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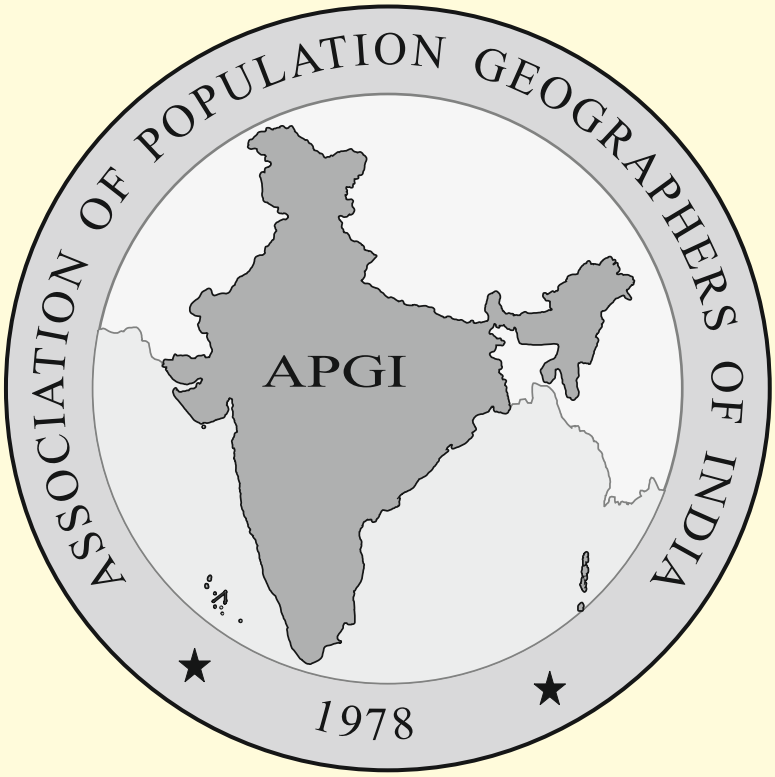

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IN REMEMBRANCE

Kamal Ramprit Dikshit
(October 1, 1927– August 2, 2025)
Editor-in-Chief, Population Geography
Formerly Professor and Head, Department of Geography,
S.B.P. Pune University, Pune, Founder President, IIG, Pune.

Association of Population Geographers of India

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CONTENTS

[1] Corresponding Author
* Invited Article

POPULATION GEOGRAPHY
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Demographic Transition: India's Window of Opportunity

V. Vidhya and P. Mohanachandran Nair

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Abstract

Demographic transition leads to a shift in the population's age distribution, characterised by a reduction in the child population and an increase in the working and elderly populations. An increase in the proportion of the working-age population, known as a "demographic dividend" or "window of opportunity", can be considered an essential factor in stimulating a nation's economy. Therefore, this study aims to examine the trends in demographic transition in India and its major states. The published reports from the Census, SRS and other economic tables were used for the analysis. It has been observed that the age distribution in India has shifted due to declining birth and death rates. The potential supporting ratio among major states has increased from 1971 to 2011. Among the Southern states, Kerala and Tamil Nadu had crossed the supporting ratio, indicating that these states had begun to reap the demographic dividend. The relationship between the supporting ratio and the GDP growth rate indicates that demographic dividends have contributed to economic growth. Over the past few decades, the rate of workforce expansion consistently surpassed that of population growth. This trend indicates a notable rise in the working-age population. Generating sufficient employment opportunities is crucial for a country's development.

Keywords: Age pyramid, potential supporting ratio, demographic dividend, labour, economic growth

Introduction

The demographic transition is a concept that describes population changes over time and is used to examine trends in the country's socio-economic development. The progression of demographic transition leads to an age-structural transition, where the child population decreases while the working-age and elderly populations increase. An Increase in the working-age population occurs during an age structural transition, often known as the "demographic dividend", and is one of the key elements for boosting a nation's economy. Two key aspects contributing to the demographic dividend are the falling birth rate and rising life expectancy. It is known that the demographic dividend does not last long. "Demographic dividend is a one-

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time opportunity during a complete cycle of demographic transition" (Lee & Mason, 2006). India is currently experiencing a period of remarkable demographic transformations, and these changes are likely to contribute to a substantially increased labour force in the country. In India, the pace and timing of the demographic transition vary across regions. The nature of changes in the age structure of the population during the demographic transition has various social and economic implications (Navaneetham, 2002). The age-structural transition in India has significantly affected changes in the workforce. As the population undergoes demographic shifts, such as a decline in the share of young dependents and an increase in the working-age population, it directly influences the size, composition and dynamics of the labour force. Numerous studies have investigated the relationship between age-structural transition and economic growth, suggesting that shifts in demographic patterns contribute to economic development by influencing savings and investment (Lee et al., 1997; Mason, 1998; Bloom & Williamson, 1997). James K.S. (2008) highlighted that many developing nations, including India, are experiencing a rapid decline in fertility, which could yield a demographic bonus that could elevate the country to a more substantial economic position.

India is well known for being one of the fastest-growing economies in the world. The United Nations Population Fund (UNFPA) State of World Population Report 2023 states that India will surpass China to become the world's most populous country by mid-2023. India's population is projected to reach 142.86 crore, compared with China's 142.157 crore, by July 2023. According to this report, 68 per cent of the Indian population is in the 15-to-64-year age group, which offers a significant advantage in terms of a large workforce. Thus, an increase in the working-age population contributes positively to GDP per capita. To gain benefits from this "window of opportunity", much more has to be done in education, employment and health. Therefore, this study examines the demographic transition in India and its major states.

Objectives

- To study the age structural transition in India and major states (region-wise) from 1971 to 2011.
- To find out the changes in workforce participation in India
- To study how the demographic dividend supports the economic growth of the country.

Data and Methodology

This study used data from published Census of India reports from 1971 to 2011, SRS reports, and other economic tables. An analysis was done for India and the major states. The 14 major states selected are grouped into six regions (1) Southern region (Andhra Pradesh, Karnataka, Kerala, Tamil Nadu) (2) Central region (Madhya Pradesh and Uttar Pradesh) (3) Eastern region (Bihar, Odissa, West Bengal) (4) Northern region (Punjab, Haryana and Rajasthan) (5) Western region (Maharashtra and Gujarat) (6) Northeastern region (Assam). Population pyramids for the states are constructed to trace the history of age composition from 1971 to 2011. To

understand the demographic characteristics, various indicators, such as the Dependency ratio, the support ratio, the GDP growth rate, and the work participation rate, were used.

Dependency ratio

This indicator provides insight into the number of people of non-working age relative to working-age people.

Dependency ratio=P (0-14) +P (60+)/P (15-59) → (1)

Supporting ratio

Supporting ratio is similar to the dependency ratio. Here, taking the population in the age group (25-59) as the numerator and the population of the age group (0-24) and the 60+ population as the denominator. Number of persons aged from 25-59 years per every person aged from (0-24) and (60+). Mathematically, the ratio can be expressed by the following formula.

Supporting Ratio= (W (25-59))/ [(0.9*P (0-24) +P (60+))] → (2)

If the numerator and denominator are the same, then the ratio is one. If it is more than one, it indicates a younger population, signaling the start of the demographic dividend.

Per capita income and Demographic dividend

Here. the concept of a demographic dividend is explained using a basic equation, with GDP per capita used as the measure of economic growth. First, GDP per capita is decomposed in the following equation (*Routledge Handbook Asian Demography*)

Y/N= (L/N) *(Y/L) → (3)

In this equation, Y denotes GDP, N denotes population, and L denotes the labour force. Then, GDP per capita is expressed as the product of the support ratio (L/N) and labour productivity.

Equation can be rewritten in growth terms as follows (*Routledge Handbook of Asian Demography,2018*)

gr (Y/N) =gr(L/N) +gr(Y/L) → (4)

Where gr denotes the growth rate, the growth in the support ratio is referred to as the first dividend, and the factors that influence labour productivity provide the second dividend.

Workforce participation

It is defined as the percentage of total workers to the total population.

Findings

Age Structural Transition in India

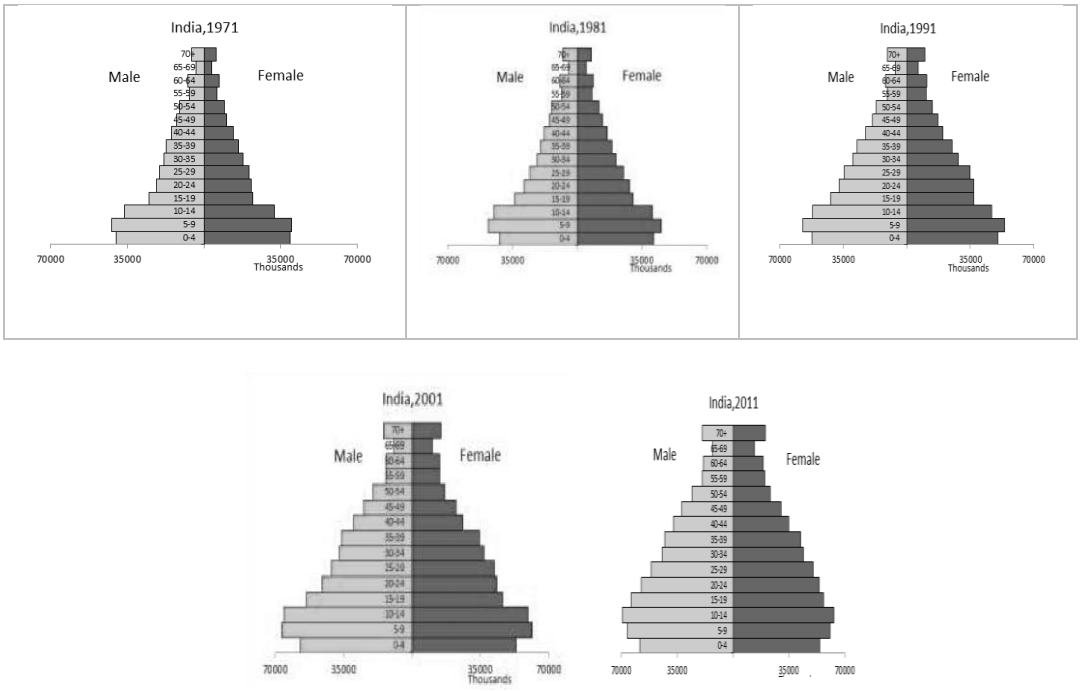
The age-structural transition of the population across the major states of India over time is compared using age pyramids.

The age pyramid of India from 1971 to 2011 is shown in Figure 1, which helps to analyse the age structure of a population over time. The age pyramid of India, with a broad base up to 2001, indicates a high birth rate. Initially, the population pyramid was wide at the bottom and gradually narrowed over time. By 2011, there was a noticeable decline in the population at lower ages, indicating a recent decline in fertility. The most significant changes happened in the shares of the youngest age groups, 0-4 and 5-9. The age distribution has changed towards the Middle Ages, with a decline in the share of the child population and an increase in the share of adults and

older people. A consequence of recent fertility declines in India was that the age pyramid's conical shape changed from 1971 to 2011, becoming nearly rectangular.

Figure 1

Age Pyramid of India: 1971-2011



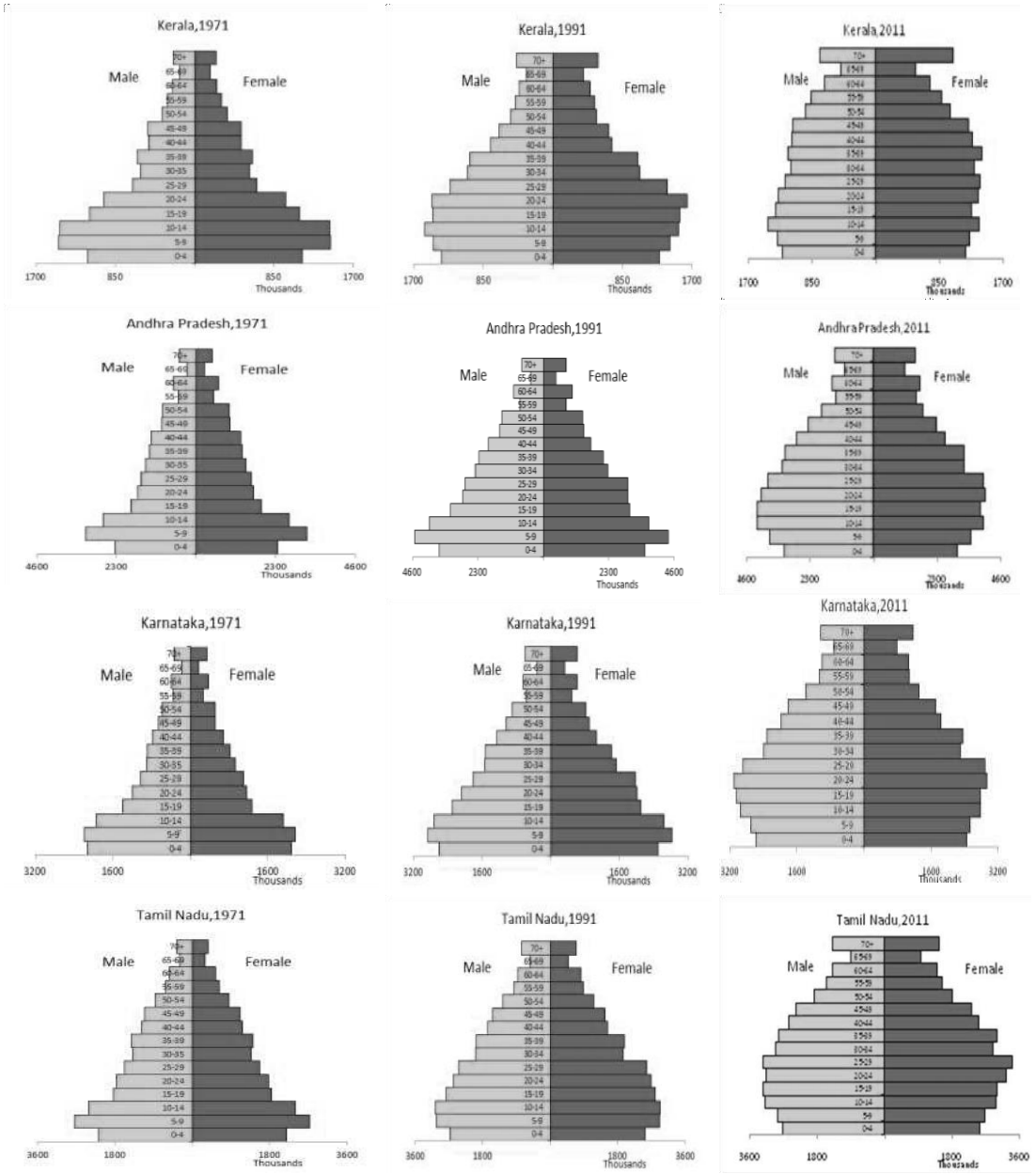
Age Structural Transition in the Southern States of India

The major states are classified into six regions: Southern, Central, Eastern, Northern, Western and Northeastern. Kerala is a state in southern India. The state had already fallen below replacement-level fertility in the 1990s, while some northern states in India were experiencing high or mid-level fertility. Thus, Kerala experienced a decline in growth rate, and the age pyramid exhibits low fertility prevailing in Kerala. Kerala (Fig. 2) displays a conical shape from 1971 to 1991. Then the pyramid forms a box-shaped structure, indicating a significant decline in the child population and an increase in the elderly population. The middle-aged population has also been bulging since 2001. Region-wise analysis of the demographic transition across the states showed that all southern states had experienced declines in the younger age cohorts (0-14) and gains in the economically active age group population. Tamil Nadu has attained the window of opportunity from the middle bulge. Fertility reduction in Karnataka is slower than in other southern states. Although all four southern states showed a comparatively significant decline in the share of the young population, the decline was highest in Kerala. By analysing the pyramid,

Kerala experienced ageing in 2011. Here, the elderly female population exceeded the male population. There was an increase in the share of the economically active population across 1971-2011 in all four states, with the most significant gain in Tamil Nadu and the smallest in Karnataka.

