Adivasi and other migrant labourers were traditionally employed in tea estates due to their inherited knowledge and skills in tea cultivation (Behal, 2006). Thus, the emergence of STP in the district increased income

opportunities for women labourers, leading to economic empowerment. The small tea plantations also created new job opportunities among the local Bodo community, leading to improved livelihoods and economic stability. The involvement of women as tea pluckers diversifies the tea garden workforce by addressing labour needs. However, the female labourers face challenges in balancing work with childcare responsibilities.

4.4 Adaptation with Small Tea Plantations

It was mentioned that initially, many pioneers were linked to large tea estates, supplying materials and engaging in various activities. Despite having fertile land, significant capital was required for expenses on saplings and labour. Some pioneers established nurseries using cuttings from nearby estates rather than investing directly in buying saplings (Sharma & Barua, 2017). Williamson Magor & Co Ltd. supported growers with seed, cuttings and training, and also provided tractors and agricultural inputs, which were later deducted from the cost of raw tea leaves. The estate factories have taken green leaves from STGs since introducing small tea plantations by making contractual agreements with the growers. At the initial stage of tea cultivation, growers were doubtful about their prospects. Over time, growers gained confidence in their tea cultivation endeavours and encouraged their successors to continue the tradition. Educated youths with modest savings increasingly opt for tea cultivation as a promising occupation in the rural economy.

Immediately after taking up small-scale tea cultivation, the growers do not get any earnings for up to 3-4 years after the inception of the plantation. During that period, they must depend on traditional food crops if their primary occupation is cultivation. Given this, some small farmers traditionally involved in rice cultivation have not been found to switch over to tea cultivation completely. Hence, in many other cases, the transition to tea cultivation does not entail converting the entire land at once; instead, it takes place gradually, plot by plot. There have been various challenges in supplying green leaves to the factories. Initially, estate factories were the sole purchasers of green leaves but struggled with low capacity, leading to lower rates and rejection of leaves. Depending only on organised tea estates, the area under small tea plantations increased to such an extent that within ten years (1991-2000), the estate factories could not take and process the increased production of leaves from the STGs. The growers repeatedly failed to get an acceptable and adequate price; sometimes their leaves were returned in the name of poor quality, and the low capacity of the estate factories. When there was no bought-leaf factory, the pioneers typically found it easier to negotiate agreements with tea estate factories with large land holdings (more than one hectare). In contrast, it proved challenging for small and marginal growers (less than one hectare) to secure agreements with these estate factories. As such, it was a big issue for those small growers, as estate factories needed green tea leaves in bulk to fulfil their annual capacity. As a result, those growers had to supply green leaves through leaf agents.

Besides the above, Udalguri district faced an alarming militancy issue during 1990-2004, posing challenges for the pioneers of small tea plantations in the district, who were often demanded large sums of money by the militants. This situation impacted the survival of many STPs in the district (Barua, 2015). Additionally, several managers of major tea estate factories fell victim to militant groups during these periods of growing tensions. The small tea growers also encountered suspicion from the Indian Army, who saw them as potential messengers to the militants. The situation, however, witnessed improvement after 2004 following the All Clear Operation conducted by the Indian Army against the National Democratic Front of Bodoland under Ranjan Daimary (NDFB-R) in Bhutan.

4.5 Emergence of Bought-Leaf Factories

As the STGs do not have their own tea processing factories, they must rely on either large or private estate factories. Among the factories, those that do not possess their tea gardens and purchase green leaves from the STGs are known as bought-leaf factories (BLF). According to TBI, BLFs are tea factories that acquire 75% of their green leaf requirements from various sources (TMCO, 2003). The advent of bought-leaf factories in the Udalguri district had a positive and encouraging impact on confirming the position of STGs within the tea sector. Despite challenges such as price fluctuations, intervention by leaf agents, limited capacity, and financial and technical constraints over the years, small tea growers have increased their land holdings and productivity over time (Hannan, 2019). Before the advent of bought-leaf factories, large tea estate factories exclusively used to purchase green tea leaves from STGs. During the 1990s, the green tea leaves were supplied to estate factories to the tune of 5,00,000 kg to 6,00,000 kg per day by STGs in the district. On the other hand, the total capacity of each estate factory had been 10,000 kg to 20,000 kg per day. In the Udalguri district, there are 25 estate factories spread across three tea belts: Bhergaon, Udalguri, and Mazbat. The growers often faced serious challenges during the peak season from August to October. Coping with them, they had to prune the garden or dispose of the leaves on the roadside due to an excessive supply. This situation resulted in the establishment of a Cooperative Tea Factory in the district. The first cooperative factory “Mwider Bagan”, which was established in Amjuli small tea plantation by the local Bodo community, is no longer operational. Initially funded by borrowing from Marwari traders, this factory faced financial struggles and ultimately had to be given to the Marwari entrepreneurs due to their inability to repay the loans.

The concept of bought-leaf factories (BLF) emerged roughly a decade ago in 2013, with the establishment of Bodoland Tea Factory as the pioneering BLF, succeeded by Rajajuli Tea Factory. During 1996-2006, there was a significant increase in the number of STGs and the area under small tea plantations in the district. However, this led to a situation where supply became consistently high, but the demand remained low. In response to this imbalance, the individuals sought to address the growing production of green tea leaves in the district by establishing a bought-leaf factory. Indigenous people did not solely establish the initial bought-leaf factory due to the financial challenges they faced in setting up a factory independently. Consequently, a collaborative effort between Marwari

traders from northern India and indigenous entrepreneurs led to the establishment of the first BLF in 2013, located in Suklaikhuti. As of 2022, there are a total of 18 bought-leaf factories in the district, and a few more are in the process of establishment. Among these, 13 bought-leaf factories are located in the Bhergaon block and five in Udalguri block. However, due to fewer small tea growers in the Mazbat block, it remains reliant on large tea estate factories.

With a rapid increase in the number of BLFs in the district, some factories are encountering a crisis in search of an adequate quantity of green leaves (Sharma & Barua, 2017). This shortage raises concerns about maintaining the quality of green tea leaves, as bought-leaf factories typically accept all types of green leaves. The processing of poor-quality leaves can adversely impact the tea market and significantly affect the marketing environment due to the production of poor-quality processed tea. In addition to purchasing leaves from growers, the bought-leaf factories often provide financial support in advance payments at the beginning of the season to STGs. These factories, mostly established on a partnership basis or as public limited firms, emerged after 1963-64, particularly in South India. According to the STGs of Udalguri district, they are not getting a better price for green tea leaves from bought-leaf factories. Therefore, they had to establish Farmer Producer Companies and Co-operative Factories. The bought-leaf factories have a major role in controlling the mechanism of price determination and quality tea produced by these players, affecting domestic price levels and damaging the quality perception of Indian tea export markets. There are different viewpoints regarding bought-leaf factories, the BLF owners, small tea growers, Association members and leaf agents in the entire tea production process and marketing system. However, with the emergence of BLFs in the present day, the growers now have the flexibility to select factories based on the competitive offer prices for green tea leaves. The growers can now even enter into agreements with multiple bought-leaf factories or estate factories for a better deal. Given the reliance on estate factory owners' behaviour and constraints, many growers opt to supply green tea leaves to the BLFs, where there are fewer restrictions regarding the quality of the leaves.

4.6 Changes in Land Use / Land Cover: Udalguri and No. 2 Rajagarh Village

Land cover signifies the spatial distribution of the different land cover classes on the earth’s surface, and can be directly estimated qualitatively as well as quantitatively by remote sensing, land use and its changes require the integration of natural and social scientific methods to determine which human activities are occurring in different parts of the landscape, even when the land cover appears to be same. Multi-temporal satellite imagery can provide the essential measurement of spatial and temporal phenomena. Eight LULC classes, i.e. forest, tea garden (including both BTE & STP), Agriculture, settlement, water bodies, sand bar, barren land and vegetation classes, are classified for the years 1991 and 2021. The results confirmed that the total area of the study area was 201340 ha (2013.40 sq. km). The areal coverage and percentage of each LULC for two periods, including 1991 and 2021, are summarised in Table 3. The LULC classification for the TM 1991 image shows that the majority of the study area was under agriculture, covering 86765 ha

(43.09%). Vegetation and settlement or built-up area covered an area of 32033 ha. (15.91%) and 19296 ha. (9.58%) respectively, whereas the aerial coverage of the Tea Garden and forest was 12762 ha (6.34%) and 14701 ha (7.30%). The other land coverage of the districts constitutes sand bar 11475 ha (5.70%), barren land 11102 ha (5.51%) and water bodies 13206 ha (6.56%) (Fig. 3). In contrast to the previous year period, in 2021, the greatest share of LULC from all classes was vegetation 37920 ha (18.83%). Agriculture covered an area of 72760 ha (36.14%). Tea garden and settlements or built-up areas constitute 33110 ha (16.44%) and 23620 ha (11.73%) respectively. The last aerial coverage was sand bar 12750 ha (6.33%), water bodies 11560 ha (5.74%) and forest 9620 ha (4.78%) respectively. From 1991 to 2021, land use land cover of the district shows that forest cover declined by 2.52% and agriculture by 6.96%. Tea gardens expanded by 10.11%, replacing significant agricultural areas. Settlement areas grew by 2.15% while barren land decreased by 5.51%. The minor shifts occurred in water bodies (-0.82%) and sand bars (+0.63%).

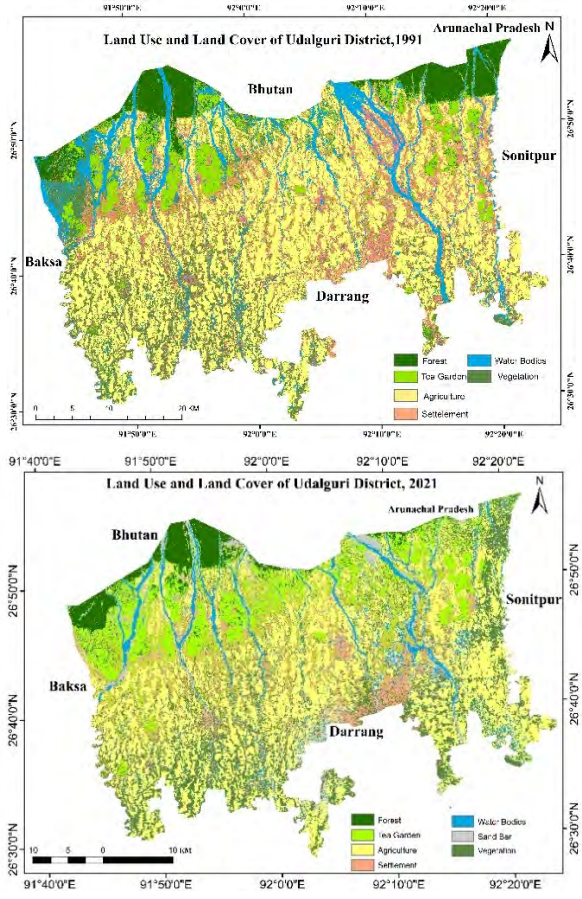

Fig. 3: Land Use / Land Cover of Udalguri District, 1991 and 2021 based on Landsat 4-5 TM (1991) and LANDSAT-8 (2021) datasets

Table 3: Area and Amount of change in different land use/ land cover categories in Udalguri District during 1991-2021

Land use/land cover categories	1991		2021		Change Between 1991 and 2021	
	Area in Ha	Area in %	Area in Ha	Area in %	Area change in Ha	Area change in %
Forest	14701	7.30	9620	4.78	-5081	-2.52
Tea garden	12762	6.34	33110	16.44	+20348	+10.11
Agriculture	86765	43.09	72760	36.14	-14005	-6.96
Settlement	19296	9.58	23620	11.73	+4324	+2.15
Water Bodies	13206	6.56	11560	5.74	-1646	-0.82
Sand Bar	11475	5.70	12750	6.33	+1275	+0.63
Barren land	11102	5.51	0	0	-11102	-5.51
Vegetation	32033	15.91	37920	18.83	+5887	+2.92
Total	201340	100	201340	100	0	0

It is observed that there has been a rapid proliferation of small tea growers with varying land-holding patterns, and the resultant diversification of economic activities has significantly changed the natural landscape of Udalguri district. Here, it focuses on how the shift from rabi crops to small tea plantations impacts land use and land cover (LULC) in different parts of the district. The study, based on an efficient methodology, has been able to identify diverse LULC types like small tea plantations, water bodies, forests, arecanut plantations, settlements, roads and other traditional crops, including paddy in No. 2 Rajagarh covering an area of 377.25 ha. This effort provides insight into spatial changes, highlighting the effects of agricultural transition on land use and environmental conditions due to the expansion of a small tea plantation in the village.

The analysis of the resultant LULC maps for 2010 and 2021 reflects the pivotal role of small tea plantations in LULC change in No. 2 Rajagarh village during 2010-2021 (Fig. 4). In 2010, autumn rice, open space, and maize dominated the landscape with a proportional coverage of 33.99%. However, due to a substantial increase in small tea plantation areas, its spatial extent has experienced an expansion of more than 2.7 times from its proportion of 11.51% to 31.86% during 2010-2021 by largely replacing autumn rice and maize cultivation (Table 4). On the other hand, winter rice cultivation has been introduced in the selected low-lying areas of the village. The land use land cover map of No. 2 Rajagarh village has been prepared on the cadastral map obtained from the Survey and Settlement Training Centre by incorporating a Google Earth background image through plot-by-plot digitisation in QGIS for 2010 and 2021.

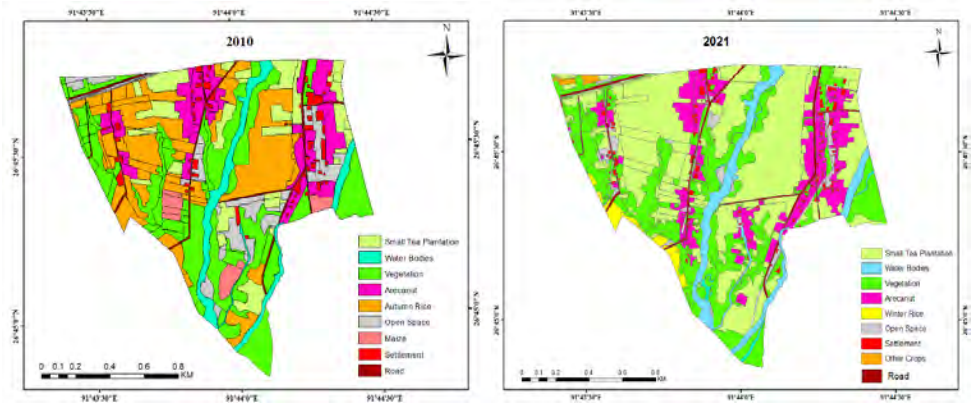

Fig. 4: Changes in Land Use / Land Cover in No. 2 Rajagarh, 2010 and 2021 based on data extracted from Google Earth (11/04/2010) & (17/01/2021)

Table 4: Pattern of Land Use / Land Cover Change in No. 2 Rajagarh (2010-2021)

Land use/land cover categories	2010		2021		Area Change between 2010 and 2021	
	Area(Ha)	Area(%)	Area(Ha)	Area(%)	Area change(Ha)	% difference in area change
Small Tea Plantation	43.42	11.51	120.20	31.86	76.78	20.35
Water Bodies	33.44	8.86	31.30	8.30	-2.14	-0.56
Vegetation Cover	76.09	20.17	72.2	19.14	-3.89	-1.03
Arecanut	41.64	11.04	41.93	11.11	0.29	0.07
Open Space	35.97	9.53	23.24	6.16	-12.73	-3.37
Settlement	27.70	7.34	29.64	7.86	1.94	0.52
Road	26.73	7.09	26.73	7.09	0.00	0.00
Autumn Rice	64.99	17.23	0.00	0.00	-64.99	-17.23
Winter Rice	0.00	0.00	22.95	6.08	22.95	6.08
Maize	27.27	7.23	0.00	0.00	-27.27	-7.23
Other Crops	0.00	0.00	9.06	2.40	9.06	2.40
Total	**377.25**	**100**	**377.25**	**100**	**0.00**	**0.00**

The analysis further reveals that the discontinuation of autumn rice and maize in the village has also been replaced by the cultivation of various crops, including vegetables, particularly in the low-lying patches unsuitable for tea. Thus, the shift from autumn rice and maize to small tea plantations indicates the preference for monoculture, largely in the form of tea plantations, leading to reduced crop diversity in the village. However, the expansion of small tea plantations has not affected the area under vegetation cover and the arecanut plantation in the village much.

4.7 Socio-Economic Determinants of Income among STGs: Insights from Multiple Linear Regression Analysis

A multiple linear regression analysis was conducted to examine the effect of various socio-economic factors on the income of small tea growers. The dependent variable is income (Rs/ha), and the independent variables included total number of workers (day/ha), years of schooling, Age of growers, family size, years of experience, production (kg/ha) and area under tea (ha). The results of the analysis are presented in Table 5.

Table 5: Model summary and coefficients of Multiple Linear Regression Analysis

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.998[a]	.995	.995	26406.315	1.717

a. Predictors: (Constant), Total no of workers/day/Hectare, years of schooling, Age, Family Size, Year of Experience, Production(kg/ha), Area (Tea in ha)

b. Dependent Variable: income(Rs/ha)

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	34474122053036.810	7	4924874579005.259	7062.843	.000[b]
	Residual	157588322040.313	226	697293460.355		
	Total	34631710375077.120	233			

a. Dependent Variable: income (Rs/ha)

b. Predictors: (Constant), Total no of workers/day/Hectare, years of schooling, Age, Family Size, Year of Experience, Production(kg/ha), Area (Tea in ha)

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	-11875.128	14266.547		-.832	.406		
	Family Size	4085.581	1123.933	.021	3.635	.000	.605	1.652
	Area (Tea in ha)	295720.948	10541.997	.906	28.052	.000	.019	51.864
	Production(kg/ha)	1.188	.395	.095	3.007	.003	.020	49.693
	Age	-76.859	259.241	-.002	-.296	.767	.702	1.425
	years of schooling	579.200	728.245	.004	.795	.427	.810	1.234
	Year of Experience	-665.589	491.711	-.009	-1.354	.177	.444	2.250
	Total no of workers/day/Hectare	-246.055	720.902	-.004	-.341	.733	.128	7.841

a. Dependent Variable: income(rs/ha)

Residuals Statistics

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	12370.16	3254053.25	286218.11	384652.578	234
Residual	-258101.953	62286.234	.000	26006.629	234
Std. Predicted Value	-.712	7.716	.000	1.000	234
Std. Residual	-9.774	2.359	.000	.985	234

a. Dependent Variable: income(rs/ha)

The R-value of 0.998 indicates a very strong correlation between the predictors or independent variables and the dependent variable, which is income (Rs/ha). The R^2 (0.995) suggests that the independent variables in the model explain 99.5% of the variability in income. The ANOVA results show the regression model is highly effective at explaining income (Rs/ha), with most variation explained by factors like plantation size, production and family size, leaving only a small unexplained portion. The very high F-statistic and significant p-value (0.000) confirm that the model is reliable, and these factors strongly influence income. Tea plantation size and production are the most impactful, as larger areas and higher yields significantly boost income, while family size also helps, likely by reducing labour cost. The other factors, like education and experience, have less impact, and age or workers per hectare show minimal effect.

The intercept value (-11875.2) is not statistically significant (p=.406), which indicates that when all independents are zero, the expected income is not meaningfully different from zero. There is a positive relationship between family size and income, as the coefficient (4085.581) indicates that as family size increases by one unit, income increases by Rs 4085.581, which is statistically significant ($p < .001$). The area under tea (Ha) has the strongest positive relationship with income, as the size of the tea plantation increases the plantation size by 1 ha, income jumps by a considerable amount. The production also positively influences income as each additional kg per hectare increases income by Rs 1.188, which is statistically significant. Age has a negligible effect on income (-76.859, $p = .767$), which suggests that the age of the growers does not meaningfully impact income. There is a slight positive effect of years of schooling and income (579.200), but statistically not significant ($p = .427$). There is a negative effect of years of schooling and income on the grower. Hiring more workers and more years of experience does not seem to help increase income.

4.8 Challenges Associated with the Sustainability of STGs

STGs in Udalguri district encounter significant challenges that impact their production and market relationships. The high costs and limited access to essential inputs such as fertilisers and pest control impact operations. The seasonal labour shortages during peak periods further hinder productivity. A lack of technical knowledge regarding modern cultivation practices results in inefficient or improper fertiliser use, impacting both soil health and crop yield. The fragmented landholding patterns add logistical and cost burdens and hamper efficient crop management. The limited financial support and access to credit prevent STGs from investing in improved equipment or resources. In terms of market relationships, STGs often depend on middlemen to sell their production due to a lack of direct buyers. This dependency reduces their bargaining power and cuts into profit margins. Moreover, price fluctuations create income instability and make it difficult to plan or expand. Due to inadequate road infrastructure and rural settings, STGs face delays in delivering fresh leaves to processing factories, which affects quality. The high costs of hired transportation add to their expenses, reinforcing reliance on middlemen for market access. A survey of 234 STGs in the Udalguri district revealed several significant challenges

impacting their production and market relationship. Approximately 68% of growers reported high input costs with an average annual expenditure of Rs 16,200 on fertilisers and pest control, consuming nearly 35% of their income. Seasonal labour shortage affected 72% of growers, particularly during peak season, increasing wages by 25% from Rs 320/day to Rs 400/day. The fragmented landholdings on an average of 0.85 ha were a concern for 60% of respondents, increasing logistical and transportation costs by 18%. The limited access to credit was reported by 63% of growers with average loans of Rs 22,000 meeting only 50% of their operational needs. Furthermore, 78% of STGs relied on middlemen receiving Rs 14/kg for fresh leaves compared to the market rate of Rs 20/kg, leading to a 30% reduction in profit margins. The poor road infrastructure delayed leaf deliveries for 55% of growers, reducing quality and income by 12%. Additionally, 58% lacked technical knowledge, leading to inefficient fertiliser use. These challenges collectively affect the sustainability and profitability of STGs in the district.

5. Conclusion

The foregoing discussion reveals that the small tea plantation, which began largely in the northern part of the Udalguri district, particularly around the large tea estates in the early 1990s, experienced an increase in area and number of small tea growers during the last two decades in Bhergaon and Udalguri CD blocks along with establishments of BLFs. The expansion of small tea plantations, however, remained very slow in the Mazbat CD block, where it is still exclusively reliant on tea estate factories to provide green leaves. Given higher returns from small tea plantations compared to traditional agricultural practices, including rice, the area under autumn rice and maize has been witnessing a decline with the expansion of the area in the district. The process of simplification, i.e. Small Tea Plantation, varies from the Tea Estates in terms of production structure and market strategies, including the spatial dimension. However, the shift from tea estates to small tea plantations carries mixed economic implications, including empowerment of STGs and challenges of economic sustainability. Consequently, mollification neither entirely ends nor directly replaces production methods that were inherited from colonial innovations in the plantation sector.

Although the expansion of small tea plantations brings about changes in land use/land cover, their impact on crop diversification through the introduction of mixed cropping appears to be more economically beneficial. Moreover, the involvement of local entrepreneurs in the tea sector diversifies income sources beyond traditional agriculture. The bought-leaf factories not only buy the green leaves from the STGs at a competitive price but also generate employment opportunities, aiding poverty alleviation. So far, the future of small tea growers in Udalguri district is concerned, and it hinges on a variety of factors, including market dynamics, government regulations, environmental considerations, and socio-economic circumstances. Adoption of modern agricultural practices and technology can enhance productivity and quality, enabling small tea growers to compete effectively. Moreover, government policies related to agriculture, land use and taxation significantly impact the viability of small tea growers. Supportive policies such as subsidies,

access to credit and extension services can facilitate growth in the tea sector. Access to markets, especially for small-scale producers and ensuring fair prices for their green leaves are crucial for the sustainability of small tea growers. Strengthening cooperatives or forming collective marketing arrangements will help small tea growers negotiate better prices and access wider markets.

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ANALYSIS OF REGIONAL DISPARITIES IN THE LEVEL OF DEVELOPMENT OF GRAM PANCHAYATS IDENTIFIED UNDER THE SANSAD ADARSH GRAM YOJANA (SAGY) IN RAJASTHAN, INDIA

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Abstract

Rural development is a vital yet complex undertaking in India, where most of the population resides in rural areas. This study investigates the disparities in the development levels of Gram Panchayats (GPs) under the Sansad Adarsh Gram Yojana (SAGY) in Rajasthan. Using a composite index of 35 infrastructure indicators, the research evaluates 190 GPs, categorising them into four groups: relatively highly developed, moderately developed, low developed, and very low developed. The results reveal significant regional disparities—only 12.10% of GPs fall into the highly developed category, while 40% are classified as low developed, and 9.48% as very low developed. The findings underscore the necessity for targeted interventions to address these inequalities, especially in underperforming regions. The study emphasises the importance of continuous monitoring, collaborative efforts, and tailored resource allocation to promote equitable development in rural areas, making a case for adaptive strategies in rural development programs like SAGY.

Keywords: Rural development, Regional disparities, Rajasthan, Sansad Adarsh Gram Yojana (SAGY), Development levels

1. Introduction

Rural development is a complex and multifaceted endeavour aimed at improving the quality of life and economic well-being of rural populations across the country. India, with a significant 70 per cent portion of its population residing in rural areas (World Bank, 2023), recognises the critical importance of uplifting these regions for overall national development. The concept of rural development in India encompasses various dimensions, including economic empowerment, social inclusion, infrastructure development, environmental sustainability, and governance reform.

Historically, rural development in India has been intertwined with agrarian reforms and initiatives aimed at boosting agricultural productivity and rural livelihoods (Swamy, 2012). For example, the Green Revolution of the 1960s and 1970s introduced high-yielding

crop varieties, irrigation infrastructure, and agricultural credit schemes, leading to a significant increase in agricultural output and rural incomes (Chanti, 2017). However, despite these efforts, rural India faces numerous challenges, including poverty, unemployment, inadequate access to basic services such as education and healthcare, infrastructure deficits, and environmental degradation (Saroha, 2017). In recent years, there has been a shift towards a more holistic approach to rural development, emphasising the need for comprehensive strategies that address the diverse needs and aspirations of rural communities. Initiatives such as the National Rural Employment Guarantee Act (NREGA), launched in 2005, aim to provide rural households with guaranteed employment opportunities, thereby enhancing livelihood security and reducing poverty (Kedia, 2023). Similarly, the Pradhan Mantri Gram Sadak Yojana (PMGSY) focuses on improving rural connectivity by providing all-weather road infrastructure, facilitating market access, and promoting economic growth in rural areas (Panda & Majumder, 2013). Moreover, the government has been promoting rural entrepreneurship and skill development through programs like the Deendayal Antyodaya Yojana - National Rural Livelihoods Mission (DAY-NRLM), which aims to empower rural women and marginalised communities by facilitating access to financial services, capacity-building initiatives, and market linkages (Chatterjee, 2017).

Environmental sustainability is also a key aspect of rural development in India, with initiatives like the Swachh Bharat Abhiyan focusing on sanitation and hygiene promotion in rural areas and schemes promoting sustainable agriculture practices and natural resource management (Khurana & Raj, 2021; Kumar Mohapatra, 2015; Ramesh et al., 2016). However, despite these efforts, challenges persist, and there is a need for continued innovation, investment, and policy reform to address the complex and interconnected issues facing rural India (Saroha, 2017). Regional disparity in India prevails at vast levels, showing stark differences in development outcomes and opportunities across various geographical regions. These disparities manifest in terms of economic growth, social indicators, infrastructure availability, and access to essential services. (Kowal & Paul, 2019). Factors such as historical legacies, uneven distribution of resources, and policy priorities have contributed to the widening gap between developed and less-developed regions. (Leyshon, 2021). In the rural-urban scenario of India, significant developmental disparities exist between rural and urban areas, reflecting economic, social, and infrastructural dimensions. (Hasib & Ahmed, 2012). Rural areas, home to a substantial portion of the population, often face challenges such as limited access to basic amenities like healthcare, education, and sanitation. Agricultural dependency, coupled with inadequate infrastructure and employment opportunities, contributes to rural poverty and migration to urban centres in search of better prospects (Chigbu, 2015; Joshi, 2019). On the other hand, urban areas, characterised by rapid industrialisation and modern infrastructure, offer greater employment opportunities, access to services, and a higher standard of living. However, urbanisation brings its own set of challenges, including congestion, pollution, inadequate housing, and socio-economic disparities (Punyamurthy & Bheenaveni, 2023). Addressing the rural -urban development gap necessitates holistic

strategies that prioritise rural infrastructure development, livelihood enhancement, skill-building, and decentralisation of governance. Sustainable rural development can help alleviate challenges faced by urban areas, such as overcrowding, strain on urban resources, and socio-economic disparities. By investing in rural development, India can potentially reduce mass migration to cities, thereby easing pressure on urban infrastructure and improving overall urban living conditions. Bridging the rural-urban divide is essential for achieving balanced regional development and ensuring inclusive growth across the country (Khurana & Raj, 2021; Ramesh et al., 2016; Rayjada, 2023; Sarabu, 2016).

Rural development in Rajasthan is a multifaceted endeavour encompassing infrastructure enhancement, community empowerment, inclusive growth, and environmental sustainability. Government schemes like SAGY play a pivotal role in driving comprehensive, participatory, and sustainable development in rural areas. It emphasises community participation and collaboration, echoing findings from research suggesting the significance of participatory approaches in rural development initiatives. (Dwivedi, 2015) . By involving villagers, government officials, and non-governmental organisations (NGOs) in decision-making processes, SAGY ensures that development projects are tailored to meet the unique requirements of each village, enhancing their effectiveness and sustainability. (Tiwari et al., 2023). Inclusive growth is another key focus of SAGY, with specific attention given to marginalised groups within rural communities. SAGY's provision of skill development programs, access to credit facilities, and support for livelihood diversification aligns with these findings, aiming to reduce disparities and promote social inclusion in rural Rajasthan (Raj et al., 2018). It also emphasises environmentally sustainable practices, reflecting growing recognition of the importance of environmental conservation in rural development efforts. (Pathak Neemaand Kothari, 2013). By promoting eco-friendly initiatives like rainwater harvesting and renewable energy adoption, SAGY seeks to enhance environmental resilience and ensure the long-term prosperity of rural communities in Rajasthan. The specific objective of the study is to examine the regional disparities in the level of development within the Sansad Adarsh Gram Yojana (SAGY) areas of Rajasthan.

2. Study Area

Rajasthan, the largest state in India by area, is characterised by its diverse geographical landscape, rich cultural heritage, and significant rural population (Sharma & Mishra, 2021). With a substantial portion of its population residing in rural areas, the state faces unique challenges and opportunities in the realm of rural development. Infrastructure development is recognised as a cornerstone of rural development initiatives in Rajasthan (Garg, 2017). Studies emphasise the pivotal role of infrastructure, including roads, sanitation facilities, healthcare centres, and educational institutions, in stimulating economic growth and enhancing living standards in rural areas (Agrawal, 2021). Government schemes like the Sansad Adarsh Gram Yojana (SAGY) have been instrumental in addressing infrastructure deficits and improving basic amenities in rural Rajasthan. Participatory approaches to rural development have gained traction in Rajasthan, with a growing body of research highlighting the importance of community participation and

empowerment in driving sustainable change. Scholars underscore the significance of involving villagers, government officials, and non-governmental organisations (NGOs) in decision-making processes to ensure the relevance and sustainability of development projects (Rayjada, 2023). Initiatives like SAGY prioritise community engagement, fostering ownership and accountability at the grassroots level. Inclusive growth lies at the heart of rural development strategies in Rajasthan, with a focus on addressing socio-economic disparities and promoting social equity. Research by Ranga Rajan Krishnamani and world bank highlights the importance of targeted interventions aimed at empowering marginalised groups, including women, children, and the elderly, to achieve more equitable outcomes (Krishnamani, 2016).

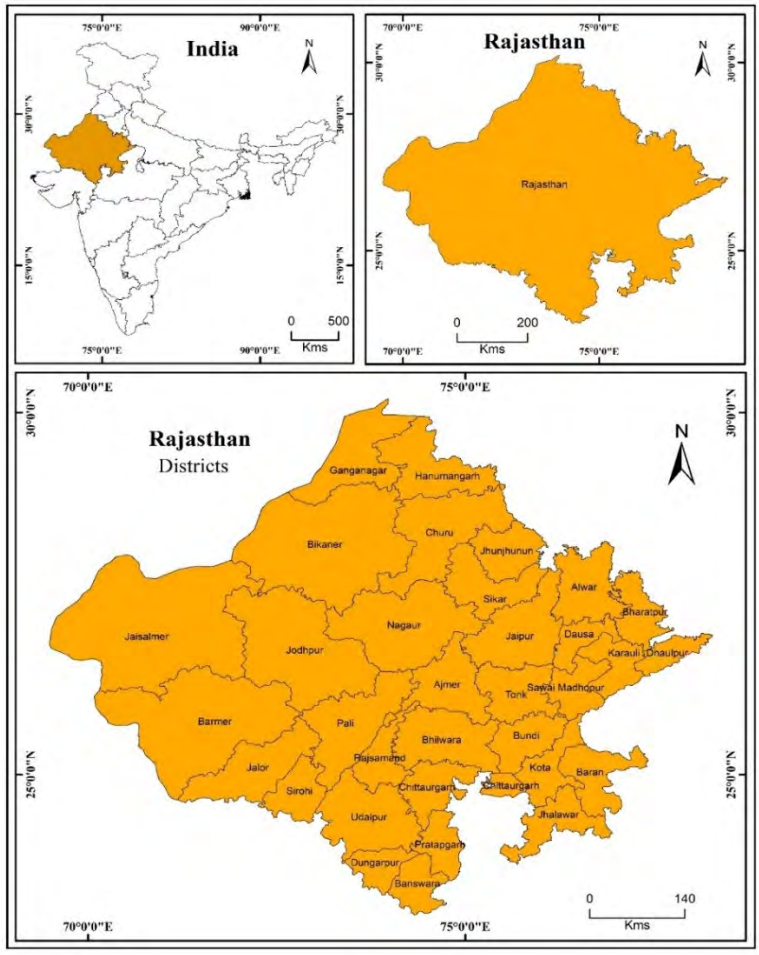

Fig. 1: Location Map of the Study Area

Government programs such as SAGY incorporate provisions for skill development, access to credit, and livelihood diversification to reduce disparities and promote social inclusion in rural Rajasthan (Sharma & Chouhan, 2024). Environmental conservation

emerges as a critical consideration in rural development discourse in Rajasthan, given the state's vulnerability to environmental degradation and climate change. Studies underscore the importance of integrating eco-friendly practices and technologies into rural development initiatives. (Sharma et al., 2022). SAGY promotes environmental sustainability through initiatives such as rainwater harvesting and renewable energy adoption, aiming to enhance resilience and ensure long-term prosperity in rural communities (SAGY, 2022).

The study focuses on Rajasthan, the largest state in India, which is an integral part of the Sansad Adarsh Gram Yojana (SAGY) Zone-2. Rajasthan is situated between latitudes 23.3° North and 30.12° North, and longitudes 69.3° East and 78.17° East. This positioning places Rajasthan predominantly in the northwestern part of India. Covering an area of 342,239 square kilometres, Rajasthan is notable for its vast and diverse geographical features, which include the Thar Desert, the ancient Aravalli Range, and its fertile plains. According to the 2011 Census, the state has a population of approximately 68.6 million people. The arid climate of Rajasthan plays a crucial role in shaping its agricultural practices and socio-economic conditions. Administratively, the state is divided into 7 divisions, 33 districts, 244 tehsils, and 9,177 Gram Panchayats, supporting a rural population across 39,753 inhabited villages. Politically, Rajasthan holds significant influence with its 25 Lok Sabha seats and 10 Rajya Sabha seats. The region faces various developmental challenges, some of which it shares with its neighbouring state, Gujarat, under the collaborative efforts within SAGY Zone-2.

3. Database and Methodology:

The study is grounded in secondary data, collected from reputable sources such as the District Census Handbooks (2011), the Mission Antyodaya database (2020), the Socio-Economic Caste Census (2011), and the Government of Rajasthan websites (2020-21). These datasets provided comprehensive insights into development disparities across 190 SAGY Gram Panchayats in Rajasthan, offering a rich and multidimensional view of regional development.

3.1 Rationale for Indicator Selection:

The methodology hinges on a well-thought-out selection of 35 indicators (listed in Table 1) across four categories: demographic, economic, infrastructural, and socio-cultural. These indicators were selected to provide a multidimensional view of development, reflecting key areas such as agricultural infrastructure, education, healthcare, and social services. These indicators were specifically chosen to reflect critical aspects of regional development, ensuring that the analysis covers not only economic performance but also infrastructural quality and social well-being.

These indicators were selected based on their relevance to both the overall objective of the research—measuring development disparities—and their proven applicability in similar developmental studies.

Table 1: Indicators Used to Measure Levels of Development

Variable	Indicators of Development	Description
Agriculture and Livelihood Support		
X1	Total households engaged in farm activities	Indicates the reliance of the local population on agriculture for their livelihood. A higher number suggests an agrarian economy and highlights the importance of agriculture-based interventions.
X2	Availability of government seed centre	Seed centres provide quality seeds, critical for improving crop yield and promoting sustainable farming practices. Their availability reflects government support for agriculture.
X3	Availability of watershed development project	Watershed projects help in water conservation, improving soil fertility, and promoting sustainable agricultural practices. They are vital for water-scarce regions.
X4	Availability of rain harvest system	Rainwater harvesting systems aid in water conservation and ensure a reliable water supply, especially in areas prone to drought or erratic rainfall.
X5	Net sown area in hectares	Represents the amount of land under cultivation, reflecting the agricultural potential and intensity of farming activities in the area.
X6	Availability of soil testing centre	Soil testing services help farmers optimize the use of fertilizers and manage soil health, leading to better agricultural productivity.
X7	Availability of fertilizer shop	Access to fertilizers is crucial for improving crop productivity, and the availability of shops ensures that farmers have timely access to these inputs.
X8	Area irrigated in hectares	Irrigation is a critical factor for agriculture, especially in areas with insufficient rainfall. More irrigated land often correlates with higher agricultural productivity.
Livestock and Dairy Development		
X9	Availability of livestock extension services	These services provide technical support to farmers engaged in animal husbandry, improving livestock health and productivity.
X10	Availability of milk routes	Milk routes are essential for dairy farmers to market their produce. A well-established route indicates good infrastructure for dairy farming.
X11	Availability of veterinary hospital	Veterinary hospitals ensure livestock health, crucial in rural areas where animal husbandry is a significant part of the economy.
Housing and Living Conditions		

X12	Total households with kutcha wall and roof	A higher number of such houses indicates poor housing conditions, reflecting low living standards and the need for better housing infrastructure.
X13	Total households with PMAY house	This indicator tracks the number of houses built under the Pradhan Mantri Awas Yojana (PMAY), a government scheme for affordable housing. More PMAY houses suggest better housing conditions.
Water, Roads, and Transport Infrastructure		
X14	Availability of piped tap water	Piped water supply indicates improved access to clean and safe drinking water, a crucial factor in rural health and well-being.
X15	Village connected to all-weather road.	All-weather roads ensure year-round connectivity, facilitating access to markets, healthcare, and education, and are key to overall rural development.
X16	Availability of internal pucca road	Internal roads made of durable materials (pucca) improve intra-village connectivity, enhancing mobility and access to services within the village.
X17	Availability of public transport	Public transport is essential for rural mobility, providing access to employment opportunities, healthcare, education, and markets.
X18	Availability of railway station	Proximity to a railway station improves connectivity to larger urban centres, facilitating trade, travel, and access to broader economic opportunities.
Electricity and Digital Connectivity		
X19	Availability hours of domestic electricity	Regular and sufficient electricity supply is essential for daily life, including education, healthcare, and economic activities like farming and small-scale industries.
X20	Availability of CSC (Common Service Center)	CSCs offer digital services like e-governance, banking, education, and telemedicine. Their presence is crucial for bridging the digital divide in rural areas.
X21	Availability of bank	Banks provide access to financial services, promoting savings, credit, and economic activities. Their availability reflects economic integration.
X22	Availability of ATM	ATMs ensure easy access to cash, supporting financial inclusion and enabling smoother transactions in rural economies.
X23	Availability of post office	Post offices provide postal services and often financial services, playing a key role in communication and financial inclusion in rural areas.
X24	Availability of broadband	Broadband access is critical for digital connectivity, facilitating education, communication, and access to government services.

Public Distribution and Education		
X25	Availability of PDS (Public Distribution System)	The PDS ensures the availability of subsidized food grains, an essential service for ensuring food security among the rural poor.
X26	Availability of primary school	The presence of primary schools indicates basic educational infrastructure, which is essential for early childhood education.
X27	Availability of mid-day meal scheme	The mid-day meal scheme provides meals to school children, improving nutrition and encouraging school attendance.
X28	Availability of middle school	Middle schools provide further education beyond the primary level, supporting continued education for children in rural areas.
X29	Availability of high school	High schools are crucial for secondary education, enabling rural students to access higher levels of education without having to travel long distances.
Healthcare and Market Access		
X30	Availability of market	A market in or near the village supports local commerce, agricultural trade, and access to consumer goods, promoting economic activities.
X31	Availability of PHC (Primary Health Center) or CHC (Community Health Center)	Access to healthcare facilities like PHCs and CHCs is critical for providing basic and emergency healthcare services in rural areas.
X32	Availability of Jan Aushadhi Kendra	These centres provide affordable generic medicines, improving access to essential healthcare for the rural population.
X33	Community waste disposal system	A proper waste disposal system helps maintain sanitation and hygiene, which is essential for public health.
Social Services and Health		
X34	Availability of Aanganwadi center	Aanganwadi centres provide early childhood care and development services, including nutrition, preschool education, and health check-ups for children and mothers.
X35	Availability of mother-child health facilities	These facilities are critical for ensuring maternal and child health, offering services like prenatal care, vaccinations, and nutrition programs.

Source: Prepared by author based on Census of India, 2011 & Mission Antyodaya, 2020

The 35 indicators were chosen to assess multiple facets of rural development, which include agricultural support (e.g., availability of soil testing centres, fertilizer shops, irrigation), infrastructure (e.g., roads, railways, electricity), basic services (e.g., healthcare, education, water supply), and socio-economic amenities (e.g., banking, communication, housing). They also cover economic, social, and infrastructural dimensions crucial to understanding rural development. Many of the variables focus on agriculture, which remains a key livelihood source in rural India, while others emphasize basic living conditions and services, contributing to an overall assessment of development. Indicators such as the availability of veterinary services, watershed projects, and Aanganwadi centres address the unique needs of rural populations, particularly in areas with agricultural and livestock-based economies.

The selected indicators collectively assess multiple dimensions of rural life, providing a comprehensive understanding of rural development. Agriculture and livelihood support indicators highlight the critical infrastructure and services necessary for farming, which is the primary source of income for many rural households. Livestock and dairy development further diversify rural income sources, while housing and living conditions reflect socio-economic well-being. Water, roads, and transport infrastructure are essential for mobility, market access, and service delivery, improving economic opportunities and quality of life. Access to electricity and digital connectivity is vital for modern economic activities, education, and governance, while public distribution and education ensure food security and human capital development. These indicators provide a holistic picture of rural development, helping identify strengths and gaps that require targeted interventions to improve living standards and promote sustainable growth in rural areas.

3.2 Weightage of Indicators:

To ensure objectivity in the assessment, each indicator was assigned a binary weightage of either 1 or 0. This weightage was based on the presence (1) or absence (0) of the indicator in a given Gram Panchayat. For example: If a Gram Panchayat has access to public transport, the indicator for public transport will be assigned a weightage of 1; if not, it receives a weightage of 0. Similarly, for healthcare facilities, the availability of a Primary Health Center (PHC) or Community Health Center (CHC) is assigned a 1 if available and 0 if not. This binary approach ensures that each indicator is given equal importance in the analysis, regardless of the specific category it belongs to. Thus, the final development score of a Gram Panchayat is calculated as the sum of the weights across all indicators.

3.3 Standardization and Composite Index:

After assigning weights, the raw data for each indicator is standardized using Z-scores to ensure comparability across different scales. The formula used for Z-score standardization is:

- The first step is to select the indicators (**X1……. Xn**) that you want to include in the composite index.
- The next step is to standardize the indicators by converting them into a standard scale, such as Z-scores. This allows for the comparison of indicators across different areas or periods.
- The formula for calculating the Z-score for a particular indicator is:

$$Z_{ij} = X_i - \bar{X} / \sigma$$

Where;

Z_{ij} = standard score of the i^{th} observation
X_i = original value of the observation
$\bar{X}$ = mean of all the values of **x**
σ = standard deviation

- Calculate the composite index by combining the standardized indicators into a single index by dividing **(X- $\bar{X}$)** by Standard Deviation (SD). i.e. **(X- $\bar{X}$ /SD).**
- In the next step the Gross Value has been calculated by the formula:

Gross value = Mean + (Z-score * SD)

- The composite index scores are computed by dividing the gross value by the total number of development indicators.

CI = GV/ Number of indicators

3.4 Justification of the Approach:

This approach ensures that each development indicator is given an equal chance to influence the final composite index. The binary weightage (1 for presence, 0 for absence) reflects whether a Gram Panchayat has access to critical resources, while the Z-score standardization levels the field across indicators measured in different units. The indicators selected align with the study's objectives of assessing regional development holistically, while the weightage system ensures transparency in how the absence or presence of key resources contributes to the development score. This method guarantees that no single category (economic, infrastructural, demographic, or socio-cultural) disproportionately influences the outcome.

4. Results and Discussion

The analysis of 35 development indicators across 190 Gram Panchayats under the Sansad Adarsh Gram Yojana (SAGY) in Rajasthan reveals significant spatial variations in performance levels. These indicators, which span demographic, economic, infrastructural, and socio-cultural dimensions, provide a comprehensive picture of the developmental

disparities within the state. The district-wise classification highlights the diverse challenges and opportunities across the region, helping to identify areas for targeted intervention.

Table 2: Level of Development

Composite Index (CI)	Level of Development
Above 0.5	Relatively High Developed
0.5 to 0	Moderately Developed
0 to -0.5	Low Developed
Below -0.5	Very Low Developed

4.1. Relatively High Developed Gram Panchayats

The relatively highly developed Gram Panchayats, accounting for 12.10% (23 Gram Panchayats), exhibit above-average performance across most development indicators. Districts like Jaipur, Jodhpur, and Udaipur are prominent in this category (Fig. 2), benefiting from better infrastructure and socio-economic services. Strong healthcare access, particularly the availability of Primary Health Centers (PHCs) and Community Health Centers (CHCs), is a significant contributor to the high performance in these areas, with Jaipur and Udaipur showing remarkable health outcomes. Educational infrastructure is another key strength, particularly in districts like Jaipur and Alwar, where primary and high schools, along with programs such as the midday meal scheme, are well-established. In terms of public transport and road connectivity, Jaipur leads with well-maintained pucca roads and all-weather roads, ensuring economic linkages and mobility.

However, some GPs in districts like Barmer and Churu struggle with deficiencies in agricultural services despite their relatively high development status. The lack of advanced irrigation systems and livestock extension services suggests that further improvements in these sectors could enhance overall development. Ajmer and Chittorgarh also demonstrate robust performance, driven by well-established roads, schools, healthcare services, and water conservation efforts. Bhilwara and Dungarpur follow closely, benefiting from government initiatives in agriculture and infrastructure.

4.2. Moderately Developed Gram Panchayats

The Moderately Developed Gram Panchayats, comprising 38.42% (73 Gram Panchayats), show a mix of progress and underperformance. Districts like Ajmer, Bhilwara, and Bikaner fall into this category, where moderate development in infrastructure and economic indicators is evident but requires further enhancement. Key strengths include improvements in basic education and access to piped water, particularly in Bhilwara and Ajmer. The presence of financial services such as banks, ATMs, and post offices also contributes to the overall development of these areas. However, significant challenges remain, especially in healthcare. Districts like Bikaner and Ajmer experience limited access to advanced healthcare services, particularly mother-child healthcare.

Additionally, waste management systems are inadequate in these areas, adversely affecting public health and sanitation, especially in Bikaner and Jalore. Sikar has made decent progress in agriculture and connectivity, but still needs improvements in healthcare and education. Similarly, rural Jaipur shows moderate development, with varying levels of access to education and infrastructure.

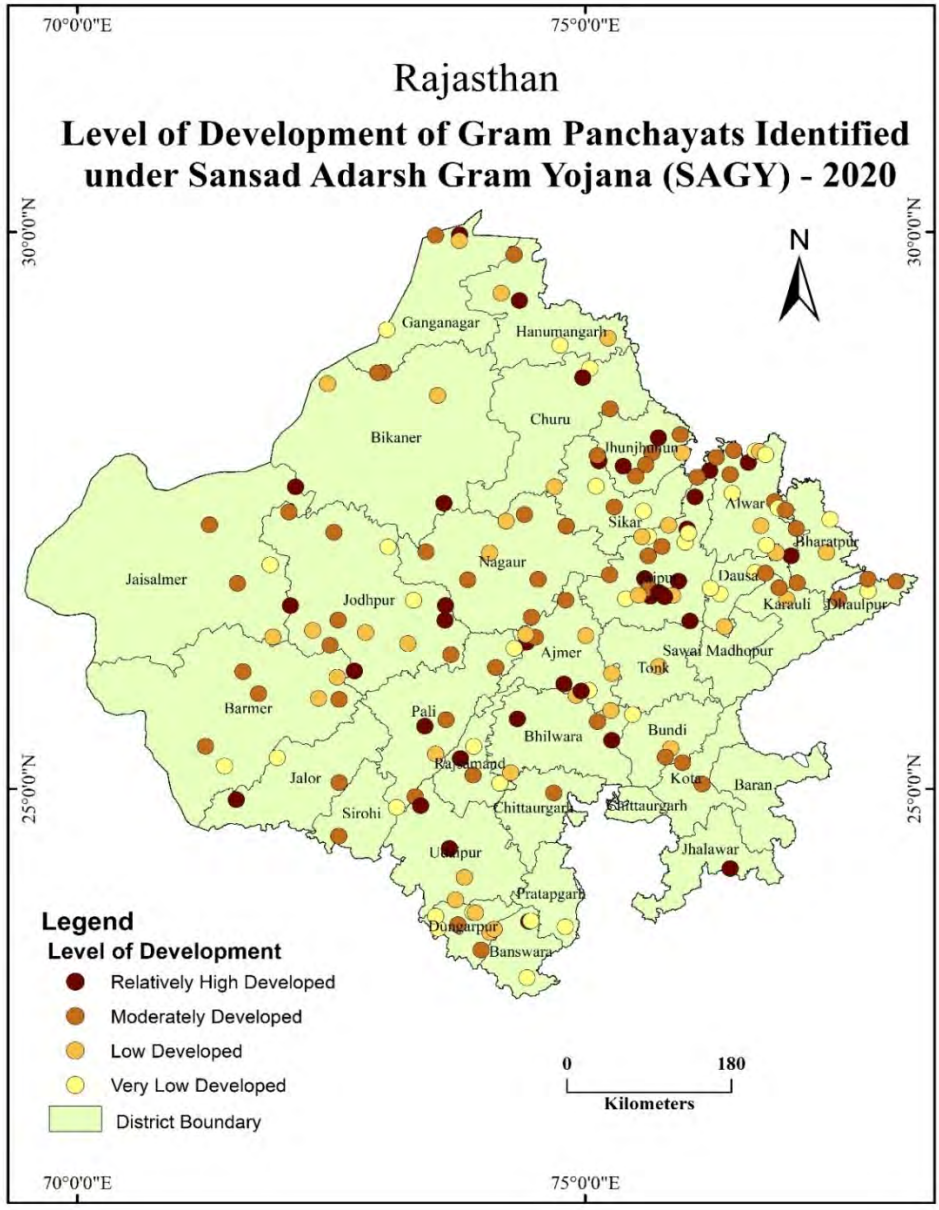

Fig. 2: Level of Development of Gram Panchayats Identified under Sansad Adarsh Gram Yojana (SAGY)- 2020-21

4.3. Low Developed Gram Panchayats

The largest group, the Low Developed Gram Panchayats, encompasses 40% (76 Gram Panchayats) of the total and includes districts like Barmer, Dholpur, and Sikar. These areas are characterised by underdeveloped socio-economic infrastructure and lagging performance across most indicators. Despite the overall low development, some strengths can be observed, such as a high level of agricultural engagement. In districts like Barmer and Sikar, agriculture plays a central role in the local economy, with high participation in farming activities and large areas of net sown land.

However, the lack of basic amenities such as sanitation, housing, and education is a pressing issue. Many households in Dholpur and Barmer still rely on temporary (kuccha) housing, and access to sanitation facilities remains inadequate. Furthermore, educational and transport services are severely lacking, particularly in Barmer and Dholpur, where many villages have limited access to high schools, public transport, and postal services. The absence of broadband and IT infrastructure in districts like Sikar and Barmer also hampers access to digital services, impacting education, governance, and economic development opportunities.

Table 3: Level of Development of SAGY's Gram Panchayat of Rajasthan, 2020-21

S. No.	Level of Development	Composite Index Value	No. of SAGY GP	Per cent
1	Relatively high developed	Above 0.50	23	12.10
2	Moderately high developed	0.50 to 0	73	38.42
3	Low developed	0 to -0.50	76	40.00
4	Very Low developed	Below -0.50	18	09.48
Total			**190**	**100.00**

4.4. Very Low Developed Gram Panchayats

The Very Low Developed Gram Panchayats, which represent 9.48% (18 Gram Panchayats), are concentrated in districts like Jaisalmer, Barmer, and Jalore, where severe developmental challenges are evident. These areas face critical issues in healthcare, education, and basic infrastructure. In Jaisalmer and Jalore, healthcare facilities, including Aanganwadi centres and PHCs, are scarce, and access to mother-child health services is limited. Educational infrastructure is similarly weak, with minimal availability of primary and high schools. Water scarcity is another major concern in this category, particularly in the desert regions of Jaisalmer, where access to clean drinking water and sanitation services is inadequate. The lack of rainwater harvesting systems exacerbates the situation, contributing to chronic water shortages. Additionally, many households in these districts live in temporary housing, and the lack of livelihood diversification further contributes to the economic vulnerability of these regions.

4.5 Spatial Variations within Districts

The study finds notable spatial variations within districts. Barmer, for example, has a high concentration of Gram Panchayats classified as low-developed or very low-developed, emphasising the need for targeted investments in infrastructure, particularly in areas such as sanitation, healthcare, and transport connectivity. Jaisalmer, facing harsh environmental conditions, suffers from severe deficits in water supply and educational infrastructure. In contrast, districts like Jaipur and Udaipur show better overall performance, with a significant number of Gram Panchayats in the relatively highly developed category, thanks to strong public services, healthcare, and road connectivity. Bikaner and Ajmer, though falling predominantly in the moderately developed category, demonstrate reasonable progress in education and economic indicators but require improvements in healthcare services and sanitation systems.

District-specific strategies that address the unique challenges of each region are indispensable. For instance, Barmer and Jaisalmer need urgent investments in water supply, sanitation, and healthcare infrastructure, while Ajmer and Bikaner should focus on improving waste management and expanding educational services. Water scarcity remains a pressing issue in districts like Jaisalmer and Barmer, necessitating the expansion of rainwater harvesting systems and improved irrigation facilities. Similarly, healthcare access, particularly in terms of PHCs, CHCs, and Aanganwadi centres, needs to be expanded, especially in the Very Developed districts. Furthermore, improving high school availability in these regions is essential for long-term socio-economic development.

The analysis of development indicators across Rajasthan's Gram Panchayats reveals substantial spatial variations in performance. Districts like Jaipur and Udaipur show commendable progress, while western districts such as Barmer and Jaisalmer face significant developmental challenges. The heterogeneity of development across districts underscores the need for tailored, district-specific interventions that address the unique needs of each region. Expanding infrastructure, particularly in healthcare, education, water supply, and sanitation, is essential to bridging the development gap and ensuring more equitable growth across the state.

5. Conclusion

The analysis of the development levels of Gram Panchayats under the Sansad Adarsh Gram Yojana (SAGY) in Rajasthan reveals significant regional disparities, highlighting the uneven progress among villages. While some Gram Panchayats have made commendable advancements, with a higher Composite Index (CI) and falling into the "Relatively High Developed" category, a large number remain in the "Low Developed" and "Very Low Developed" categories. This underscores the complexity of rural development and the challenges in achieving uniformity across regions.

The classification of Gram Panchayats into four levels of development—Relatively High Developed, Moderately Developed, Low Developed, and Very Low Developed—reflects the nuanced nature of rural development in the state. The analysis shows that 40% of the Gram Panchayats fall under the "Low Developed" category, while only 12.10% are "Relatively High Developed." This indicates that, while significant progress has been made in certain areas, there are still substantial gaps in infrastructure, healthcare, education, and socio-economic opportunities that need to be addressed. The presence of 9.48% of Gram Panchayats in the "Very Low Developed" category further accentuates the urgent need for targeted interventions.

The findings of the study suggest that a one-size-fits-all approach to rural development is not effective. Instead, tailored interventions that consider the unique challenges and opportunities of each Gram Panchayat are essential. This includes addressing deficits in basic services, such as water supply, sanitation, healthcare, education, and transportation, while also fostering human capital and economic opportunities. Additionally, the promotion of sustainable practices, particularly in water management and agriculture, is crucial for long-term development.

Continuous monitoring and evaluation of the SAGY initiative are also critical. Learning from the success stories of the relatively highly developed Gram Panchayats can help replicate best practices in lower-performing areas. Policymakers and stakeholders should work together to ensure that resources are allocated effectively to address the most pressing needs, particularly in the very low developed Gram Panchayats.

In conclusion, while SAGY has laid the groundwork for transformative rural development in Rajasthan, addressing regional disparities remains a critical challenge. Achieving equitable and inclusive development requires collaboration between government agencies, local communities, and development partners. By prioritizing the least developed villages and focusing on sustainable growth, Rajasthan can make significant progress toward achieving the goals of SAGY and ensuring a prosperous future for its rural population.

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EXPLORING THE QUALITY OF LIFE OF THE SELECTED INDIGENOUS TRIBES IN THE HILLY TERRAIN OF SUB-HIMALAYAN NORTH BENGAL

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Abstract

The quality of life of the hilly tribes of India is crucial to understand. For this, the study attempted to analyse the socio-demographics, habitation, livelihood conditions, and quality of life of the tribal communities, namely the Tamang, Lepcha, and Sherpa tribes, in the hilly areas of Darjeeling and Kalimpong districts of West Bengal. To meet this objective, 471 tribal household surveys were conducted using a questionnaire schedule, structured interviews, and field surveys. The research considers both the socioeconomic and demographic well-being of individual tribes or tribal communities with their physical capacity, psychological, level of independence, financial resources, social relationships, living environment and surroundings, spirituality, religion, and personal belief systems. The study finds that these tribal communities underwent many socio-demographic, habitat, and economic challenges even in the twenty-first century. Moreover, they required an improvement in their quality of living. The prevalence of inadequate higher education, diminished social participation, marital disorders, health issues, substandard housing, unmet household needs, primary employment, reduced income, financial obligations towards dependents, limited livestock, and recurrent financial crises was notable. Addressing these issues requires targeted policies, education and skill development, and community-driven initiatives to improve their livelihoods. These measures will enhance the quality of life among the tribes and promote inclusive regional growth.

Keywords: Demographic, Livelihood Conditions, Quality of life, Scheduled Tribe, Darjeeling Himalayan Region

1. Introduction

Socio-demographic and economic aspects, such as satisfaction of needs, well-being, working conditions, and other indicators, are often broadly discussed. Still, it is crucial to understand the contemporary status of the indigenous peoples, especially the tribal people. According to Article 366 (25) of the Indian Constitution, Scheduled Tribes are the tribal communities that are designated under Article 342 of the Constitution to the people who suffer from significant social and educational opportunities and financial constraints due to

primitive practices in agriculture, insufficient facilities for infrastructure, and geographic remoteness (*National Commission for Scheduled Tribes, n.d)*. In the Indian context, tribes are called 'scheduled tribes,' an institutional and legal word to classify ethnic communities based on their socioeconomic condition and cultural and religious customs to offer preferential consideration as specified by the Constitution (Lama & Bhui, 2018). The expansion of globalisation and modernity has brought about numerous developments, including technical advancements and improved healthcare facilities. However, most indigenous or tribal people live in the primitive era with few improvements in their lifestyles concerning education, culture, tradition, and other social organisations (Keshlata et al., 2023). In general, scheduled tribes in India are the nation's aboriginal population. They are the oldest ethnological groupings among India's national population, known as Adivasis or original dwellers. They symbolise their native culture, habitat, and customs. India possesses one of the most populous tribal communities in the world, second only after Africa (Govindharaj, 2016). Throughout India, ethnic groups are placed at the margins of mainstream society as they are considered to be backward, underprivileged, and at a lower livelihood (Deb, 2022). This livelihood stability is described as having adequate and sustained means of income and other wealth that allow the household to meet its basic needs. This includes enough access to food supplies, fresh water, healthcare services, opportunities for education, housing, community involvement, and social life (Frankenberger, 1996).