Figure 2

Age Pyramid of Southern States from 1971–2011



Source: Census 1971-2011

Figure 3

Age Pyramid of States in the Central Region

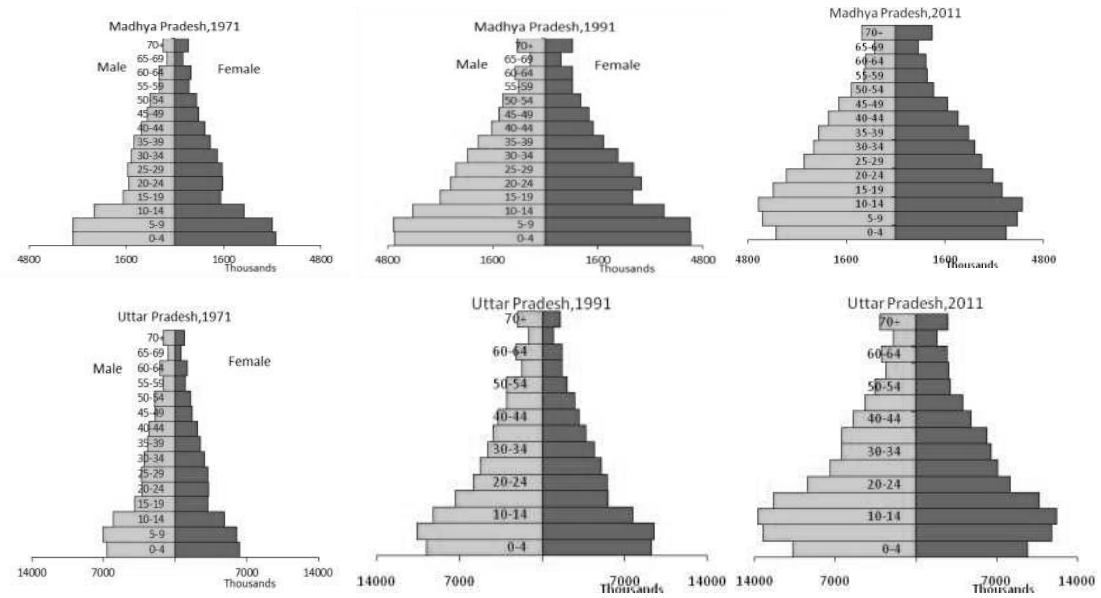
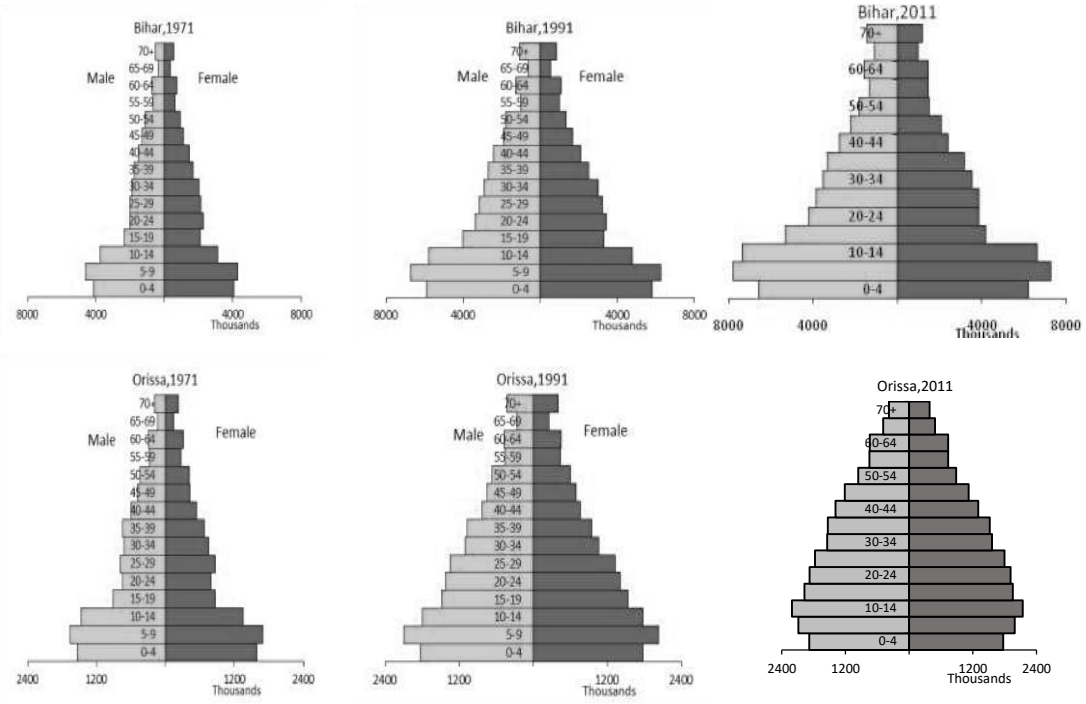


Figure 4

Age Pyramid of States in the Eastern Region



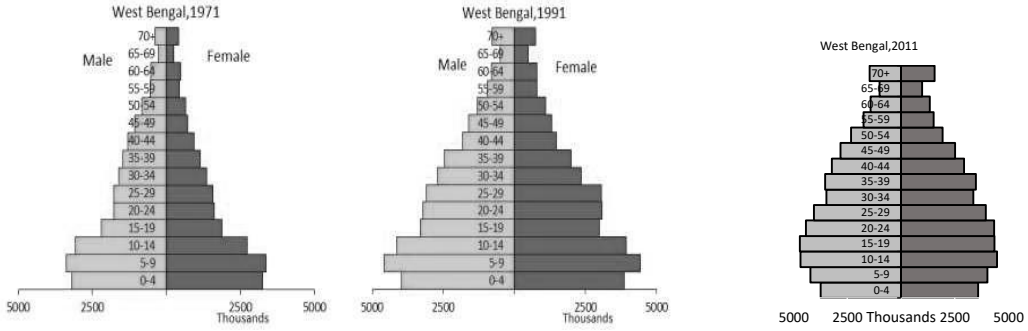


Figure 5

Age Pyramid of States in the Northern Region

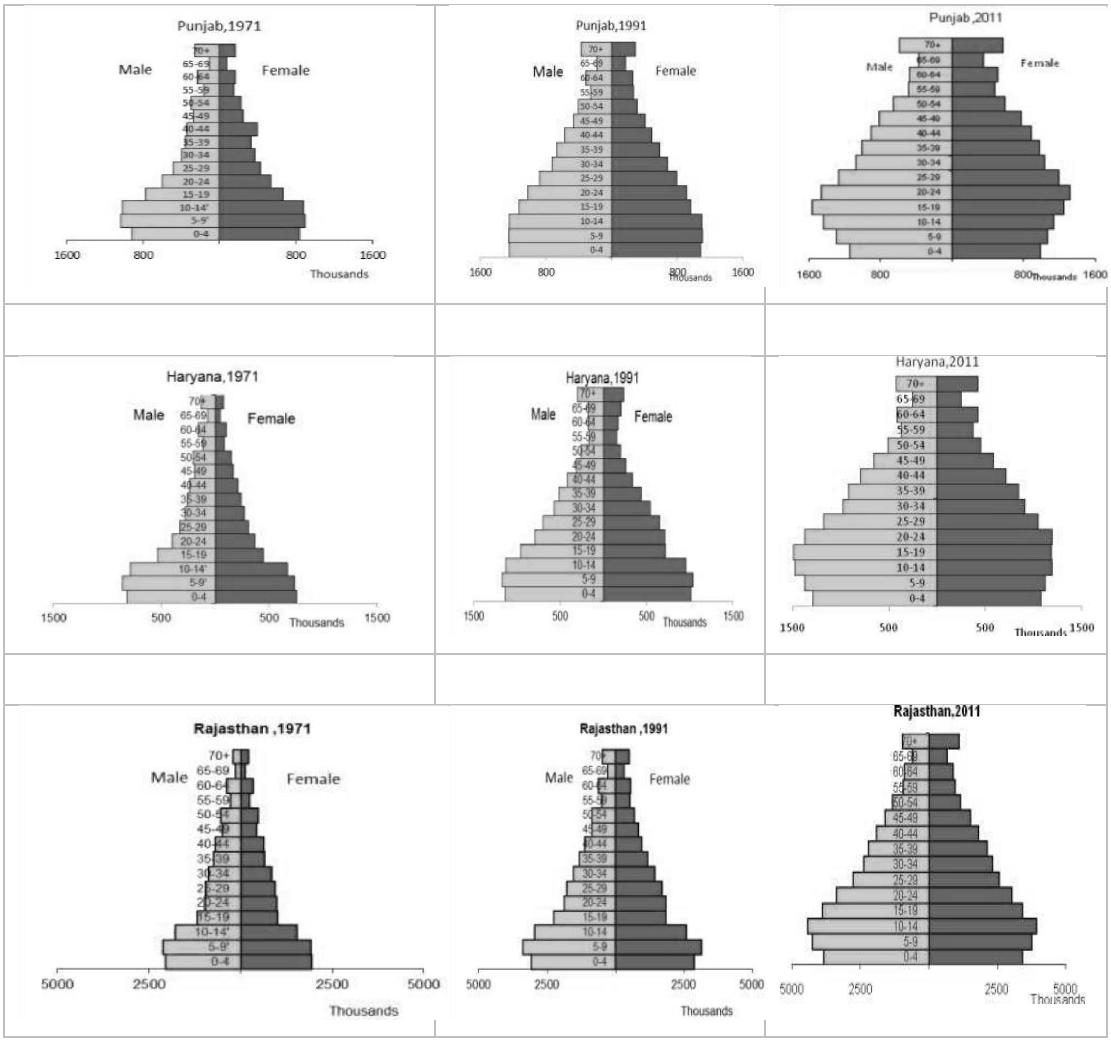


Figure 6

Age Pyramid of States in the Western Region

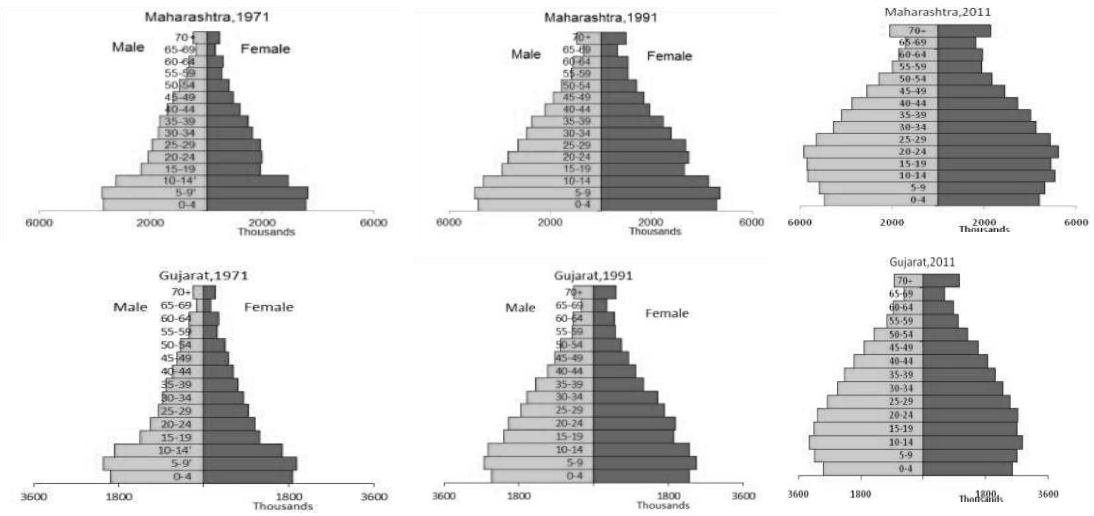
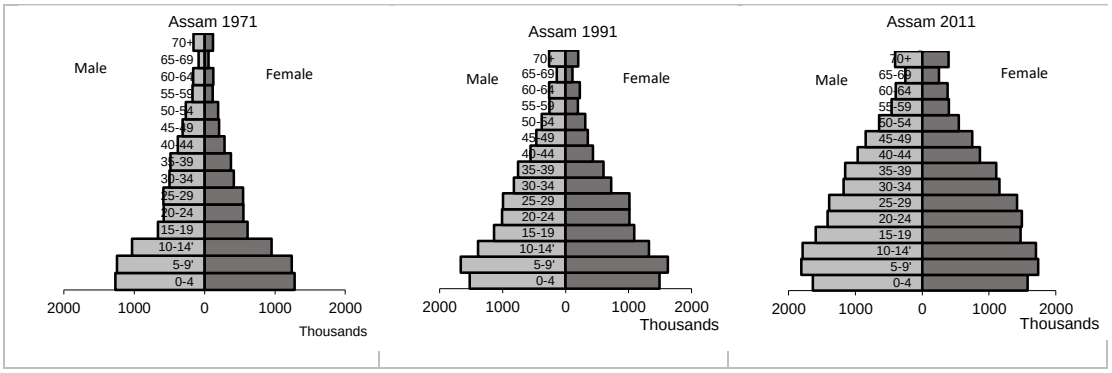


Figure 7

Age Pyramid of States in the North-Eastern region



Source: Census 1971-2011

Age Structural Transition in the Major States of India

Madhya Pradesh and Uttar Pradesh are situated in the central part of the country. These states are still lagging behind the other states in benefiting from windows of opportunity. Regarding the increasing share of the middle-aged population, the age pyramids of Maharashtra and Gujarat show the benefits of demographic bonuses since 2011.

Bihar, Odisha, and West Bengal are the states in the eastern region of the country. Age pyramid of Bihar from 1971 to 2011 indicates an increase in the proportion of children in the (5-9) age group. The older population is deficient in this region. West Bengal, Orissa and Madhya Pradesh are experiencing a sharp increase in the youth (15-59) from 1971 to 2011. In Punjab and Haryana, the proportion of old age groups is expanding due to the rise in the share of the middle-aged

population.

The shape of the age pyramid in West Bengal changed from conical in 1991 to rectangular in 2011. In Rajasthan, the child population decreased gradually from 1971 to 2011. The conical shape of age pyramids has been maintained in Rajasthan over the decades because older cohorts were invariably smaller than younger cohorts. Rajasthan seems to take longer to realise the benefits of demographic bonuses than other states, particularly the southern states. All the states in India under consideration are experiencing a sharp increase in the old (60+) population from 1971 to 2011. Due to declining fertility, the proportion of children aged 0-14 would decrease across all Indian states. Compared with the southern states, the northern states have the highest share of children. Many Indian states still have a high proportion of young population, and in some of these states, this demographic trend is expected to persist and even increase over the next two decades. Upon analysing the age pyramids of major states, it is evident that the age structural transition differs from region to region.

Dependency Ratio

The dependency ratio, expressed as a percentage of the population in the dependent age group to the working-age population, serves as another indicator for analysing the age structure of the population. The dependency ratio for India and the states concerned are discussed below.

The dependency ratio declined in India from 1971 to 2011. In 1971, more than 92 per cent of the total population in India was dependent on the young population, but in 2011, it was only 65 per cent, a decline of 29 per cent during the period. The old-age dependency ratio increased by 22 per cent from 1971 to 2011. The young-age dependency ratio declined from 81 per cent to 51 per cent during the same period, a nearly 37 per cent decline. Similarly, the dependency ratio in major states declined from 1971 to 2011, particularly the young dependency ratio across all four southern states.

Table 1

Dependency Ratio of India and Major States from 1971 to 2011

States	1971			1981			1991			2001			2011		
Dependency ratio	Total	Young	Old	Total	Young	Old	Total	Young	Old	Total	Young	Old	Total	Young	Old
India	92.3	80.8	11.6	85.3	73.3	12.0	79.3	67.2	12.1	75.1	62.0	13.0	65.2	51.0	14.2
Kerala	86.8	75.2	11.6	73.8	60.7	13.0	62.9	48.5	14.4	57.6	41.1	16.5	56.3	36.6	19.3
Andra Pradesh	88.1	76.1	11.9	82.5	70.4	12.1	74.8	62.9	11.8	65.7	53.1	12.6	55.9	40.5	15.4
Tamil Nadu	79.3	66.9	12.4	70.0	59.1	10.8	62.2	50.1	12.1	55.8	42.0	13.8	51.5	35.7	15.7
Karnataka	94.3	82.4	11.8	85.6	73.5	12.1	76.1	63.7	12.3	65.5	52.8	12.7	55.6	40.8	14.7
Madhya Pradesh	97.8	86.5	11.2	99.2	79.1	20.1	93.4	74.4	19.0	84.2	71.1	13.1	71.5	57.1	14.3
Uttar Pradesh	94.7	81.5	13.2	94.3	81.1	13.2	93.1	80.1	12.9	92.8	79.2	13.5	77.6	63.8	13.8
Bihar	94.1	82.7	11.4	94.3	81.1	13.2	92.1	80.1	11.9	95.3	82.1	13.1	89.7	75.5	14.2
Orissa	93.7	81.9	11.8	86.0	74.2	11.8	81.1	68.1	12.9	71.0	56.8	14.2	62.4	46.8	15.6
West Bengal	93.3	83.0	10.2	79.7	69.9	9.8	82.0	71.1	10.9	67.7	55.7	11.9	55.2	41.9	13.2
Punjab	93.9	79.6	14.3	81.0	66.9	14.1	74.3	60.6	13.7	68.1	52.8	15.2	56.0	39.9	16.1
Rajasthan	98.8	87.8	10.9	94.1	82.5	11.6	89.9	77.9	11.9	88.3	75.5	12.7	73.1	60.1	12.9
Haryana	108.3	96.2	12.0	92.4	80.3	12.1	88.6	74.1	14.5	77.1	63.8	13.2	62.3	48.2	14.0
Gujarat	93.6	83.3	10.2	80.8	70.1	10.6	73.0	61.9	11.0	65.9	54.4	11.4	58.5	45.9	12.5
Maharastra	89.0	78.2	10.7	80.8	69.2	11.5	74.8	62.5	12.2	69.0	54.3	14.6	57.8	42.1	15.6
Assam	106.6	93.0	9.4	*	*	*	84.2	74.4	9.9	76.4	66.0	10.3	65.4	54.3	11.0

*Census was not conducted in Assam due to insurgency

Source: Author's calculation using census data

The old age dependency ratio increased from 1971 to 2011 in all states. Until 2001, Andhra Pradesh had the highest total and young dependency ratios. However, by 2011, Kerala had the highest dependency ratio. The dependency ratio was lowest in Tamil Nadu in 2001, and the decline in the ratio since 1971 was the least in this state. The largest decline in the dependency ratio from 1971 to 2011 was in Kerala. In Kerala, the old-age dependency ratio increased continuously from 1971 to 2011, indicating an ageing population. In Madhya Pradesh and Uttar Pradesh, the young dependency ratio declined from 1971 to 2011. The total dependency ratio and the young dependency ratio are continuously declining in the Eastern states over the entire period. In Bihar, the overall dependency ratio and the young dependency ratio were highest throughout the period. In these states, old-age dependency has shown a consistent decline from 1971 to 2001, with an increase in 2011. The old dependency ratio is high in Maharashtra, while the young dependency ratio is high in Gujarat. Assam had the highest total dependency ratio in 1971 (106.6); the dependency ratio declined from 1971 to 2001, particularly in the young dependency ratio. Analyses reveal that the total and young dependency ratios in northern states have consistently declined throughout the period.

Workforce Participation Rate

India's workforce participation rate (WPR) has slightly increased over the last five decades. In 1971, only 34.2% of the total economically active population was engaged in work, while this figure rose to 39.7% by 2011. WPR for males marginally increased from 51.5 % in 1991 to 53.2 % in 2011; for females, it improved slightly from 22.2 % to 25.5 % during the same period. The largest increase in WPR took place in Karnataka; WPR is lowest in Kerala for both males and females. Rajasthan noted the highest WPR among northern states (1971-2011). Haryana improved the WPR from 26.4 in 1971 to 39.8 in 2001; after that, a slight decrease in WPR was observed in 2011(35.1 %). WPR in western states showed that female WPR is higher in Maharashtra than in Gujarat. Table 2 shows that the percentage of workers in India increased significantly between 1971 and 2011. Additionally, the rates of male and female work participation differ significantly over the period in India. The percentage change in workforce participation shows a 6% increase from 1991 to 2011 in India. There is no promising trend in the overall work participation in India and the states.

Supporting Ratio

The supporting ratio is similar to the Age Dependency Ratio, but in the supporting ratio, the population in the age group 25-59, rather than 15-59, is considered in the numerator. This is because most youths will be employed only after turning 25.

Table 2

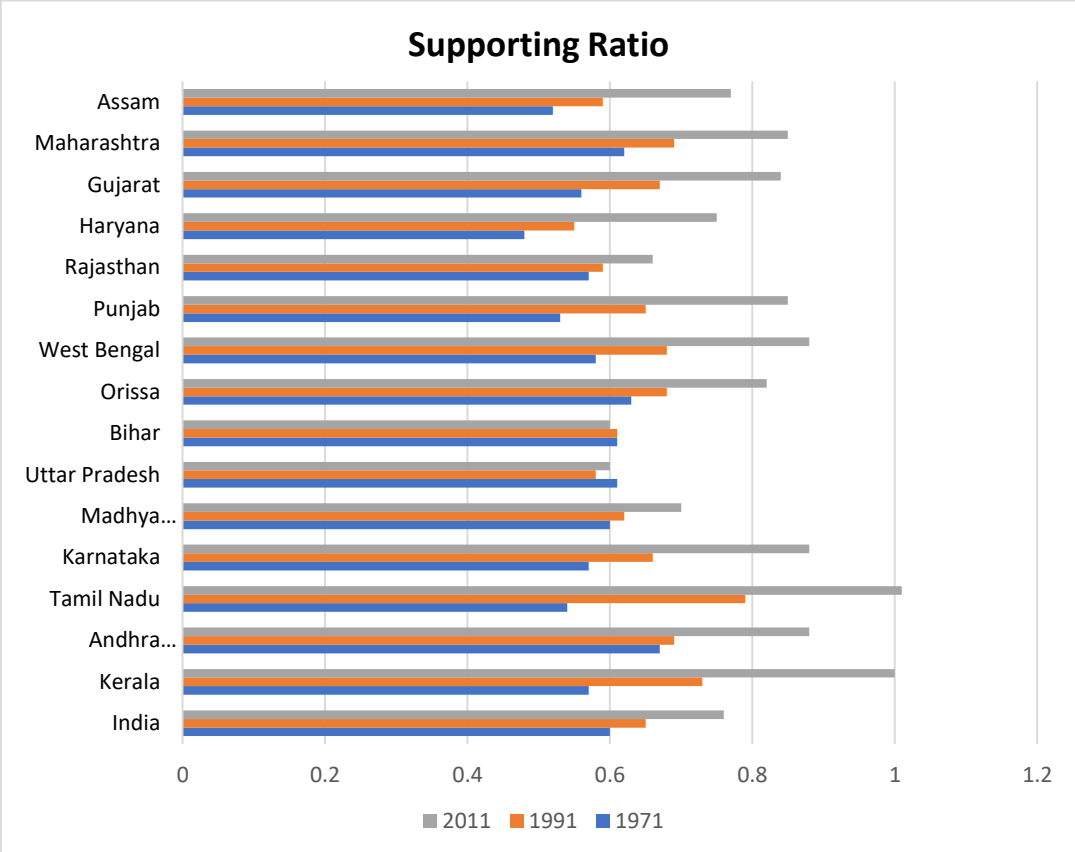
Work Participation Rate in India and Major States From 1971–2011

States	1971			1981			1991			2001			2011		
WPR	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F
India	34.2	52.8	14.2	36.7	52.6	19.0	37.4	51.5	22.2	39.1	51.6	25.6	39.7	53.2	25.5
Kerala	29.1	45.0	13.5	30.5	44.8	16.6	31.4	47.5	15.8	32.2	50.2	15.3	34.7	52.7	18.2
Andra Pradesh	41.4	58.2	24.2	45.7	57.7	33.5	45.0	55.4	34.3	45.7	56.2	35.1	46.6	56.9	36.1
Tamil Nadu	35.8	56.0	15.1	41.7	56.5	26.5	43.3	56.3	29.8	44.6	57.6	31.5	45.5	59.3	31.7
Karnataka	34.7	54.4	14.2	40.2	54.5	25.3	41.9	54.0	29.3	44.5	56.6	31.9	45.6	58.9	31.8
Madhya Pradesh	36.7	53.7	18.6	38.5	53.5	22.3	42.8	52.2	32.6	42.7	51.5	33.2	43.4	53.5	32.6
Uttar Pradesh	30.9	52.2	6.7	29.2	50.3	5.4	32.2	49.6	12.3	32.4	46.8	16.5	32.9	47.7	16.7
Bihar	31.0	52.2	8.9	29.7	49.2	9.1	32.1	47.9	14.8	33.7	47.3	18.8	33.3	46.4	19.0
Orissa	30.4	46.2	7.3	32.7	54.4	10.7	37.5	53.7	20.7	38.7	52.5	24.6	41.7	56.1	27.1
West Bengal	28.0	48.8	4.4	28.3	48.7	5.8	32.1	51.3	11.2	36.7	53.9	18.3	38.0	57.0	18.0
Punjab	28.9	52.8	1.2	29.3	53.1	2.3	30.8	54.2	4.4	37.4	53.6	19.0	35.6	55.1	13.9
Rajasthan	31.2	52.1	8.3	30.4	49.9	9.3	38.8	49.3	27.4	42.0	49.9	33.4	43.5	51.4	35.1
Haryana	26.4	47.2	2.4	28.3	48.9	4.7	30.9	48.5	10.7	39.6	50.2	27.2	35.1	50.4	17.7
Gujarat	31.4	51.2	10.3	32.2	52.2	11.0	40.2	53.5	25.9	41.9	54.8	27.9	40.9	57.1	23.3
Maharastra	36.5	52.1	19.7	38.7	52.5	23.4	42.9	52.1	33.1	42.4	53.2	30.8	43.9	56.0	31.0
Assam	28.4	48.8	4.7	*	*	*	36.0	49.4	21.6	35.7	49.8	20.7	38.3	53.5	22.4

*Census was not conducted in Assam due to insurgency
Note: WPR: Work participation rate; T: Total; M: Male; F: Female
Source: Author's calculations using census data

Figure 8

Supporting Ratio for India and Major States



Source: Census 1971–2011

Table 3
Supporting Ratio for Major States

Supporting Ratio					
Year	1971	1981	1991	2001	2011
India	0.60	0.60	0.65	0.68	0.76
Southern states					
Andhra Pradesh	0.67	0.63	0.69	0.76	0.88
Karnataka	0.57	0.59	0.66	0.75	0.88
Tamil Nadu	0.54	0.71	0.79	0.88	1.01
Kerala	0.57	0.60	0.73	0.87	1.00
Central states					
Madhya Pradesh	0.60	0.58	0.62	0.62	0.70
Uttar Pradesh	0.61	0.58	0.58	0.56	0.60
Eastern states					
Bihar	0.61	0.59	0.61	0.58	0.60
Orissa	0.63	0.61	0.68	0.73	0.82
West Bengal	0.58	0.61	0.68	0.76	0.88
Northern states					
Punjab	0.53	0.57	0.65	0.71	0.85
Rajasthan	0.57	0.55	0.59	0.58	0.66
Haryana	0.48	0.50	0.55	0.63	0.75
Western states					
Gujarat	0.56	0.59	0.67	0.74	0.84
Maharashtra	0.62	0.64	0.69	0.73	0.85
North Eastern states					
Assam	0.52	NA	0.59	0.67	0.77

Source: Author's calculations using census data

In India, the supporting ratio gradually increased from 1971 to 2011, rising from about 0.60 in 1971 to about 0.76 in 2011. The support ratio was comparatively high in most southern states, especially in Kerala and Tamil Nadu, which had the highest value, and exceeded 1 in 2011, indicating that the states have begun to experience the demographic dividend. The other two states in the southern region, Andhra Pradesh and Karnataka, will achieve the demographic dividend in the very near future. The gradual rise in the support ratio in Madhya Pradesh and Uttar Pradesh is occurring at a slower pace compared to other states, causing these states to lag in achieving the demographic windows of opportunity. Among the eastern states, Bihar exhibits a fluctuating trend in support ratio from 1971 to 2011. On the other hand, Orissa and West Bengal have consistently increased support ratios over the same period. In Punjab, Haryana and Rajasthan, supporting ratios have been rising over the decades. Similarly, most of the states in the western and northeastern regions show an increasing trend in the support ratio.

Per Capita Income and Demographic Dividend

Here, the concept of a demographic dividend is explained using a basic equation, with GDP per capita used as the measure of economic growth. First, GDP per capita is decomposed in the following equation.

$Y/N = (L/N)*(Y/L)$

In this equation, Y denotes GDP, N

denotes population, and L denotes the labour force. Then, GDP per capita is expressed as the product of the support ratio (L/N) and labour productivity. Equation can be rewritten in growth terms as follows

gr (Y/N) =gr(L/N) +gr(Y/L)

Table 4

GDP as the Sum of the Growth Rate of Support Ratio and Labour Productivity

GDP as the sum of the growth rate of support ratio and labour Productivity **gr(Y/N) =gr (L/N) +gr (Y/L) 1991**-2011		
States	*gr(Y/N)*	*gr(L/N) +gr(Y/L)*
India	1.59	1.37
Kerala	0.2654	0.2192
Andhra Pradesh	0.1163	0.1048
Tamil Nadu	0.2186	0.1980
Karnataka	0.1779	0.1577
Madhya Pradesh	0.1262	0.1091
Uttar Pradesh	0.1009	0.0866
Bihar	0.0884	0.0715
Orissa	0.1761	0.1314
West Bengal	0.1338	0.0973
Punjab	0.1198	0.0975
Rajasthan	0.1453	0.1158
Haryana	0.1634	0.1323
Gujarat	0.2051	0.1930
Maharashtra	0.1679	0.1573
Assam	0.1299	0.1089

Source: Author's calculations using census and GDP

Table (4) illustrates the relationship between GDP and economic growth; the GDP growth rate is calculated as the sum of the support ratio and labour productivity. It implies that increases in labour force participation and productivity played an essential role in generating economic growth. The GDP growth rate in India and its states (1991 to 2011) is approximately equal to the sum of their growth rates in support ratio and labour productivity. As a result, the relationship between GDP growth and labour productivity indicates that the demographic dividend contributed positively to economic growth.

Summary and Conclusion

Age structural transition is a fundamental component of demographic transition, and it can be effectively visualised through the age pyramid, which provides a comprehensive representation of the age-sex composition of the population. Age pyramids of India showed a clear shrinking at young ages from 2001 due to the recent fall in fertility. The proportion of children in the population has decreased, while the percentage of adults and the elderly has increased, indicating a shift in the demographic profile towards middle age. The transition of population to the Middle Ages surely reduces the dependency ratio, and it is hopeful for a better reaping of the window of opportunity. In the near future, India will be the largest contributor of the working-age population due to the achievement of a window of opportunity. All the southern states have experienced a decline in the younger age cohort (0-14) and a gain in the economically active population. Among the states, the decline in the young population was highest in Kerala. According to the pyramid,

Kerala experienced ageing in 2011. The elderly female population is higher than the elderly male population. Madhya Pradesh, Uttar Pradesh, and Rajasthan are still lagging behind the other states in benefiting from windows of opportunity. In Punjab and Haryana, the proportion of old age groups is expanding due to the increasing share of the middle-aged population. Age pyramids of Maharashtra and Gujarat show an achievement of demographic bonus since 2011. Ageing populations are expected to affect social security and healthcare delivery in Kerala, Tamil Nadu, Punjab, and Karnataka. To effectively address the challenges of population ageing, India must implement comprehensive, long-term health and social security policies.

The dependency ratio is another indicator for analysing changes in a population's age structure. The dependency ratio declined from 1971 to 2011, particularly the young dependency ratio across all four southern states. The largest decline in the dependency ratio from 1971 to 2011 was in Kerala, which experienced a tremendous increase in old-age dependency during the same period. Among the central states, the supporting ratio has increased from 1971 to 2011. The southern states show the greatest increase in the level of the supporting ratio from 1971 to 2011; Kerala and Tamil Nadu crossed the level of supporting ratio, and it is more than one in 2011, indicating that the states have started the demographic dividend. The relationship between GDP per capita, support ratio and labour productivity revealed that the demographic dividend had a positive impact on economic growth. There is an upward trend in India's overall GDP and that of its states. The analysis of total workers in India shows that the work participation rate has increased continuously over the last five decades; there is a considerable difference in the work participation rates of males and females. It can be observed that the participation rate first declines in the lower age groups, then increases in the prime age group, and finally declines in the older age group. Changes in workforce participation rates indicate that in the coming decades, the working-age population (15-59) will increase significantly, leading to a rise in labour supply. The age structural transition in India significantly influences the composition and functioning of the workforce. To sum up, governments should focus on building human capital through targeted investments in education, employment, healthcare, and nutrition to reap the benefits of the window of opportunity provided by age-structural transitions. The age structural transition indicates the necessity of considering the population profile in various planning and policy formulation in India and its states.

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Micro-Level Population Forecasting and Built-up Area Modelling: Durgapur, West Bengal

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Abstract

The implementation of micro-level planning depends on the availability and use of local resources, such as land ceilings, distribution, surplus, and a region's carrying capacity. Therefore, spatio-temporal modelling of land use, urban growth, and expansion is crucial to support decentralised planning. The aim is to model urban growth by projecting future populations for 2021, 2031, and 2041 at a micro-level and predicting built-up expansion through 2032. For this, six trend extrapolation methods were compared: Simple Linear, Simple Exponential, Simple Geometric, Constant Share, Shift Share, and Share of Growth. Built-up areas were forecasted using Artificial Neural Networks within a GIS environment. The trend extrapolation methods yielded satisfactory results, with the Simple Linear and Constant Share methods displaying lower percentage errors. The Durgapur Municipal Corporation projected the highest populations for 2021 (644,441), 2031 (701,662), and 2041 (744,881). Spatial modelling indicates a total increase in built-up area of 39.75 sq. km between 2017 and 2032, with the largest rise in the Faridpur-Durgapur block (25 sq. km), followed by Andal and Pandaveswar. Trend extrapolation methods are a practical approach for small-area total population forecasting. The built-up area model forecasts significant growth from 2017 to 2032, with Durgapur and Andal emerging as population hubs. This research addresses gaps in small-area forecasting studies by examining methodological approaches in data-scarce environments and exploring the urban dynamics of an emerging centre in a developing country. The study aims to raise policymakers' awareness of the rapid expansion of unplanned settlements surrounding the Durgapur region.

***Keywords*:** Microlevel population forecasting, trend extrapolation, built-up prediction modelling, artificial neural network

Introduction

The pivot of any planning and policymaking is the development of the people. National and state-level planning, also known as sectoral, macro-level, or regional planning, focuses on broader goals, e.g., the allocation and utilisation of resources at the state and district levels. Sectoral

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planning is set at the top level and flows down to a specific administrative level, e.g., state or district level. (Mishra et al., 2000, p. 43). Whereas micro-level or decentralised planning commences at the grassroots level. It focuses on the people, the most important factor for the development (Mishra et al., 2000, p. 43) and strengthens the weak aspects of macro-level planning by linking with sectoral goals. Local-level resource utilisation, emphasising local problems and people's participation, not only enhances infrastructure but also reduces the cost of implementing the plan by minimising the scope for corruption at different levels. Besides, the ease of implementation of the plans is another factor (Jana, 1999). In India, agriculture is a significant economic activity, and the majority of the population lives in rural areas. Centralised planning does not appear effective in such a structure. (Majumdar, 2003). Microlevel studies are also necessary for cases involving changes to block- or district-level administrative boundaries over time. In that scenario, it is best to select more micro-level administrative units, such as census tracts, towns, and villages. Implementation of micro-level planning depends on resources and their utilisation, i.e., land ceiling, land distribution, surplus, and local resource potential. Hence, modelling land-use distribution, urban growth, and expansion in the spatio-temporal domain is necessary to support decentralised planning. This study combines the geographical and statistical components of population expansion, and the reference framework it provides will be used for spatial, micro-level, decentralised planning.

Durgapur city, one of India's largest industrial hubs, began to evolve between 1955 and 1960, with the establishment of numerous public- and private-sector enterprises. Hence, the city is an Industrial city based on its functional characteristics. The most dominant factor of population growth or formation of settlement patches at urban centres and their peripheral areas can be attributed to the development of industries and mines over the years (Chatterjee & Sarkar, 2018). Being part of the Damodar Valley and the Chota Nagpur Plateau, it possesses enormous mineral resources, especially coal. The region possesses excellent economic prospects, even though the country's first shale gas reserve was recently discovered by the Oil and Natural Gas Corporation of India (ONGC) in the region (Offshore energy, 2011). Since the emergence of the urban centres, the region has witnessed a rapid growth of industries, mines, settlements and other built-up areas; consequently, that rapid development has brought a considerable amount of environmental degradation associated with the same (Chatterjee & Sarkar, 2018). Therefore, it is necessary to assess the region's sustainability through future predictions and simulations. From a methodological perspective, this study also strengthens the applicability of the simple trend extrapolation method and ANN for micro-level population forecasting and built-up area

modelling.

Literature Review

Population projection is the numerical output of a process, subjective or objective, based on assumptions about the future population (Isserman & Fisher, 1984; Keyfitz, 1972). A forecast is a type of projection that produces an almost accurate prediction, according to the analyst. Unlike projections, forecasts are judgmental in nature (Murdock, 2019; Smith et al., 2013, p. 3). Small-scale area projection is becoming increasingly important because it enables detailed planning, such as deciding where to build new schools, hospitals, and roads, whether to increase power plant output, and how to assess the environmental impact of population growth. Small-scale forecasting is often avoided due to a lack of data, the tedious process of collecting, sorting, tabulating, analysing, and presenting data. For example, even in a village-level study, a small-scale area may encompass many villages, significantly increasing the workload. Additionally, population size presents another challenge. However, when block- or village-level boundaries change frequently, micro-level forecasting becomes essential to address these issues effectively.

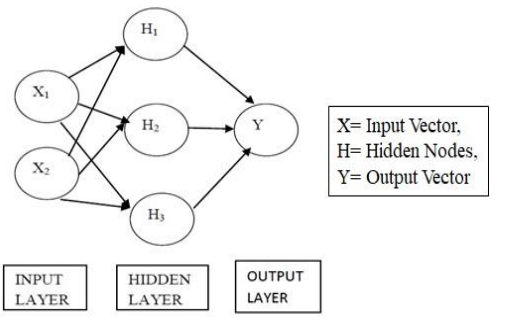
The choice of forecasting methods depends on factors such as population size, growth pattern, time horizon, resources, and data availability. Some techniques focus solely on the total population, while others include elements of population change, such as age-, sex-, and race-specific births, deaths, and migration. For projecting the total population, simple extrapolation methods such as linear, exponential, shift-share, and share-of-growth often suffice, especially for short- to medium-term periods. More advanced methods, like cohort-component models, require extensive data, including details on births, deaths, migration, and demographic structure. Structural models require data on both explanatory and dependent variables, whereas urban systems models rely on specifics such as vacant land, zoning laws, employment, transportation, and related factors. Basic trend extrapolation and ratio methods only need total population figures from two points in time (the latter for the constant-share method). Nonetheless, at national, state, and multi-regional levels, the cohort component method is generally regarded as the "gold standard." However, the data required for this model across many small areas can be substantial and often unavailable. Typically, the more complex, accurate, or comprehensive an approach is, the less precise it may be compared to simpler methods. Although advanced techniques can provide more detailed insights, they often lead to larger errors. From a research perspective, forecast accuracy is crucial and is a key factor in selecting a forecasting method. However, it is not the only consideration; utility, timeframe, costs, and ease of implementation also influence its suitability. Accuracy can

be evaluated through bias (average percentage difference) and precision (algebraic error). MALPE (Mean Algebraic Percentage Error) assesses bias by balancing positive and negative values, while MAPE (Mean Absolute Percentage Error) is the most widely used for evaluating population forecast accuracy. Overall, MAPE is generally preferred for population forecasting and accuracy assessment over other error metrics.