According to the 2011 Indian census, India has about 104 million tribal people divided into 705 tribes, accounting for 8.6% of the total population. Darjeeling and Kalimpong districts have a combined population of 18,46,823; the hill population was 8,75,703, while the plain population was 9,71,14. At the same time, 28.65% of ST was found in the hills and 15.07% in the plains (Subba & Rai, 2017). Darjeeling and Kalimpong districts are the two administrative areas in the Himalayan region. Some portions of the Darjeeling district are in the foothill zone, while the Kalimpong district has mountainous topography (Raha & Tripathy, 2022). Darjeeling Himalaya is a setting with numerous challenges and exceptions that studies on postcolonialism have attempted to comprehend via research in other South Asian regions; therefore, exploring these through Darjeeling would offer new views and guide new ideas. Before knowing Darjeeling, one needs to look at its past, or rather, the fantasies built about the region (Tamang, 2022). In the early nineteenth century, Grant and Llyod found Darjeeling was practically desolate, with a population of one hundred, mostly Lepchas and Limbus, the ridge, which eventually evolved into the core of urban growth rather than rural districts. According to the 1901 census, the population of the Darjeeling Hills had risen to 2,49,117 over a century later (Dozey, 1922; Tamang, 2022). The three mountainous subdivisions of the district (Darjeeling, Kalimpong, and Kurseong) were later administered by the Autonomous Hilly Council of Darjeeling Gorkha, which went into operation on August 22, 1988 (Cajee, 2018). According to historical and legendary accounts, the Tamangs originated in Tibet. The Tamang community is divided into many sub-castes designated as 'thar.' Each one 'thar' has a name, such as Sangden, Bomjan, Yonjan, and Pakhrin. Tamangs are a significant

Tibeto-Burmese-speaking community in Nepal (Tamang, 2003). The Sherpas, an ethnic group of Tibetan ancestry, are frequently categorised as a Scheduled Tribe in the Bhotia. Sherpas are native to Nepal's Himalayas, but in India, they primarily inhabit the Darjeeling and Kalimpong districts of West Bengal, Sikkim, and the northeastern states. Previously, they migrated to India from Nepal. They belong to the Mongoloid race (Coomar & Ganguly, 2022). Tamangs and Limbu were recognised as ST in 2003, bringing the total number of declared Scheduled Tribes in West Bengal up to forty. The prominent tribes in the Darjeeling Himalayan region include Lepcha, Limbu (Subba), Tamang, Sherpa, Bhutia, and Yalmo (Roy, 2016). Even in the twenty-first century, scheduled tribe (ST) inhabitants in the hilly region continue to be concerned about their quality of life (QOL) and socio-demographic circumstances (Barman & Roy Chowdhury, 2023). Roy (2016), Datta (2006), and other studies on the major scheduled tribes (i.e., Tamang, Lepcha, and Sherpa) of the Darjeeling region explore the social, cultural, and economic aspects; thus, there is an absence of viewpoints on the quality of life among these tribal populations.

However, it is important to know and briefly discuss problem identifications about these tribal communities' socio-demography, livelihood, and contemporary quality of life. This will not only serve their well-being, but it is also necessary for the total growth of any nation, especially the developing nation of Asia, state, or district; the concurrent and even development of all societal communities is fundamental. For this, the government and decision-makers must carefully monitor social and economic situations. Identifying the problems and challenges encountered by the diverse parts of society is required to make this possible (Subba & Rai, 2017). Demographers, anthropologists, geographers, and other social scientists throughout India look to tribal sociodemographic research, but no such study has been found discussing contemporary issues among these tribes. Thus, the current study focuses primarily on the social and environmental well-being of the Scheduled Tribe community in West Bengal's Himalayan districts of Darjeeling and Kalimpong. Furthermore, information on integrating their natural surroundings, demographics, social and cultural status, financial status, community institutions, understanding, attitude, and experience with ecological and development efforts has been gathered to understand better current patterns in their quality-of-life development among tribal people in the extremities of the Eastern State, such as West Bengal's Darjeeling Himalayan region.

The study was conducted to emphasise the current socio-demographics, residences, and livelihood conditions of the Tamang, Lepcha, and Sherpa Tribes in the Darjeeling Himalayan region of the hilly blocks of Darjeeling and the entire Kalimpong District of West Bengal. The study also aims to determine the Quality of life (QoL) spatially of the selected tribal communities in the study area.

2. Geography of the hilly region of Darjeeling and Kalimpong districts

Darjeeling is West Bengal's northernmost district, bordering Sikkim to the north, Bhutan to the east, and Nepal to the west. On February 14th, 2017, the Kalimpong subdivision was separated from West Bengal's Darjeeling district and formed as a new

district. The district's scheduled tribe population was 29.79%. In the Kalimpong district, Gorkhas comprise most of the population, with a sizeable minority of tribal residents (*District Environment Plan* 2021). However, at present, the Darjeeling district is physically divided into two different regions: the hills, which hold the five Community Development Blocks, namely Kurseong, Rangli Rangliot, Darjeeling Pulbazar, Jorebunglow Sukiapokhri, and Mirik, and the plain regions, which include the remaining blocks. The Kalimpong district has been subdivided into the Gorubathan, Kalimpong-I, and Kalimpong-II Community Development Blocks. Under the jurisdiction of the West Bengal state government, the Gorkhaland Territorial Administration constitutes a semi-autonomous administrative entity that holds authority over the district's entire hilly landscape. Many Ethnicities reside in the Darjeeling District, an ethnic group that includes the Lepcha, Tamang, Sherpa, Bhutia, Limbu and others. Since the 1950s, many Tibetan immigrants from Tibet have also settled there (District Environment Plan for Darjeeling, 2023).

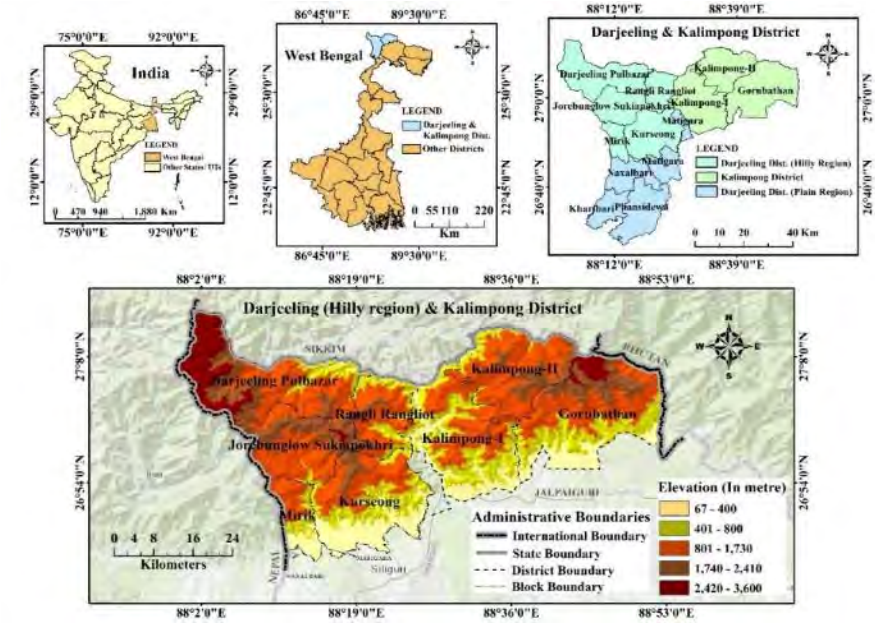

Figure 1: Location Map of the study region of Darjeeling & Kalimpong District, West Bengal, India

The terrain is quite complex, with numerous minor and significant relief formations. The hills rise abruptly from the lowlands, around 150 meters high, and continue northwest towards Sandakphu (3636 meters). The two primary rivers are the Teesta and the Rangeet. These glacier-fed rivers come from Sikkim. The Teesta flows from the Zemu glacier of northern Sikkim, while the Rangeet comes from the Rothong glacier of western Sikkim. It has an average monsoon climate, with rainy summers and dry winters. It has a refreshing climate and unrivalled visual splendour, reinforced by the magnificent perspective of Kanchendzonga, which has led to its emergence as the "Queen of All Hill Stations" (Cajee, 2018). According to the research concentration, the study area (Figure 1)

is limited and subject to consideration for the hilly portion of the Darjeeling and Kalimpong districts. It has international borders with Nepal towards the west and Bhutan in the east, a state boundary with Sikkim in the north, a district boundary with Jalpaiguri, and a block boundary with Naxalbari, Matigara in the South and southeast. With a total size of 2176.5 sq. km, this district's geographic boundaries are 26°45' and 27°13' N latitudes to 87°59' and 88°53' E longitudes. Darjeeling Himalaya remains entangled in a vicious cycle of growth. With a growing population, there has been a steady growth in the geographical region under cultivation for subsistence, followed by increased reliance on livestock farming. Tourism, along with tea plantations that garnered prominence for Darjeeling Himalaya, are primarily consequences of the climate (Khawas, 2002).

3. Methodology

The socio-demographic, housing, and livelihood of all tribal households have been assessed using primary-level household survey data collected from July to December 2022. Darjeeling Pulbazar, Jorebunglow Sukiapokhri, Rangli Rangliot, Mirik, and Kurseong blocks of the Darjeeling district, with the three C.D. blocks (Kalimpong-I, Kalimpong-II, and Gorubathan block) in the Kalimpong district, constitute the study region that has been addressed regionally and communally. According to research studies on tribal communities, this household-level study comprises three ethnic groups: Tamang, Lepcha, and Sherpa.

3.1 Sampling Framework

As per the studied literatures, selected socioeconomic, housing, and livelihood variables (Figure 2) were considered for this study to evaluatethe current development status among the selected tribes in the hilly region of Darjeeling and Kalimpong district of West Bengal. The head of the household was generally interviewed. In the unavailability of the family head, other elderly members were interviewed. Considering the heterogeneous distributional pattern of the different tribal populations throughout the Darjeeling and Kalimpong hilly regions, the multi-stage stratified random sampling method was used to

$$n = \frac{N}{1 + N(e)^2}$$

$$n = 398.72$$

select the sample.

Yamane's (1973) formula is used to determine the sample size.

Where,

n = Sample size
N= Population (total tribal population, i.e., 124787)
e= Level of significance (0.05z

The inclusion of 399 household surveys is necessary to achieve a 95% confidence level. In accordance with this criterion, the study encompassed 471 tribal households as a

sample, which is 1.18 times higher than the calculated figure. From eight blocks, 471 households were selected based on the proportional allocation of the total planned tribes. Of that total, around 67.1% households are Tamang, 16.8% Sherpa, and 16.1% are Lepcha. In the entire population of the sampled tribal residences, out of 1933 individuals, Tamang comprise around 71%, Sherpa 15%, and Lepcha 14%.

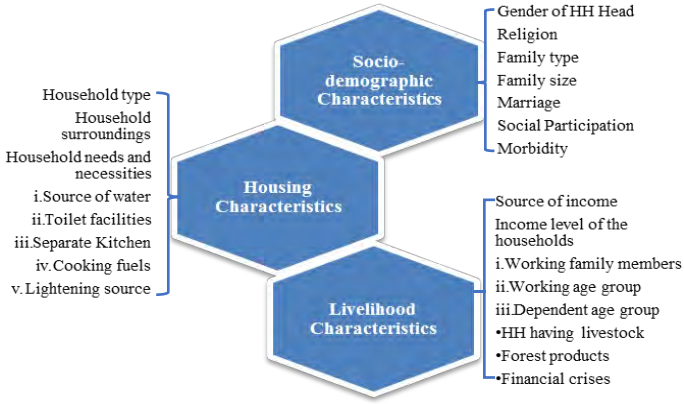

Figure 2: Different variables of the Socio-demographic, housing and livelihood characteristics

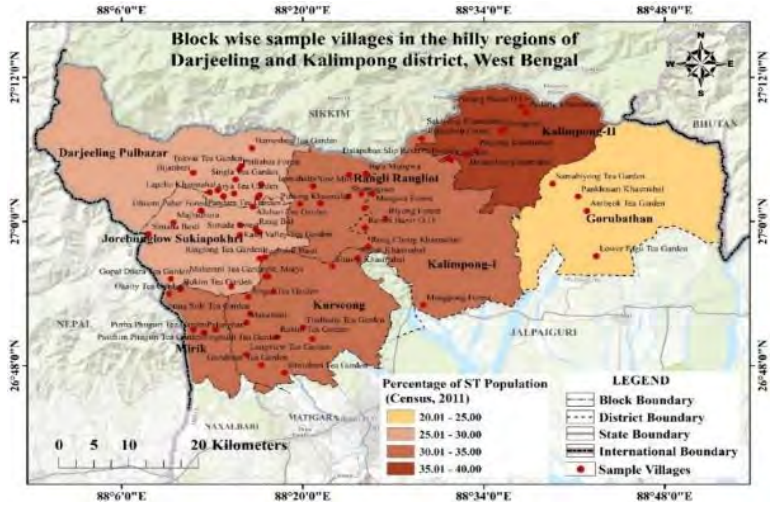

Figure 3: Block-wise sample villages of the tribal households in the study area

This cross-sectional community-based (Scheduled Tribe) study was conducted in a hilly rural region. This research plan is based on data from a primary survey of Scheduled Tribe household populations that was conducted in the eight hilly blocks of the Darjeeling (i.e., Darjeeling Pulbazar, Rangli Rangliot, Jorebunglow Sukiapokhri, Kurseong and Mirik) and Kalimpong (i.e. Gorubathan, Kalimpong-I and Kalimpong-II) districts of West Bengal. Based on the multistage stratified random sample approach, 40 villages were selected throughout the region (Figure 3).

3.2 Analytical Framework

The data have been tabulated and analysed with the help of IBM SPSS Statistics version 26. The study results were represented using descriptive statistics, which included frequencies, percentages, averages, and standard deviations (SD). The primary analysis entailed computing the frequencies and proportions of the selected sociodemographic and livelihood variables for the selected tribal populations. Also, block-wise socio-demographics, households, and livelihood characteristics among tribes were shown by thematic maps in the different C.D. blocks of the hilly region of Darjeeling and Kalimpong districts of West Bengal. For the geospatial mapping, ArcGIS version 10.8 was used. The ground control shows the sample villages of the study area's points data (latitude and longitude), which was taken through the mobile camera with the current GPS location enabled during the household survey in a particular village. Moreover, the spatial map was also created for the quality-of-life domains among the selected tribes in the study area.

3.3 WHOQOL-100 Scoring

The WHOQOL-100 measures a person's quality of life. Six domain scores, 24 specialised aspect scores, and one general facet score used to assess the overall quality of life and health. The scores for each of the six domains- physical, psychological, level of independence, social relationships, environment, spirituality, religion, and personal beliefs reflect a person's view of their quality of life in that area. Higher scores suggest a higher quality of life, while domain and facet scores are graded positively. Higher scores are not always associated with a higher quality of life based on some characteristics (pain and discomfort, negative feelings, medicine dependence, etc.) because some scales do not change positively (World Health Organization, 2012).

The internal consistency was examined using Cronbach's alpha (Amirrudin et al., 2020). The World Health Organisation Quality of Life-100 was tested using this method, with the acceptable results criteria greater than 0.70 value. Those six domain variables of the WHOQOL-100 were physical capacity, psychological, level of independence, social relationships, environment, and spirituality, religion, personal beliefs.

4. Results and Discussion

4.1 Socio-demographic characteristics of the selected tribal communities

In every community, socioeconomic and demographic characteristics such as level of education, health condition, income, etc., substantially impact development (Buragohain, 2013). The present study attempts to briefly study the socio-demographic and livelihood features of the sample tribal households. Table 1 represents some of the socio-demographic features of the sample household of the Tamang, Lepcha, and Sherpa communities of the Darjeeling and Kalimpong hilly regions using descriptive statistics results.

4.1.1 Gender

Gender is a social construct that refers to men and women's expected roles in creation, development, and power dynamics in diverse societal contexts. Culture develops and transforms into its present shape. As a result, cultural factors significantly impact tribal gender dynamics (Bhattacharya & Pal, 2022). It's found that 84.50 per cent of the sample households were headed by male members, indicating that most of the socioeconomic activities taken up by the households were male-dominated livelihood activities, where the highest per cent of male household heads found among the Sherpa (87.34%), followed by Lepcha (84.21%) and Tamang (83.86%) tribe (Table 1). In terms of block levels, the men household head depicts (Figure 4a) the highest in Gorubathan (91.67%), then Darjeeling Pulbazar (91.25%), Kurseong (86.57%), Kalimpong-I (86.44%), Kalimpong-II (82.35%), Mirik (81.08%), and 79.35 per cent in Jorebunglow Sukiapokhri. Among these tribes, the highest percentage of male tribal household head members was found among the Sherpa (about 87%) and female Tamang tribes (16.14%), respectively. The role of the head of the tribal household can vary widely depending on the specific cultural, social, and political structures of the tribe.

Table 1: Socio-demographic characteristics of the sample scheduled tribe households

Variables	Characteristics	Level	Tribes (in %)			Total (%)
			Tamang	Lepcha	Sherpa	
Gender	Gender of the ST household head	Male	83.86	84.21	87.34	84.50
		Female	16.14	15.79	12.66	15.50
Religion	The religion of ST household	Hindu	3.16	3.95	5.06	3.61
		Buddhist	92.72	52.63	88.61	85.56
		Christian	4.11	43.42	6.33	10.83
Educational Status	Complete Level of Education	No Education	15.51	15.79	6.33	14.01
		Pre-Primary	4.75	5.26	3.80	4.67
		Primary	37.97	38.16	44.30	39.07
		Secondary	28.80	26.32	35.44	29.51
		Higher Secondary	8.23	9.21	5.06	7.86
		Graduation	4.11	5.26	3.80	4.25
		Post Graduation	0.63	0.00	1.27	0.64
Family Type	Structure of the family	Nuclear Family	51.27	56.58	60.76	53.72
		Joint Family	44.62	42.11	37.97	43.10
		Extended Family	4.11	1.32	1.27	3.18
Family Size	No. of household's members	Less than 3	13.29	13.16	13.92	13.38
		3 - 4	56.65	67.11	58.23	58.60
		5 - 6	24.37	17.11	21.52	22.72
		More than 6	5.70	2.63	6.33	5.31
Marriage	Preferred age of marriage in the community	Below 18	28.16	27.63	30.38	28.45
		18-21	23.42	26.32	16.46	22.72
		Above 21	48.42	46.05	53.16	48.83
	Type of marriage	Arrange marriage	31.65	32.89	32.91	32.06
		Love marriage	68.35	67.11	67.09	67.94
Social Participation	Usual visit and participation in gram Sabha, panchayat, and village programme	No participation	2.22	2.63	7.59	3.18
		Low	17.09	7.89	16.46	15.50
		Moderate	30.70	27.63	27.85	29.72
		High	50.00	61.84	48.10	51.59
Morbidity	Any members suffered from diseases (past year)	No	80.38	77.63	86.08	80.89
		Yes	19.62	22.37	13.92	19.11

Source: Primary field survey of the ST households in the hilly Darjeeling & Kalimpong dist., 2022

4.1.2 Religion

Religion remains an important aspect of the diverse socio-cultural activities in the Darjeeling Himalayas. The populace is primarily Nepali-speaking. They follow Hinduism, Buddhism, and Christianity (Lama and Rai, 2016). Most tribal communities in the research area identified as Buddhists (85%), followed by Christians and Hindus (Table 1). While Hindu tribes worship goddesses like Durga, Kali, Hanuman, and Saraswati, Buddhist tribes visit their Gumba, or monastery, to honor Lord Buddha. Many Hindu tribespeople, primarily Buddhists, have converted to Christianity. As a result, they practice their former religion rarely and adhere rigidly to church regulations. Research on Hinduism and Christianity is severely lacking. Only 10.83% and 3.61% of tribal households follow Christianity and Hinduism, respectively. In the block level, the share of Buddhism was higher, including Darjeeling Pulbazar (93.75%), Gorubathan (91.67%), Jorebunglow Sukiapokhri (91.30%), Kalimpong-I (88.14%) and Mirik (86.49%). In comparison, the percentage of Christians was significantly higher in Rangli Rangliot (24.36%), Kurseong (19.4%), and Kalimpong-II (17.65%). However, most tribes' belief in animism has not faded, and religion is regarded as a social tool that promotes societal solidarity and responsibility (Figure 4b).

4.1.3 Educational status

The literacy rate of every community is an important standard for measuring socioeconomic growth. The educational status of the head of a tribal household can vary widely depending on factors such as location, access to educational opportunities, government policies, and individual circumstances. From the study, it is found that among the different selected tribal communities (Table 1), more than 15 per cent of non-literate household members are from the Lepcha (15.79%) and Tamang (15.51%) as compared to the Sherpa (6.33%). In the case of block-level educational status (Figure 4c), it is found that the non-literate tribes are primarily found in the Jorebunglow Block, Rangli Rangliot, Kurseong, Kalimpong-I and Gorubathan (more than 10%). The difference in literacy level was because of their circumstances; they often face challenges in accessing quality education due to geographic remoteness, socio-economic disparities, and cultural differences. Most tribes reside in rural regions and have limited access to school; the proportion of tribes who discontinue their studies rises when it comes to their higher levels of educational attainment (Dunn, 1993).

4.1.4 Family type and size

Family is a fundamental social institution established on biological and marital ties. Diverse tribes may possess distinct familial structures, which can differ significantly based on cultural practices, rituals, social organization, socioeconomic factors, and historical contexts within a tribal group or community (Deb, 2022). Some common family types found in the study areas were the nuclear family, a small family consisting of a married couple and their children. This is considered the basic family unit in many societies. On the other hand, a joint family is a traditional family structure where several generations live under one roof or

nearby, including grandparents, parents, children, and spouses. An extended tribal family is a family structure within a tribal community beyond the nuclear family unit. It encompasses a broader network of relatives, often spanning multiple generations, who live together or nearby and share responsibilities, resources, and social connections. The nuclear family has a higher share (53.72%) throughout the region than the combined and extended families (Table 1). The Mirik and Rangli Rangliot blocks have a higher percentage of joint families (more than 50%) (figure 4d). At the same time, among the tribal communities, the Tamang people lived in a joint family in higher proportion than the Lepcha and Sherpa.

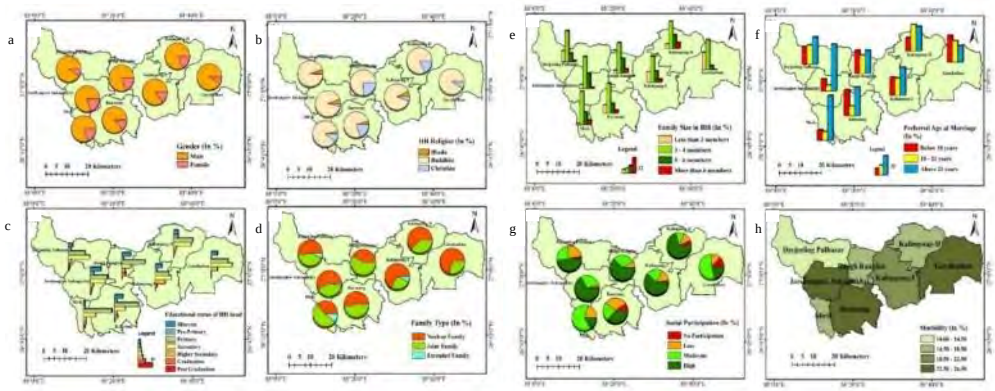

Figure 4: Socio-demographic characteristics of the selected tribal communities

In many tribal communities, family size tends to be influenced by factors unique to their specific cultural and environmental context. Some of the broad findings from the study data are shown in Table 1. According to the total number of family members, four different types of families have been recognised: small (less than three people), mild (3-4 people), moderate (5-6 people), and huge high (more than 6 peoples). The research area has the highest concentration of mild-sized families (58.60 per cent). In Mirik, Jorebunglow Sukiapokhri, and Darjeeling Pulbazar, more than 60% of tribal households belong to mild-sized families. Smaller families comprise more than 20% of tribal houses in the Gorubathan, Darjeeling Pulbazar, and Kalimpong-I blocks (Figure 4e). Only 5.31% of households have large-sized families, whereas 22.72% of moderate-sized and only 13.38% of households have small families. The Lepcha community comprised a significant proportion of households, with mild (67.11%), whereas the highest share of moderate family members is found in the Tamang (24.37%). Among the tribal communities, small and large size families (13.92 and 6.33%, respectively), the Sherpa tribe's share is high. However, nearly 13 per cent of all these tribes' household members were less than 3, and most have 3-4 family members (Table 1).

4.1.5 Marriage

Despite assertions of primitive tribal identities, caste remains a significant factor in marriage. The preferred age for marriage within a tribal community can vary significantly

based on specific cultural, social, and economic factors. In this study, it was found that overall marriage practices among the selected tribal communities were primarily above the age of 21 years (48.83%), whereas 22.72% of marriages take place at the age of 18-21 years, and the most concerned 28.45% of marriages below the age 18 years. Before 18 years of age, marriages were found mainly among the Sherpa tribes, higher than the Tamang and Lepcha. Moreover, the preferred age of marriage among these tribal communities was nearly 72%, above the age of 18 years (Table 1). Spatially, in terms of the block level, it was found that more than 20% of the marriages below 18 years found among tribes in the blocks of Gorubathan, Kurseong, Rangli Rangliot, Kalimpong-I, Darjeeling Pulbazar, and Kalimpong-II. Whereas above 21 years, tribe marriages were found in more than 40% of Kurseong, Kalimpong-I, and Darjeeling Pulbazar, only Jourbunglow Sukiapokhri and Mirik block found more than 70% in the study area (Figure 4f). It is important to note that there is no one-size-fits-all answer, as different tribal communities have unique customs and traditions. However, some common trends can be observed in certain tribal societies. There were two common marriage practices: arranged and love marriage. Traditionally, arranged marriages were common in many tribal communities. However, at present, love marriages are becoming more prevalent. Based on the study results (Table 1), the contemporary marriage practices among the tribes were mostly love marriages (67.4%) rather than arranged marriages. Among the selected tribal groups, Tamang tribes (68.35%) were found higher in this love marriage preferences and current practices than the Lepcha and sherpa. In the block-level study of the type of marriage practices and preferences, it was found that only Rangli Rangliot and Gorubathan block tribal people practices and prefer arranged marriage more than 50 per cent, While Kalimpong-I, Darjeeling Pulbazar, Kalimpong-II (more than 30%), and rest below 30%.

4.1.6 Social Participation

The level of social participation among tribal communities can vary widely based on cultural traditions, geographical location, access to resources, and exposure to outside influences. High social participation was found to be more concentrated among the tribes of Kalimpong-II, Jorebunglow Sukiapokhri, Rangli Rangliot, Kalimpong-I, and Darjeeling Pulbazar (more than 47%) as compared to other blocks in the region (Figure 4g). In contrast, the number of such social participants was high in the Gorubathan, Kurseong, and Kalimpong-II blocks (more than 6%). However, among these tribes, the social participation rate was comparatively higher among the Tamang (more than 97%) than the Lepcha and Sherpa (Table 1).

4.1.7 Morbidity

Some key considerations regarding morbidity within tribal communities were: Morbidity among the tribal community was more than 20 % in the Jorebunglow Sukiapokhri, Kurseong, Gorbathan, and Kalimpong-I blocks (Figure 4h). Prevalence of morbidity was

found to be higher among the Lepcha (about 22%), followed by the Tamang and Sherpa (Table 1). Indigenous peoples or Scheduled Tribes (STs) have made far slower progress on developmental indices than predicted, particularly in terms of health. They have high mortality and malnutrition rates, the lowest standard of obstetric care, and fall among the country's poorest recipients of healthcare (Raushan & Acharya, 2018).

4.1.8 Household Types and Surroundings

In hilly regions, including tribal areas, households often have different types of constructions based on the availability of resources and the level of infrastructure development. The terms "kuccha," "pucca," and "semi-pucca" refer to the types of construction materials and methods used in building houses. Kuccha houses are made of non-durable and locally available materials like mud, bamboo, thatch, or other natural materials. Meanwhile, semi-pucca houses incorporate elements of both kuccha and pucca construction. They may use a combination of durable and non-durable materials. The pucca houses use durable and permanent materials such as baked bricks, cement, concrete, and metal (Deb, 2022). In the study area's selected tribal population, the kuccha household (HH) found more than 10 per cent in the Gorubathan, Rangli Rangliot, and Kalimpong-II blocks. Furthermore, the pucca tribal household was comparatively high in Kurseong, Kalimpong-I, and Darjeeling Pulbazar (more than 40%) (Figure 5a). It was also found that the majority (more than 50%) of these selected tribal households (Table 2) were semi-pucca in structure compared to pucca and kutcha. This Kucha household was found to be comparatively more common among the Lepcha. It depends on factors such as household income, resources, government policies, and the level of development in the tribal community within that region.

In the tribal areas, the households tend to be deeply intertwined with the local communities' rugged terrain, dense forests, and unique cultural practices. These households were typically built with an understanding of the local environment. They were designed to withstand natural disasters like landslides, heavy rainfall, and other challenges. The structure and layout of houses often carry cultural significance and may be influenced by indigenous beliefs, rituals, and customs. The study results found that, overall, 44.95% of selected tribal households were situated near steep hills, followed by 33.59% near small to moderate landslide-prone areas, 6.77% situated near riverbanks, 4.81% both landslide and steep hills, and 9.88% of them lived in the lower highland or the foothill areas (Figure 5b). Among these tribes (Table 2), the Lepcha people and their households found most of the nearby landslide surroundings, whereas the Tamang were mainly found along the riverbank and steep hills. Sherpa people's houses were found in both landslide and steep hill areas. Due to the risk of landslides, households are often situated in areas less prone to soil erosion and geological instability. Some communities may have relocated to safer locations after experiencing landslides in the past. In some areas, households were situated near riverbanks, which provide a vital water source for various domestic and agricultural needs. However, this proximity can also pose risks during periods of heavy rainfall.