Given the current context of population growth, planners and city administrators must understand future scenarios using suitable forecasting and predictive methods. A model is a simplified representation or abstraction of reality. In contrast, simulation can be defined as the imitation of a real-world process or phenomenon (Banks et al., 2001). Simulations help us forecast the behaviour of systems over time, enabling us to anticipate the future occurrence of these phenomena. The application of ANN is evident in various fields of earth science, such as examining land-use patterns across border regions, modelling the spatial distributions of rainfall, land surface temperature, and urban growth, and predicting LULC. Cellular automaton combined with Markov chain modelling is another emerging technique in LULC modelling within the GIS environment (Yirsaw et al., 2017). The Artificial Neural Network (ANN) has become a proficient tool for analysing changing land-use patterns in an area. ANNs, or neural networks, are a specialised branch of Artificial Intelligence that offers advantages over traditional statistical modelling (Gardner & Dorling, 1998; Lu et al., 2012). ANNS resemble the structure of interconnected neurons in the human brain, where nodes (neurons) in the input layers connect to nodes in the hidden layers, ultimately forming an output node (Figure 1a). ANNs have proven to be essential tools for pattern recognition and function approximation (Luk et al., 2001). Several types of modelling tools are available, but justifying their use can be difficult. Therefore, validation and calibration are vital to any analysis.

Figure 1a

The Basic Structure of an Artificial Neural Network (ANN)



This study aims to examine changes in built-up and non-built-up areas of three blocks in Paschim Bardhaman District: Faridpur, Andal, and Pandaveshwar, in relation to the area's population dynamics. Population growth and the expansion of built-up areas are strongly linked in many regions worldwide. The area's population was estimated using a comparative analysis of six trend extrapolation methods, selecting the

most accurate one. A forecast for future land use and land cover (LULC) in 2032 was produced by applying the Cellular Automata-artificial neural network (ANN) technique within a GIS environment. Landsat images from 1987, 2002, and 2017 were sourced from the USGS website at 15-year intervals. These images were classified into two main categories: built-up and non-built-up, for each respective year. A projection for 2032 has also been developed.

The Artificial Neural Network (ANN) has become an effective method for analysing the changing land-use patterns of an area. ANNs, or neural networks, are a specialised branch of Artificial Intelligence that provide advantages over traditional statistical modelling (Gardner & Dorling, 1998; Lu et al., 2012). ANNS resemble the structure of interconnected neurons in the human brain, where nodes (neurons) in the input layers connect to nodes in the hidden layers, ultimately forming an output node (Figure 1a). ANNs have proven helpful for pattern recognition and function approximation (Luk et al., 2001). Several modelling tools are available, but their justification can be challenging. Therefore, validation and calibration are vital for any analysis.

Materials and Methods

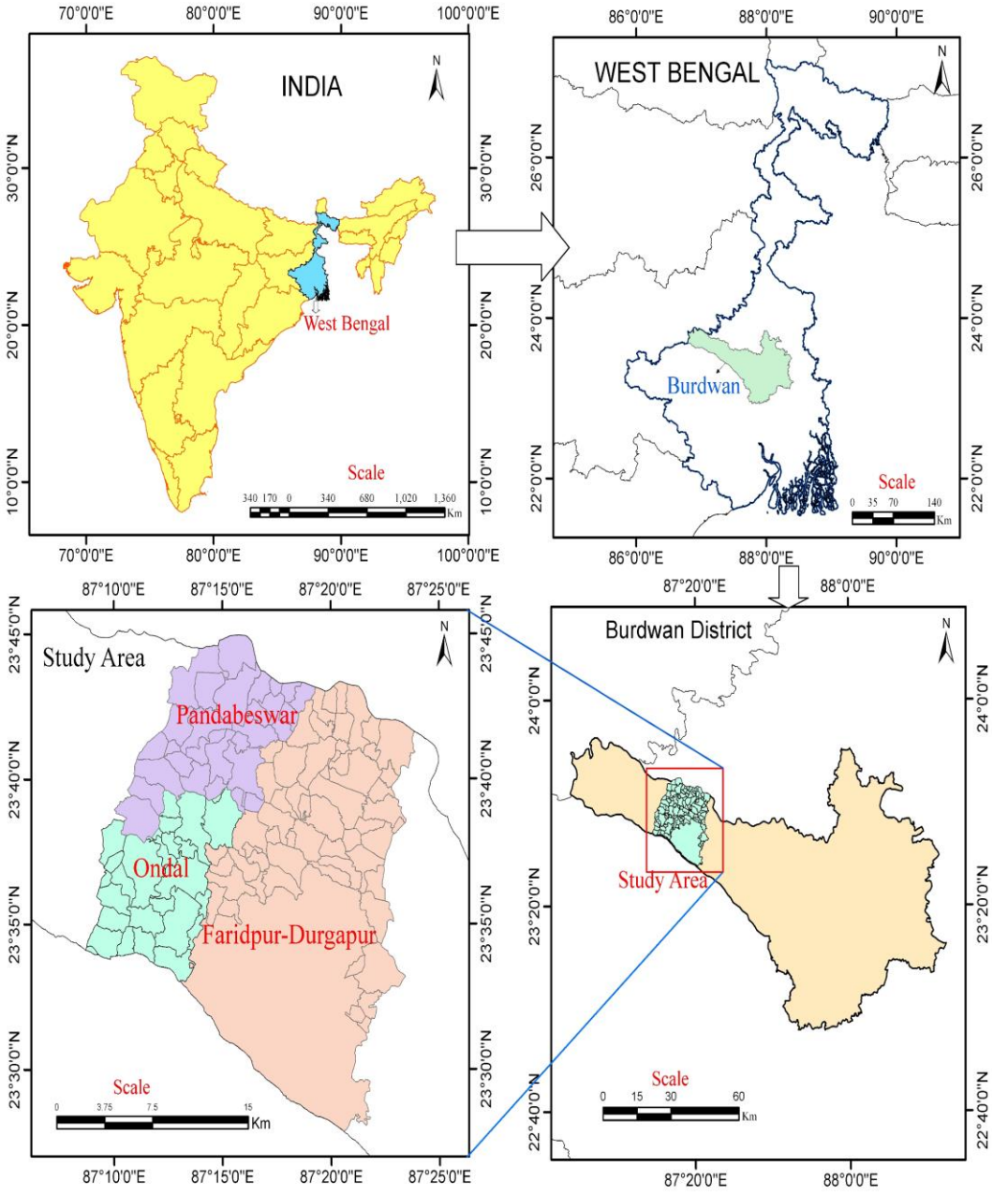
Study Area

Three Community Development (CD) blocks in Burdwan district, namely Faridpur-Durgapur, including Durgapur Municipal Corporation (DMC), Andal, and Pandabeswar, have been selected for the study. Forecasting has been conducted at the micro-level, i.e., villages, towns, municipal corporations, and municipalities, with a total of 114 Micro Administrative Units (MAUs) in these three blocks, covering approximately 495.5734 sq km. These MAUS have been designated as the study area (Figure 1). Industrial development has been the primary driver of population growth in the region; therefore, all the MAUs are either within or adjacent to the Durgapur Industrial belt. The region serves as a transition zone between the Chhotanagpur Plateau and the Ajay-Damodar-Darakeswar Plain.

Therefore, both the alluvial plain and the dissected denudational plateau, known as the Rarh region, are visible in the study area, interwoven with hillocks, mounds, and low-lying valleys. The overall slope of the study area is gentle, descending from west to east, with the highest elevation of 163 m above mean sea level (MSL) at the Sonpurbajari coal mine area and the lowest of 32 m MSL at Damodar.

Figure 1b

Location and Extent Map of the Study Area



Source: Reproduced from general administrative maps & police station maps

Figure 1c

The Flow Chart of the Methodology Followed by the Present Study

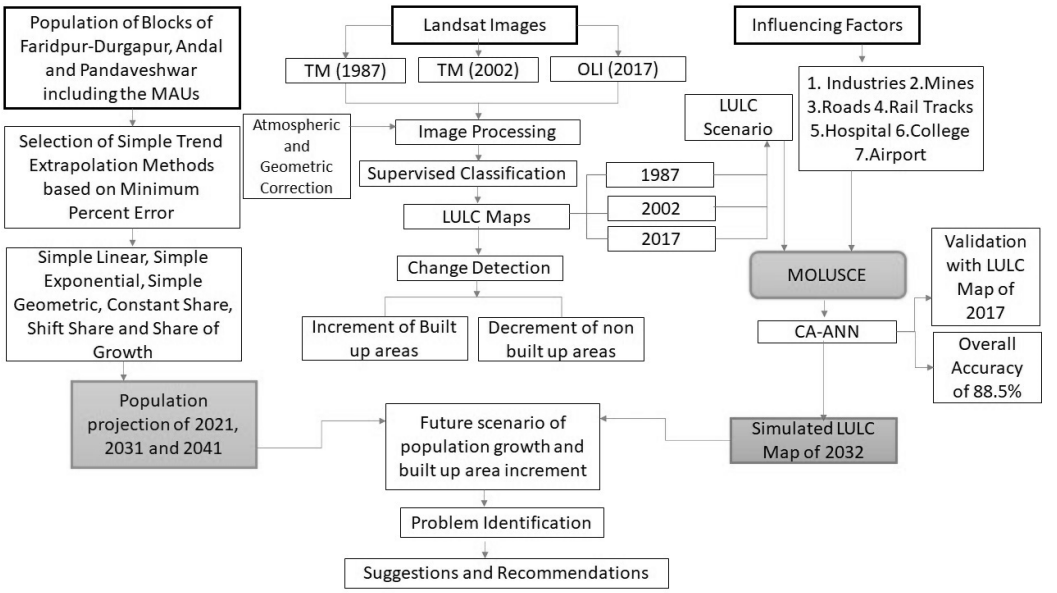


Table 1

Decided Parameters for Population Forecast

Base year	Launch year	Target years	Base period (#Years)	Projection horizons (#Years)	Projection interval (#Years)
1961	2011	2021, 2031, 2041	50	10, 20, 30	10

Source: Determined by the author

Forecasting Future Population

Since the population forecast depends on the trend of population growth (Smith et al., 2013), such as linear, exponential, geometric, or growth similar to that of the larger parent area (for the ratio method), each forecasting technique is based on its own assumptions and equation (Table 2). Unlike national trends, growth in smaller areas is not consistent over time. Therefore, in the current study, total population forecasting for the years 2021, 2031, and 2041 has been carried out using six simple trend extrapolation techniques: simple linear, simple exponential, simple geometric, constant share, shift-share, and share of growth, across all administrative units. For the methods of constant share, shift-share, and share of growth, the projected populations for the Burdwan district in 2021, 2031, and 2041 were derived from the population projection study based on the "United Nations Medium variant projection up to 2051" (Rudra, 2017). We calculated the accuracy of each technique as a percentage error, and the technique with the lowest percentage error was selected as the

forecast. The parameters used for these estimates are listed in Table 1.

Accuracy of Forecasts

There is an inverse relationship between population size and forecasting error. Specifically, the smaller the population or jurisdiction, the greater the error (Tayman et al., 1998; Wilson et al., 2022). For example, an error of 1000 people might be 1% at the state level, 20% at the district level, and over 80% at the block level. Another reason for higher error in small areas is that the growth rate tends to change more rapidly and dramatically than in larger areas. The most significant errors usually occur in areas experiencing rapid growth or decline (Smith et al., 2002). In this study, error percentages were calculated for individual units, and MAPE was computed for each method.

Built-up Area Modelling

After performing the necessary pre-processing steps, such as stacking, clipping, radiometric correction, and atmospheric correction on the Landsat data (path 139, rows 44) collected in 1987 (TM), 2002 (TM), and 2017 (OLI) from the United States Geological Survey Earth Explorer website, LULC images depicting built-up areas were generated. Non-built-up areas were extracted from Landsat images from 1987, 2002, and 2017 using the supervised maximum likelihood classification (MLC) method (Figure 2).

For stacking, all the bands except the thermal band have been used. MLC in GIS refers to a classification method in which pixels are assigned to a class based on their maximum probability of belonging to that class (Ahmad & Quegan, 2012).

Table 2

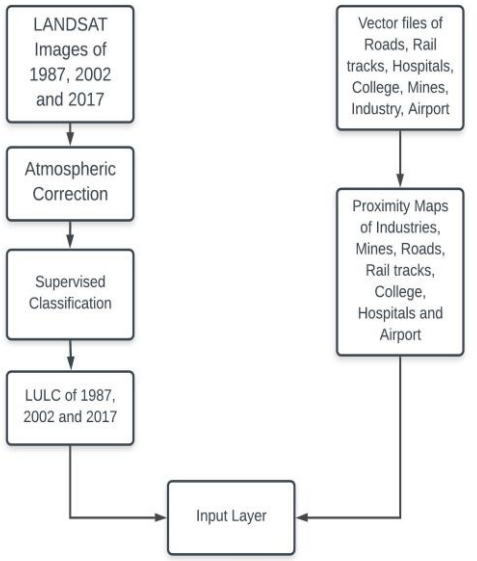
Showing Different Forecasting Methods Applied, Their Assumptions and Equations

Method	Assumptions	Equation	Components of the equation
Simple Linear (SL)	The population will change by the same number of persons in the future as it did in the past (Smith et al., 2013)	$Pt = P_1 + (z)(AANC)$ $AANC = {(P_1 - Pb)}/{y}$	Pt = Population in the target year, z = # of years in the projection horizon P_1=Population in the launch year; P_b=Population in the base year; and y= # of years in the base period. ln= Natural logarithm e^{rz} =Exponential of rz $AANC$ Average annual absolute change
Simple Geometric (SG)	The population will increase (decrease) at the same annual percentage rate during the projection horizon as during the base period.	$P_t = P_l(1 + r)^z$ $r = (P_1 - Pb)^{1/y} - 1$	
Simple Exponential (SE)	Growth rates are based on continuous compounding	$P_t = P_{l^{e^{rz}}}$ $r = {[ln(P_1 - Pb)]}/{y}$	

Constant Share (CS)	The smaller area's share of the larger area's population is held constant at the level observed in the launch year.	$P_{it} = (P_{il}/P_{jl})P_{jt}$	i = Smaller area j = Larger Area l = Launch year t = Target Year b = Base Year z = Projection horizon y = Base period
Shift-Share (SS)	Each smaller area's percentage of the larger area's total annual growth will change by the same yearly amount as over the base period	$P_{it} = P_{jt}[\frac{P_{il}}{P_{jl}} + \left(\frac{z}{y}\right)\left(\frac{P_{il}}{P_{jl}} - \frac{P_{ib}}{P_{jb}}\right)]$	
Share of Growth (SOG)	The smaller area's share of population growth will remain the same over the projection horizon as during the base period.	$P_{it} = P_{il} + \left[\frac{P_{il} - P_{ib}}{P_{jl} - P_{jb}}\right](P_{jt} - P_{jl})$	

Figure 2

Preparation of the Input Layer for the Model



Source: Author (for Figs. 2 to 5)

In this study, two principal classes- built up and non-built up were obtained with user accuracy, producer accuracy, overall accuracy and Kappa Coefficient values of 94.67, 93.29,94.16 and 0.91; 96.27, 89.35,94.56 and 0.89; 92.72, 91.59,91.84 and 0.88 for the years of 1987, 2002 and 2017, respectively. Built-up areas include roads, rail tracks, residential complexes, schools, colleges, hospitals, and the like, while non-built-up areas include forests, rivers, and barren lands. Based on these outcomes, a LULC prediction for 2032 has been made using the CA-ANN method in QGIS 2.18 after proper training, calibration, and validation (Figure 5).

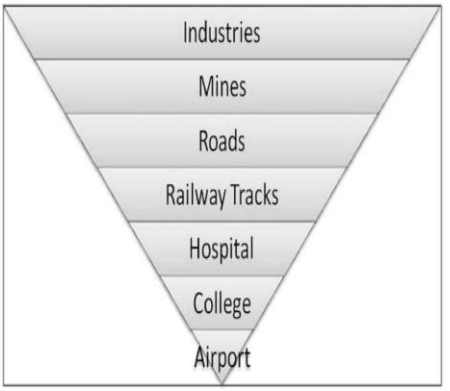
Advances in science and technology have enabled us to use various techniques for simulating ideal situations, such as Artificial Neural Networks (ANNs), Markov Chain Analysis, and Logistic Regression; thus, the careful selection of an appropriate method is a fulcrum for gaining insight into future scenarios.

The availability and proximity of amenities, such as railway stations, schools, colleges, industrial complexes, and hospitals, greatly influence the settlement pattern of an area. The main factors that have

determined the study area's existing land-use pattern are industries, mines, roads, rail tracks, hospitals, colleges, and airports (Figure 3a).

Figure 3a

Arrangement of Factors According to Their Weight of Influence Upon the Existing Land Use Pattern of the Study Area



The input layers comprise LULC maps for 1987 and 2002 in stage 1 (Figure 4) and 2002 and 2017 in stage 2 (Figure 5), along with proximity maps of influencing factors, including industry, mines, roads, rail, hospitals, colleges, and airports. All proximity maps are in raster format (Figure 3b). To obtain the proximity maps, vector files of the influencing factors were converted to raster format, and the proximity maps were generated in QGIS. These proximities, or factor maps, are normalised to values between 0 and 1. This enables us to examine the effects of the proximity factors on the LULC scenario of the study area, where the built-up area is a function of all the above-mentioned proximity factors. In the Input Layer, all factors are arranged in the model according to their influence on the built-up area. The LULC simulation has been carried out to generate maps for 2017 and 2032 using the MOLUSCE plugin in QGIS 2.18.