4.1.9 Household facilities

In the hilly tribal regions of the Darjeeling Himalayan region, ensuring basic amenities for households is of utmost importance for their well-being and quality of life. Those households have specific needs and necessities shaped by the rugged terrain, climate, cultural practices, and sometimes limited access to modern amenities. Based on the results of Table 2, specific needs and necessities related to water, toilet facilities, separate kitchens, and light sources in these areas were discussed.

a. *Source of Water:* Most of the selected tribal household's source of water (mainly for drinking, cooking, hygiene, and other usage) was from the nearby stream flow (48.03%), then shared public tap (21.36%), 16.39% from spring water, 13.19% of other sources, including the tank facilities and only 1.04% (Gorubathan) through well or tube well (Figure 5c). Similar studies for the research area highlight the region's poor water management. Most ST homes get their drinking water from untreated sources. However, some ST homes utilise purified tap water. Again, streams, tank/ reservoirs and other water bodies are more commonly used than rivers as drinking water sources (Subba & Rai, 2017).

b. *Toilet Facilities:* Unimproved toilet facilities (i.e., shared toilet, open defecation) were found more among Lepcha (about 18%), followed by Sherpa and Tamang. Toilet facilities in the selected tribal households were found overall, except in the Gorubathan, Rangli Rangliot, Kalimpong-I, and Kurseong blocks, where more than 10 per cent do not have toilet facilities. Even some households in the Gorubathan, Darjeeling Pulbazar, Kurseong, and Rangli Rangliot (more than 2.5%) found open defecation practices (Figure 5d).

c. *Separate Kitchen:* Except for Kalimpong-I and Kalimpong-II, other blocks (Jorebunglow Sukiapokhri, Mirik, Rangli Rangliot, Darjeeling Pulbazar, and Kurseong) in the study area had more than 10 per cent of tribal households without a separate kitchen room (Figure 5e). Separate kitchens were provided in about 88% of these tribes, the highest among Tamang (90%) and less than 80% among Sherpa and Lepcha households (Table 2).

d. *Cooking fuel:* Traditional cooking fuels (e.g., wood, crop residuals, dung cakes) among the tribal households were found in more than 30 per cent of the Gorubathan, Kalimpong-II, and Rangli Rangliot blocks (Figure 5e). It was evident from the study results that these tribes mostly use and prefer to use modern (LPG) fuels for cooking, but still, many of the Tamang tribe prefer to use traditional cooking fuel, which was found to be higher than that of the Sherpa and Lepcha. This is primarily due to affordability and socio-economic issues.

e. *Source of light:* It is important to note that the choice of light source depends on factors such as accessibility, availability of resources, cost, and environmental considerations.

Tamang households found more electricity for their source of light than the Sherpa and Lepcha tribes. Almost all the blocks have more than 85 per cent of the tribal households electrified, except Gorubathan (75%) and Kalimpong-I (76.27%). Overall, 87% of tribal households have electricity. However, some tribal households (8%) were found to use solar light and biogas for their household light, and only 6% of them use traditional (kerosene) light (Figure 5f).

Table 2: Housing characteristics of the sample scheduled tribe households

Variable	Characteristics	Level	Tribes (in %)			Total (%)
			Tamang	Lepcha	Sherpa	
Household type	Structure of the household	Pucca	37.97	35.53	39.24	37.79
		Semi Pucca	53.16	52.63	54.43	53.29
		Kuccha	8.86	11.84	6.33	8.92
Household's surroundings	Household's locational geographies	Landslide area	33.55	44.59	44.30	37.15
		Riverbank	8.39	6.76	1.27	6.91
		Steep hill	49.03	40.54	26.58	43.84
		Both a landslide and a steep hill	3.23	4.05	7.59	4.10
		Others	5.81	4.05	20.25	7.99
Household needs and necessities	Main source of drinking Water	Protected/Unprotected Spring	18.04	13.16	7.59	15.50
		Stream/Canal	52.53	44.74	32.91	47.98
		Own/Public/Shared tap	21.52	13.16	40.51	23.35
		Well-covered/uncovered	0.32	1.32	0.00	0.42
		Other	7.59	27.63	18.99	12.74
	Type of toilet Facilities	Own flush/pit toilet	89.24	81.58	82.28	86.84
		Shared toilet	7.91	15.79	17.72	10.83
		Open defecation	2.85	2.63	0.00	2.34
	Provision of a separate kitchen	No	9.87	11.84	22.78	12.37
		Yes	90.13	88.16	77.22	87.63
	Type of fuels used for cooking	Wood/Crop Residue/Dung cakes	23.42	18.42	7.59	19.96
		Liquid Petroleum Gas (LPG)	73.10	78.95	88.61	76.65
		Others	3.48	2.63	3.80	3.40
	Source of lightning in the household	Electricity	88.61	84.21	86.08	87.47
		Kerosene	5.70	2.63	5.06	5.10
		Others	5.70	13.16	8.86	7.43

4.2 Livelihood patterns of the selected tribal communities

In the hilly regions of Darjeeling and Kalimpong districts, the Lepcha, Tamang, and Sherpa communities have distinct livelihood patterns influenced by the area's unique terrain, climate, and cultural heritage. Some common livelihood patterns of these tribal communities are shown in Table 3. These communities often practice subsistence agriculture, cultivating crops and horticulture in terraced fields. It is important to note that while tea garden labour provides an important source of income for many tribal households, it may also come with challenges such as seasonal employment, exposure to weather conditions, and sometimes issues related to labour rights and fair wages, for these averse reasons, some households engage in multiple and other livelihood activities. Individual households may engage in a combination of these activities to diversify their sources of income and enhance their resilience to economic challenges. However, their inadequate level of educational attainment, existence within isolated areas, and lack of access to knowledge about the outside world were still among the obstacles to their effective economic growth (Deb, 2002).

These livelihood patterns were indicative of the diverse and adaptive strategies employed by these communities to thrive in the challenging terrain of the Darjeeling and Kalimpong districts.

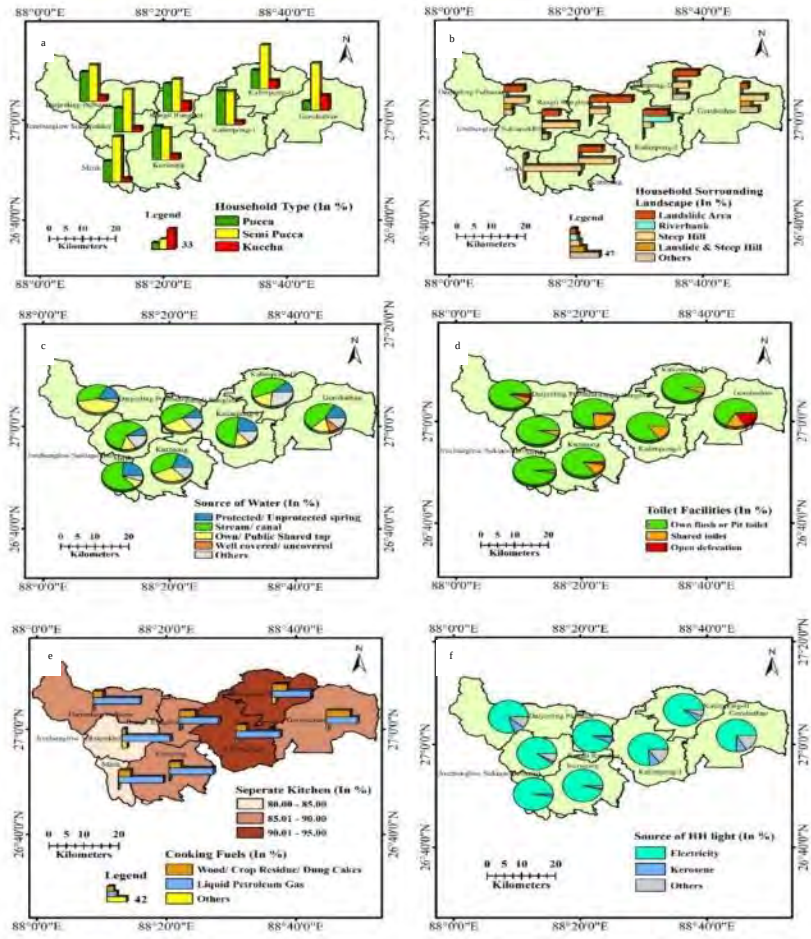

Figure 5: Household characteristics of the selected tribal communities

4.2.1 Occupational status

The Lepcha, Tamang, and Sherpa communities engage in various occupational activities influenced by the local environment, cultural practices, and economic opportunities. The share of daily labourers (mostly tea garden, then construction) was high in all the blocks (Figure 6a). Apart from the labourers, other sectors were also found, such as cultivation, agricultural workers, small or medium shops, service members, and other occupations like drivers and homestay businesses. Overall, 54% selected tribals' main occupation (Table 3) as a daily labourer, followed by service sectors (16.14%), Cultivators (12.39%), shop runners (4.39%), and others (13.19%). A similar study by Subba & Rai (2017) also found that the occupations with the most significant percentages were tea garden labour, farming-

owned land, self-employed professionals, small-scale businesses, and agricultural land. Non-agricultural labour, livestock rearing, trade activity, and driving account for a small proportion of the ST population.

Table 3: Livelihood characteristics of the sample scheduled tribe households

Variable	Characteristics	Level	Tribes (in %)			Total (%)
			Tamang	Lepcha	Sherpa	
Occupational Status	Main source of income	Cultivation	5.06	27.63	18.99	11.04
		Daily Labour	60.13	55.26	37.97	55.63
		Small / Medium Shop	6.01	0.00	3.80	4.67
		Servicemen	17.72	7.89	13.92	15.50
		Others	11.08	9.21	25.32	13.16
Income Level	Family member's monthly income	Less Than 3000	2.53	7.89	5.06	3.82
		3000-5000	24.68	19.74	17.72	22.72
		5000-7000	17.09	21.05	25.32	19.11
		7000-10000	19.30	15.79	25.32	19.75
		Above 10000	36.39	35.53	26.58	34.61
Workforce	Number of working family members in the household	1 Member	56.65	59.21	65.82	58.60
		2 Members	28.48	23.68	22.78	26.75
		3 Members	10.76	15.79	7.59	11.04
		More than 3 Members	4.11	1.32	3.80	3.61
	Working age group pop. Dependent age group population	Age group of 15-64 years	80.62	75.96	79.47	79.77
		Age group of under 15 years.	11.50	16.03	11.41	12.16
		Age group of above 64 years.	7.88	8.01	9.13	8.07
		Total dependent	19.38	24.04	20.53	20.23
Livestock	Households, any livestock, herds, farm animals/ poultry	No	36.62	19.74	29.49	32.69
		Yes	63.38	80.26	70.51	67.31
Forest products	Using different forest products	No	64.56	82.89	75.95	69.43
		Yes	35.44	17.11	24.05	30.57
Financial Crises	The frequency of financial crises that households faced	Always/most of the time	36.39	59.21	45.57	41.61
		Occasionally	49.68	34.21	37.97	45.22
		Never	13.92	6.58	16.46	13.16

4.2.2 Income level

Many tribal households rely on tea gardens and other labourer work and subsistence agriculture, which provide a basic income and also, those engaged in agriculture or animal husbandry have a moderate income, while individuals involved in trade, commerce, or tourism-related activities have higher earning potential. Over the study area (Figure 6b), more than 64.6 per cent of tribal households' income levels were below ten thousand rupees, whereas only 35.4 per cent were above ten thousand. Moreover, 3.5 per cent of those with an income level of less than three thousand rupees were found among them over the region. Most of the Sherpa tribe's household income (65%) was below ten thousand compared to the other two tribal households (i.e., Tamang and Lepcha). This was because of their low wages, insufficient work participation rate, and problems in their current employment situations. A similar study indicated that a significant proportion of households belonging to Scheduled Tribes earn less than ten thousand rupees per month. However, the other social caste found a higher monthly income of ten thousand rupees than ST households (Subba & Rai, 2017).

4.2.3 Workforce

The workforce and its participation indicate the percentage of people involved in economic occupations in the entire population (Deb, 2022). Combating poverty remains one of the most significant challenges in the progress of our nation's process since it is closely related to their vocations and labour participation, improving their living standards. Most tribes were still engaged in low-productive farming and other lower-paid jobs, which was also seen in their high poverty rate, and many times higher than that of the other communities (Mehta & Singh, 2021). Their participation in different sectors of the economy reflects their skills, cultural practices, and adaptability to the region's unique terrain. An overview of the workforce participation of these tribal communities was discussed and portrayed in Figure 6c, d, e and Table 5.

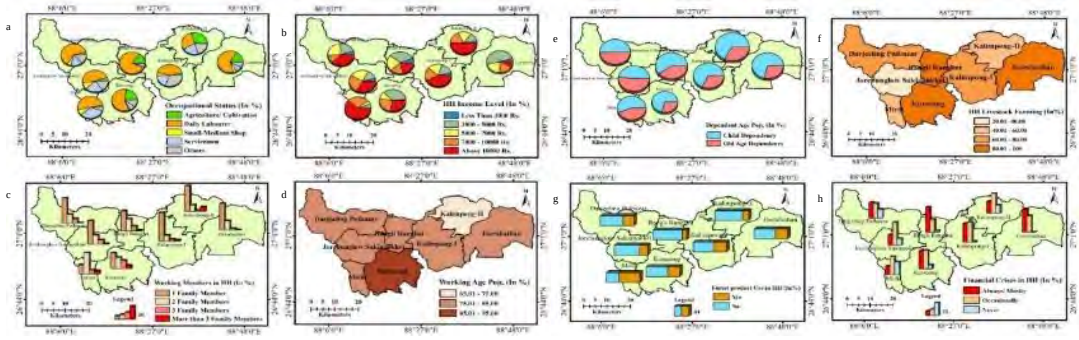

Figure 6: Socio-economic and livelihood characteristics of the selected tribal communities

a. *Working Family Members in the HH:* The number of working family members in tribal households varies widely based on family size, age distribution, and economic opportunities available in their respective areas. Some families have multiple members actively engaged in various economic activities, while others have fewer members contributing directly to the workforce. In the study area (Figure 6c), the majority (58%) of the tribal households have only one working family member, followed by 27.8 per cent of 2 members, 10.1 per cent of 3 members, and only 4.2 per cent of households have more than three working family members.

b. *Working age population:* The working-age population typically refers to individuals between the ages of 15 and 64. In tribal households of the Tamang, Lepcha, and Sherpa communities of Darjeeling and Kalimpong districts, the proportion of working-age individuals varies based on family size, age distribution, and local economic opportunities. Overall, 79.7 per cent of the working-age group tribal population was found in the study area. The working age group was more proportionate in the Kurseong and Mirik blocks (more than 80%) than in the others (Figure 6d). The number of three working family members in the tribal households was high among the Lepcha tribe. On the other hand, comparatively fewer working family members were found in the Tamang and Sherpa households.

c. *Dependency:* Individuals aged below 15 and older than 65 are often considered part of the dependent population. Nevertheless, there are also some individuals with disabilities and non-working adults who are reliant on working members for their livelihood, such as students and unemployed family members, sometimes due to illness or other circumstances. The proportion of the dependent tribal population in the study area (Figure 6e) was about 21.3 per cent. The children's population was 12.5 per cent, and 7.9 per cent were adults. This dependent age group population was highest in Kalimpong-II, Rangli Rangliot, Gorubathan, and Jorebunglow Sukiapokhri (more than 21%) blocks. The dependent age group population was the highest among the Lepcha tribe compared to the other two tribes (Tamang and Sherpa).

4.2.4 Livestock

Livestock plays a crucial role in the livelihoods of tribal households in the Darjeeling and Kalimpong districts, including those belonging to the Tamang, Lepcha, and Sherpa communities. The general overview of the types of livestock commonly raised by these communities: where the households often keep cattle for dairy, which provides a source of milk and other dairy products for the family's consumption and potential sale. Goats are commonly raised for their meat, and hens and ducks are raised for eggs and meat. It was important to note that the choice of livestock differs based on factors such as altitude, climate, available resources, and cultural practices specific to each community. From the results, it was found that a total of 68.5 per cent of sample households of the selected tribes have livestock (raised by the selected tribal communities). All blocks except Mirik, Kalimpong-II, and Sukhiapokhri have more than 60 per cent of the tribal households' rear livestock farming (Figure 6f). Livestock farming was found to be highly prevalent among the Lepcha tribe, followed by the Sherpa and Tamang (Table 3). However, in all these circumstances, environmental factors substantially impact the livelihoods and economies of the inhabitants of Darjeeling Himalaya. Subsistence agriculture, cattle, forestry, and related activities substantially impact their livelihood (Khawas, 2002).

4.2.5 Forest Products

Forests are of the utmost importance to the tribal economy and have traditionally served as a means of subsistence and livelihood. The indigenous people's economy was mainly forest-based and comprised various economic activities such as hunting, food collecting, shifting cultivation, cultivating land, and handicrafts. Forests and tribes are economically intertwined (Lama & Bhui, 2018). These communities know their natural environment and rely on forest resources for subsistence and economic activities. Communities frequently utilize various forest products, particularly local medicinal plants and herbs sourced from the forests. These plants were utilized in traditional healthcare practices. Wild fruits, mushrooms, ferns, and other edible items were collected from forests for consumption. Timber and bamboo serve as significant forest products utilized in construction, including residential structures and the production of household items such as baskets and containers, as well as in animal husbandry. The use of forest products among

the tribes within these blocks (Figure 6g) was about 32.8 per cent. Mirik, Kalimpong-I, Gorubathan, Kurseong, and Darjeeling Pulbazar blocks have more than 30 per cent of tribes directly or indirectly using forest products. The use of forest products was higher among the Tamang tribes than the Sherpa and Lepcha tribes (Table 3).

4.2.6 Financial Crises

Financial vulnerability, particularly in lower-income and socioeconomically deprived communities like tribes, derives from their constant reliance on informal funding sources (Kumar, 2017). The occurrence of financial crises among the selected tribal communities' households (Figure 6h) was primarily found occasionally (45.24%), 41.47% faced always or mostly, and only 13.29% have never faced financial crises. In the case of always or mostly faced financial crises, the Rangli Rangliot, Gorubathan, and Kalimpong-I tribes consist of more than 45 per cent. The most frequent financial crises faced by Lepcha people are compared to those faced by the Sherpa and Tamang. Financial crises affect the tribal communities. The factors that trigger these crises include economic downturns, natural disasters, health emergencies, or other unforeseen events like crop failure, livestock loss, and limited access to credit.

4.3 Quality of life of the Tamang, Lepcha and Sherpa tribes

The results of Table 4 show that the independence domain exhibits the highest mean score (57.62) in comparison to the physical, psychological, social relationships, spirituality, religion, and personal beliefs domains, while the environment domain has a comparatively lower mean score of 46.0. This study found that the highest mean score among the six WHOQOL-100 domains was found in the level of independence. reflecting a significant degree of freedom and contentment with the meaning of life. The lowest mean score is observed in the environment, indicating that economic resources, availability and accessibility of information and educational institutions, and, importantly, access to healthcare services and transportation options in the hills area are suboptimal.

Table 5 lists the mean values for the various aspects of the hilly tribal people's quality of life. The scores for the aspect were very poor (0 to 1), poor (1 to 2), neither poor nor good (2 to 3), good (3 to 4), and very good (4 to 5). Most of the facets' mean values fall between 2 and 3, which is neither good nor poor. Work capacity gets the highest mean score (2.99), whereas pain and discomfort frequently receive the lowest mean score (1.01). The maximum mean score for energy and fatigue in the physical capability area was 2.26; a low mean score was reported for pain and discomfort. Self-esteem has been identified to have a maximum mean of 2.97, followed by thinking, learning, memory, and concentration (2.40), positive feelings (2.36), bodily image and appearance (1.70), and negative feelings (1.51) in the psychological area. Whereas the working capacity (2.99), activities of daily living (2.48), and mobility (2.25) facet scores for the level of independence domain were neither good nor bad, and dependence on medication or treatment (1.79) was found to be poor in the tribal population. Social relationships were important for human beings, and it

was found that social support (2.80), personal relationships (2.63), and sexual activity (2.37) were neither good nor bad among the tribes. One of the most crucial variables was the environment, particularly in the predominantly hilly tribal areas, which influences people's quality of life and level of subsistence. The mean score was high in the home environment (2.80), and the minimum mean score was 1.55 in health and social care: accessibility and quality. Moreover, the last domain, spirituality, religion and personal beliefs, was found to have a moderate mean score of 2.73, while overall, it consists of a 2.71 mean score.

Table 4: Summary of the WHOQOL-100 domains

Domain	Mean	Standard Deviation	Cronbach's Alpha
Physical Health	53.05	10.94	0.68
Psychological	51.40	10.71	0.66
Level of Independence	57.62	9.63	0.70
Social Relationships	52.04	8.51	0.72
Environment	46.00	9.01	0.74
Spirituality, Religion & Personal Beliefs	54.53	19.09	0.65
Overall	54.16	16.08	0.69

Source: Primary field survey of the ST households in the hilly Darjeeling & Kalimpong dist., 2022

The quality-of-life mean score in the hilly Darjeeling and Kalimpong districts of West Bengal is necessary to understand (Table 6 and Figure 7). Regarding the physical health domain, significantly tribal inhabitants of Mirik had the highest QOL score (59.91), followed by Jorebunglow Sukiapokhri with 56.45, Kalimpong-II with 56.19, Darjeeling Pulbazar with 53.46, Kurseong with 52.18, Kalimpong-I with 50.74, Gorubathan with 48.78, and Rangli Rangliot C.D. block with 47.97. Subsequently, it has been found that the tribes in the Kalimpong-I block have a higher psychologically-related QOL (58.64) than the tribes living in the other blocks, including Darjeeling, Pulbazar, Gorubathan, Kurseong, Jorebunglow Sukiapokhri, Kalimpong-II, Rangli Rangliot, and Mirik block. The level of independence is another important domain that signifies autonomy at different levels. It was statistically significant, with the highest score in the Mirik (65.41) block of the Darjeeling district, followed by Kalimpong-I, Darjeeling Pulbazar, Kurseong, Gorubathan, Kalimpong-II, Jorebunglow Sukiapokhri and 50.87 in Rangli Rangliot. For these tribal people, social connections with other people on individual, societal, communal, and other levels are also essential.

Table 5: Mean value of all the facets of WHOQOL-100 among the ST household respondents

Domain	Facets	Mean ± SD
Physical Capacity	Pain and discomfort	1.01±0.98
	Energy and fatigue	2.26±0.74
	Sleep and rest	1.73±0.74
Psychological	Positive feelings	2.36±0.84
	Thinking, learning, memory, and concentration	2.40±0.90
	Self-esteem	2.97±0.75
	Bodily image and appearance	1.70±0.61
	Negative feelings	1.51±0.95
Level of Independence	Mobility	2.25±0.55
	Activities of daily living	2.48±0.64
	Dependence on medication or treatments	1.18±0.93
	Work capacity	2.99±0.90
Social Relationships	Personal relationships	2.37±0.53
	Social support	2.80±0.63
	Sexual activity	2.63±0.57
Environment	Physical safety and security	2.67±0.49
	Home environment	2.80±0.63
	Financial resources	2.32±0.76
	Health and social care: accessibility and quality	1.55±1.03
	Opportunities for acquiring new information and skills	1.57±1.06
	Participation in and opportunities for recreation/ leisure activities	2.54±0.79
	Physical environment (pollution/noise/traffic/climate)	2.65±0.60
	Transport	2.29±0.64
SPIR	Spirituality/Religion/ Personal Beliefs	2.73±0.95
Overall	Overall quality of life and general health perceptions	2.71±0.80

Source: Primary field survey of the ST households in the hilly Darjeeling & Kalimpong dist., 2022

Table 6: Descriptives of the WHOQOL-100's domains within the different C.D. Blocks

C.D. Blocks	n	Physical Health	Psychological	Level of Independence	Social Relationships	Environment	Spirituality, Religion & Personal Beliefs
Kurseong	67	52.18±7.38	51.19±9.82	59.27±11.31	52.60±9.44	45.83±8.04	55.78±14.65
Rangli Rangliot	78	47.97±7.95	46.32±6.74	50.87±9.28	47.84±8.36	47.74±7.71	50.59±14.74
Mirik	37	59.91±2.80	49.44±7.49	65.41±3.85	58.25±3.35	44.13±2.76	51.18±10.81
Jorebunglow Sukiapokhri	92	56.45±11.37	50.58±6.48	52.94±7.09	51.13±7.67	54.84±8.96	58.63±13.36
Gorubathan	24	48.78±9.85	53.02±15.92	58.40±9.53	48.18±11.90	36.30±5.28	50.78±31.13
Kalimpong-I	59	50.74±10.09	58.64±13.17	64.64±8.38	55.33±7.69	41.79±6.82	55.90±24.72
Darjeeling Pulbazar	80	53.46±13.06	54.01±13.58	59.39±8.28	52.37±7.55	42.17±7.62	54.61±25.70
Kalimpong-II	34	56.19±15.80	48.53±7.37	57.49±4.88	52.57±7.68	43.36±6.90	54.23±13.56
F-statistic		7.849	8.557	22.695	8.569	31.325	1.473
P-value		0.000**	0.000**	0.000**	0.000**	0.000**	0.175

Source: Primary field survey of the ST households in the hilly Darjeeling & Kalimpong dist., 2022

Significance level: *P<0.05, **P<0.01

There were six C.D. blocks with QoL scores greater than 50 in the social relationships category, including Mirik, Kalimpong-II, Kalimpong-I, Kurseong, and Darjeeling Pulbazar. In contrast, the two blocks, Rangli Rangliot and Gorubathan, have a QOL score in the social relationship category below 50. The tribal people were known to live close to nature, and the environment played a significant part in their standard of living. According to the study results for this environment domain, all other blocks of the study region's tribal residents have less than a 50 score in their quality of life related to the environment, apart from the Jorebunglow Sukiapokhri block (54.84). However, there was no such statistically significant

difference found for the spirituality, religion, and personal beliefs (SRPB) related QoL, ranging from 50.59 in the Rangli Rangliot to 58.63 in the Jorebunglow sukiapokhri block's tribal inhabitants of the study area.

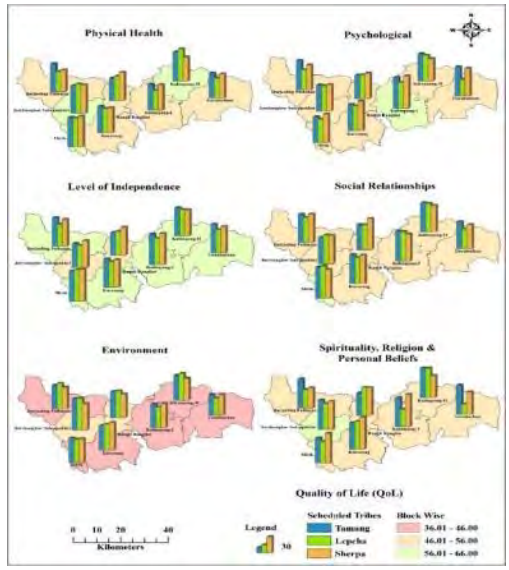

Figure 7: Block-wise Quality of Life (QoL) among the selected Tribes

The quality-of-life mean score among the different tribal communities, especially the predominant tribes (i.e., Tamang, Lepcha, and Sherpa) in the hilly Darjeeling and Kalimpong districts of West Bengal, is necessary to understand.

The selected tribal communities of the Tamang, Lepcha, and Sherpa households QoL were examined in this study region (Table 7 & Figure 7). Where it was found that these selected tribes had significant mean scores, higher than 50 in their physical health domain,

apart from the Lepcha tribes. Similar findings were found for the psychological domain, where the mean QoL score for Tamang and Sherpa tribal communities was significantly higher than 50 and less among the Lepcha (46.55). However, the QoL scores of the tribal communities studied were significantly higher than 50 in the domain connected to the level of independence. It has been found that only the Lepcha (49.34) tribe has QoL mean scores below 50, which were related to social relationships. It is important to know the environment-related QoL among the indigenous tribes, especially among the study region's hilly tribal communities. Regarding the study's findings, the selected tribal communities have average QOL scores in the environment domain below 50. This is noteworthy because it impacts the livelihood and QoL of hilly tribal people. However, it was found that these tribes have higher than 50 mean QOL scores related to the spirituality, religion, and personal beliefs domain.

Table 7: Descriptives of the WHOQOL-100's six domains among the selected tribal communities

Tribes	(n)	Physical Health	Psychological	Level of Independence	Social Relationships	Environment	Spirituality, Religion & Personal Beliefs
Tamang	316	54.02±10.77	52.85±11.26	58.56±10.04	52.50±7.84	46.23±8.92	55.87±18.83
Lepcha	76	49.89±9.36	46.55±7.62	52.96±8.10	49.34±10.53	47.05±9.31	50.49±20.89
Sherpa	79	52.38±12.47	50.51±9.69	58.48±8.04	52.80±8.57	43.93±8.89	53.24±17.79
F-statistic		4.618	11.384	11.159	4.654	2.728	2.684
P-value		0.010*	0.000**	0.000**	0.010*	0.066	0.069

5. Suggestions

Based on the study, the following suggestive measures have been drawn-

a. Efforts to enhance educational opportunities and skills development can increase workforce participation and will improve the economies of these tribal communities.

b. Organizations, NGOs, and government initiatives may play a significant role in implementing water supply, sanitation, and energy access projects in the Darjeeling Himalayan region. These efforts can significantly improve the quality of life for tribal households in the region.

c. It is essential to note that addressing socio-demographic and quality of life problems requires a multi-dimensional approach involving infrastructure development, community engagement, and sustainable practices. Additionally, considering the specific challenges of the hilly terrain, solutions must be adapted to the local context.

d. Due to the hilly terrain, households may implement measures like contour bunding, check dams, and vegetative barriers to prevent soil erosion and landslides.

e. Efforts to mitigate the impact of financial crises on tribal households may involve targeted support, such as emergency relief, access to credit, training in new livelihood skills, and community-based social safety nets.

f. Additionally, policies and programs focused on building economic resilience and sustainable livelihoods can help strengthen the financial well-being of these communities in the long term.

g. Due to the unavailability of water in many parts of hilly regions, households may require storage facilities like tanks or reservoirs to ensure a continuous supply.

h. Depending on the level of connectivity with surrounding societies, tribal communities should interact with government agencies, NGOs, and other external organisations to address specific needs or issues.