The final simulated images for 2017 and 2032 were produced using ANN analysis with the Cellular Automata-Artificial Neural Network (CA-ANN) model. The ANN Multilayer Perceptron was run for 1000 iterations, incorporating 10 hidden layers and five validation cycles. Using LULC images from 1987 and 2002, along with relevant influencing factors, a simulated LULC map for 2017 was generated and validated against the actual 2017 LULC map, achieving an overall Kappa score of 88.5%. This included a Kappa (overall) of 0.80713, Kappa (histogram) of 0.99680, and Kappa (location) of 0.80972. Similarly, the LULC for 2032 was simulated using input layers from 2002 and 2017, along with the influencing factors layers.

Figure 3b

Proximity Maps of the Influencing Factors

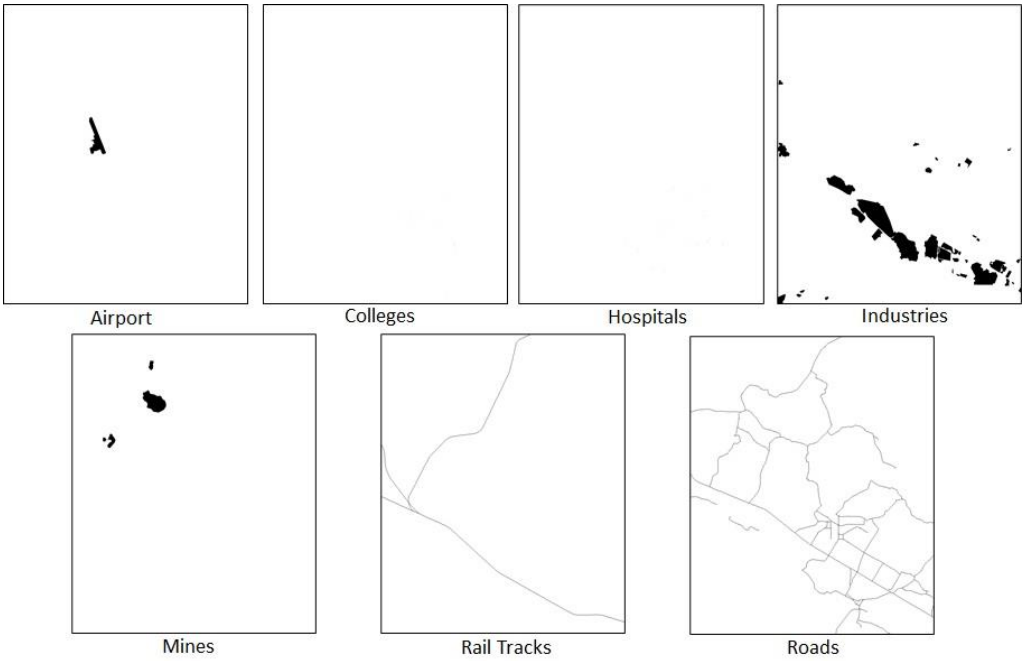


Figure 4

Derivation of the Output Layer From the Model: Stage 1

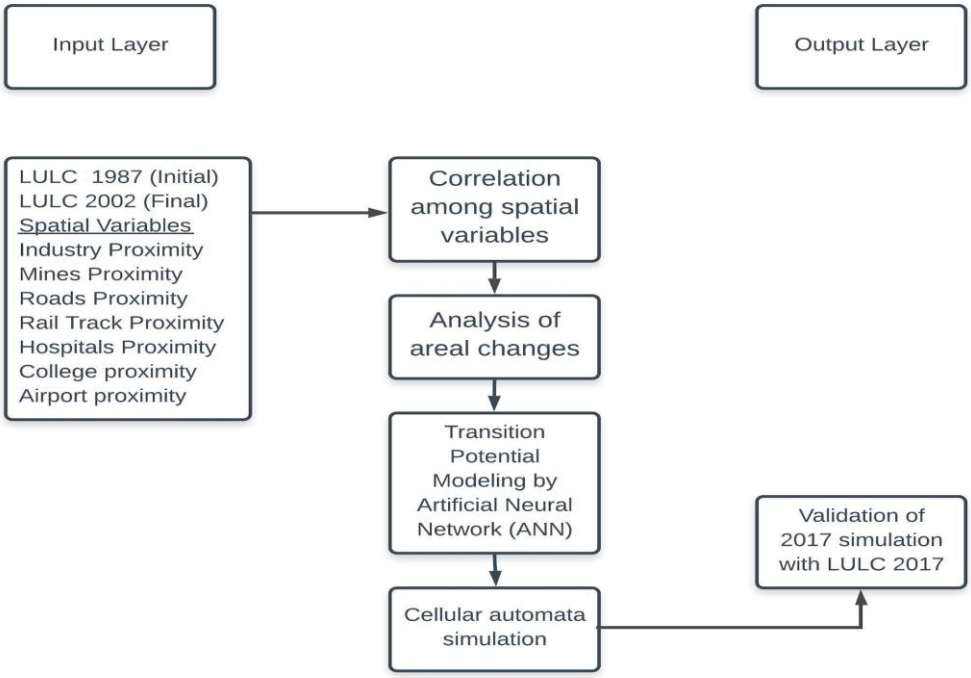


Figure 5

Derivation of the Output Layer From the Model: Stage 2

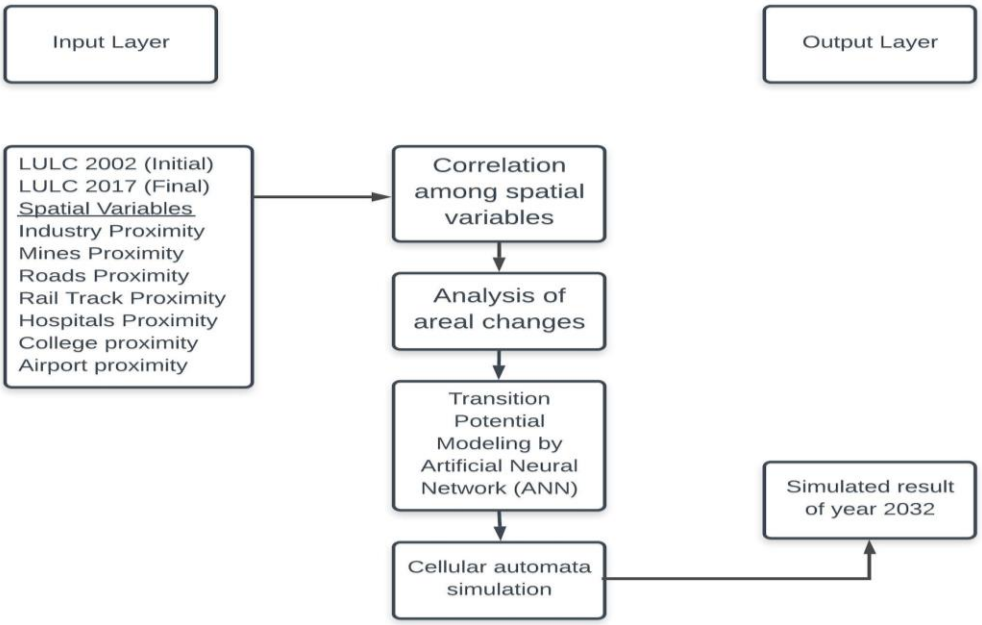


Table 3

Landuse and Landcover Classification Values in Sq. Km.

Pearson's Correlation Matrix (1987-2002)							
	Industry	Airport	College	Rail Track	Mines	Hospital	Roads
Industry	_	0.0979	0.795347	-0.05043	-0.50293	0.81825	0.48342
Airport	_	_	-0.2137	0.350677	0.697173	-0.1520	0.3479
College	_	_		-0.221312	-0.82224	0.98300	0.34436
Rail Track	_	_		_	0.30653	-0.16523	0.3368
Mines	_	_	_	_	_	-0.7801	-0.00703
Hospital	_	_	_	_	_		0.37443
Roads							

Table 4

Pearson's Correlation Matrix of the Factors Affecting the LULC: 2002–2017

Pearson's Correlation Matrix (2002-2017)							
	Industry	Airport	College	Rail Track	Mine	Hospital	Road
Industry	_	0.0979758	0.795347	-0.0504	-0.50293	0.818256	0.48342
Airport	_	_	-0.213705	0.3506	0.6971733	-0.15205	0.34799
College	_	_	_	-0.2213	-0.82229	0.983004	0.34436
Rail Track	_	_	_	_	0.306533	-0.165235	0.33687
Mine	_	_	_	_	_	-0.78019	-0.0070
Hospital	_	_	_	_	_	_	0.37443
Road	_	_	_	_	_	_	_

Source: Tables 4 to 7, 9, 10 and 11 computed in this Study from LANDSAT Images

Using LULC images from 1987 and 2002, along with relevant influencing factors, a simulated LULC map for 2017 was generated and validated against the actual 2017 LULC map, achieving an overall Kappa score of 88.5%. This included a Kappa (overall) of 0.80713, Kappa (histogram) of 0.99680, and Kappa (location) of 0.80972. Similarly, the LULC for 2032 was simulated using input layers from 2002 and 2017, along with the influencing factors layers. Calibration, training, and validation are essential steps for achieving accurate results throughout the ANN process. Layers between the input and output layers are known as hidden layers, which enhance analysis by enabling forward and backward propagation. These mechanisms assign weights and produce meaningful outputs. It is important to note that the activation function within the CA-ANN structure involves repeated forward and backward propagations, loading numerical probability values into the hidden-layer neurons. This process generates a validated, self-learning outcome that encapsulates the system's overall functionality.

Discussion and Results

It is to be borne in mind that the analysis in this modelling is done in a two-stage process. First, we perform training and validation using a reference image from a year (Figure 6). For this, we use the classified images from 1987 and 2002 as inputs to the model, along with rasters of the influencing factors, to obtain a simulation LULC map for 2017. After validating it against our original LULC map for the same year, a simulation of the LULC scenario was conducted in 2032.

One essential part of our analysis involves calculating the correlation between factors or variables that influence built-up magnification in this study area (using the Pearson Correlation method). It presents a matrix showing the level of correlation among the variables (Table 3). It has been observed that the built-up area has been steadily increasing over the years. It grew from 25.78 sq.km in 1987 to 72.05 sq.km in 2002 (Table 4) and eventually to 98.91 sq.km in 2017 (Table 5). The model forecasts that the built-up area will increase to 138.72 sq.km in 2032 (Table 6).

The transition matrix shows the percentage change in the two classes, built-up and non-built-up, over 15 years (1987-2002). It was found that 62% of the built-up area remained built-up in the subsequent year, 2002, and almost 12% of the non-built-up area was transformed into built-up area (Table 6).

Table 5

Change of Built-up and Non-Built-Up Area Between 1987 And 2002

LULC	1987 (In Sq Km)	2002 (In Sq. Km)	Δ (Change of Area in Sq. Km)	1987 (% of the Area)	2002 (% of the Area)	Δ%
Built-up	25.78	72.05	46.27	5.1854	14.4913	9.3058
Non-Built-up	471.39	425.13	-46.27	94.8145	85.5086	-9.3058

Table 6
Change in Built-up and Non-Built-up Areas Between 2002 and 2017.

LULC	2002 (In Sq. Km)	2017 (In Sq. Km)	Δ (Change of Area in Sq. Km)	2002 (% of the Area)	2017 (% of the Area)	Δ%
Built-up	72.05	98.91	26.86	14.49130	19.89449	5.403193
Non-Built-up	425.13	398.26	-26.86	85.50869	80.10550	-5.403193

Table 7

Change of Built-up and Non-Built-up Area Between 2017 and the Simulated Year 2032.

LULC	2017 (In Sq. Km)	2032 (In Sq. Km)	Δ (Change Of Area In Sq. Km)	2017 (% Of The Area)	2032 (% Of The Area)	Δ%
Built-up	98.91	138.72	39.81	19.8944	27.9026	8.0081
Non-Built-up	398.26	358.45	-39.81	80.10550	72.0973	-8.0081

Similarly, the transition matrix in Table 8 shows that 0.6400, or 64%, of the built-up area remained built-up in 2017, whereas 0.1241, or 12%, of the non-built-up area was transformed into built-up in 2017 (Table 7).

Finally, it is found that the 0.99 or 99% built-up area of 2017 is expected to remain built up in 2032, and the 0.0999 or almost 10% non-built-up area is likely to be transformed into built-up in 2032 (Table 8).

The simulation of the LULC map for the year 2032 has been prepared with an overall accuracy of 88.5%, i.e., the percentage of correctly classified pixels relative to the referenced (actual) pixels is 88.5% (Table 9).

Table 10 depicts the increment of built-up areas at the cost of the decrement of the non-built-up regions over the years. The built-up area is predicted to reach 138.72 sq km in 2032, almost 40 sq km more than in 2017.

Table 8
Transition Matrix Between Built-up and Non-Built-up: 1987–2002

Transition Matrix (1987-2002)		
LULC	Built-up	Non Built-up
Built-up	0.626532	0.373468
Non-Built-up	0.118573	0.881427

Table 9
Transition Matrix Between Built-up and Non-Built-up: 2002–2017

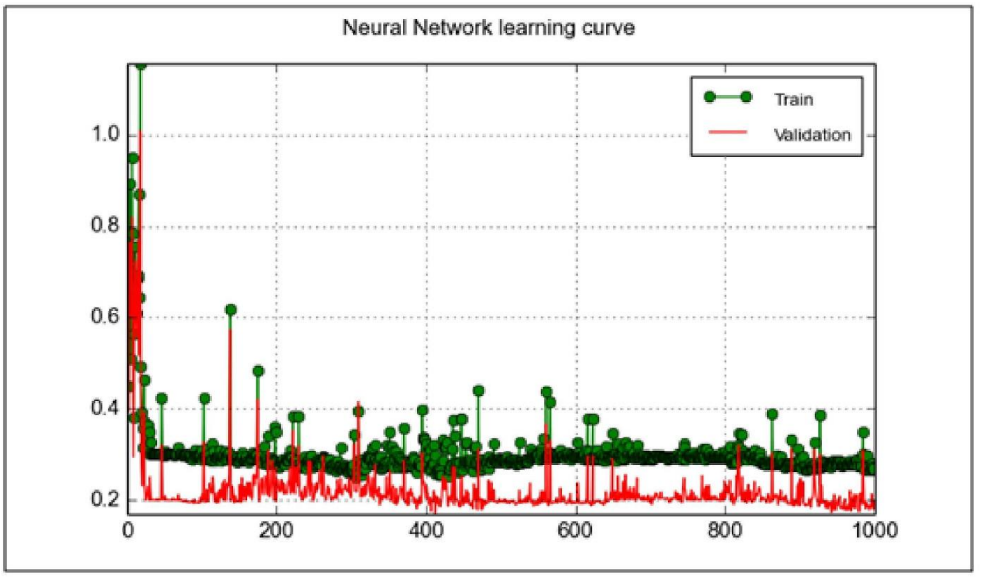
Transition Matrix (2002-2017)		
LULC	Built-up	Non-built-up
Built-up	0.640021	0.359979
Non-built-up	0.124195	0.875805

Table 10
Transition Matrix Between Built-up and Non-Built-up: 2017–2032

Transition Matrix (2017-2032)		
LULC	Built-up	Non-built-up
Built-up	0.999982	0.000018
Non-built-up	0.099974	0.900026

Figure 6

Artificial Neural Network Learning Curve Images



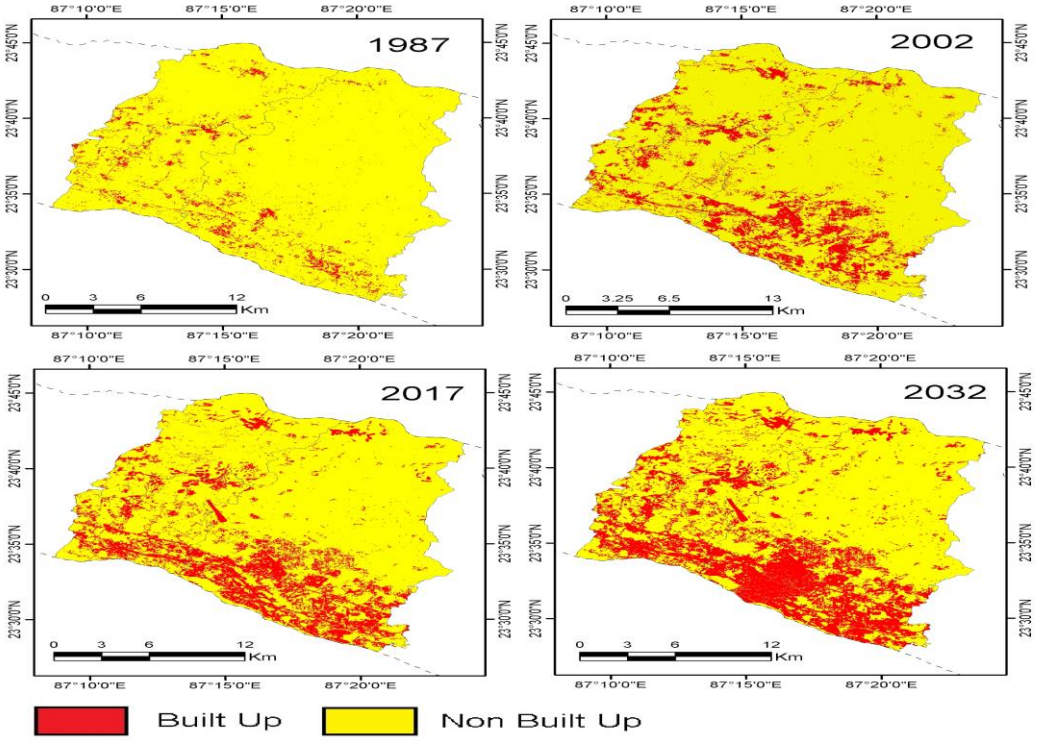
Source: Computed in this study from LANDSAT

The increases in total built-up area from 1987 to 2002 and from 2002 to 2017 are 46.27 sq. km and 26.86 sq. km, respectively. These are mainly concentrated in the Durgapur and Andal urban centres in the southern and southeastern parts of the study area. A slight expansion of the built-up area in the northern part is observed, driven by mine expansion (Figure 7). Consequently, a consistent upward trend in built-up areas has been recorded over the years and is likely to continue, driven by high population growth. The model forecasts that the built-up area will reach 138.72 sq. km by 2032 (Table 6). On a block-wise basis, the most significant increase in built-up area was observed in Faridpur Durgapur Block, rising from approximately 65 sq. km in 2017 to around 90 sq. km in 2032 (Figure 8).