The study's main limitations are that the data utilized was cross-sectional and only encompassed quantitative attributes, whereas future research could benefit from using a qualitative approach for enhanced understanding. Furthermore, research was restricted to a certain geographic area of chosen tribal habitats, and only a limited range

of social, economic, and demographic characteristics was examined regarding quality of life

6. Conclusion

This study underscores the socio-demography and quality-of-life challenges faced by the Tamang, Lepcha, and Sherpa tribes in the Darjeeling and Kalimpong districts of the Sub-Himalayan region of West Bengal. Despite the rich cultural heritage and natural surroundings, these tribal communities face persistent issues such as limited educational opportunities in some areas, inadequate health services, economic vulnerabilities, and environmental risks. The WHOQOL-100 analysis revealed that while certain domains, like independence and social relationships, reflect moderate satisfaction, others, such as the environment and access to resources, highlight critical gaps in quality of life. Livelihood patterns remain rooted in traditional sectors like agriculture and tea plantations, with limited diversification into higher-value economic activities. Furthermore, issues like frequent financial crises, insufficient infrastructure, and dependence on natural resources continue to hinder sustainable development. Addressing these issues requires a multidimensional approach, including targeted policy interventions, enhanced education and skill development programs, and community-driven initiatives to improve socio-economic, demographic, health, sanitation, livelihood, and infrastructure. Such measures will elevate the quality of life of these tribal populations and will contribute to the inclusive growth and sustainability of the region.

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Ethical Statement: Before and during the study, every single tribal household was surveyed, and consent was obtained using the structured questionnaire. The information gathered file has none of the details that might be used to identify the survey respondents uniquely and was solely to be used for academic purposes.

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UNDERSTANDING THE URBANISATION SHIFTS IN DEVELOPING COUNTRIES: A GEOSPATIAL INVESTIGATION OF WEST BENGAL, INDIA

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Abstract

Urbanisation is the process of a region gaining people through immigration and natural growth, industrialisation, commercialization, increased work opportunities, and lifestyle changes. This study examines West Bengal's urbanisation trend and pattern between 1951 and 2011, focusing on the last decade. The study uses census data and secondary data sources to analyse the trend and pattern of urbanisation. West Bengal has experienced the fastest rise in Census Towns (CTs) among Indian states, with the number of CTs increasing from 30 to 780 between 1951 and 2011. The proportion of people living in urban areas increased from 23.88% to 31.87%, between 1951-2011 but most CTs grew in the last decade. The urbanisation level in West Bengal has always been higher than in India since independence. The urbanisation pattern was centred on the Kolkata metropolitan area until 2001, but since then, it has shifted towards the periphery district of Kolkata due to the rapid rise of CTs and the growth of small-sized towns. The continuous decline of the primacy index indicates a diffusive pattern of urbanisation in the state. The new CTs require proper urban planning and effective urban governance for better urban services.

Keywords: Urbanisation, West Bengal, Census Town, Rank Size Rule, Surface Trend.

1. Introduction

Urbanisation is reshaping the global economy, transitioning from agriculture to non-agricultural pursuits. Presently, 55% of the world's populace resides in urban regions, yet notable inequalities persist between affluent and impoverished nations (UN-DESA, 2019). Affluent nations have achieved an 80% urbanisation rate, contrasting with developing nations experiencing rapid expansion, surpassing 50% (Das & Kar, 2022). India embarked on its contemporary urbanisation journey post-independence, witnessing a surprising surge as per the 2011 Census, with urban populations outpacing rural ones (Census of India, 2011). Worldwide, urban dwellers have risen from 30% in 1950 to the current 55.3%, poised to escalate to 68.4% by 2050 (UN-DESA, 2019). Although affluent nations are forecasted to hit 79.1% urbanisation by 2020, compared to 51.7% in poorer nations, global disparities endure (UN-DESA, 2019), notwithstanding varying national definitions of urban areas. India reported 377.10 million urban inhabitants, marking a progression from 10.84%

in 1901 to 31.16% in 2011 (Census of India, 2011). West Bengal, as per Guin (2017), sustains a higher urban population percentage than the national average, a trend pre-dating Independence.

In India, the trend of urbanisation has shifted from big cities to small urban centres since 2001-2011 (Jain & Korzhenevych, 2020) in the form of Census Towns (CTs) and the emergence of these CTs during the most recent census era was unprecedented. The Indian government has implemented initiatives like JNNURM, Smart Cities Mission, and AMRUT to promote regional development and decentralization. Small urban centres offer economic opportunities and better living standards, leading to migration from rural areas (Guin and Das, 2015). Major metropolitan areas face challenges like overcrowding, congestion, high living costs, and environmental degradation. Investments in transportation infrastructure have improved connectivity between small towns and rural areas (Chakrabarti&Mukherjee 2022). The rise of information technology and remote work has made smaller urban centres more accessible. Local governance structures and planning mechanisms have also contributed to the growth of these urban centres (Samanta, 2017). Population growth in large metropolitan cities has decreased, but peripheries have seen higher growth due to CTs, emphasizing the importance of interaction between core cities and peripheries (Pradhan, 2013).

India, a major emerging economy in the Global South, is undergoing an urban revolution with massive population growth, but a significant portion still lives in poverty (Jain & Korzhenevych, 2020). This presents an opportunity for economic, social, and ecological transformation. However, researchers argue that Indian urbanisation may be unsustainable due to its dominant urban system, control of large cities, challenges in housing, transport, electricity, water supply, pollution, congestion, and social exclusion (Guin & Das, 2015). Government policies have been lackadaisical in addressing these issues (Samanta, 2017). West Bengal as a state of India saw a significant increase in urban population from 1901 to 2011, rising from 12.19% to 31.87%. The country's urbanisation began with industrialisation post-independence, with a notable surge in small-scale urban centres in the 2011 census. Despite starting as the fourth most urbanized state at independence, by 2011, West Bengal had fallen to fifteenth place (Census of India, 2011). Unlike India's rural population growth of 1.17%, the urban population grew by 2.80% between 2001 and 2011. While India's urbanisation rate increased from 17.29% to 31.20% between 1951 and 2011, West Bengal's rose from 23.88% to 31.87%. Initially, urbanisation in West Bengal was centred on Kolkata, but it has spread to neighbouring districts in recent times (Giri, 1998). This expansion has altered the region's urbanisation pattern from monocentric to a more dispersed one, with rapid growth in census towns, particularly in smaller size categories (Guin, 2017). West Bengal has the highest rate of urbanisation among Indian states, with a significant increase in small towns and populations between 2001 and 2011 (Mukhopadhyay et al., 2020). The region's once-monocentric pattern has shifted, with new urban centres (CTs) emerging in low-populated areas surrounding Kolkata. Initially, concerns were raised about census authorities artificially inflating the increase in CTs, but

research shows this is not a result of activism. With 526 small towns in the 2011 Census, over 60% of newly developed urban centres are further away from major cities (Pradhan, 2013; Guin, 2017).

This article primarily tries to explore the evolution of urbanisation in West Bengal between 1951 and 2011, with a particular focus on the significant growth of Census Towns (CTs) within the state and the driving forces behind this rapid expansion. Furthermore, it examines the proliferation of CTs within the Kolkata Metropolitan Region (KMA). A comparative analysis is conducted on the methodologies used to define urban criteria, comparing those of the Census of India with the UN-DEGURBA method. Drawing upon secondary data, the study concludes that CTs require urban governance structures such as "Nagar Panchayat" or "Town Panchayat" to provide improved urban services. However, there remains a substantial question regarding whether such urban governance is truly necessary for the upgrading of CTs. A primary survey is deemed necessary to arrive at a conclusive decision regarding the requirement for urban governance in these CTs. The transition of urbanisation in West Bengal over five decades, focusing on the surge of Census Towns (CTs) and their significance in the Kolkata Metropolitan Region (KMA) has been addressed here. It also addresses the need for urban governance structures for improved urban services in CTs, suggesting a comparative analysis of urban criteria methodologies. However, it raises a critical question about the necessity of such governance for CTs' development and proposes a primary survey to determine the requirement accurately. The study effectively conveys the main points but could benefit from clearer organization and refinement for better readability. Additionally, the argument about the necessity of urban governance for CTs' development requires further exploration and evidence to strengthen its validity. Many previous studies have been done on the trend of urbanisation of West Bengal during 1951-2011 but very limited studies have been done about the notable shift of urbanisation in the state between 2001-2011 due to the emergence of small-sized urban centres. West Bengal serves as a significant case study for analyzing contemporary urban transition processes and emerging urban structures from 2001 to 2011, given their immediate context (**Fig. 1**). Beyond the primary objective, the study also aims to illuminate the development of cities from Class I to Class VI, population distribution within these urban centres, and the progression of urbanisation in West Bengal from 1951 to 2011. Although the main focus of this study is the state's pattern of urbanisation from 1951 to 2011, there is a special emphasis on the last decade (2001–2011) because West Bengal has experienced the highest growth in CTs during this time, changing the state's urbanisation pattern from monocentric to polycentric. This framework guides the subsequent sections of the research paper. The following segment briefly outlines the study's scope, data sources, and methodology, providing an overview of India's ongoing urban transformation. Following this, a concise historical account of West Bengal's urbanisation from 1951 to 2011 is presented. Subsequently, attention is given to analyzing the geographical and demographic shifts characterizing the state's urban transition between 2001 and 2011. Concluding the paper, the final section summarizes the principal findings, while the preceding section highlights emerging issues and proposed policy approaches.

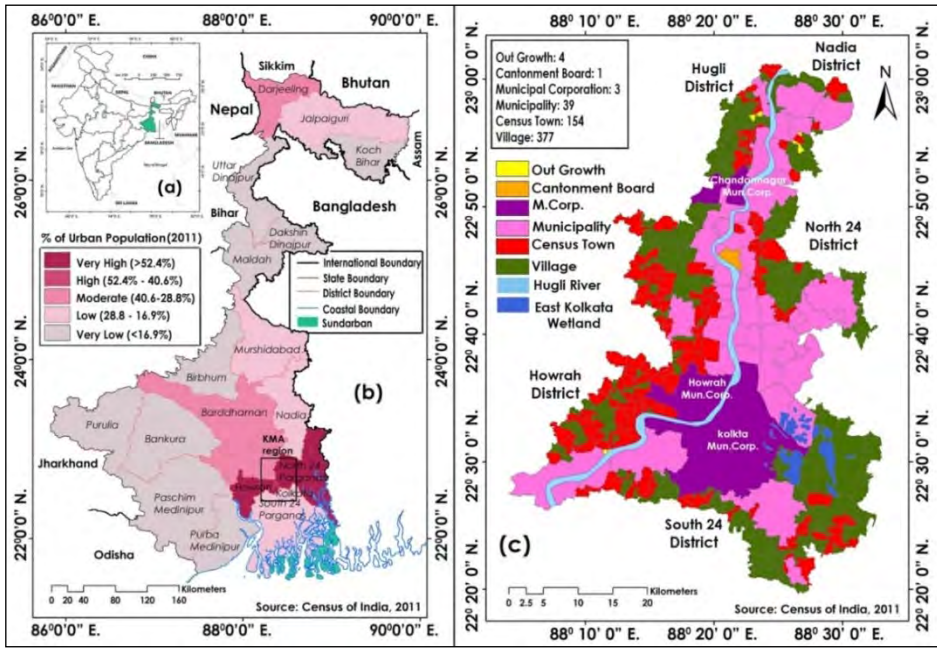


Fig. 1: Location of the study area (a) India, (b) West Bengal and (c) Kolkata Metropolitan Area (KMA) region

2. Background of the study

Almost three times as many people lived in urban areas in India in 2011 than there were in rural areas, where the growth rate was just 12%. With the number of census towns tripling from 1,362 in 2001 to 3,894 in 2011, small towns and census towns accounted for a large amount of this expansion. Around 35 million people moved from agriculture into non-agricultural occupations between 2004–2005 and 2011–2012; this change is linked to the changing employment structure (Guin, 2017). Access to jobs has been made easier in these regions by improved communication and transportation, and small and medium-sized communities have benefited from the cheap labour available to pursue non-agricultural jobs. The majority of these urban peripheries are next to larger cities and rural communities that have begun to exhibit urban traits, including the rise of market towns (Pradhan, 2013). Being close to rural regions has protected them from the risks of major metropolitan centres and allowed them to become hotspots for growth and demand for new goods and services. The level of urbanisation varied from state to state at the country level. The huge growth of small-sized urban centres is the main reason behind the variation of urbanisation level in India and the growth of small-sized urban centres (**Fig. 2a**). Small-sized urban centres make a substantial contribution, but they are frequently overlooked in policy talks and administratively regarded as rural villages, which lowers the importance of developing urban infrastructure (Guin & Das, 2015).

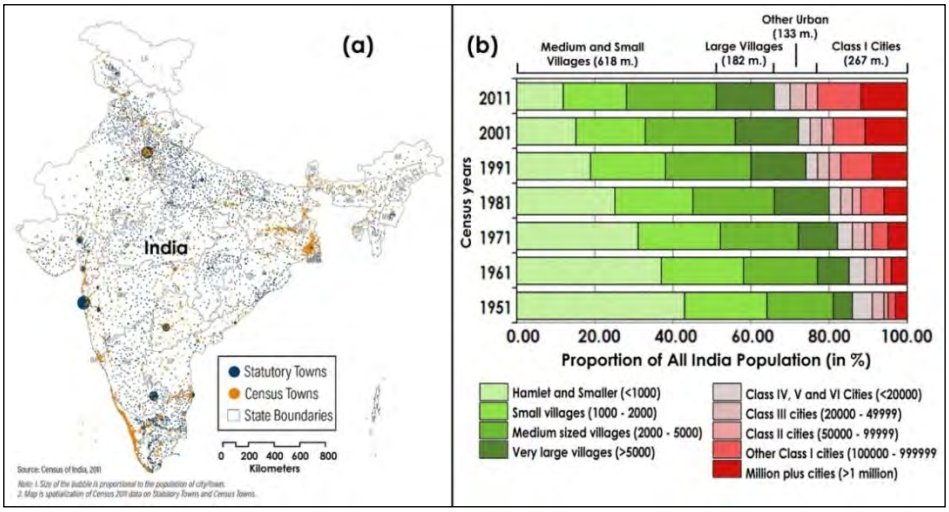
Urbanisation inequality has been evident in India (**Fig. 2b**) since the post-independence era with a top-heavy urban scenario. The data from India's census from 1951 to 2011 shows a consistent decrease in the number of hamlets and smaller settlements, with a slight decline in small villages and a slight increase in medium-sized villages. However, the number of very large villages increased from 5 in 1951 to 16 in 2001 and then decreased to 15 in 2011. Class III cities showed stability, while Class II cities showed minor fluctuations. Class I cities saw a notable increase, while the number of million-plus cities showed steady growth, indicating significant urbanisation and development in larger urban centres. Overall, the data suggests a general trend of urbanisation and growth in larger settlements, with stability observed in smaller settlements and cities during the 2001-2011 Census periods. The dataset in **Table 1** shows the urban population percentages in West Bengal and India from 1951 to 2011. West Bengal had 23.88% of its population in urban areas, while India had 17.29%. Over time, both cities experienced gradual urbanisation, with West Bengal reaching 24.45% in 1961 and India at 17.97%. By 1981, West Bengal's urban population reached 26.47%, while India's reached 23.34%. By 1991, West Bengal's urbanisation rate was 27.48%, while India's was 25.72%. By 2011, West Bengal's urban population reached 31.87%, indicating convergence in urbanisation trends between the states(**Table 1).**

Table 1: Trend of Urban Population Growth of West Bengal during 1951-2011

Year	Percentage of Urban Population	
	West Bengal	India
1951	23.88	17.29
1961	24.45	17.97
1971	24.74	20.22
1981	26.47	23.34
1991	27.48	25.72
2001	27.97	27.78
2011	31.87	31.16

The level of urbanisation in West Bengal varies significantly across districts, ranging from 8.33% in Bankura to 100% in Kolkata, averaging 28.78% (**Table 2**). Kolkata stands out as the primary hub of urban development in West Bengal, encompassing the Kolkata Urban Agglomeration (KUA) spread across five districts. In 1951, KUA housed over three-quarters of the state's urban population, a figure that dwindled to 50% over the span of 50 years, owing to the emergence of industrial complexes such as Asansol-Durgapur, Siliguri, and Haldia port. The 2011 Census also revealed a notable shift in India's urbanisation landscape, with the number of Census Towns (CTs) escalating from 1,362 in 2001 to 3,892 in 2011(Census of India, 2011). Accounting for their contribution to urban expansion, the proportion of CTs residing in urban areas surged from 7.4% in 2001 to 14.4% in 2011(Census of India, 2011). New CTs accounted for over 70% of peripheral expansion in India, significantly altering the spatial organization of major urban agglomerations (UAs) with populations exceeding one million. The evolving dynamics of

CTs over the past decade have significantly influenced the nation's perception of urbanisation, underscoring the importance of comprehending and accommodating municipal system diversity.



Source: Calculated by the authors based on Census of India, 1951 to 2011

Fig. 2:(a) Location of the Statutory Towns (STs) and Census Town (CTs) in India, (b) proportion of Indian population in different units during 1951 – 2011

In 2011, West Bengal, Kerala, Tamil Nadu, Uttar Pradesh, Andhra Pradesh, and Maharashtra, the initial six states, collectively accounted for over 60% of the total influx of new Census Towns (CTs). Kerala and West Bengal notably surpassed other states in both population density and urban expansion between 2001 and 2011, with smaller to medium-sized communities effectively addressing issues of top heaviness. The emergence of new CTs in West Bengal carries significant spatial ramifications, given the prevailing rural-urban disparity and the continuum of settlement patterns within the region's smaller and medium-sized urban centres. Kolkata Urban Agglomeration (UA) housed 59% of the state's urban population, while the western and northern regions exhibited less than one urban centre per 100 individuals. The state is actively promoting the development of local urban centres to counteract the spatially imbalanced and mono-centric trend of urbanisation, deviating from the dominance of the Kolkata UA. In 2011, there was a noteworthy increase in the number of new CTs in the state, coinciding with a reduction in urbanisation inequality, which warrants further investigation. While the proportion of urban dwellers in Kolkata and Asansol experienced a decline from 63.64% in 2001 to 52.71% in 2011, town densities witnessed an upsurge in the western and northern districts.

3. Database and Methodology

The current study's aim has been fulfilled through the utilization of secondary data sources gathered from the Census of India spanning the years 1951 to 2011. The District Census

Handbook (1951-2011) and the Primary Census Abstracts for both India and West Bengal (1991-2011) served as the primary resources for gathering data on urban population, the count of cities categorized from Class I to Class VI, and the respective populations of these cities. National Highways (NH) data were extracted using Google Earth Pro, while the map of West Bengal was obtained from Diva-GIS. The detailed methodology of the study has been represented in a flow chart (**Fig. 3**).

Table 2: District-wise share of urban population to total district population in West Bengal during 1951-2011

Sl.	Districts	1951	1961	1971	1981	1991	2001	2011
1	Bankura	7.17	7.34	7.47	7.63	8.29	7.37	8.33
2	Barddhaman	14.78	18.2	22.78	29.39	35.09	36.94	39.89
3	Birbhum	6.47	6.97	7.03	8.28	8.98	8.57	12.83
5	Dakshin Dinajpur*	12.01	16.7	22.39	27.35	26.68	13.11	14.11
6	Uttar Dinajpur*						12.06	12.05
7	Darjeeling	21.22	23.16	23.05	27.55	30.47	32.34	39.42
8	Haora	32.41	40.48	41.93	45.12	49.58	50.36	63.38
9	Hugli	25.4	25.96	26.47	29.53	31.19	33.47	38.57
10	Jalpaiguri	7.23	9.11	9.6	14.05	16.36	17.84	27.38
11	Koch Bihar	7.51	7.01	6.83	6.91	7.81	9.11	10.27
12	Kolkata	100.0	100.0	100.0	100.0	100.0	100.0	100.0
13	Maldah	3.75	4.16	4.22	4.78	7.07	7.32	13.58
14	Murshidabad	7.86	8.54	8.45	9.36	10.43	12.49	19.72
15	Nadia	18.18	18.41	18.74	21.59	22.63	21.27	27.84
17	North 24 Parganas**	60.34	62.89	69.55	76.26	51.23	54.3	57.27
18	South 24 Parganas**					13.31	15.73	25.58
20	Purba Medinipur***	14.1	14.45	14.46	16.17	19.24	20.18	11.63
21	Paschim Medinipur***							12.22
22	Purulia	6.71	6.81	8.26	9.01	9.44	10.07	12.74
With Kolkata	Mean	21.57	23.13	24.45	27.06	26.34	25.71	28.78
	Standard Deviation	14.63	15.74	17.23	18.89	14.51	14.89	16.67
	Coefficient of Variation	0.68	0.68	0.71	0.71	0.55	0.58	0.58
	C.V In %	67.81	68.02	70.45	69.8	55.03	57.96	57.91
Without Kolkata	Mean	16.34	18.01	19.42	22.2	21.74	21.32	24.82
	Standard Deviation	14.63	15.74	17.23	18.89	14.51	14.89	16.67
	Coefficient of Variation	0.91	0.87	0.89	0.85	0.67	0.71	0.67
	C.V In %	89.51	87.37	88.73	85.09	66.69	69.84	67.14

Source: Census of India, 1951 to 2011

Note.* From 1951-1991 the combined district was known as West Dinajpur, **1951-1981 the combined district was known as 24 Parganas, ***1951-2001 the combined district was known As Medinipur.

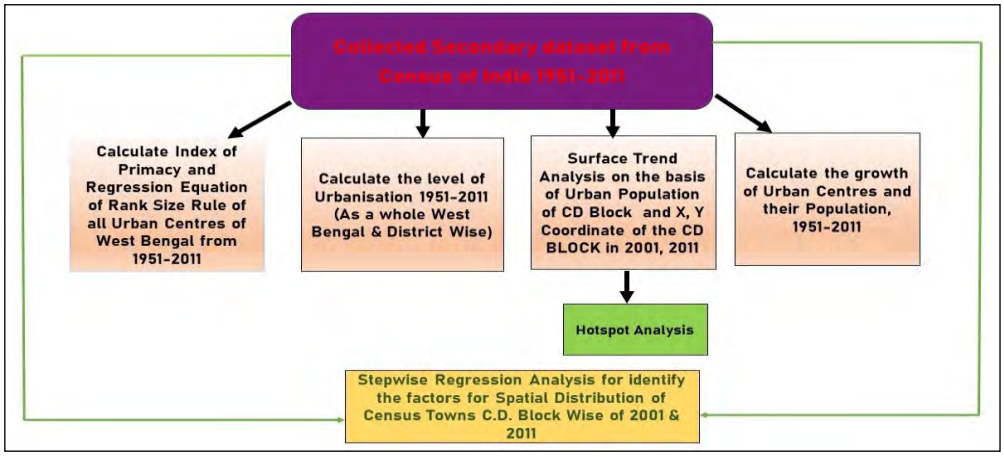


Fig. 3: Methodological workflow of the study

3.1 Rank Size Estimation and Level of Primacy:

The rank-size rule and nature of the primacy index formula are as follows:

$$P_r = \frac{P_i}{r} \quad (1)$$

Where P_r denotes the Population of the r^{th} rank size city, P_i indicates a population of the largest city, r is the rank of the city.

$$PI = \frac{P_1}{P_2} \quad (2)$$

PI is the nature of the Primacy Index P_1 is the population of the largest city, P_2 is the population of the 2nd largest city.

The analysis encompasses the growth of the urban population, the evolution from Class I to Class VI cities, and the population dynamics of these urban centres from 1951 to 2011, aiming to elucidate the spatiotemporal trends of urbanisation in West Bengal. To delineate the distribution inequality within the urban population, the Primacy Index and Rank Size Rule (Zipf, 1941) have been computed for all urban centres in West Bengal over the aforementioned period. Urban primacy, denoting the disproportionate dominance of one city over others in terms of population, economic activity, or cultural influence, is assessed through a quantitative measure known as the "index of urban primacy." Although there is no universally accepted metric for urban primacy, various methods exist to gauge it. Comparing the population or economic output of the largest city, typically the capital, with that of the next largest city or the combined populations or outputs of multiple other cities is a commonly utilized approach. A high primacy ratio indicates urban primacy, signifying the dominance of one city within the urban landscape.

3.2 Simultaneous Fraction Procedure (Cramer's Rule):

Using the Simultaneous Fraction Procedure (Cramer's Rule), the surface trend of urbanisation in West Bengal from 2001 to 2011 was plotted. For the simultaneous fraction method, the district's urban population and district coordinates were utilized. For this calculation the following steps are followed:

$$an\ (a1) + b\sum XY(b1) + c\sum Y(c1) = Z\ (d1) \quad (3)$$

$$a\sum X(a2) + b\sum X^2(b2) + c\sum XY(c2) = XZ\ (d2) \quad (4)$$

$$a\sum Y\ (a3) + b\sum XY\ (b3) + c\sum Y^2\ (c3) = \sum YZ\ (d3) \quad (5)$$

where, n is a number of observations, X and Y are the district coordinates and Z is the urban population.

Then, calculate multiple linear equations.s

$$(Zc) = [x + (y*X) + (z*Y)] \quad (6)$$

Where Zc is, the computed value of the surface trend and x, y, z denote determinant of matrix A, B, X respectively.

Finally, calculate the residual value of the surface trend:

$$(Z - Zc) \quad (7)$$

Where, Z is the observed value and Zc is computed value.

To prepare the map of the surface trend of urbanisation Inverse Distance Weightage(IDW) a standard interpolation tool has been used.IDW is a technique of interpolation which fits the continuous models of spatial variations (Patra et al., 2018). In this study, it is used to interpolate surface trends of urbanisation data. This method derives the value of some new locations by using the data of some known locations. It is measured through the following equation:

$$\hat{X}_P = \sum_{i=1}^{N} w_i X_i \quad (8)$$

$$w_i = \frac{d_i^{-\alpha}}{\sum_{i=1}^{N} d_i^{-\alpha}} \quad (9)$$

Where,$\hat{X}_P$ represents the unknown data on the surface trend of urbanisation, $X_i$is data of known points, N for the number of observations, w_i Indicate the weight of each concerned data point, d_i denotes the distance between known and unknown points and α Indicates the power.

3.3 Spatial Autocorrelation Analysis

For assessing the degree of spatial clustering of the surface trend of urbanisation in spatial autocorrelation Moran's I used. By using Moran's I we identify how an observation is similar and distant. (Haldar et al., 2023). It can be measured through the following equation:

$$I_i = \frac{Z_i - \bar{Z}}{\sigma^2} \sum_{j=1, j \neq i}^{n} \left[W_{ij} \left(Z_j - \bar{Z} \right) \right] \quad (10)$$

Where, $Z_i$is the value of the Z variable of the alternative; $\bar{Z}$is the mean value of variable Z; $Z_j$indicates the Z variable value of other locations where $\neq i$;σ the variance of variable Z and W_{ij}denotes the weighted value among the locations i and j.

Values of Moran's I are between -1 to +1, where near to +1 value indicates spatial clustering which means similar values are more probably to be found to each other and near to -1 value indicates spatial dispersion (Haldar et al., 2023). Hotspot analysis is used to identify groupings within spatial data. Based on high and low values of a given data this grouping represents hot spot and cold spot respectively. **(**Haldar et al., 2023).Getis-ord G* statistics have been applied to identify hot spots and cold spots. Through hotspot analysis, we validate the spatial data that the patterns that are noticed are statistically significant or not. (Haldar et al., 2023). In this study, the hotspot analysis was used to locate the surface trend of urbanisation in West Bengal. The hotspot analysis is measured through the following equation:

$$G_i^* = \frac{\sum_{j=1}^{n} W_{ij} x_j - \bar{x} \sum_{j=1}^{n} W_{ij}}{s \left\{ \left[n \sum_{j=1}^{n} W_{ij}^2 - \left(\sum_{j=1}^{n} W_{ij} \right)^2 \right] / (n-1) \right\}^{0.5}} \quad (11)$$

Where,W_{ij} denotes the spatial weighted matrix between observations i and j, $x_j$indicates the value of selected attributes of observation$j$, n is the total number of observations in the dataset,$\bar{x}$ Denotes sample means that. $\bar{x} = \frac{\sum_{j=1}^{n} X_j}{n}$and S indicates Standard error, $S = \sqrt{\frac{\sum_{j=1}^{n} x_j^2}{n} - (\bar{x})^2}$

3.4 Stepwise Regression

For find out the factors which control the spatial distribution of Census town block-wise stepwise regression has been done (Guin & Das, 2015). The equation followed in this regression is as follows:

$$Y = \alpha + \beta_1 x_1 + u \ldots \text{(Step 1)}$$
$$Y = \alpha + \beta_1 x_1 + \beta_2 x_2 + u \ldots \text{(Step 2)}$$
$$Y = \alpha + \beta_1 x_1 + \beta_2 x_2 + \beta_n x_n + u \ldots \text{(Step 3)} \quad (12)$$

Where Y represent the dependent variable, $\alpha$is intercept, β is the slope, x is the independent variable and the error term of the regression is denoted by u.

4. Results

4.1 Analysis of urban growth patterns in West Bengal

4.1.1 Growth of Urban Population during 1951-2011

Since independence, in each decadal census, West Bengal has consistently exhibited a higher level of urbanisation compared to the national average, although the disparity in urbanisation levels between the two entities has been gradually narrowing over time. In 1951, the proportion of the urban population in West Bengal stood at 23.88%, surpassing the urban population share of the entire country, which was recorded at 17.29% (see **Table 1**). **Table 1** further indicates a progressive increase in the urban population share of West Bengal throughout the study period, with no instances of decline from the preceding decade. Even though West Bengal has always had a higher rate of urbanisation than the rest of the nation, this difference has gradually closed as a result of the industrial belt along the Hugli River, which is the primary driver of the state's urbanisation, stagnating decade after decade. As a result, rural-to-urban migration within the state has also gradually decreased. The distribution of urban population or the degree of urbanisation across the state exhibits significant disparities. In 1951, this ranged from 3.75% in Maldah to 100% in Kolkata, with an average rate of 21.57%. By 2011, the range expanded from 8.33% in Bankura to 100% in Kolkata, with an average rate of 28.78% (see **Table 2**).