In addition to the common trend of positive population growth, some MAUs experienced negative population growth, e.g., Bhaburia, Chak-Laudoha, and Kamardanga in the Faridpur Durgapur block, and Hansdiha in the Pandabeshwar CD block.

Figure 7

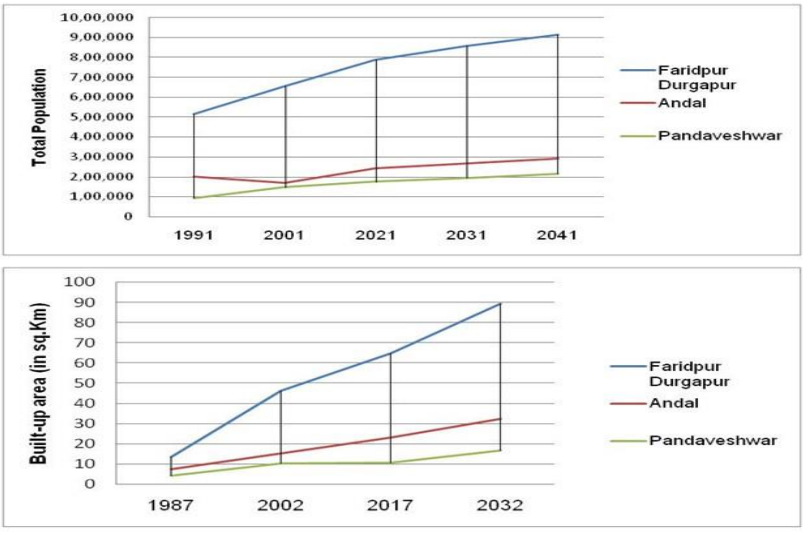
Land Use Land Cover Scenario of the Study Area From 1987–2017 and Simulated Land Use and Cover Scenario for 2032



Source: Generated from LANDSAT Images

Figure 8

Association of Total Population and Built-Up Area Growth



Source: Prepared from District Census Handbooks of Burdwan district and Landsat images

Among them, the highest negative growth observed for Hansdiha of Pandabeshwar (Table 11) is because the settlement area of Hansdiha village has completely transformed into the Sonpurbazari open-cast coal mine area (Mourya & Chakraborty, 2012)

Table 11

Validation Result Showing Parameters of Kappa Statistics

Percentage of accuracy	88.5285
Kappa (Overall)	0.80713
Kappa (Histogram)	0.99680
Kappa (Location)	0.36534

Out of the 112 forecasted administrative units, 77 units have produced sufficient accuracy. Hansdiha, Bhaburia, and Chaklaudoha showed a negative change; Kamardanga showed no change; and the remaining units failed to meet the required accuracy, i.e., an upper threshold of 20 % error. Among all six methods, constant share has been selected for 25 units, simple linear for 23 units, shift share for 12 units, share of growth for eight units, simple exponential for six units and simple geometric for four units with MAPEs of 8.625226, 6.383572, 5.916224, 4.948268, 9.409007 and 2.883625, respectively. The highest forecasted population for DMC was 644,441, 701,662, and 744,881 for 2021, 2031, and 2041, respectively.

Urban growth forecasting is a vital tool for regional planning, providing essential information to manage expansion, encourage sustainable development, and ensure the efficient allocation of resources. The present study demonstrates that increments in built-up areas are closely linked to population growth over time. Population forecasts based on simple trend extrapolation methods and built-up area modelling using CA-ANN are expected to provide valuable insights into the behavioural patterns of growth and development of the MAUs at small-scale units, aiding urban planners, administrators, and decision-makers to consider people and land within the framework of sustainable and inclusive planning. Despite some limitations, simple trend extrapolation methods remain useful for population forecasting, particularly at smaller scales in a developing country like India. Notably, growth in built-up areas and population is mainly observed in the south and southeastern parts of the study area, often at the expense of non-built-up land. The results highlight and predict further increases in built-up regions, which could impact sustainable growth by significantly affecting local resources and the environment. Further research and studies focusing on micro-level planning and assessment are recommended, particularly in the context of sustainable development and comprehensive inclusive growth within urban planning.

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Bridging the Gender Gap: The Role of Reservations in Enhancing Women's Participation in Indian Elections

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Abstract

Women's participation in the political process both causes and reflects their empowerment in society. Since the 1990s, there has been a remarkable increase in women's political turnout in India. The country's prevailing socio-political factors strongly influence electoral participation. The study examines trends, issues, and challenges related to women's reservation, participation, and engagement in electoral processes across various social groups in Indian states and union territories, using secondary data from the Election Commission of India's website. The findings show a tentative yet significant and encouraging correlation between women's reservation and their electoral involvement. Many socio-political factors affect women's voting behaviour. Interestingly, the success rate of women candidates has consistently exceeded that of their male counterparts since the general elections began. Despite considerable progress as voters over the decades, women remain underrepresented in Parliament, state assemblies, and political parties. The 73rd and 74th Amendments to the Indian Constitution mandate a one-third quota of seats for women in Panchayati Raj Institutions (PRI) and Urban Local Bodies (ULB). Additionally, the Women's Reservation Bill, which seeks to reserve 33% of seats in Parliament and State Legislative Assemblies for women, has been passed by both houses of Parliament, though its implementation remains pending. India's continued failure to fully enact the Women's Reservation Bill underscores political parties' lack of genuine commitment to significantly enhancing women's participation in elections.

***Keywords*:** Electors, Lok Sabha, Rajya Sabha, parliament, PRI

Introduction

Following independence, with a parliamentary form of government and a constitutional democracy, India is committed to holding free and fair elections regularly. The results of these elections determine the composition of the executive branch, the two houses of parliament, the state and union territory legislative assemblies, and the president and vice president. Since the 17th century,

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elections have been the primary approach by which the contemporary democratic process has been implemented (Manin, 1997). In a democracy, an election is a formal, participatory event in which voters select an individual to serve in public office at regular intervals. So, the voluntary participation of voters is a critical aspect of electoral processes; otherwise, the electoral system, or even democracy itself, may not be functional. Voting rights should be extended to all members of society without discrimination based on their social class, caste, gender, race, or colour. Such an arrangement in a democracy is termed 'universal adult franchise', which is practised in India. This will ensure that everyone has an equal opportunity to participate in the electoral process. However, not all citizens have historically been able to vote, particularly women and other members of weaker social groups.

In colonial India, the Indian women's suffrage movement battled for the right of Indian women to vote. In 1917, Margaret Cousing collaborated with others to establish the 'Women's Indian Association' in Madras, thereby initiating the demand for franchises (Nair, 1996). The organisation focused on equal opportunities and women's suffrage rights. The women's suffrage campaign led to the granting of the right to vote to women in all British provinces and the majority of princely states, and, in some instances, the ability to run for local elections between 1919 and 1929. However, based on property requirements, these privileges were only granted to a relatively small group of Indian women. Later, the Government of India Act of 1935 extended the right to vote to more women, albeit with requirements such as literacy, property ownership, or marriage to a wealthy man (Rai, 2017).

Women's active participation in electoral processes is a reliable indicator of the effective development of democracies worldwide (Nelson & Chowdhury, 1994; Rai, 2017; Thomas & Wilcox, 2005). After independence, the Constitution of India aims to eliminate unfair treatment among different groups in society by banning discrimination based on religion, race, caste, sex, or place of birth, and by reserving specific electoral seats for women. Elections in every state are held under adult suffrage in accordance with Article 326 of the Indian Constitution. Voter equality is protected by this provision, regardless of caste, religion, colour, or gender. However, despite 70 years of independence and the constitutional mandate to promote equality in all aspects of public life, including electoral politics, discrimination against women persists in India, including electoral politics (Rai, 2017).

Reservations are a form of affirmative action aimed at creating a level playing field or equal opportunity by addressing the slow progress of minority and female participation in areas where they have historically been underrepresented, such as employment, education, and political institutions. Reservation in the political system serves as a means

of redistributing participation among groups excluded from the political decision-making process. Having a voice in political decisions enables communities to secure social protections such as health, safe drinking water, and education. It has been observed that female politicians influence public spending decisions and tend to favour investments in social protection (Yañez-Pagans, 2014). Additionally, public goods that are more closely linked to women's concerns are more extensively financed by women in leadership positions (Chattopadhya & Duflo, 2004).

As of August 1, 2023, the global average participation rate of women in national parliaments was 26.7 per cent. Regional averages of women's representation in parliament also vary geographically, and this variation is influenced by factors such as the status of women in each region and government-affirmative actions. Women's representation in the Americas (34.8%), Europe (31.4%), and sub-Saharan Africa (26.8%) is higher than the global average. In comparison, Asia (21.3%), the Pacific (22.85%), and the Middle East and North Africa (16.4%) have lower average shares of women in their parliaments than the global mean. It is noteworthy that women's participation in parliament also varies across the globe at sub-regional and country levels.

Gender equality and a meaningful, functional democracy are fundamentally linked to women 's political engagement. The rise in women 's political participation strengthens the legitimacy of democratic institutions (Karp & Banducci, 2008). It enables women to participate directly in government decision-making processes and provides a way to ensure they are held more accountable. Women's political participation includes not only involvement in decision-making and political activism within the power structure, but also voting. Since there were no reserved seats for women in the assembly under India's post-independence constitution, women's participation in elections lagged behind men's. Gender inequalities in parliamentary representation and the smaller number of female ministers have been observed since the first general election. The percentage of women members in the 17th Lok Sabha (the Lower House of the Indian Parliament) has remained below 15%, despite the global average of 26. 7 per cent for female representation in national parliaments as of August 1, 2023 (IPU, 2023). However, there is optimism that the proportion of seats won by women has increased from 4.4% in the first Lok Sabha election in 1952 to 14.36% in the 2019 general election (ECI, 2019). Particularly in the 1990s, under the 73rd Amendment to the Indian Constitution, women were granted the right to one-third of Panchayat seats, thereby increasing their opportunities to participate in local community governance and significantly increasing women's voter turnout.

In the 2019 Lok Sabha elections, female voter turnout (67.18 per cent) not only slightly exceeded male

turnout (67.02 per cent) but also narrowed the gender gap in turnout (ECI, 2019). This indicates that women are actively engaging in political activities, which is an unquestionably positive development. However, the number of women representatives in assemblies and parliamentary elections has not improved substantially. In particular, women's participation in political elections varies considerably across regions of India. In light of various perspectives on women's participation in the electoral process, the current study analyses trends, barriers, and factors influencing women's electoral involvement.

Objectives

Reservation of parliamentary seats for women is a milestone in itself, ensuring greater representation of women and combating gender inequality in politics. Women's political participation is uneven across India, especially in parliamentary (Lok Sabha) elections. The number of women who run for office and the number elected as representatives are the primary metrics used in this study to assess the level of women's political participation influenced by women's reservation. So, against this conceptual background mentioned above, the following objectives have been listed to be fulfilled in this paper:

1. To examine the significance of women's representation in politics.

2. To find out the spatio-temporal change in women's representation in Indian politics.

3. To assess the regional pattern of women's representation in the Indian electoral process.

4. To identify the factors affecting women's representation in the electoral process.

Methods and Materials

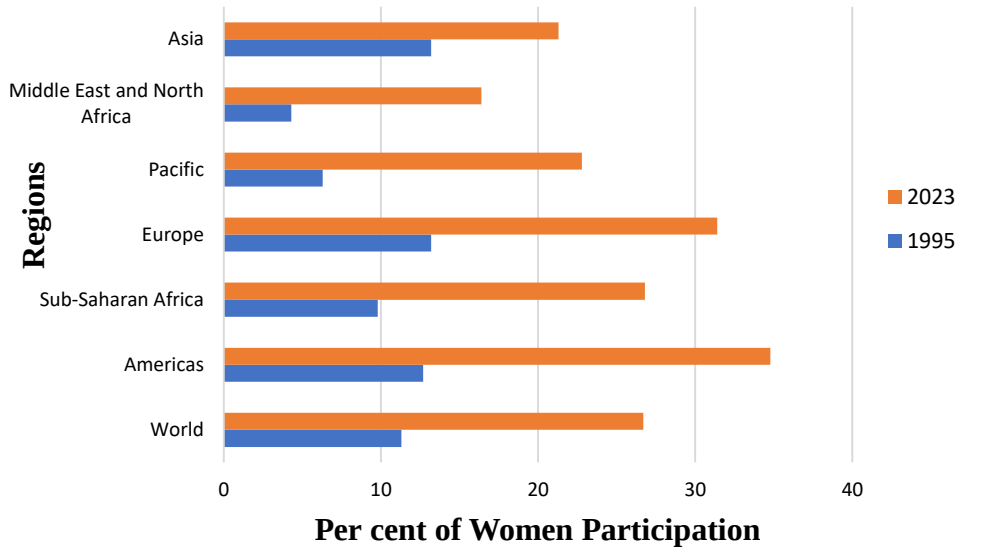
Data for the present study are obtained from various secondary sources, such as the website of the Election Commission of India (ECI), a constitutional body, and social aspects-related data are taken from publications of the Census of India 2011. The ECI conducts and regulates elections in the country and maintains data on the whole affair. The result of the 17th Lok Sabha election is available on the website. It has been studied how women's political involvement is changing over time across different states and UTs. MS Excel and SPSS are used to analyse data and prepare cartograms for visual representation.

Geographical Distribution of Women in Parliaments

Women have historically been underrepresented in politics and other institutions across many nations. Despite more women being elected to leadership positions in government and state, this historical trend persists. As of August 1, 2023, the global average of women in national parliaments has more than doubled over the last 25 years, from 11.3 per cent in 1995 to 26.7 per cent in 2023 (+15.4 points). The percentage of women in parliament increased across all regions, with the Americas making the most significant strides and Asia the least (Fig. 1).

In terms of regional growth in women's participation in their parliament between 1995

Fig:1-Region-wise Women in Parliaments



Source: http://archive.ipu.org/ & https://data.ipu.org/ and 2023, the Americas (+22.1 points) has experienced the highest growth, followed by Europe (+18.2 points), Sub-Saharan Africa (+17 points), the Pacific (+16.5 points), the Middle East and North Africa (+12.1 points), and Asia (+8.1points) (IPU, 2023). Less than 10% of seats in the single or lower houses of parliament were held by women in 109 out of the 174 countries for which statistics were available for the year 1995, only 2.9% of parliaments, all in Europe, had women in positions of 30% or more, but in 2020, women held less than 10% of seats in lower and single houses in just 24 out of 191 countries (IPU, 2020). In 7 countries (including Rwanda, where women's representation in the lower house exceeds 60%), women hold 50% or more of the seats in the lower or single-chamber of parliament in 2023. Twenty-five years after the Fourth World Conference on Women in Beijing (1995), aspirations for women's political involvement have risen. In general, parliaments are constantly progressing towards gender parity.

It has been observed that only a few States had female quotas prior to 1995; in most cases, these quotas were voluntary adoptions by individual political parties. However, by 2015, quotas were in place in more than 120 countries worldwide (IPU, 2020). Rwanda is the country that has achieved the most significant progress between 1995 (4.3%) and 2023 (61.3%) in terms of women's participation in the lower or single house of parliament, following the 30% female representation quota set in the 2003 Rwandan Constitution. (Sharma, 2022). Thus, by reserving seats for women, the number of women in parliament can be

increased, thus achieving gender parity.

An independent-samples t-test is used to assess the significance of the electoral quota for women (either in parliament or within political parties) on their representation in parliament worldwide. The test is based on data from women parliamentarians in countries with an electoral quota for women (106) and without one (77) in their lower or single house of parliament (Table 1). The t-test is statistically significant. Women representatives in the lower or single house parliaments that have an electoral quota for women (Mean =30.40, SD =11.56) are significantly higher (Mean difference 11.30, 95% CI [7.84, 14.76]) than the parliaments that have no electoral quota for women (Mean =19.09, SD =11.89), (t = 6.451, with df =181 (p<0.001), two-tailed test).

Table 1

Mean Difference of Women Parliamentarians Between the Countries With Electoral Quota and Without Electoral Quota for Women

	Electoral quota for women (either in parliament or in political parties)	N	Mean	Std. Deviation	Std. error mean
Women Parliamentarians in the lower or single house	YES	106	30.40	11.56	1.12
	NO	77	19.09	11.89	1.36

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Inter of the Difference	
									Lower	Upper
Representation of Women in the Lower House or Single House	Equal variances assumed	.024	.877	6.451	181	.000	11.30142	1.75190	7.84464	14.758
	Equal variances not assumed.			6.422	161.187	.000	11.30142	1.75979	7.82619	14.776

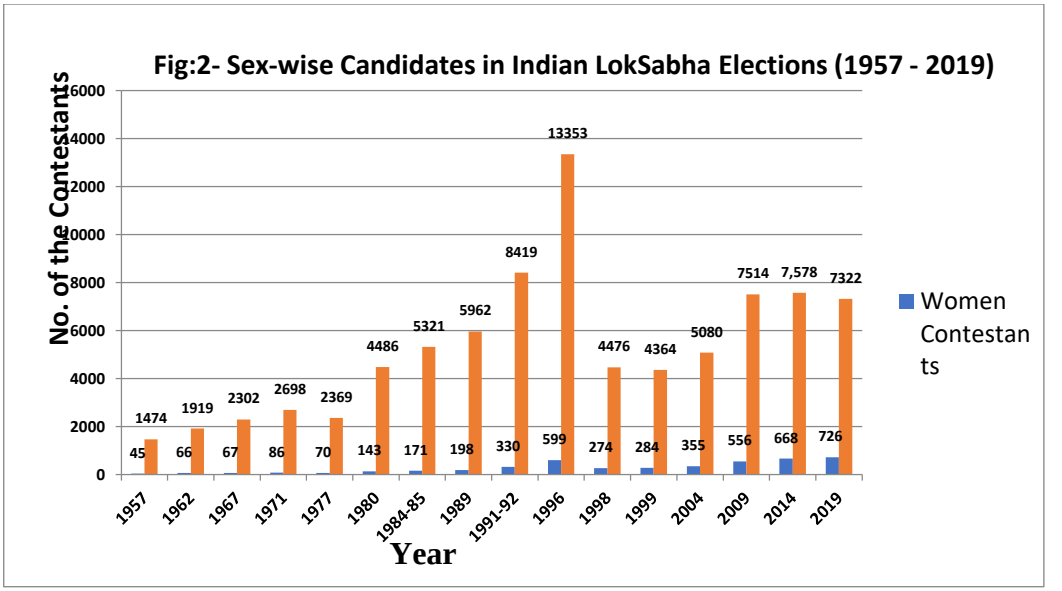
These findings suggest that seat reservations for women in parliament effectively improve women's representation.