Table 2 vividly illustrates that throughout all census periods between 1951 and 2011, Kolkata maintained a 100% urbanisation level due to the absence of rural administrative units. While the urbanisation levels in the outer districts of Kolkata are lower than in Kolkata itself, most districts have seen a continuous increase in urbanisation from 1951 to 2011. For instance, District Howrah increased from 32.41% in 1951 to 63.68%, and even the less urbanized district of Maldah increased from 3.75% in 1951 to 13.58% in 2011. The consistent growth of urbanisation in these districts outside Kolkata suggests a continuous influx of urban population. However, some districts have exhibited steady or slow increases over the decades. While the share of the urban population in the peripheral districts of Kolkata is not experiencing substantial growth, districts farther from the state capital are witnessing higher growth rates in urban population compared to those near Kolkata. Additionally, this table provides insights into the urban landscape of West Bengal with and without Kolkata. The average urbanisation rate, including Kolkata, increased from 21.57% in 1951 to 28.78% in 2011. Excluding Kolkata, the average urbanisation rate of the state decreased from 21.57% to 16.34% in 1951 and 28.78% to 24.82% in 2011.

4.1.2 Growth of Urban centres of West Bengal during 1951-2011

As per the Census of India, all urban centres in the country are categorized into six groups based on their population size, with Class I, II, III, IV, V, and VI having population sizes of more than 100,000, 50,000-99,999, 20,000-49,999, 10,000-19,999, 5,000-9,999, and below 5,000 respectively. These urban centres are further divided into three main categories: large, medium, and small. Large urban centres comprise only Class I cities, while Class II and III cities fall under medium-sized urban centres, and the remaining classes constitute small urban centres. In 1951, the proportion of large urban centres was 5.83%, housing more than half of the urban population (see **Table 3**). This share of large

urban centres continuously increased from 1951 to 2001 and their population had a minor decrease between 1951-1971 but again from 1971-2001 it continuously increased in every decade, but, in the last decade, the share of large urban centres and the urban population of that large urban centre proportion declined, due to small urban centres saw significant growth, with their population more than doubling in the same period (2001-2011) (**Table 3**). This substantial expansion of small urban centres and their population indicates a shift in the urbanisation pattern in West Bengal from metropolitan cities to smaller urban areas. Medium size urban centres (class II and class III) slightly increased between 1951 to 1961 also their population increased within this period. But from 1961 to 2011 share of those urban centres continuously decreased, though between 1961 and 1971 the medium-sized urban centres decreased their population increased during this period but after 1971 to 2011 their population decreased meanwhile small urban centres emerged within this period also small urban centres population has increased.

Table 3: Share of Urban population and urban centres in West Bengal during 1951-2011

Size of Urban Centres and Population (in %)		1951	1961	1971	1981	1991	2001	2011
Large (Class I)	Urban Centres	5.83	6.49	6.73	8.25	11.52	15.69	6.81
	Urban Population	57.47	55.13	54.91	55.63	63.97	74.11	61.95
Medium (Class II & III)	Urban Centres	35.83	36.22	35.87	31.62	25.13	22.87	12.97
	Urban Population	30.09	32.45	33.22	31.4	23.78	16.52	16.89
Small (Class IV-VI)	Urban Centres	58.33	57.3	57.4	60.14	63.35	61.44	80.22
	Urban Population	12.44	12.41	11.87	12.97	12.25	9.38	21.16

Source: Census of India, 1951 to 2011

Between 1951 and 2001, West Bengal experienced a fluctuating urban growth pattern, with an initial increase in small urban centres and a population decline due to various factors. Post-Independence industrial expansion, administrative reclassification, decentralized urbanisation, and rural-urban migration were key drivers. However, by the 1970s, industrial growth stagnated due to political instability, labour strikes, and outdated infrastructure (Bhattacharya, 2006). Kolkata-centric urbanisation concentrated economic activities, leading to outmigration from smaller towns. Poor infrastructure and connectivity in small urban centres also contributed to population decline. Economic reforms in the 1990s facilitated faster urbanisation, but small towns were left out due to limited integration (Banerjee & Roy, 1993). Agricultural dependence and land scarcity also affected the economic viability of these towns. Urban outmigration from smaller urban centres led to a reduction in population growth.

4.1.3 Rank Size Distribution and Nature of Primacy

From 1951 to 2011, the application of the rank-size rule to all urban centres in West Bengal illustrated an imbalanced urban development trend. Kolkata, as the sole

metropolitan city in West Bengal, consistently maintained a significantly higher population than expected from 1951 to 2011. Analysis of the regression table (**Table 4**) reveals that throughout the entire study period, the correlation between the theoretical rank of urban centres and their population, as hypothesized by Zipf, accounted for less than 10% of the variance, indicating a lack of perfect correlation between rank and population size of urban centres. The other two parameters intercept and slope, hold significance. The intercept signifies the population of the largest city concerning rank Over the study period from 1951 to 2011, the intercept value continuously decreased, indicating a consistent decline in the population of the largest urban centres, with this population diffusing to smaller-sized urban Census Towns (CTs) (see **Table 4**). According to Zipf's (1949) rank-size theory, the slope value represents the force of diversification and unification within urban populations. While the algebraic sign of the slope is disregarded, an increasing slope indicates the unification of the urban population into one or two urban centres, whereas a decreasing slope suggests the diversification of the urban population from one core urban centre to smaller-sized urban centres.

Table 4: Regression results for Rank-Size distribution and index of primacy for the urban centres in West Bengal during 1951-2011

Census Years	Intercept (a)	Slope (b)	R^2	Index of Primacy	Census Years	Intercept (a)	Slope (b)	R^2	Index of Primacy
1951	164725	1857.5	0.08	5.88	1991	154306	550.8	0.07	4.62
1961	142150	1029.2	0.07	5.71	2001	193160	708.3	0.09	4.54
1971	152602	923.4	0.08	4.27	2011	101363	152.1	0.06	4.18
1981	153017	708.3	0.09	4.44					

Source: Census of India, 1951 to 2011

The gradual decrease in the slope suggests a diversification of the urban population from one primary urban centre to various smaller-sized urban centres, attributed to the substantial growth of these smaller urban areas. Understanding the growth and development of any urban region is often assessed through the growth of its Primate City, gauged by its primacy index. This index is calculated by dividing the population of the largest urban centre by that of the second largest, serving as a measure of primacy. **Table 4** also reveals a continuous decline in the magnitude of the primacy index from 1951 to 2011, indicating a narrowing gap between the populations of the largest and second-largest urban centres. Despite the decline in the primacy index from 5.88 in 1951 to 4.18 in 2011, the urban system remains highly imbalanced within the state.

4.1.4 Emergence of urban centres during 2001-2011

As per the Census of India, all statutory towns, Census Towns (CTs), Notified Areas, and Cantonment Boards are considered urban centres. The number of urban

centres in West Bengal increased from 376 to 910 between 2001 and 2011. During this period, over 50% of the total urban centres were identified as CTs. When categorized by district, Class I to Class VI cities are further classified into three groups: large urban centres (Class I), medium-sized urban centres (Class II & III), and small-sized urban centres (Class IV to VI).

In Kolkata, the urban population share remained consistently at 100% for both years, with the entire urban population concentrated within the single large urban centre of Kolkata itself. In 2001, the number of small and medium-sized urban centres did not significantly impact the increase in urban centres. However, between 2001 and 2011, there was a significant change due to the substantial growth of CTs, predominantly falling under small-sized urban centres. During this period, the share of small-sized urban centres and their population experienced tremendous growth, particularly in the peripheral districts of Kolkata, such as Howrah, Hugli, North 24 Parganas, South 24 Parganas, and Nadia (see **Fig. 4a**). Even in the westernmost districts of Purulia, Bankura, and Barddhaman, there was an increase in the share of small-sized urban centres during this period (see **Fig. 4a**). Similarly, the northernmost districts of Darjeeling, Jalpaiguri, and Coochbehar witnessed a significant rise in small-sized urban centres and their population.

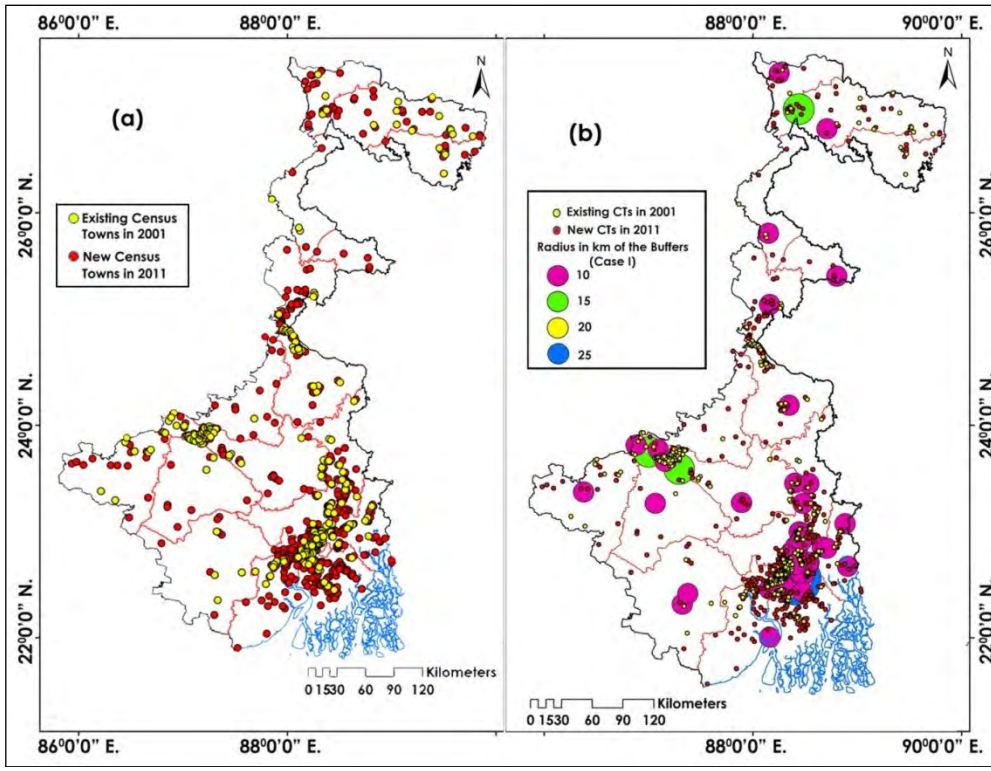


Fig. 4:(a) Emergence of Census Towns (CTs) during 2001-2011 in West Bengal and (b) Concentration and dispersion nature of CTs

4.2 District-level growth of CTs

A comprehensive analysis of census data spanning from 1951 to 2011 indicates that there were no significant spatial changes in the growth of Census Towns (CTs) between 1951 and 2001. However, in the last decade, from 2001 to 2011, CTs experienced tremendous growth, particularly in the Kolkata Metropolitan Area (KMA). Collectively, the five districts comprising the KMA (North 24 Parganas, South 24 Parganas, Nadia, Howrah, and Hugli) accounted for over 50% of the new CTs in 2011 (see **Table 5**). Additionally, apart from these five districts, the northern and westernmost districts witnessed a substantial number of new CTs in 2011 (see **Table 5**).

Table 5: District-wise distribution of census towns (CTs) in West Bengal during 2001-2011

Districts	CTs in 2001		CTs in 2011		Change in number	Change in share
	Actual	Share	Actual	Share		
Bankura	2	0.79	9	1.15	7	0.36
Barddhaman	55	21.83	85	10.90	30	-10.93
Birbhum	1	0.40	14	1.79	13	1.40
Darjeeling	4	1.59	24	3.08	20	1.49
Howrah	50	19.84	135	17.31	85	-2.53
Hooghly	28	11.11	64	8.21	36	-2.91
Jalpaiguri	13	5.16	35	4.49	22	-0.67
Koch Bihar	4	1.59	12	1.54	8	-0.05
Maldah	3	1.19	27	3.46	24	2.27
Murshidabad	22	8.73	65	8.33	43	-0.40
N. Dinajpur	3	1.19	5	0.64	2	-0.55
Nadia	15	5.95	55	7.05	40	1.10
North 24 Parganas	20	7.94	78	10.00	58	2.06
Paschim Medinipur*	9	3.57	11	1.41	2	-2.16
Purba Medinipur*			20	2.56	20	2.56
Purulia	9	3.57	25	3.21	16	-0.37
S. Dinajpur	0	0.00	5	0.64	5	0.64
South 24 Parganas	14	5.56	111	14.23	97	8.68
Total	252	100.00	780	100.00		

Source: Census of India, 2001 to 2011

Note. *in 2001, the combined district known as Medinipur

A significant number of new CTs emerged in Murshidabad district. In Jalpaiguri, the newly emerged CTs were scattered throughout the district, with the economy predominantly reliant on tea plantations, leading to an increase in CTs. Interestingly, in Malda district, the newly emerged CTs were primarily concentrated in the southern portion where large urban

centres are absent. The substantial influx of CTs in Barddhaman district can be attributed to its agricultural and industrial development. Similarly, the westernmost districts of Birbhum, Purulia, and Bankura also experienced a significant increase in new CTs, albeit to a lesser extent compared to the northern districts.

4.3 Concentration and dispersion nature of CTs

As noted by Bala (1982), newly emerging Census Towns (CTs) can be broadly categorized into two types: those concentrated around large urban centres and those dispersed and located away from such centres. A detailed analysis of previous literature, including studies by Dasgupta (1987) and Kundu (1992) indicates that in both India and West Bengal, the majority of new CTs were concentrated around metropolitan cities or large urban centres until the 2001 census. It has been observed that a village may transform into a CT if it plays a significant socio-economic role within its surrounding villages, even without proximity to metropolitan cities (Rondinelli, 1983). However, in the most recent census, Pradhan (2013) applied a buffer approach around Class I cities (those with a population of more than 100,000) to analyse the concentration and dispersion nature of newly emerged CTs in 2011 in India. The results revealed a contrary trend from previous censuses: only about one-third (31.06%) of the newly emerged CTs were concentrated around Class I cities, with the remainder located far from large urban centres. This study also employed a similar method to (Chakrabarty et al., 2015) to understand the nature of newly emerged CTs in West Bengal in 2011. Initially, three buffers were drawn around individual urban centres based on their population size (see **Table 6**). CTs within these buffers were termed "Suburban New CTs," while those outsides were labelled "Subaltern New CTs".

Table 6: Buffer-wise distribution of urban centres

Size Class of Urban Centres	The radius of the Buffer (in Km)		
	Case I (Base)	Case II (+25%)*	Case III (-25%)**
1 lakh -5 lakhs	10.00	12.50	7.50
5 lakh-10 lakhs	15.00	18.75	11.25
10 lakh -40 lakh	20.00	25.00	15.00
More than 40 lakhs	25.00	31.25	18.75

Note. * Radius is 25% larger than base (Case I), ** Radius is 25% smaller than base (Case I) as proposed by Pradhan (2013)

Source: Calculated by the authors based on the Census of India, 2011

The results presented in **Table 7** indicate the total number of new CTs within the buffer of each particular district, along with the percentage of new CTs within the buffer area of each district. Across all districts combined, 31.06% of newly emerged CTs are located around Class I cities. Consequently, more than two-thirds of new CTs are situated outside the buffer area of Class I cities. This suggests that the old pattern of monocentric urbanisation has gradually diminished. Additionally, when the buffer radius is increased by 25%, the share of new CTs rises to 35.23%, whereas a 25% decrease in radius reduces it

to 27.84% (**Table 7**). However, the distribution of new CTs around the proximity of Class I cities varies from district to district. Highly urbanized districts like North 24 Parganas, Howrah, Hugli, and Barddhaman exhibit a higher concentration of new CTs around Class I cities. Conversely, in less urbanized districts such as Nadia, South 24 Parganas, Malda, and Murshidabad, the share of new CTs around large urban centres is minimal (**Fig. 4b**). This indicates that non-urban areas of highly urbanized districts, which are proximate to Class I cities, are rapidly transforming into CTs, while areas in districts with lower urbanisation levels, located far from large urban centres, are also undergoing CT transformation.

Table 7: Buffer-wise distribution of Census Towns

District	The radius of the Buffer (in Km)		
	Case I (Base)	Case II (+25%)*	Case III (-25%)**
Bankura	0 (0.00)	0(0.00)	0 (0.00)
Barddhaman	12 (40.00)	15 (50.00)	10 (33.33)
Birbhum*	--	--	--
Darjeeling	6 (30.00)	7 (35.00)	6 (30.00)
Howrah	28 (32.94)	32 (37.65)	21 (24.71)
Hooghly	25 (69.44)	32 (88.89)	21(58.33)
Jalpaiguri	5 (22.73)	9 (40.91)	1 (4.55)
Koch Bihar*	--	--	--
Maldah	3 (12.50)	4 (16.67)	5 (20.83)
Murshidabad	3 (6.98)	1 (2.33)	5 (6.98)
North Dinajpur	0 (0.00)	0 (0.00)	0 (0.00)
Nadia	7 (17.50)	14 (35.00)	13 (32.50)
North 24 pgs	52 (89.66)	56 (96.55)	50 (86.21)
Paschim Medinipur	0 (0.00)	1 (14.29)	1 (14.29)
Purba Medinipur	1 (6.25)	0 (0.00)	0 (0.00)
Purulia	2 (12.50)	2 (12.50)	2 (12.50)
South Dinajpur	1 (20.00)	2 (40.00)	2 (40.00)
South 24 pgs	19 (19.59)	11 (11.34)	12 (12.37)
West Bengal	164 (31.06)	186 (35.23)	147 (27.84)

Source: Census of India, 2011

Note. * Birbhum and Koch Bihar have no Class I Cities as Classification of Pradhan (2013)

4.4 Surface trends of urban growth

The surface trend of urban growth at the level of CD blocks was assessed using the simultaneous fraction approach, commonly known as Carmer's Law, along with three key factors: the urban population of each specific CD block and their corresponding X and Y coordinates. This examination delved into a comprehensive analysis of the urban growth trends between 2001 and 2011, focusing on both district and CD block levels. At the CD block level in 2001, the application of Carmer's Rule highlighted Domjur, Sankrail, and Bally

Jagachha blocks within the Haora district as exhibiting notably high levels of urbanisation, while Gosaba block in South Twenty-four Parganas displayed the lowest urbanisation rate. By 2011, the trend persisted with several blocks in the Haora district, including Domjur, Sankrail, Panchla, and Bally-Jagachha, maintaining high levels of urbanisation. Meanwhile, the Gosaba block retained its position with the lowest urbanisation rate.

The analysis of CD block-level data from 2001 to 2011 indicated a notable shift in urban concentration (**Fig. 5a** and **5b**). In 2001, urbanisation was centred on Kolkata and a few nearby blocks; by 2011, it increased to several nearby districts, including Purulia, Barddhaman, Birbhum, Darjeeling, and Jalpaiguri. This expansion was influenced by neighbouring states, particularly Jharkhand, which played a significant role in fostering urban growth in the westernmost districts. Additionally, factors such as the Siliguri urban agglomeration and the presence of tea cultivation contributed to urban growth in northern regions. Conversely, blocks situated near the Bay of Bengal in the southernmost areas exhibited consistently low to very low levels of urbanisation in both 2001 and 2011. This trend was attributed to limited non-agricultural activities in the region, resulting in migration away from these areas. The findings underscored the dynamic nature of urban growth, influenced by a combination of geographical, economic, and social factors. Understanding these trends is crucial for informed urban planning and resource allocation to support sustainable development in diverse regions.

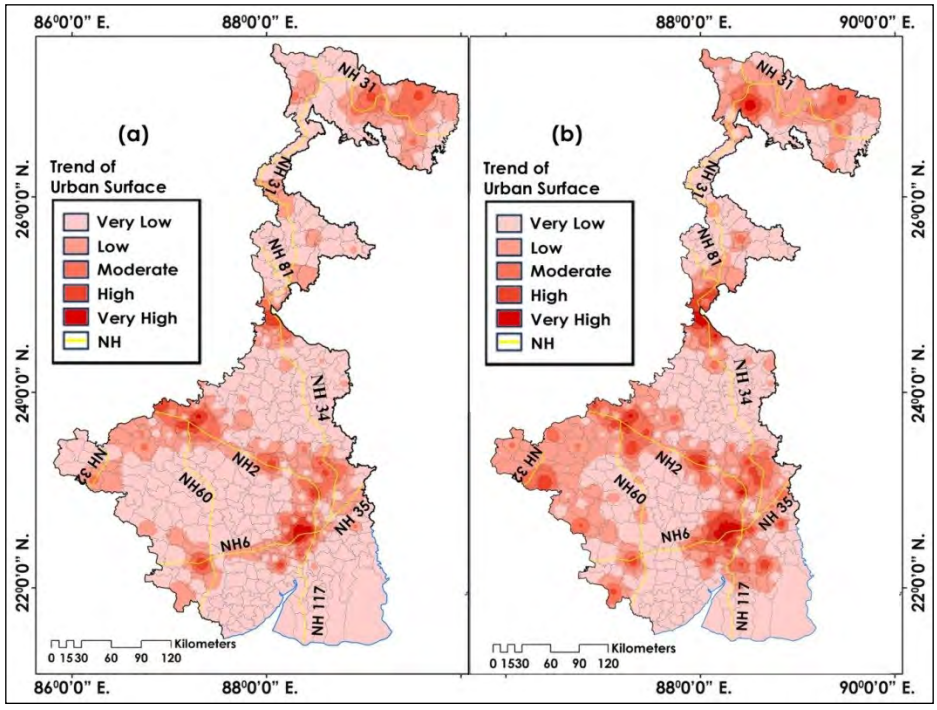


Fig. 5: Depicting the surface trend of Census Towns (CTs) as implications of urban growth at CD Block level for (a) 2001 and (b) 201

4.5 Hotspot Analysis

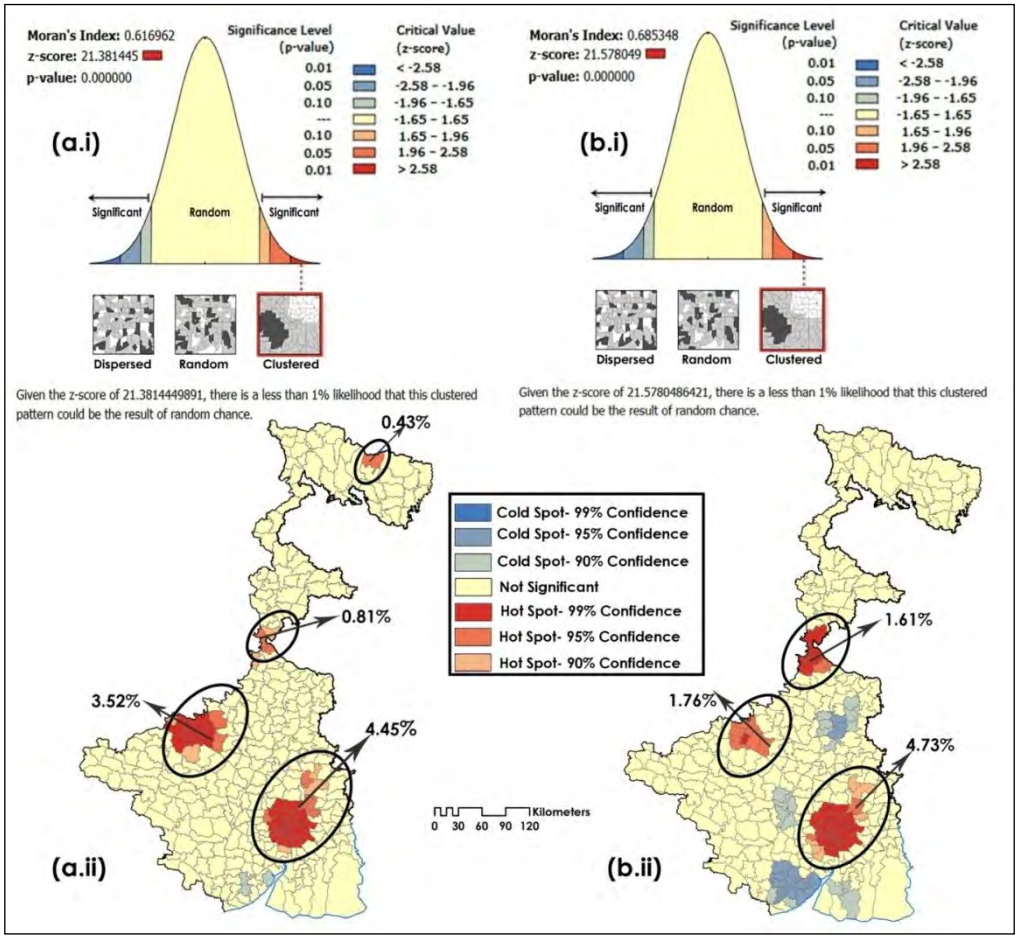


Fig. 6:(a.i) and **(b.i)** show the spatial autocorrelation for 2001 and 2011, respectively and **(a.ii)** and **(b.ii)** show the surface trend of urban growth for 2001 and 2011 respectively at the CD Block level in West Bengal

The spatial distribution of urbanisation across block levels in West Bengal is examined in hotspot analysis. Before conducting hotspot analysis, the presence of spatial autocorrelation among neighbouring observations in the datasets was evaluated. Moran's I statistic was employed as a measure to assess this spatial autocorrelation (Haldar et al., 2023). The results of Moran's I values at the CD Block level for both 2001 and 2011 revealed a tendency towards positive clustering. Specifically, in 2001, Moran's I value was calculated to be 0.61, indicating that 61% of the surface trend data for CD Blocks demonstrated positive clustering, with a Z value of 21.38 and a significant P value of 0.000. By 2011, this Moran's I value increased to 68%, with corresponding Z and P values of 21.57 and 0.000, respectively (see **Fig. 6a.i** and **6a.ii**). This spatial autocorrelation analysis offers valuable insights into the spatial patterns of urban growth (Haldar et al., 2023). In

2001, 32 blocks were identified as hotspot regions with a confidence level of 99%. The majority of these hotspots were concentrated within the Kolkata metropolitan area, with the remaining hotspots situated in the western part of the Barddhaman district. Similarly, in 2011, 42 blocks were designated as hotspot regions with a confidence level of 99%. Similar to 2001, the focal points of hotspot regions were primarily within the Kolkata metropolitan area but also extended towards the surrounding districts of Kolkata and Barddhaman (refer to **Fig. 6b.i and 6b.ii**). Furthermore, in 2011, blocks within the Murshidabad district were also identified as hotspot regions. This categorization of hotspot areas for urbanisation trends was attributed to the proliferation of non-agricultural activities and the presence of major highways such as NH-2 in Barddhaman district and NH-34 in Murshidabad district. Overall, the analysis provides valuable insights into the spatial patterns of urbanisation in West Bengal, highlighting areas of significant growth and the factors contributing to these trends.

4.6 Urban transition in Kolkata Metropolitan Area (KMA) during 2001-2011

Similar to West Bengal, the Kolkata Metropolitan Area (KMA) region has witnessed significant growth in Census Towns (CTs) over the past decade. While the number of Municipal corporations has remained constant, there has been a notable decrease in the absolute population and the proportion of male non-agricultural workers from 2001 to 2011. In contrast, **Table 8** shows that while the overall number of CTs, their population, and their percentage of the primary male non-agricultural population all increased over that time, the population density fell. This points to a demographic change in the KMA region, with people moving from large cities to smaller CTs and growing secondary and tertiary economic activity in these smaller regions. The number of villages in the area has remarkably decreased over this time, along with the population, population density, and percentage of male non-primary workers in the villages.

Table 8: Nature of urban characteristics in Kolkata Metropolitan Area (KMA) during 2001-2011

Type of administrative units	2001					2011					
	Number of units	Area (sq.km)	Population Size	Population Density	Share of male non-primary workers	Number of units	Area (sq km)	Population Size	Population Density	Share of male non-primary workers	Population growth rate
Municipal Corporation	3	285	5750265	20176	93.88	3	285	5740636	20142	93.48	-0.17
Municipality	38	631.99	6695461	10594	92.16	39	656.83	7327623	11156	90.36	9.44
Census Town	80	185.1	1028217	5554	88.4	154	342.71	1829098	5337	89.40	77.89
Cantonment Board	1	3.68	22041	5989	90.42	1	3.68	17380	4723	89.4	-21.15
Out Growth	12	29.93	65462	2187	84.54	4	16.33	22909	1402	90.58	-65.00
Village	462	715.71	1275432	1782	63.81	377	546.851	947122	1731	62.69	-25.74

Source: Calculated by the authors based on the Census of India, 2001 and 2011

Figures 8a and **8b** further illustrate that many villages exhibited urban characteristics as early as 2001 and 2011. Consequently, many villages have transformed

into CTs by adopting urban attributes. This transformation is attributed to changes in economic activities, with a considerable number of villages transitioning from the primary sector to the secondary and tertiary sectors. The Kolkata Metropolitan Area (KMA) region has undergone notable demographic and economic shifts over the past decade, with a particular focus on the proliferation of Census Towns (CTs) and the urbanisation of previously rural areas. The surge in CT numbers within the KMA signifies a trend towards urbanisation and demographic redistribution away from major metropolitan hubs. This shift is underscored by the decline in both the total population and the proportion of male non-agricultural workers within Municipal corporations, juxtaposed with the rise seen in CTs. This trend suggests a reconfiguration of population and economic activities towards smaller urban centres. Additionally, the expansion of secondary and tertiary economic activities in CTs indicates a broadening of the economic base beyond primary sectors, potentially fostering enhanced employment prospects and economic development in these locales. Conversely, the decrease in the number of villages, coupled with declines in population and workforce participation rates, signals a pattern of rural depopulation and economic restructuring. The transition of many villages with urban characteristics into CTs highlights a formalization of their urban status, driven by shifts in economic activities and population dynamics. This transformation is attributed to the evolving economic landscape, with agriculture-based sectors giving way to secondary and tertiary industries, reflecting broader economic restructuring processes. In sum, the KMA region exhibits a nuanced interplay of demographic shifts, economic transformations, and urbanisation dynamics, emphasizing the necessity for comprehensive urban planning and policy interventions to address emerging challenges and capitalize on opportunities presented by these changes.

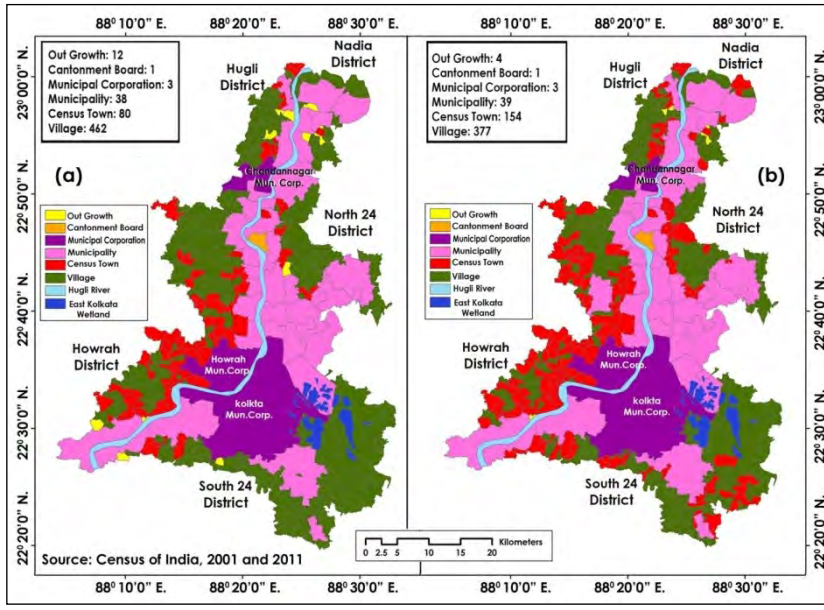


Fig. 7: Urban transition in Kolkata Metropolitan Area (KMA) (a) as per Census of India during (a) 2001 and (b) 2011

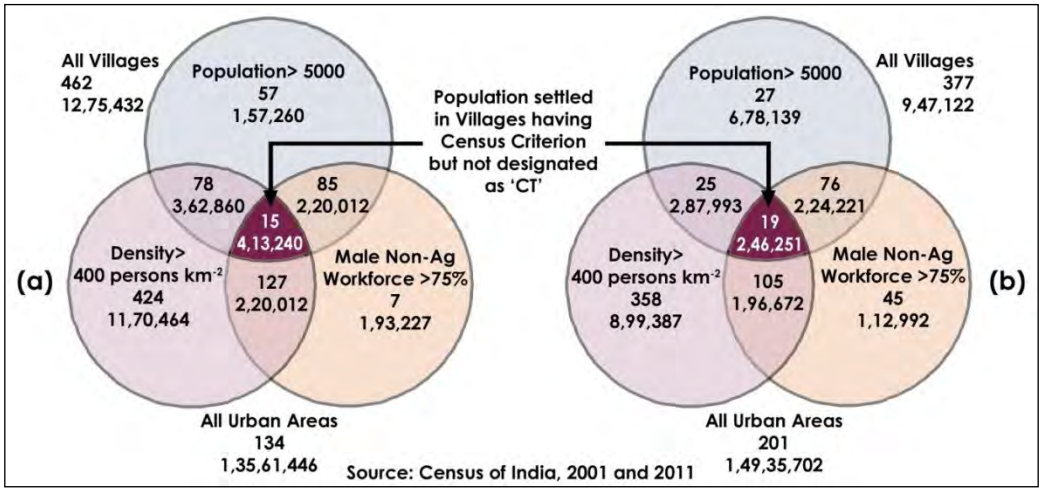


Fig. 8: Change in settlement structure, Kolkata Metropolitan Area in (a) 2001 and (b) 2011

In particular, the number of units, population size, population density, and the proportion of male non-primary workers to total workers are highlighted in **Table 8**, which presents statistics on several types of administrative units for the years 2001 and 2011. A variety of administrative unit types are listed in the table, including Villages, Census Towns, Municipal Corporations, Municipalities, and Cantonment Boards. Between 2001 and 2011, the Municipal Corporation and Census Towns' Populations increased, and the rest of the administrative units' populations decreased. Census towns and municipalities have a positive population growth rate. Among these two administrative census towns, the highest population growth rate is 77.89%, and the rest of the administrative units have a negative Population growth rate. In comparison to other administrative entities, Municipal Corporations and Municipalities have larger population densities in both years, which suggests higher degrees of urbanisation and denser settlement patterns. According to the statistics, between 2001 and 2011, the proportion of male non-primary workers declined in the majority of administrative units except Census Town and Outgrowth. This can point to a move toward primary industries like agriculture, or it might point to economic shifts and automation that reduce the number of non-primary occupations. The population size, density, and percentage of male non-primary workers vary significantly throughout the various categories of administrative divisions. For example, compared to Census Towns, Municipal Corporations and Municipalities often have larger populations and densities. Over the ten years from 2001 to 2011, the table shows how the demographic changed across various administrative unit types, with particular attention paid to changes in the workforce's composition, urbanisation, and population growth trends.

According to the UN-DEGURBA approach, urban and rural areas are further subdivided into seven subclasses for the KMA region (**Table 9**) based on total population size and population density (Persons/km^2). This analysis outlines the complexity of defining urban and rural areas globally, showcasing different approaches used in India and other

countries while highlighting a notable international effort to develop a standardized methodology. This study concludes that, by the Census of India, which includes Statutory Towns, they fall under the category of Urban Center in UN-DEGURBA; Indian CTs are Dense Urban Center in UN-DEGURBA in both of the years of comparison between the UN-DEGURBA method of urban and rural area delineation of KMA region in 2001 and 2011 (**Fig. 9a** and **9b**). Numerous villages fall within the Peri-Urban Center category, while others are in the Rural Cluster zone, Low-Density Rural Center, and both. Therefore, it is evident that the distinction between an urban and rural administrative entity varies depending on the approach and the criteria used.

Table 9: UN-DEGURBA Method of Classification

Population Density	Population Size			No Minimum Population Size Criterion
	>50,000	50000-5000	5000-500	
>1500	Urban Centre	Dense Urban Centre	Rural Cluster	
300-1500		Semi-Dense Urban Centre		Suburban or Peri-Urban Centre
300-50				Low-Density Rural Centre
<50				Very Low-Density Rural Centre

Source: Adopted from Sudeshna et al. (2023)

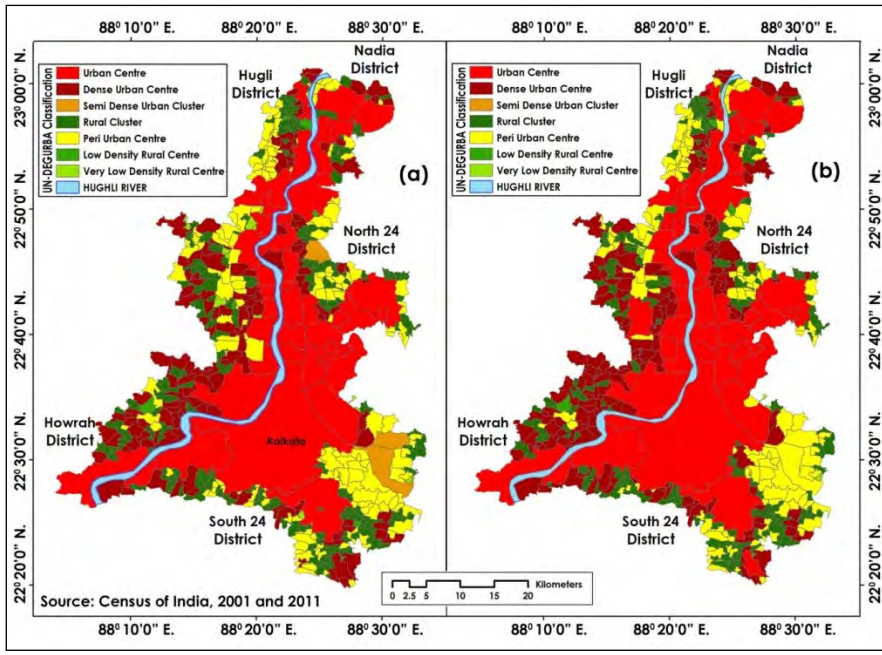


Fig. 9: Urban transition in Kolkata Metropolitan Area (KMA)as per UN-DEGURBA classification during (a) 2001 and (b) 2011

4.7 Factors Controlling the Spatial Distribution of Census Town CD Block Wise

Based on our previous analysis, it has been established that over the past decade, there has been a continuous increase in the number of small urban centres, primarily categorized as Census Towns (CTs). To discern the factors influencing the growth of CTs, stepwise regression analyses were conducted to examine the spatial distribution of census towns at the CD block level for the years 2001 and 2011. In this regression model, the number of CTs within each block was considered the dependent variable (Y), while independent variables included Total Population (TOT_P), Percentage of Main Worker Males (MAINWORK_M), Percentage of Main Household Worker Males (MAIN_HH_M), Percentage of Main Other Male Workers (MAIN_OT_M), Population Density (Pop_Den), Percentage of Cultivable Area (CL_Area), Percentage of Female Non-Agricultural Population (F_Non_Agr), Availability of National Highways (NH), State Highways (SH), Railways (RL), and Important Metalled Roads (IMR).

Table 10: Results of Stepwise Regression Analysis for Spatial Distribution of Census Towns, CD Block Level for 2001 and 2011

Year	Variables	Standardized Coefficients	Collinearity Statistics		R	R^2	Adjusted R^2	F	Sig.
		Beta	Tolerance	VIF					
2001	(Constant)	0.51	1	1	0.612	0.375	0.369	67.31	0.00
	MAIN_OT_M	0.506	0.994	1.006					
	MAIN_HH_M	0.283	0.993	1.007					
	MAINWORK_M	0.168	0.993	1.007					
2011	(Constant)	0.603	1	1	0.794	0.631	0.626	143.557	0.00
	MAIN_OT_M	0.554	0.983	1.018					
	MAIN_HH_M	0.414	0.966	1.035					
	MAINWORK_M	0.154	0.847	1.181					

Source: Calculated by the authors based on the Census of India, 2001 and 2011

The stepwise regression analysis for the CD blocks in 2001 revealed that out of the 10 independent variables, only three other male workers, main male household workers, and main male workers, essentially representing the male non-agricultural population, influenced the distribution of CTs. This model accounted for only 37.5% of the variance at a 99% significance level (see **Table 10**). However, in 2011, while the same three independent variables remained significant as in 2001, one new independent variable, total population, also demonstrated statistical significance in CT distribution. Overall, in 2011, this model explained 63.1% of the variance at a 99% significance level (see **Table 10**). This suggests that the variables significant in 2001 remained prominent in 2011, as evidenced by the substantial increase in variance explained from 37.5% to 63.1%. Hence, the findings indicate a positive correlation between the share of the male main non-agricultural population and the proliferation of CTs. The diversification of economic activities and the presence of a male non-agricultural population are pivotal factors contributing to the growth of CTs. Moreover, the development of non-agricultural activities and industrialisation emerges as significant factors driving the growth of CTs in West Bengal.

5. Discussions

Since independence, the rate of urbanisation in West Bengal has consistently exceeded that of the country as a whole. The proliferation of small urban centres has been a key factor driving this ongoing urbanisation trend in the state. Guin (2017) previously argued that the rapid growth of Census Towns (CTs), primarily spurred by the emergence of small settlements, has been the principal contributor to high urbanisation rates in both the nation and the state. Additionally, the presence of numerous small industries, particularly the jute industry, the establishment of railway towns due to railway expansion, and the growth of cantonment towns have significantly influenced the surge of urbanisation in West Bengal (Samanta, 2017). Another noteworthy aspect of urbanisation in the state is the uneven distribution of urbanisation, particularly evident in the Kolkata district. This unevenness stems from historical factors, notably the influx of residents into Kolkata from the eastern region of Bengal in 1971, resulting in a concentrated urban population in and around the Kolkata district (Dasgupta, 1987). However, starting from the 1980s, there has been a notable shift in urbanisation patterns.

With the rural economy transitioning towards secondary and tertiary sectors, the rural market expanded, leading to an increase in the number of small towns. Consequently, urbanisation began to spread from the core Kolkata metropolitan region to its periphery (Giri, 1998). One intriguing observation throughout the study period is that while the level of urbanisation in the Kolkata district has consistently remained at 100%, there has been a discernible shift in the distribution of urban population within the district. The share of the urban population has declined within the Kolkata district itself and has concurrently increased in peripheral districts such as Howrah, North Twenty-four Parganas, and Hugli. This shift can be attributed to the emergence and growth of small towns in these peripheral areas (Das & Kar, 2022). Several elements, including the development of minor urban centres, industrialisation, past migratory patterns, and economic transformations, are highlighted in the research on the dynamics of urbanisation in West Bengal. It also sheds insight into how urban growth has changed over time in the area by highlighting the geographical distribution of urbanisation inside the Kolkata district and its outskirts.

While urbanisation levels vary across districts, the inter-district differences are primarily attributed to variations in natural resources, socio-economic development, industrialisation, transportation infrastructure, and other geographical factors (Bhowmick and Sivaramakrishnan, 2021). The proportion of the urban population and the distribution of urban centres, ranging from large to small, in West Bengal remained relatively stable from 1951 to 2001. However, in the last decade, both the urban population share and the number of urban centres have experienced significant expansion, driven by the growth of non-primary activities in smaller urban areas (Guin & Das, 2015). Additionally, the rapid development of transportation networks and the increase in job opportunities in non-agricultural sectors, coupled with lower living costs, have attracted a considerable influx of people from rural areas to these smaller urban centres, as opposed to larger cities (Das & Kar, 2022). Historically, West Bengal was dominated by the primate city of Kolkata.

Although Kolkata maintained its primacy in 2011, the primacy index between Kolkata and the second-largest urban centre, Haora, has steadily declined over the study period. This trend suggests diversification of the urban population away from a single core urban centre towards smaller urban centres (Das & Kar, 2022). There has been a focus on the many variables influencing urbanisation, such as natural resources, industry, socioeconomic development, and transportation infrastructure. It also talks about the mechanics of urban expansion, and how economic possibilities and cheaper living expenses are causing a trend towards smaller metropolitan regions. The factors influencing urban migration are also highlighted in the book, including better employment and transit options. Decentralization of urban population and resources is suggested by the decreasing primacy index between Haora and Kolkata.

An in-depth examination of census data spanning from 1951 to 2011 reveals a notable trend: while there were no significant changes in the growth of Census Towns (CTs) between 1951 and 2001, the last decade witnessed a tremendous surge in their numbers. The distribution pattern of newly emerged CTs in 2011 indicates dispersion away from major urban centres, suggesting a transition from rural to urban settlements occurring in situ (Denis et al., 2017). Several factors contribute to this substantial growth in CTs, with the Census of India's urban classification playing a crucial role. Additionally, many villages have transformed CTs, as documented by Guin and Das (2015). Various regional industries have also contributed significantly to the proliferation of CTs. For instance, the expansion of the tea industry in the Darjeeling and Jalpaiguri districts, the influence of silk industries in Murshidabad, and the bidi industry in Maldah have all fuelled the growth of CTs in their respective regions (Guin and Das, 2015). Furthermore, the presence of statutory towns and the growth of non-agricultural activities have been cited as factors driving CT growth in Murshidabad district (Roy &Samanta, 2018). Similarly, the industrial and coal mining developments in Barddhaman district have spurred the growth of CTs in that area (Samanta, 2017). Overall, the past decade has witnessed a decline in primary and secondary activities alongside a notable increase (9-11%) in tertiary activities. The development of small service centres and markets of smaller sizes has also contributed to the growth of CTs in West Bengal (Roy & Samanta, 2018).

Census Towns are growing in a very different way than they were ten years ago. A notable uptick in growth has been seen in the past ten years. This suggests that the region's urbanisation processes and settlement patterns are changing dynamically. The expansion of CTs is attributed to several causes, such as shifting census definitions, rural-to-urban migration patterns, and regional economic activity. A mix of social, economic, and policy issues determines the dynamics of urbanisation, as the text demonstrates. The development of CTs in certain areas is mostly driven by regional industry and economic activity. The given examples—the tea industries in Darjeeling and Jalpaiguri, for instance—emphasize how localized urbanisation processes are and how crucial regional economic dynamics are. There is a change in the economic landscape, with a rise in tertiary activity and a fall in primary and secondary industries. This change in the spatial distribution of urban settlements is a reflection of larger economic changes taking place in West Bengal.

Overall, this research highlights the interaction between demographic, economic, and policy variables influencing urbanisation trends in the region and provides insights into the complex nature of CT growth in West Bengal.

The significant surge in Census Towns (CTs) over the past decade has seen more than 50% of this growth concentrated in the Kolkata Metropolitan Area (KMA). This concentration primarily stems from the burgeoning development of the manufacturing and service sectors within and around the KMA, as highlighted by Chakraborty et al. (2015). Moreover, the expansion of non-agricultural activities from Kolkata metropolitan to its peripheral districts, coupled with a notably higher natural population growth rate in these smaller urban centres compared to metropolitan cities, has played a pivotal role in driving the growth of CTs in this region, as noted by Das and Kar (2022). Additionally, the presence of highways has contributed positively to the proliferation of CTs. State and national highways, in particular, have facilitated the transformation of numerous large villages into CTs in West Bengal, as underscored by Chakrabarti and Mukherjee (2022). Notably, while the Hugli River was historically the primary influencer of urbanisation in Kolkata until 2001, the advent of improved road connectivity has emerged as another crucial factor catalyzing the growth of CTs in these regions, as observed by Bhowmick and Sivaramakrishnan (2021). The main factor driving CT concentration is the growth of the manufacturing and service industries in and around the KMA. This implies that patterns of urban expansion are greatly influenced by economic issues. The expansion of CTs in the area is driven by the population growth rate of the smaller urban areas. This emphasizes how crucial demographic patterns are to the process of urbanisation (Haldar et al., 2023).

In essence, a holistic examination of the forces propelling the expansion and clustering of Census Towns (CTs) within the Kolkata Metropolitan Area (KMA) underscores the intricate interplay among economic, demographic, and infrastructural facets in urban evolution. Notably, the outcomes of stepwise regression analysis concerning CT distribution reaffirm a significant factor: the presence of male non-agricultural workers substantially contributes to the proliferation of CTs. Furthermore, the transformation of numerous large villages into CTs is attributed to the shift of economic activities from the primary sector to the secondary and tertiary sectors within these locales. This demonstrates how fundamental changes in the economy have an impact on how urban landscapes are shaped. All things considered, this provides insights into the complex and diverse nature of urbanisation processes, clarifying the intricate relationships between economic, demographic, and infrastructure factors that propel the expansion and change of urban settlements such as CTs in the KMA and throughout West Bengal. (Guin and Das, 2015).

6. Conclusion and Policy Perspectives

This research investigates the temporal evolution of urbanisation in West Bengal spanning from 1951 to 2011, with a focus on the emerging trends of rapid urbanisation observed in the state during the last decade. The analysis reveals that between 1951 and 2001, the urbanisation dynamics in West Bengal were primarily characterized by the

dominance of the metropolitan city of Kolkata. However, in the past decade, this monocentric urbanisation pattern has transitioned towards a polycentric model, driven by significant growth in the number of small-sized cities, particularly Census Towns (CTs), in comparison to larger urban centres. This shift towards a polycentric pattern has been observed not only within the vicinity of Kolkata but also in the peripheral districts as well as in the western and northern regions of the state. The continuous decline in the primacy index further indicates the diffusion of urbanisation across the state.

Additionally, the study finds that only 31.06% of the newly emerged CTs are located near class I cities, with the majority being situated farther away and referred to as "Subaltern CTs." However, there exists a significant intra-district variation, where CTs in highly urbanized districts tend to be closer to class I cities compared to those in less urbanized districts. The results of stepwise regression analysis suggest that the increasing male non-agricultural population is a key factor driving the significant growth observed in CTs.

Furthermore, amidst the era of neo-liberalization, where economies in highly urbanized states like Tamil Nadu, Maharashtra, and Gujarat are flourishing, West Bengal's economy has faced decline. This is attributed to the concentration of new investments primarily in major cities, leaving the newly emerged CTs, particularly those in underdeveloped regions of the state, without significant benefits from such investments. Moreover, the newly emerged CTs are predominantly governed by rural panchayats, resulting in a lack of basic urban services and amenities. Therefore, in line with the emerging diffusive pattern of urbanisation, there is a pressing need for diffusive economic activities and proper urban planning facilitated by urban governance. Following the example of other states like Andhra Pradesh, Gujarat, Madhya Pradesh, Uttar Pradesh, and Tamil Nadu, West Bengal must consider establishing "Nagar Panchayats" by the 74th Constitutional Amendment Act of 1992 to ensure better provision of urban services in small towns and CTs.

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SPATIALITY OF DISPARITIES IN SOCIO-ECONOMIC DEVELOPMENT OF VIDARBHA REGION, MAHARASHTRA

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Abstract

Regional disparity is one of the major contemporary problems at various scales, such as global, national and state levels. Despite the prosperous state of India, Maharashtra has pronounced intra-state disparity. Vidarbha is one of the geographical regions of Maharashtra, identified as a backwards region by various committees appointed by the government. Although Vidarbha is identified as backwards in the state, the region has intra-regional disparity. Hence, the paper attempts to assess the spatial pattern of regional disparities in socio-economic development within the Vidarbha region. The assessment is based on block-level data. To measure the socio-economic development of each block, 30 indicators have been considered based on demographic, economic, social and infrastructural dimensions of development. The outcome revealed different degrees of development, ranging from very high to low levels of development. The results of the analysis corroborated with Friedman's core-periphery model. The highly developed blocks are characterised by good quality of social and infrastructural facilities. These blocks encompass commercial centres and district headquarters, with a high rate of urbanisation, and the blocks perform as the core of the region. The less developed blocks are mainly situated in remote areas characterised by forests and dominant tribal belts. These blocks require focused attention to enhance infrastructural and social facilities to achieve balanced regional development. The study may be helpful for policymakers and development practitioners to plan and minimise spatial disparities.

Keywords: Regional Disparity, Regional Development, Spatial Disparities, Urbanization.

1. Introduction

As a developing country, India exhibits the uneven distribution of spatial contours of development that leads to inter- and intra-regional disparities. Regional disparities refer to uneven development across geographical scales and are influenced by a broad spectrum of social, economic, and spatial phenomena (Milek, 2018). These disparities hinder the holistic development of the country, posing challenges to national integration and political stability (Ahmad and Rahman, 2022). Disparities are a multiscale phenomenon (Wei, 2015), as their extents differ from country to country and region to region. In the contemporary era, the persistence of regional disparities has become a crucial problem as the majority of

countries of the world are confronting today, specifically in developing countries, where lack of pertinent planning, haphazard urban growth, spatially selective agglomeration of economic activities and uncontrolled population growth causes intensifying regional disparities (Zali et al., 2013).

Since the inception of India's planning system, balanced regional development has been one of the main objectives to achieve the overall development of the country. Despite concerted efforts, regional disparity in the context of economic and social development has been persisting at the national and regional levels. These disparities, stemming from a range of factors, including unequal allocation of resources and differences across various sections of society, have driven the adoption of different developmental programmes (Kurian, 2007). The country's economic growth trajectory, while positive, has further perpetuated the inter-sectoral and inter-regional disparities (Papola, 2006); it poses a significant challenge for academicians and policymakers. Despite the plethora of development programmes, regional disparity persists over time.

Maharashtra is described as one of the most developed and economically affluent states in India. Despite its overall progress, the problem of regional disparities has been a characteristic feature of Maharashtra and its persisting date back to the time of the formation of the state (Kamdar, 2009) In contemplation to measure the regional imbalance in the state, the Government of Maharashtra formed two major committees, i.e. Dandekar (1984) and Kelkar (2013). These committees have underscored the issue of regional imbalance in the state and identified that the Vidarbha region is comparatively more backwards, emphasising the need for targeted development strategies. However, despite policy recommendations and resource allocation, the cycle of underdevelopment persists in the region.

The Vidarbha, a primarily agrarian region, faces adverse experiences that have contributed to its underdevelopment. The region experiences agrarian distress and economic risks as a result of its reliance on cotton farming, irregular rainfall patterns, and insufficient irrigation infrastructure. Additionally, inadequate infrastructure, limited industrialisation, and lack of economic opportunities further exacerbate the challenges for development. The region comprises 11 districts and 120 blocks; some blocks are likely to be very highly developed, and some blocks are less developed. Therefore, it is essential to assess the socioeconomic development at the block level, from which the intra-regional disparities can be traced at the block level (Narain et al., 2002). The present paper attempts to assess socio-economic development through different dimensions in the Vidarbha region. The research seeks to suggest some measures to reduce regional disparities. The study will be helpful for local administrators and policymakers in planning to reduce spatial disparities.

2. Study Area

Vidarbha is one of the geographical regions located in the eastern part of Maharashtra and holds a distinctive position within the state, both geographically and socio-

economically. Geographically, it extends from 18^0 42′ N to 21^0 44′ N latitude and 76^0 00′ E to 80^0 55′ E longitude, including the Nagpur and Amravati administrative divisions (Figure 1). Vidarbha is bordered by Madhya Pradesh to the north and northeast, and by Chhattisgarh to the east and southeast, Telangana to the south, and the Jalgaon and Aurangabad districts of Maharashtra to the west. The region covers an area of 97404 sq. km. It represents 31.6% of the total geographical area of Maharashtra and is home to 21.3% of the total population of the state. A total of 11 districts, i.e., Amaravati, Yavatmal, Buldhana, Akola, Washim, Nagpur, Wardha, Bhandara, Chandrapur, Gadchiroli and Gondia and 120 blocks are included in the region.

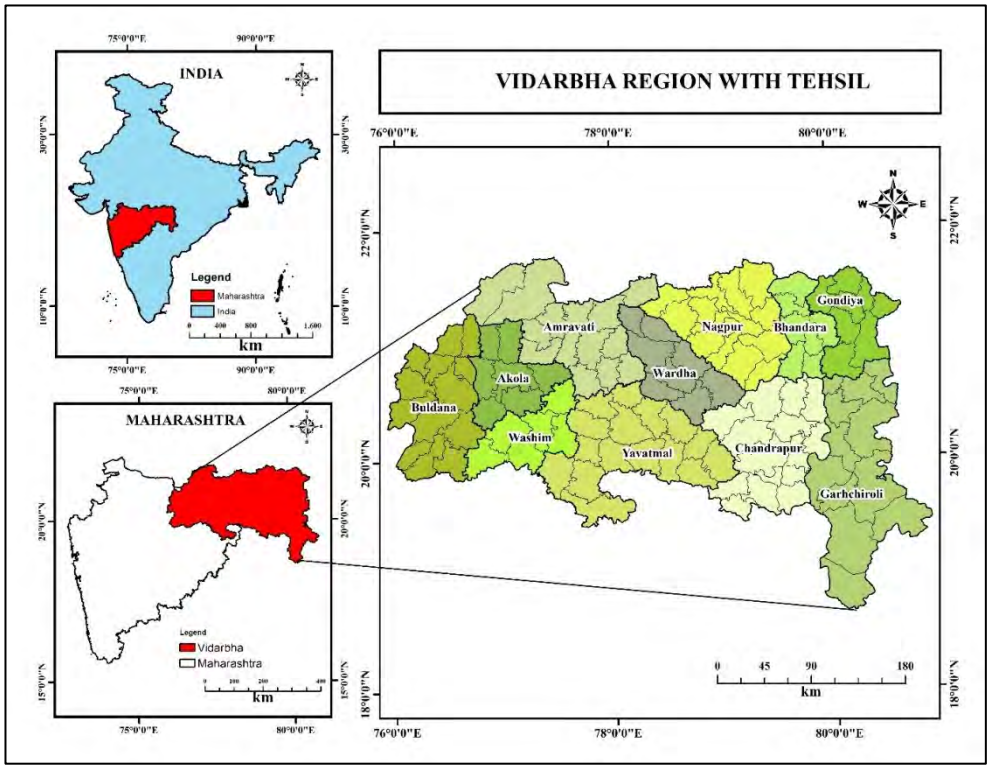

Figure 1. Location Map of Vidarbha

The most distinguishing characteristic of Vidarbha is its richness of natural resources, specifically minerals, as it holds approximately 60% of the mineral resources of Maharashtra. Despite this abundance, the development of the region has lagged behind other parts of the state, with significant disparities in socio-economic parameters. These disparities are further exacerbated by the agrarian crisis, as agriculture dominates the economy. The region suffers different challenges, including agrarian distress, as it is marked by high rates of farmer suicides, limited industrial development and infrastructural gaps. These issues interplay complex roles, along with socio-political factors, leading to chronic underdevelopment. Vidarbha is unique for its socio-cultural fabric and the regional issues that have persisted from the formation of the state. One of the most pressing

challenges is inadequate irrigation facilities, which limit agricultural productivity and impede development (Kelkar, 2013). The reliance on rain-fed agriculture makes it highly vulnerable to erratic weather patterns and further intensifies agrarian distress. Furthermore, gaps in education, healthcare, and employment opportunities hinder the region's overall progress. While Vidarbha has considerable potential for development, especially in sectors such as agriculture and mining, these opportunities have yet to be fully realised due to governance and policy shortcomings.

Understanding the dynamics of socio-economic development in Vidarbha is crucial to formulating targeted policies and interventions to address these challenges and promote inclusive growth and development. By addressing the intra-regional disparities in the region, the study seeks to contribute to the discourse on balanced regional development.

3. Database and Methodology

The present study is based on secondary data, and sources are the District Census Handbook, 2011 and the District Socio-economic Review, 2023, Maharashtra. The study attempts to measure the status of development based on various indicators, as Nizamuddin (2014) has pointed out, development is a multidimensional process, and a single indicator cannot fully capture its impact. In conformity with the focus of the study on socio-economic development, regional disparities have been examined in the context of various dimensions such as (i) Demographic, (ii) Economic, (iii) Social, and (iv) Infrastructural. The demographic and social dimensions encompass social progress, and the economic and infrastructural dimensions encompass the region's economic well-being. The socio-economic development was measured for each block, considering 30 indicators based on demographic, economic, social, and infrastructural dimensions of development (Figure 2).