Furthermore, the geographic distribution of women's representation in parliament varies across regions. Data from the Inter-Parliamentary Union as of August 1, 2023, shows significant differences in women's representation among South Asian nations. Countries such as Nepal (33.1%), Bangladesh (20.9%), and Pakistan (20.5%) have higher proportions of women in their lower houses of parliament than India does. Since Bangladesh's independence, it has reserved seats for women in parliament, with the system amended in 2011 to reserve 50 seats. Following

the implementation of affirmative action in 2007, Nepal's 2015 constitution mandated that women occupy 33% of all seats in the Constituent Assembly (CA) (Lotter, 2018; Upreti et al., 2020). The quota system is not accepted in Bhutan, the Maldives, and Sri Lanka, as reflected in their lower levels of women's representation in parliament.

Trend in Women Candidates in India

Individual socio-demographic factors, such as income and education, as well as social-cultural norms and caste, are also linked to women's chances of participating in politics. (Agarwal, 1997; Vissandjee et al., 2006; Banerjee, 2003; Gleason, 2001). While the number of female candidates in parliamentary elections has grown over time, their proportion when compared to male candidates is still low (Fig. 2). As per data from the Election Commission of India, about 9% of the 8,049 candidates running in the 2019 Lok Sabha elections were female, which was around 3% in the 1957 Lok Sabha election. The number of women running for parliamentary seats has increased over the period, but the pace has been very slow.



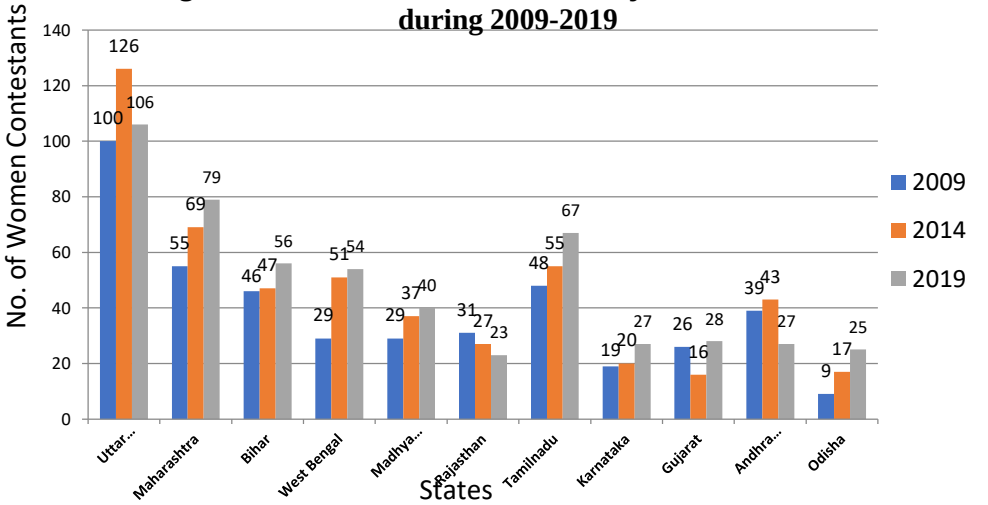
It exceeded double digits after the 1980 Lok Sabha election, when 143 women ran for office for the first time. Since the beginning of the 1990s, women have been contesting parliamentary seats at a slightly higher rate than earlier.

It is noteworthy that 13952 people ran for the Lok Sabha in the 1996 election. The number of candidates in this Lok Sabha election was by far the highest ever, and it still holds the record till the 17th Lok Sabha election. The first five general elections, from 1952 to 1971, at the national level led to a one-party-dominant system in which Congress ruled the roost. In contrast, general elections from 1977 onwards reveal a pattern of increasing participation with many political parties in the fray. The number of parties participating in elections

increased after 1989, as the Congress-led order collapsed and political entrepreneurs founded new parties based on social divisions rooted in ascriptive identities, particularly religion and caste (Vaishnav & Hintson, 2019). So, an increasing number of parties resulted in more candidates in the general elections at that time. The initial security deposits, set in 1947 at 500 rupees for general candidates and 250 rupees for candidates from Scheduled Castes or Tribes (SC/ST), remained unchanged for 50 years (till 1996) (Kapoor & Magesan, 2018). In 1996, candidates paid nothing in security deposits for the general elections. So, a large number of independent candidates could easily file nominations. The Election Commission of India eventually increased the deposits sharply and a variable amount, to INR 10,000 for general candidates and 5,000 rupees for SC/ST candidates, as a result of a massive influx in the number of candidates in the elections of 1996 (Kapoor & Magesan, 2018; Bhattacharya & Mitra, 2014). The participation of independents was thus disproportionately impacted by the increase in deposits in the following elections.

Women's electoral inclusion received little attention during the initial years of the post-independence period, with few concerted or coordinated efforts. As of the 2011 census, the top 11 states by population account for almost 3/4 of the total Lok Sabha seats. More than 3/4th of the women candidates in the three most recent Lok Sabha elections (2009, 2014, and 2019) came from these eleven states, as found in an analysis of the geographical distribution of candidates (Fig. 3).

Fig:3- Women Contestants Across Major States in India during 2009-2019



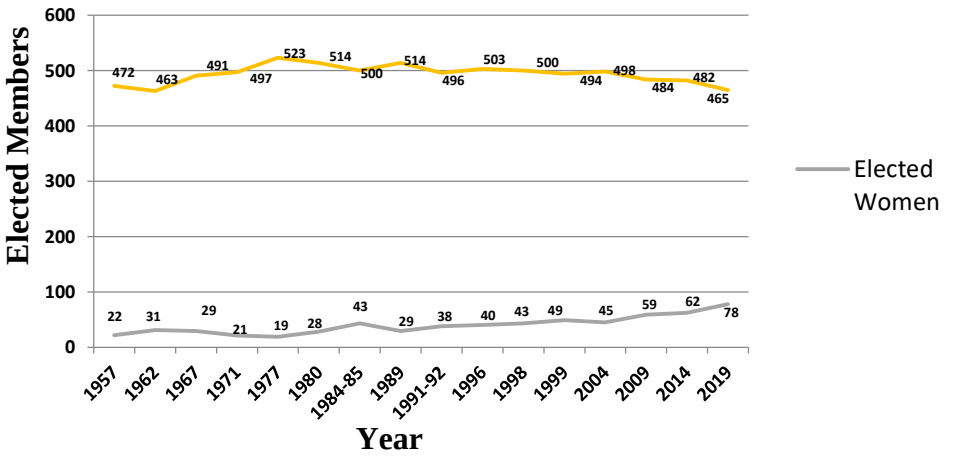
Despite higher literacy rates in South Indian states, the number of women candidates nominated for the general election remains unsatisfactory. State parties play a crucial role in selecting women candidates. In the 2019 Lok Sabha election, the Bharatiya Janata Party (BJP) fielded 12.6 per cent

female candidates, while the Congress Party fielded 12.9 per cent of all candidates. However, state-based parties like AITMC in West Bengal nominated 37.1% of women candidates, and the BJD nominated 33.3% in Odisha. Conversely, YSRCP nominated 16% female candidates in Andhra Pradesh in the 2019 Lok Sabha election.

Women's Representation in the Lok Sabha in India

Membership in the parliament is a prerequisite for holding public office in parliamentary democracies like India. The data on women's representation in the Lok Sabha suggest that the proportion of women representatives has remained low relative to their male counterparts. Despite rising women's representation over time, the rate is extremely slow. Less than 15% of all Lok Sabha members were women in the 2019 Lok Sabha election, the highest percentage of women representatives in the Indian parliament till the 17th Lok Sabha election. The lack of political voice and poor representation of women in parliament results from gender-based exclusions (Kumar & Rai, 2007; Rai, 2011). A variety of factors, some universal and gender-specific, and others country-specific and localised, influence women's participation in formal politics (Rai, 2011). It has been proposed that women's electoral participation is typically lower than men's in India and other countries, either because of the socialisation that women have received that differs from men's, particularly in terms of marriage, motherhood, employment, and property ownership, or because women have fewer resources (Burns et al., 2001; Rai, 2011). Parliaments not only enact laws and hold the executive accountable, but they also assert a 'representative claim' (Saward, 2010) to speak for various constituencies, identity groups, and interests (Rai & Spary, 2019).

Fig:4- Gender Gap in Elected Members in the Previous Lok Sabha Elections of India (1957 -2019)



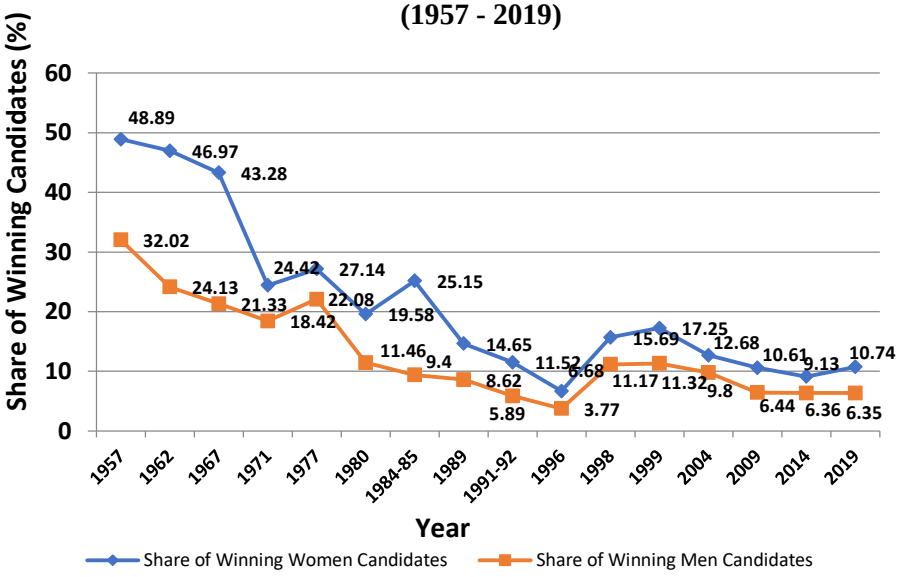
The number of women parliamentarians has remained significantly low since the first election. India achieved the highest number of female MPs (78) in the 2019 Lok Sabha election, and this number has increased very slowly since the 1989 Lok Sabha (Fig. 4).

The 72nd and 73rd constitution amendment bills (1992-1993) ensured women's participation in local bodies, but the 81st constitution amendment bill (1996) for reservation of women in Parliament failed to gain the approval of the Lok Sabha, resulting in very low representation of women in Parliament to date. The spatial distribution of MPs also varies across states and political parties. In the 17th Lok Sabha election (2019), among the eleven most populous states, Odisha had the highest percentage (33.3%) of female MPs, followed by West Bengal (26.2%), Gujarat (23.1%), Maharashtra (16.7%), Andhra Pradesh (16.0%), Uttar Pradesh and Madhya Pradesh (13.8%), Rajasthan (12%), Tamil Nadu (7.7%), Bihar (7.5%), and Karnataka (7.1%). In 2019, 41 of the 78 elected women were from the BJP, compared to 6 from the Congress party, but the share of female MPs within the BJP was only 13.50%, and within Congress, just 11.50%. From this perspective, regional parties performed much better, with the AITMC and the BJD recording 40.9% and 41.70%, respectively, in the 2019 general election. Thus, state-based regional parties are emerging as a significant force in reducing the gender gap among elected members of Parliament.

The lack of 'winnability' of women has been cited as a political reason why political parties do not allocate seats to women in national and state elections (Deshpande, 2004). As Figure 5 shows, women's share of winning candidates has remained higher than men's since the 1957 general election. However, women's winnability has decreased over time as more female candidates participate in the parliamentary electoral process. There were three female candidates for every 100 male candidates in 1957, but by 2019, the number had increased to 10, which is still very low but a significant improvement. Although the number of female candidates has increased, actual female representation has not improved. Compared with the 1960s, when there were significantly fewer female candidates, but they had a better chance of winning, this success rate has dropped significantly. One factor behind the declining success rate among women can be explained by the nature of the parties from which candidates contest. In the 2019 general election in India, out of 726 women candidates, 272 candidates were from registered (unrecognised) parties, followed by 226 independent candidates, and 171 candidates of national parties and 57 candidates of state parties. Of the 78 female candidates who won, 58 came from national parties, 17 from state parties, two were independent, and one came from a registered but unrecognised party. The percentage of female candidates from national parties who won the election was 33.92, followed by state parties at 29.82, independent candidates at 0.88, and registered

(unrecognised) parties at 0.37. As a result, more women are running for office, but their low success rate has reduced the proportion of successful candidates.

Fig:5- Share of Winning Candidates out of Contestants in Lok Sabha Election of In (1957 - 2019)



Issues and Challenges

The women's movement in India has raised awareness of the discrimination and marginalisation that women experience throughout the nation and has made a strong case for their inclusion in the political sphere after independence. Target 5.5 of the Sustainable Development Goals (SDGs) aims to ensure women's full and effective participation and equal opportunities for leadership at all levels of decision-making in political, economic, and public life (SDG, 2015). One of the indicators of this target is the proportion of seats held by women in (a) national parliaments and (b) local governments. Women's reservation was introduced at the local government as early as 1993 by the 73rd and 74th Amendments to the Constitution of India. It mandated that at least 33 per cent of the seats in Panchayati Raj Institutions (PRIs) and Urban Local Bodies (ULBs) be reserved for women through direct election. As of 08.09.2021, 22 states in India have implemented a policy reserving 50% of seats for women in Panchayati Raj Institutions (PRIs) (MoPR, 2021). Indeed, several states have surpassed the 50% threshold for female representatives in PRIs, suggesting that women are increasingly securing seats in areas that were not designated for them. But the upsurge in women's representation in the national parliament has not been seen even

after 75 years of independence. Even though women comprise 48.46% of India's population (Census of India, 2011) and 48.09% of those who are registered to vote (ECI, 2019), they currently hold only 14.94% of the 17th Lok Sabha and 14.05% of the Rajya Sabha, while in the state legislative assemblies, women on average constitute about 7.5% of total members (MoLJ, 2022). The central issue of the reservation of seats for women in parliament is whether it can be a highly beneficial tool for their empowerment. The 73rd and 74th Constitutional Amendment Acts have been enforced across all Indian states without provoking any animosity or resistance from male politicians or society at large (Kishwar, 1996). This 1993 amendment served as a stimulus, propelling more than 14.5 lakh women into positions of leadership in local governance and administration throughout India (MoPR, 2020). Under the reservation policy, women elected to leadership positions invest more in public goods that are more directly related to women's concerns (Chattopadhya & Duflo, 2004). One significant influence of women in local politics has been their role in curbing alcohol-related dominance in numerous rural communities (Outlook India, 2023). Thus, reducing disparities in political agency also helps resolve imbalances in other domains (Sen, 1999).

The IPU (2023) has observed that chambers with reserved seats for women, or those combined with voluntary party quotas, produce a significantly higher proportion of women than chambers without such measures. Therefore, parliamentary reservations have played a crucial role in advancing women's representation. Another issue related to reservations in the Indian political system that is often overlooked is the reservation of women within political parties. This could also be a decisive factor in increasing women's representation (IPU, 2023). Several countries lack laws mandating women's representation in their parliaments, yet many parties reserve seats for women (Table 2). These initiatives are also highly effective at enhancing women's political representation.

The political, cultural, and social environments are frequently unwelcoming or even hostile to women's involvement in politics (Shvedova, 2005). Due to a variety of structural, functional, and individual factors that vary across social contexts in different countries, women have historically been marginalised in political structures and processes (Bari, 2005). Women are disadvantaged and excluded from decision-making forums because of India's extremely discriminatory and hierarchical social and cultural structures. Since they do not participate much in Indian politics, their struggles and issues are frequently disregarded and unacknowledged (Alam, 2015).

Political Environment

The political approach is based on male norms. It emphasises the ideas of "winners and losers," competition, and confrontation rather than empathy, cooperation, and consensus, thereby risking the outright rejection of women's participation in politics (Shvedova, 2005; Thanikodi & Sugirtha, 2007).

Table 2

Political Representation of Women in Different Countries (as of September 2023)

Country	Per cent of Elected Women	Quota in Parliament	Quota in Political Parties
Sweden	46	No	Yes
Norway	46	No	Yes
South Africa	45	No	Yes
Australia	38	No	Yes
France	38	No	Yes
Germany	35	No	Yes
UK House of Commons	35	No	Yes
Canada	31	No	Yes
US House of Representatives	29	No	No
US Senate	25	No	No
Bangladesh	21	Yes	No
Brazil	18	No	Yes
Japan	10	No	No

Source: Compiled from Inter Parliamentary Union data

https://www.ipu.org/resources/publications/reports/2023-03/women-in-parliament-2022

The main political barriers that women face are a lack of party support (such as limited financial aid for female candidates), limited access to political networks, a lack of well-developed educational programmes for women's leadership generally and for assisting young women in pursuing political careers, and the fundamental dimensions of the electoral system, which favour men (Shvedova, 2005). Another obstacle to women's political participation is the dominance of men in politics, political parties, and formal political structures. The low proportion of women in India's political party structures further hinders women's efforts to gather support and secure resources to grow their political constituencies, as well as to mobilise the human and financial resources needed to satisfy their demands and ambitions within those constituencies (Rai, 2011). The parliamentary work schedule is another manifestation of the male-dominated work pattern. It is frequently marked by a lack of structures that support working mothers in general and female MPs in particular (Shvedova, 2005).

Socio Economic Environment

Women's participation in political institutions and elected bodies is directly affected by their social and economic standing. The socio-economic barriers affecting women's participation in parliament, aside from a lack of sufficient funding, are: (a) illiteracy and restricted access to education and career options; and (b) the combined weight of household responsibilities and work commitments (Shvedova, 2005). Women spend far more time caring for their homes and children than men do due to the ongoing unequal distribution of family care responsibilities (Shames, 2015). This means that men are more likely to run for office despite their families' discouragement, while only women with supportive families can do so. Women's political engagement is also significantly impeded by poverty (Sharma, 2019). At the turn of the millennium, media systems that aim to boost advertising revenue have operated in a political climate that welcomes large inflows of capital, leading to an increase in commercialisation (McAllister & Applequist, 2015). The 'commercialisation' of politics has serious consequences, such as the dominance of advertising in politics, the use of branding and marketing strategies by professionals, extensive campaign financing and moneyed influences (Mcallister & Applequist, 2015). Additionally, women's access to and ownership of productive resources is restricted, which limits the range of work that can be done in politics (Bari, 2005) and the opportunity to participate in politics as well.