All four dimensions of the index are independently calculated with the help of the Z-score method (Equation 1) to understand disparities in different dimensions of development, based on studies done by Sharma and Mishra (2016), Raj et al. (2019), and Ahmed and Rahman (2022). According to Kar (2021), the method is apt to get a composite score of socio-economic development involving a large number of positive or negative indicators. The formula is as follows:

$$Z_{ij} = \frac{X_{ij} - \bar{X}_j}{\sigma_j} \qquad \text{Equation (1)}$$

Where,

Z_{ij} = Z-score for the variable X_{ij} in block ith

X_{ij} = Actual value of the indicator from block ith

$\bar{X}_j$ = Mean of the indicator values across all blocks

σ_j = Standard deviation of the indicator values across all blocks

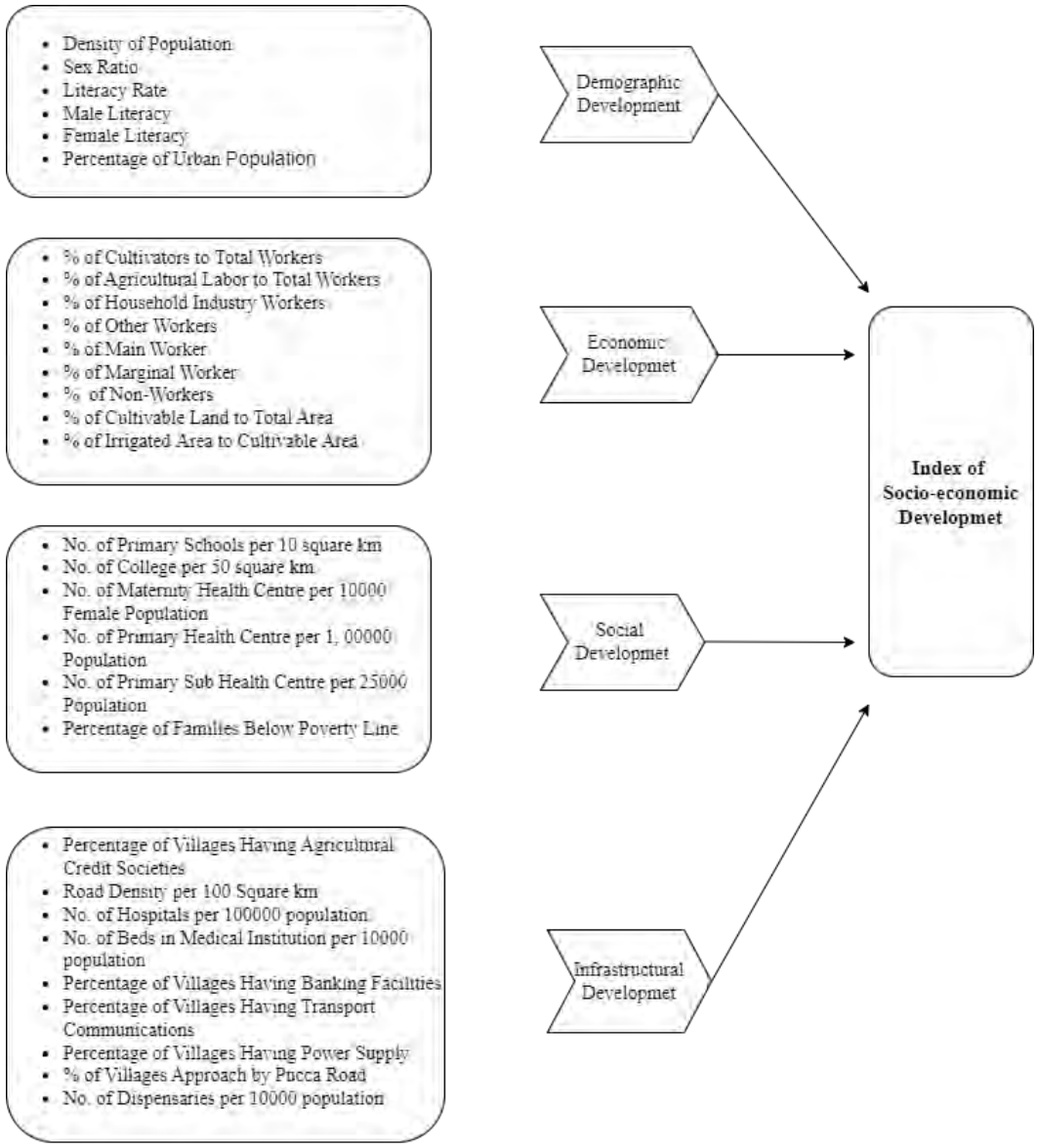

Figure 2. Indicators, Dimensions and Subsequent Stages for Formulation of the Index of Socio-economic Development

The composite index (dimension index) for each dimension has been calculated using Equation 2. The resulting dimension index provides a standardised composite z-score for each block, reflecting the summation of performance across different indicators.

$$Dimension\ Index = \sum_{j=1}^{n} Z_{ij} \qquad \text{Equation (2)}$$

Where,

Z_{ij}= denotes the z-score of the jth indicator for the ith block

i = denotes the blocks

j = denotes the indicators (e.g., literacy, urbanisation, sex ratio)

n = denotes the total number of indicators used in that particular dimension.

Further, the dimension index was used to get an integrated picture of socio-economic development using equation 3.

$$Index\ of\ Socio-economic\ Development = \frac{1}{n}\sum_{d=1}^{n} D_{id} \quad \text{Equation (3)}$$

Where,

D_{id} = denotes the dimension index of the jth dimension for the ith block

i = denotes the blocks

d = denotes the dimensions (demographic, Economic, Social, infrastructural)

n = denotes the total number of dimensions.

The index has been categorised into four development groups by applying an equal interval classification method, i.e., very highly developed, highly developed, medium developed, and less developed, and spatial disparities are represented on the Arc Map 10.3 platform.

4. Results and Discussion

Regional disparities stem from unequal regional development, which varies across regions based on social, economic, and demographic characteristics (Kundu and Mondal, 2012). The study assesses the regional disparities in terms of demographic, economic, social and infrastructural dimensions, as these play fundamental roles in regional development.

4.1 Demographic Development

The demographic dimension of development significantly influences the pace and structure of socio-economic development, as it reflects the composition and distribution of the population, which in turn may affect various spheres of development, such as the social, economic, infrastructural, etc. Changes in demographic indicators often lead to fundamental shifts in social structure, with urbanisation, literacy rates, population density, and sex ratios as key markers of development. These demographic indicators are particularly relevant in the context of regional disparities, as they shape the socio-economic landscape of different areas.

The Vidarbha region has 120 blocks out of which 10 blocks are identified as very highly developed (6.66 to 15.75). These are Nagpur Urban, Nagpur Rural, Kamtee,

Amravati, Akola, Wardha, Chandrapur, Yavatmal, Bhandara and Gondia (Figure 3). In all these blocks, the higher rates of urbanisation, elevated literacy levels, and dense populations contribute to the high demographic development. The Nagpur urban block has the highest composite score because of the best performance of selected indicators, like 100 per cent urbanisation and the highest population density. The 74 blocks come under the category of highly developed (-2.46 to 6.65), mainly from Nagpur, Amravati, Akola, Gondia and Wardha, based on better performance in different parameters of development. Out of 120 blocks, 31 belong to the medium developed (-11.58 to -2.47) category of development. It exists in Amravati, Buldhana, Washim, Yavatmal, Nagpur, Chandrapur and Gadchiroli districts. The remaining five blocks belong to less developed (-20.70 to -11.59). It includes Gondpipri, Jiwati in Chandrapur and Etapalli, Sironcha, and Bhamragad in Gadchiroli. Sparse population densities, low rates of urbanisation, and low literacy levels are key contributing factors to their slower pace of development. These blocks need exceptional attention levels up to literacy sex ratio.

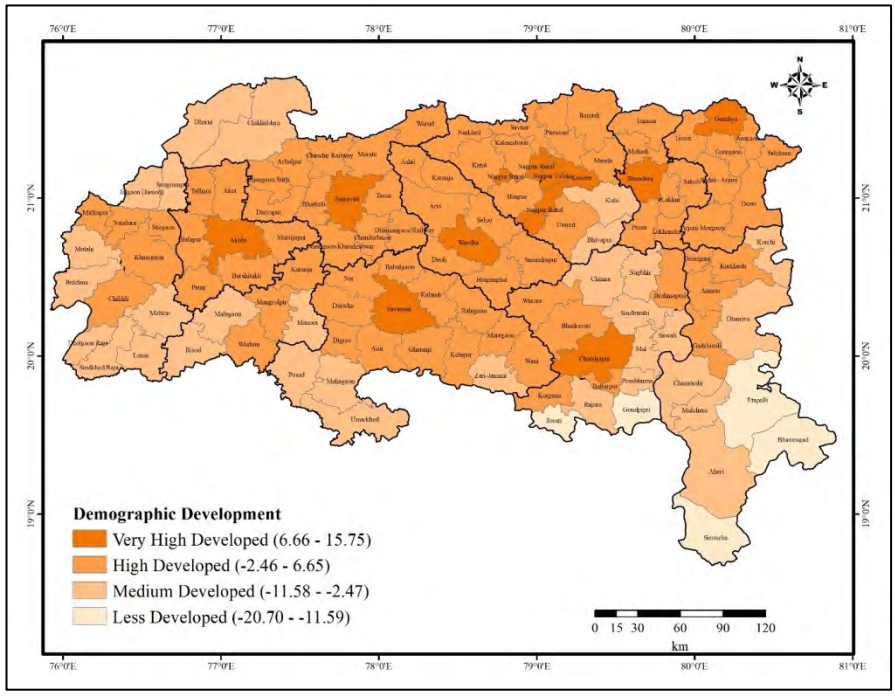

Figure 3. Status of Demographic Development in Vidarbha

4.2 Economic Development

The uneven distribution of economic opportunities among the regions is referred to as regional disparities in economic development. Economic development is the keystone of overall development. It lays the foundation for holistic societal progress, creating a synergy that propels the standard of living. The research incorporates various indicators for the assessment; those are available at the block level.

In the study area, Nagpur Urban and Amravati blocks are identified as highly developed (3.29 - 6.11) as the blocks perform well in economic indicators like the percentage of main workers and very low percentages of marginal workers (Figure 4). Highly developed (0.47-3.28) includes 19 blocks. These are Akola, Gondia, Bhandara, Wardha, Chandrapur, Chamorshi, Hingna, Gadchiroli, Narkhed, Nagpur Rural, Katol, Mauda, Bhivapur, Kalmeshwar, Washim, Buldhana, Karanja and Warora. A larger percentage of arable and irrigated land boosts the block's prosperity. There are 80 blocks belonging to the medium developed (-2.35 - 0.46**)** category of development. Out of that, a larger number of blocks belong to Bhandara, Chandrapur, Yavatmal, Buldhana and Washim districts. Less developed (-5.17 to -2.36) blocks belong to Amravati (Anjangaon Surji, Daryapur, Bhatkuli, Chandurbazar, Chikhaldara, Dharni), Gondia (Sadak Arjuni, Deori, Arjuni Morgaon), Chadrapur (Nagbhir), Gadchiroli (Etapalli, Mulchera, Bhamragad), Yavatmal (Digras, Maregaon), Buldhana (Lonar, Deolgaon Raja), and Akola (Murtijapur, Patur) districts. The performance of selected economic indicators is poor. In these blocks, the percentage of non-workers and marginal workers is high, and the other indicators moderately affect the level of development.

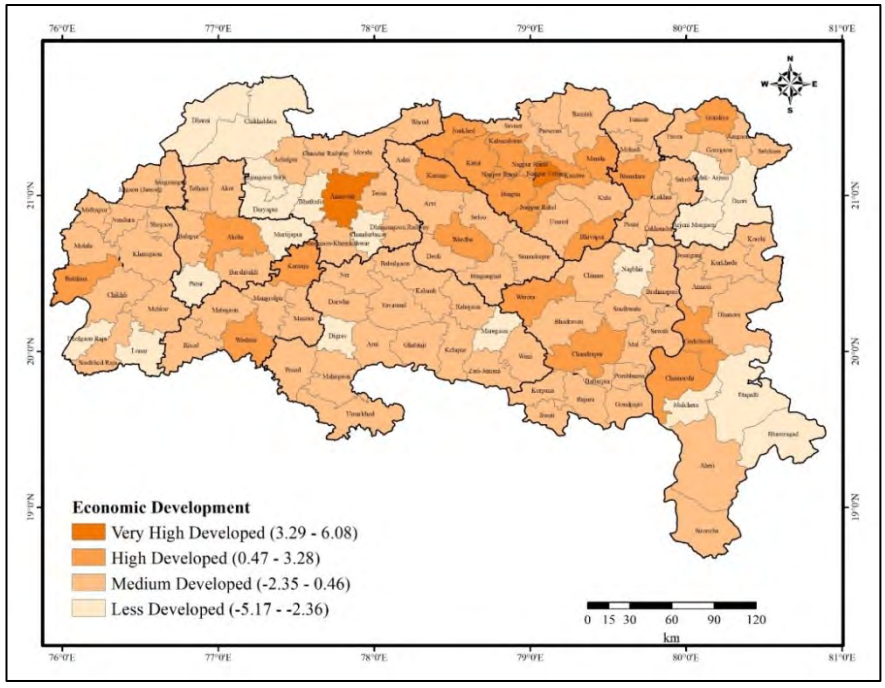

Figure 4. Status of Economic Development in Vidarbha

4.3 Social Development

Social development is a crucial dimension of overall development (Sharma 2014); it encompasses housing, social security, health, education, and individual social services (Pratiwi and Susiyanto 2021). It is the process of uprising that improves the ability of the

society to fulfil its ambitions. It implies a qualitative change in the way the society shapes itself and carries out its activities.

There are two blocks belonging to the very highly developed (4.53-8.15) category of social development. These blocks are Nagpur Urban and Amravati due to good health and educational facilities, performing well in social development (Figure 5). The 12 blocks, namely Umred, Savner, Gondia, Bhandara, Akola, Kalmeshwar, Nagpur Rural, Katol, Kalmeshwar, Hingna, Buldhana, Kamtee, and Kuhi, belong to highly developed (0.90-4.52). The number of blocks mainly comes from the Nagpur district. Medium developed (-2.73-0.89) category includes 83 blocks. The maximum number comes mainly from Wardha, Gondia, Chandrapur, Amravati, and Buldhana. There are 23 blocks belonging to the less developed (-6.36 to - 2.74) category of social development. The blocks majorly come from Gadchiroli, Yavatmal, Amravati, Chandrapur, Washim and Bhandara. The blocks have a higher percentage of below-poverty-line population due to a lack of health, education and communication facilities.

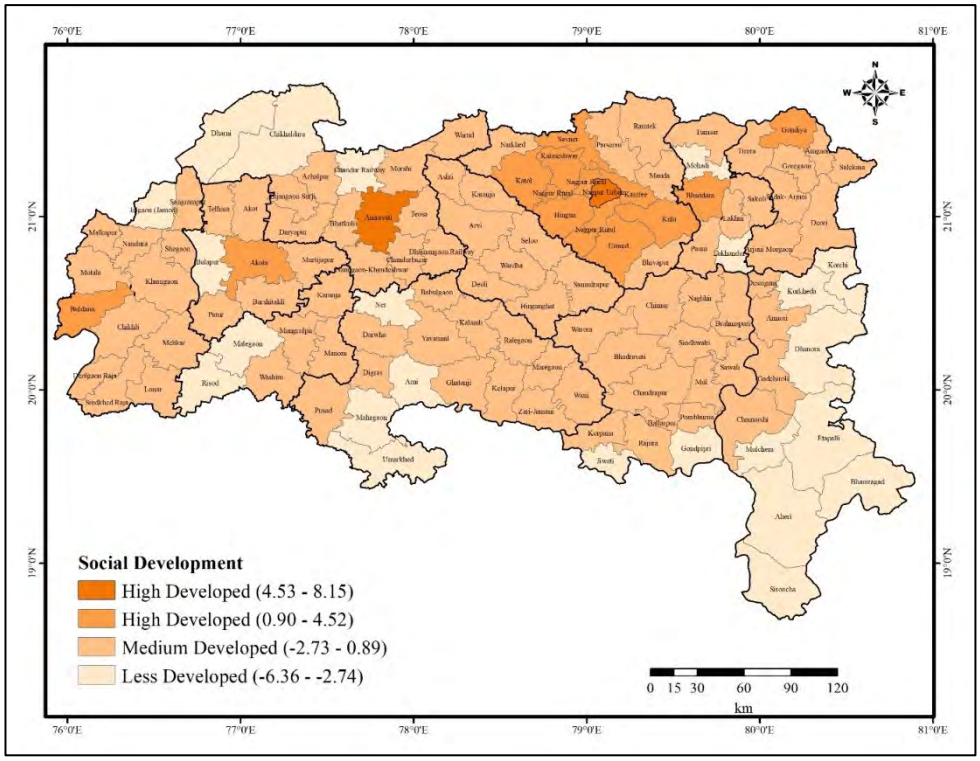

Figure 5. Status of Social Development in Vidarbha

4.4 Infrastructural development

Infrastructure facilities are considered vehicles of regional development, as they fast-track economic development (Olufemi et al., 2013). Infrastructure plays a multifaceted role in regional development by providing the physical backbone necessary for economic

growth, social progress, and the well-being of communities. Strategic investment in infrastructure can unlock the potential of regions, enhance quality of life and create equal development opportunities.

There are three blocks, namely, Nagpur Urban, Amravati and Akola, that are very highly developed (11.85 – 22.22). These blocks have well-developed infrastructural facilities like transport and health facilities. Out of 120 blocks, 19 blocks are included in the highly developed (1.47 - 11.84) category of infrastructural development. Out of 19 blocks of highly developed areas, nine blocks come from the Nagpur district. These blocks incorporate dense road connectivity, and people have easy access to all educational and health facilities. Medium Developed (-8.29-1.46) includes 87 blocks from all districts of Vidarbha. Most of the blocks come from Wardha, Bhandara, Yavatmal, Washim, Buldhana and Amravati. 11 blocks fall under the category of less developed (-19.29 to -8.92). The blocks belong to Gondia, Gadchiroli, Buldhana, Chandrapur and Amravati (Figure 6).

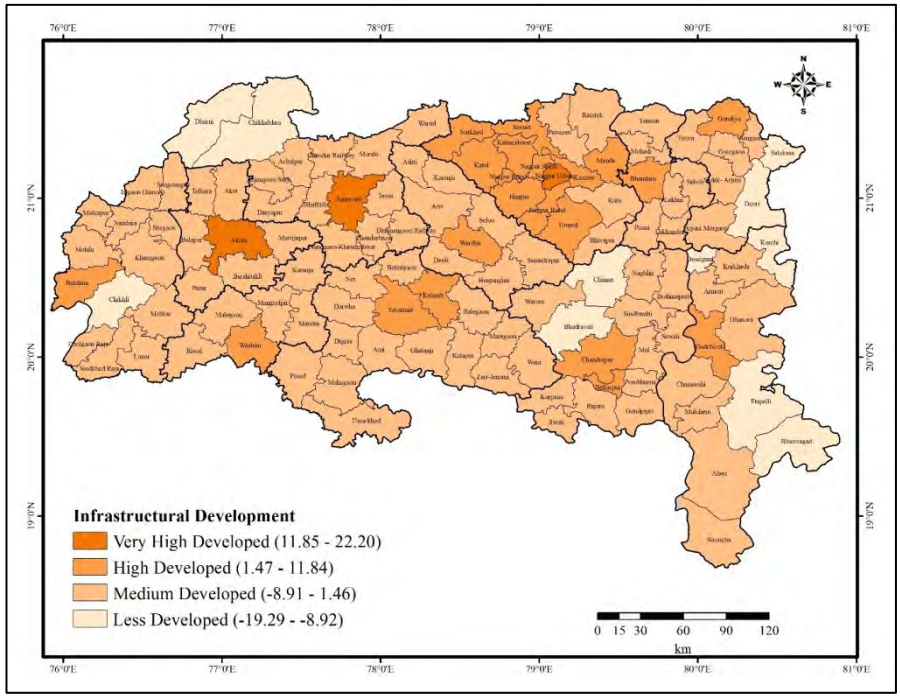

Figure 6. Status of Infrastructural Development in Vidarbha

4.5 Socio-economic Development

The concept of development is central to any issue about change in the socio-economic domain (Chojnicki, 2010). It is an outcome of the socio-economic system and its process (Minocha 1983), which carries progress through the process of social and economic transformation within the region. It encompasses a multifaceted approach to improving the overall well-being and quality of life within society, addressing various

interrelated spheres such as demographic dynamics, economic prosperity, social equity, and infrastructural advancements.

The spatial pattern of regional disparities in overall development can be discerned by representing the level of development (Figure 7). There are three blocks, namely Nagpur Urban, Amravati and Akola, identified as very high development (6.76 – 13.08). The blocks likely exhibit significant economic development because of the presence of industrial and commercial centres. The blocks perform excellently in each dimension of development and typically have well-established infrastructure such as roads, transportation networks, utilities (electricity, sanitation), and communication facilities. This infrastructure supports the functioning of various economic and social activities within the region. Highly Developed (0.43 – 6.75) includes 28 blocks. Most of them come from the Nagpur district; these are performing well in all demographic, economic and infrastructural indicators like literacy, sex ratio, urbanisation, percentage of main workers, road density, etc. Other blocks include the district commercial centres and comparatively good social and infrastructural facilities. There are 84 blocks identified as medium developed (-5.90 – 0.42). The majority of blocks come from Gondia, Yavatmal, Buldhana, Akola, Bhandara, and Chandrapur. The remaining five blocks fall under the less developed (-12.23 to -5.91) category of socio-economic development. Less developed blocks exhibit deprivation in socio-economic facilities. The blocks come from the Gadchiroli (3) and Amrawati (2) districts. These blocks are situated in peripheral areas of the region, having a higher percentage of tribal population, and they depend on primary economic activity. Sironcha, Etapalli, Bhamragad (Gadchiroli), Chikhaldara, Dharni (Amrawati) blocks.

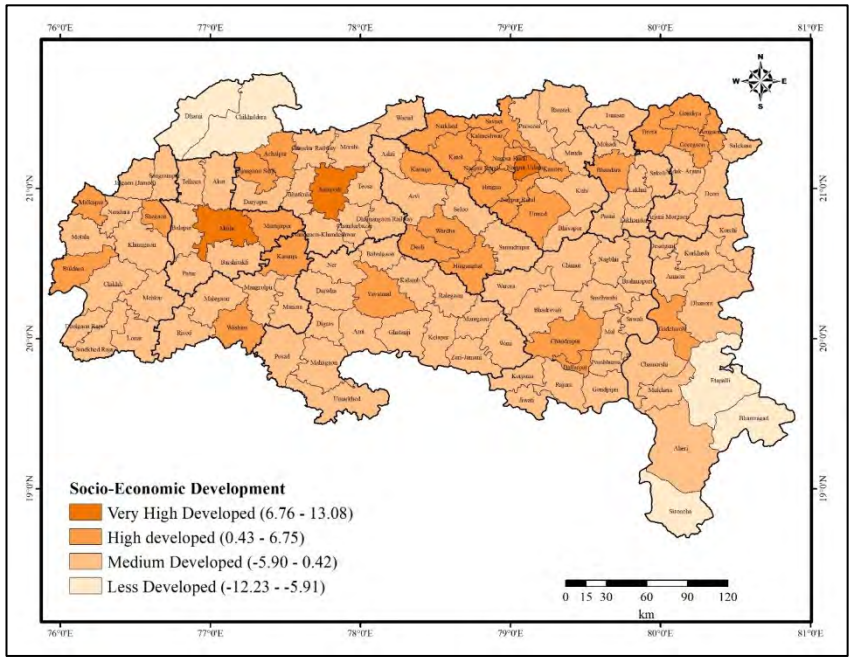

Figure 7. Status of Socio-economic Development in Vidarbha

The result of the study aligns with the 'core' and 'periphery' characteristics of Friedman's (1966) core-periphery model. The model describes that the core is an important location having a higher level of economic development, urbanisation, and well-developed infrastructure, the blocks identified as very highly developed exhibit similar characteristics of the 'core' concept and the blocks identified as the medium and less developed exhibits accordingly more or less same characteristics of semi-periphery and peripheral area of the model. These blocks have limited urbanisation, a low level of infrastructural development and a high poverty level.

The results have been validated with NITI Aayog's Aspirational Block Programme (https://abp.championsofchange.gov.in/). The programme has identified 27 blocks as aspirational in Maharashtra, of which 10 are located in the Vidarbha region. The research work identifies that out of those 10 blocks, six blocks are Jiwati (Chandrapur), Aheri (Gadchiroli), and Karnja (Wardha), which come under the medium developed category, and the remaining four blocks are Bhamragad, Sironcha (Gadchiroli), Dharni, and Chikhaldara (Amravati) are categorised under the less developed category. The result highlights the pressing need for concerted efforts to bridge the development gap within the region.

The number of blocks is categorised in terms of all the dimensions of development; there are relatively fewer blocks in the "Very High" and "High Developed" categories across the different dimensions (Table 1). This implies that there is room for improvement and targeted interventions to enhance development levels in the region, particularly in the economic, social, and infrastructural dimensions.

Table 1. Dimension-wise Number of Blocks in Different Levels of Development

Dimensions	Very Highly Developed	High Developed	Medium Developed	Less Developed
Demographic	10	74	31	5
Economic	2	19	80	19
Social	2	12	83	23
Infrastructural	3	19	87	11
Socio-economic Development	3	27	85	5

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4.6 Inter-Relationship Among Different Dimensions of Development

All spheres (dimensions) of development must flourish simultaneously for the inclusive and balanced development of the region. The Pearson correlation matrix displays the correlation coefficients between the various development dimensions (Table 2). A perfect negative correlation is denoted by a correlation coefficient of -1, no correlation is shown by a correlation value of 0, and a perfect positive correlation is denoted by 1. The correlation coefficient between Demographic and Socio-Economic dimensions is 0.865, indicating a strong positive correlation. This suggests that as the demographic indicators (such as literacy, urbanisation, sex ratio, etc.) improve, the overall socio-economic

conditions also tend to improve. The correlation coefficient between Infrastructural and Socio-Economic dimensions is 0.886, which is the highest correlation in the matrix. This strong positive correlation suggests that better infrastructure (e.g., transportation, communication, utilities) is closely associated with better socio-economic conditions. The correlation coefficient between Economic and Social dimensions is 0.615, indicating a moderate positive correlation. This implies that economic development and social factors (such as education, health, and quality of life) tend to be interrelated, but other factors influence their relationship. Improvements in one dimension are often associated with positive changes in other dimensions, particularly for infrastructure and socio-economic conditions.

Table 2. Correlation Matrix of Different Dimensions of Development

Dimensions of Development	Demographic	Economic	Social	Infrastructural	**Socio-Economic**
Demographic	1.000				
Economic	0.485	1.000			
Social	0.582	0.615	1.000		
Infrastructural	0.581	0.643	0.636	1.000	
Socio-Economic	0.865	0.730	0.783	0.886	1.000

Correlation is significant at a 5 % level. (p-value < 0.05)

5 Conclusion

Assessing regional disparities in the study area underscores significant spatial variations and uneven development patterns. The highly developed blocks have characteristics of the ‘core’ area, such as good quality social, economic and infrastructural facilities. All the less developed blocks are situated in peripheral areas, some of which are tribal-dominated, characterised by low social and economic status and fewer infrastructural facilities. In addition, lack of economic opportunities, inadequate human capital development, and poor connectivity hinder the ability to attract investment and foster sustainable development. These blocks need distinct attention to improve infrastructural and social facilities and achieve the well-being of people to attain balanced regional development. Accordingly, development measures must be prioritised in medium and less-developed blocks in the region. Through the lens of the Core-periphery model, it becomes evident that the disparities in development between the core and peripheral areas are starkly apparent. The Nagpur urban, Amravati, and Akola areas act as the ‘core’ by attracting investments, infrastructure, and economic activities as very highly developed blocks. The less developed blocks, such as Etapalli, Bhamragad, Sironcha (Gadchiroli), Dharni, and Chikhaldara (Amravati), are peripheral and highlight the pronounced lower socio-economic development. This distribution signifies a concentration of resources, infrastructure, and economic activities in blocks of the core areas and the blocks in the peripheral areas face significant challenges in overall development that corroborate the

concept of spatial inequality within the region. By prioritising less developed blocks and implementing targeted, context-specific strategies, policymakers and stakeholders can work towards ensuring more equitable and inclusive development, ultimately contributing to the overall socio-economic progress of the region and its people.

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News and Notes

CALL FOR ABSTRACTS

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Geographical visualization, otherwise geovisualization, is a dynamic and evolving field that leverages various techniques to represent spatial data visually. Geovisualization is a powerful tool that enhances our understanding of geographical entities and supports decision-making across various fields. For instance, environmental monitoring utilizes geovisualization to track changes like deforestation and climate shifts. Disaster management benefits from mapping affected areas and planning evacuations. Geovisualization helps monitoring crop health and resource allocation. In urban planning, it helps design efficient cities by analyzing population density and land use. Public health uses it to visualize disease spread and healthcare access. Transportation and logistics improve route planning and traffic management. In real estate, it aids in analyzing property locations. Additionally, it's employed in military strategy, education, and tourism to enhance decision-making and user engagement. With the advent of big data, geovisualization tools are increasingly integrating large datasets from various sources, including satellite imagery, sensors, and social media. Overall, a geographical visualization can help identify region-specific challenges and opportunities, and promote tailored solutions that are effective and efficient. With this background, the Department of Geography, Central University of Tamil Nadu, Thiruvarur is organizing its flagship programme, GeoVista 2025, a scientific platform to enhance geographical visualization across the disciplines.

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Authors shall submit their abstract in 200 to 300 words with a clear title, and author list. The authors are instructed to download the abstract template from the conference website and upload their abstract in the word format (.docx) and register for the conference until 28.02.2025 using the registration link in the website.

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GeoVista Talent Hunt '25 includes exciting events that provide a platform for young talents to showcase their geovisualization skills and creativity. The talent hunt not only celebrates student creativity but also helps participants build confidence, gain exposure, and connect with their peers. It provides a unique opportunity for students to explore their potential and take bold steps toward their dreams through following competitions.

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IGS TALENT TEST 2025

The Indian Geographical Society is organising the State-wide 15th Talent Test for Young Geographer – 2025 for the final year UG and PG students of Geography Departments in Tamil Nadu on 07th January, 2025 (Tuesday) through online mode. The Executive Committee of the Society, through the Coordinator, is organising this event with the support of Head of the Colleges/Institutes/Geography Departments.

The Head of the Geography Departments are requested to share the registration link https://forms.gle/ngt9TePJWLiHAbTZ8 to the students for registering themselves for participating in the Talent Test.

The Results of the winners of UG & PG Talent Test 2024 will be published on the same day and the participation certificates will be sent separately to the individual participants.

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I, K. Kumaraswamy, hereby declare that the particulars given above are true to the best of my knowledge and belief.

Dr. K. Kumaraswamy
Editor, The Indian Geographical Journal

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