Cultural Environment

Culture constitutes a multifaceted lens through which political issues can be discussed and addressed (Melucci, 2013). Gender is an element of a complex matrix of social hierarchies that make up political power in most cultures. But regardless of their group, men are always better equipped to participate in the political process than women (Thanikodi & Sugirtha, 2007). Patriarchy uses the 'ideology of gender roles' as an ideological tool to place men in the public sphere and women in the private sphere of the home as spouses and mothers (Bari, 2005). This is one of the key factors influencing women's political participation worldwide. Women are far less likely than men to show ambition in running for public office and to perceive an equitable political landscape (Lawless & Fox, 2008). Women's ability to engage in politics is also significantly hampered by the threat of violence (Nussbaum, 2006).

Conclusion

The sluggish yet steady rise in women's electoral participation reflects a broader commitment to democratic inclusion in India. This paper critically examines the idea of establishing a quota or reservation for women in parliament or other supportive environments to boost women's representation. However, before women's representation at higher levels of government, where it

remains disproportionately low, can be guaranteed, there are still challenges to be addressed, including entrenched gender biases, resource scarcity, and barriers arising from the political, social, and cultural environment. A multifaceted strategy is needed to address these problems, including societal transformation, legal reforms, and ongoing efforts to remove the obstacles to women's equal participation in politics. Since women make up nearly half of the population, having more women in politics could improve women's status in society and the efficiency of government.

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Economic Impact of the COVID-19 Pandemic on the Banaras Metal Repoussé Craft: An Artisanal Case Study

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Abstract

With every major crisis comes great responsibility. During a pandemic, there is an urgent need to maintain physical distancing, follow hygiene protocols, and conduct adequate testing and treatment for those infected. The government of India ensured that no one went hungry during the lockdown; however, this was not achieved at the grassroots level. One such group was the artisans of Banaras's metal repoussé craft. The demand for craft items has fallen sharply, with little to no market for these products. The purchasing power of consumers has declined significantly due to the COVID-19 pandemic's impact across all sectors of society. The primary aim of the study is to identify and analyse the existential threats faced by the Banaras metal repoussé craft artisans during the pandemic. Snowball sampling and secondary data were employed for data collection, while both qualitative and quantitative methods were used for analysis. The study concluded that the economic impact of the lockdown was considerable, causing difficulties not only for the craft artisans but also for the government.

***Keywords*:** Cultural heritage, existential threat, lockdown, metal repoussé, pandemic

Introduction

Humans began leading sedentary lives around 13,000 years ago, which resulted in domestication of animals and the development of agriculture as a means of obtaining food. Humans have started sharing space with animals in various aspects of their lives (Pueyo, 2020). Consequently, the transmission of diseases, viruses, and bacteria from animals to humans began. About 60%-70% of diseases are zoonotic, meaning they are transmitted from animals to humans,

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and COVID-19 is one of them. Globally, lockdowns were introduced to prevent the spread of the disease (World Health Organisation, 2020). Lockdowns and social distancing measures were implemented to curb the spread of SARS-CoV-2 (Jamal et al., 2023). To combat this highly contagious disease, the Indian government adopted several modern Artificial Intelligence (AI) and Internet of Things (IoT) solutions to contain the coronavirus (Gupta & Suekha, 2020). The lockdown affected all segments of society, but Banaras' metal repoussé artisans were the hardest hit, as they had no alternatives and no support (Jamal & Sen, 2022). They faced an existential threat, as all economic activities apart from the production of essential goods came to a halt due to the nationwide lockdown (Organisation for Economic Co-operation and Development, 2020). The coronavirus pandemic devastated the livelihoods of Banaras metal repoussé craft artisans, leaving them with nothing. Approximately 90%-95% of artisans became distressed owing to pandemic-related frustrations. Those employed in the formal sector managed to cover their expenses and fared better than workers in the informal sector (International Labour Organisation, 2020).

Artisans had accepted that the coronavirus was present but failed to understand that a complete lockdown was in place during the initial phase, when coronavirus cases were in the hundreds or thousands (Food and Agriculture Organisation, 2020). Subsequently, the number of SARS-CoV-2 cases exceeded 50,000 daily, and the lockdown was implemented nationwide in phases (Hameed, 2019). Such measures raised serious questions, such as whether the government treasury has sufficient funds or is seeking revenue from the public through taxation without regard for their concerns (Shakeel & Ramay, 2020). Wherever there is a gap in disease control, it should be addressed. Given the origin of these cases, proper monitoring of their spread is essential. The most difficult decisions must be made to control their transmission, as tuberculosis is the world's deadliest infectious disease, killing more than lakhs of people in India alone (Wilson, 2020). However, the strict lockdown in Banaras has led to several positive changes, including improvements in air quality. The enhancement in Ganges water quality during the lockdown, as factories and industries remained closed, was one of the main factors contributing to reduced pollution in the river. People have become more aware of the importance of personal hygiene, including washing hands frequently and refraining from spitting in public places, thereby indirectly helping purify the air around us (Ramakrishnan & Tripathi, 2020).

Contextual Framework

Handicraft products have been a source of pride for India since ancient times (Jamal & Sen, 2018). Metal repoussé is a traditional craft practised in India since Vedic times. The word repoussé is French, meaning to push. Archaeological surveys, based on the discovery of copper tools at ancient Harappan sites in Kalibangan, Rajasthan, and Baluchistan, Pakistan, have revealed evidence of old metal vessels in the Indian subcontinent. In India, metal vessels are broadly classified as sacred and spiritual objects. Many people are involved in metal repoussé artwork, which has been their main livelihood for generations (Fengfan & Yue, 2020). There is no definitive evidence about the origin of the Banaras metal repoussé craft, but some believe it began during the time of Raja Saheb of Kashi. Raja Saheb was fascinated by metal repoussé and interested in developing various metal crafts for religious and royal uses. He also patronised artisans from Varanasi, who had a significant influence on his decisions regarding handicraft welfare. Later, metal repoussé craft gained popularity across India and abroad. It is a vital part of Varanasi's renowned artwork, symbolising purity and sanctity. Built heritage represents the unique and valuable legacy of any region, and Banaras is one such place (Jamal & Hazarika, 2020). Artisans from Varanasi are specialised in this sacred craft, embodying its holiness.

Repoussé refers to the process of embossing metal from the reverse side by hammering. In the craft of metal repoussé, the nakshaband first prepares designs, or naksha, of the desired product on paper. Then the naksha is drawn on a white sheet of paper, preferably A1 or A2 size. The shopkeeper or customer would bring their naksha and request that it be cast into their metal products. The designs are traced onto metal sheets using a pointed sumbi and a small hammer. Later, they began embossing designs on metal sheets with customised sumbi. Subsequently, they prepare the sheet according to a design using materials such as copper, silver, brass, or other suitable metals. Heat the metal sheet with the design to strengthen it. Afterwards, embossing is carried out at increasing concentrations every minute. Subsequently, Naksheband enlarges the naksha, and then, with the help of Sumbi, they emboss that design from the reverse side (Geographical Indications Journal, 2016). They were unable to understand the government's strategy for preventing the coronavirus. What parameters had the government set for this, and was there a lack of transparency between them? Furthermore, no coronavirus tests had been conducted in their area yet.

Figure 1

Process Involved in the Preparation of Metal Repousse Craft

Source: Field Survey, 2020-2022

The situation in Banaras was extremely alarming because nobody knew when normalcy would return (Singh, 2020). Some artisans sold tea, vegetables, fruits, and betel to support their livelihoods during the pandemic. Markets were closed, and after reopening, there was no demand or customers. Markets reopened on an odd-even basis, as per the government's notification, and violators faced penalties. If shopkeepers followed government guidelines, they would have two days off in one week and three days the next (Hindustan Times, 2020). There was a complete lockdown over the weekend. Even those working from home were severely affected, as there was little to no demand for metal repoussé crafts. Major corporations also paused their operations and cut salaries for their highly skilled employees; imagine then the predicament of metal artisans. Their products are handmade, and they need to go outside to open their shops and sustain their livelihoods (The Hindu, 2020). The extended lockdown, which lasted an exceedingly long period, devastated artisans' livelihoods. The highest levels of government announced the extension. People understood that the subsidy would be extended for the next six months, meaning the economic situation would not improve for half a year. It was further confirmed that no economic activities would be permitted during this period, except for the provision of essential goods and services (World Economic Forum, 2020). Those Girastas/middlemen who dared to continue their work during lockdown 1.0 halted their operations. They withdrew following the Prime Minister of India's announcement of a six-month extension to the Ujjwala subsidy. This was a clear message to the nation that no economic activity would resume before September 2020. The lockdown has taught the public to maintain social distancing, take daily baths, understand what a virus is, and how infections spread from person to person (Isaifan, 2020).

Study Area

Morphology is critically important because it encompasses the built structure, layout, foundation, and architecture, as highlighted by Jamal et al. (2020). Metal repoussé craft preparation is mainly concentrated in various clusters in Banaras, including Kasi Pura, Bulitan, Piyari, and Thatheri Bazaar, with Piyari being the most renowned (District Census Handbook, 2011). However, rising land prices have made it increasingly costly for artisans to sustain their metalwork activities along the Ganga River (Jamal et al., 2021). This has prompted artisans to move to Kasi Pura and Bulitan. The metal craft area is situated near the coastal outskirts of the Ganga and its environs. The city lies between 25° 15' N and 25° 22' N latitude and 82° 57' E and 83° 01' E longitude (Department of Landscape Architecture, 2014; Figure 2).

Kasi Pura is famous for its metal repoussé craft, named after the Kasera community traditionally living there. Every family member was usually involved in this craft, working with hammer and kalam on street corners. About 50 years ago, their houses were situated in the main market; today, they have moved to the streets, continuing to flourish in the market for steel and silver vessels and maintaining their role as patrons of this craft in Banaras.

Objective of the Study

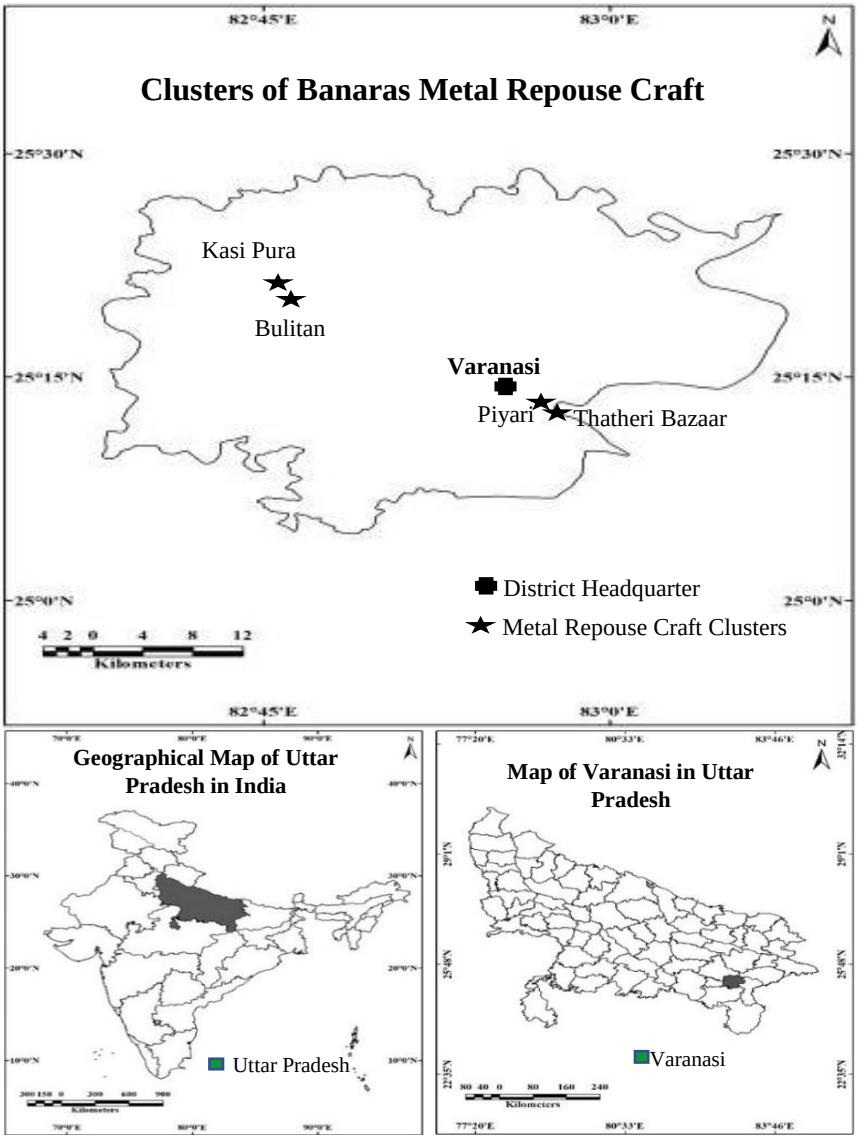
Identify and analyse the kind of existential threat Banaras metal repoussé craft artisans faced during the coronavirus pandemic.

Database and Methodology

Every social science study chooses its database and methodology to achieve specific results. This research concentrates on Banaras metal repoussé craft clusters: Piyari, Kashi Pura, Thatheri Bazaar, and Bulitan. These clusters were surveyed to understand the adverse conditions artisans faced during the pandemic and the difficulties they encountered under exceptional circumstances. The study uses both primary and secondary data.

Figure 2

Study Area of Banaras Metal Repoussé Craft



Source: Geographical Indications of Goods Act, 2022

A household survey was conducted using purposive sampling in the Banaras district of Uttar Pradesh, India, from 2020 to 2022, with an adequate number of participants from each cluster included in the analysis.

Some of the secondary data sources include the World Health Organisation, the Organisation for Economic Co-operation and Development, the Ministry of Health and Family Welfare, the International Labour Organisation, the District Census Handbook for Varanasi, and the Department of Landscape Architecture, which were incorporated to draw a probable conclusion. Qualitative and quantitative techniques were employed for analysis, and additional empirical and descriptive methods were utilised to achieve the desired result. Different software, such as ArcGIS and MS Office, were used to prepare maps, flowcharts, and bar diagrams.

Major Findings

Repoussé is a metalworking technique where a ductile or soft metal is shaped into various designs by hammering. The artisan's livelihood is at risk due to the lockdown, as they are not allowed to leave their homes for work. If they were prevented from going outside to do metal work, how would they earn money and support their families, who rely on them? The sector most affected was the informal sector, where artisans work on a daily wage basis, and they faced the most challenging times of their lives during the pandemic.

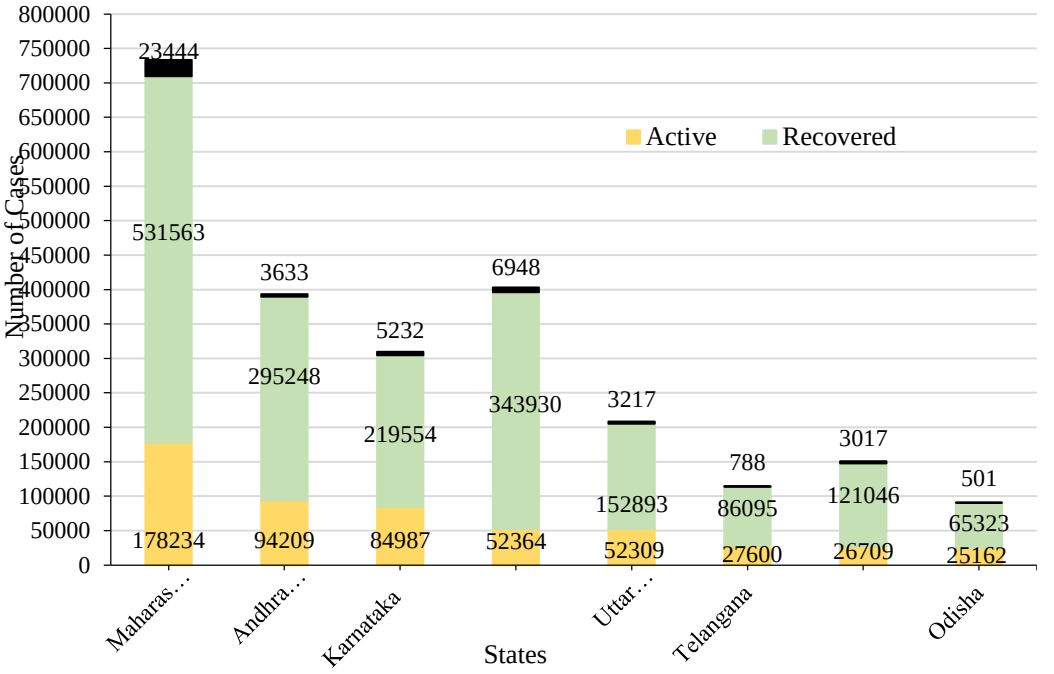
They were fed up with the Indian government's lip service and promises. They were truly facing an existential threat despite compromising Article 21 of the Indian Constitution, which states the right to life with dignity. Artisans were selling their ancestral precious items to eat one meal a day. In a single stroke, the coronavirus has thrown them back into the dark ages, from which it would be challenging for them to sustain their basic needs (Figure 3).

Culture as a Way of Life

The reach of the Kasera community extends beyond the fairs and festivals of Banaras. Many of them travel to Allahabad during the Maha Kumbh Mela, which is celebrated once every 12 years, to earn some extra money. Allahabad is renowned as the Sangam city, Tirth Raj, the abode of God, and Kumbha city. Several artisans, accompanied by their families, travel to Allahabad and stay there for a month or until the culmination of the Maha Kumbh. There are three types of Kumbh Mela: annually, once every 6 years (Ardh Kumbh), and once every 12 years (Maha Kumbh).

Figure 3

Coronavirus Cases Across Top 8 Indian States as of August 2020



Source: Ministry of Health and Family Welfare, 2020

However, artisans preferred to attend the Maha Kumbh at Allahabad and avoided taking part in other Kumbh melas. Before going there, they shipped their metal craft products from Banaras to Allahabad by train. Upon arrival, they temporarily secured a space, set up their shops, and started selling Banaras' intangible cultural heritage through their metal goods. In the world-famous mela, millions of tourists arrive not only from India but also from around the world. Foreign visitors are eager to experience the mela's rich cultural heritage and purchase culturally themed products. Visitors are keen to learn about and inquire how the products are made and how the responses are created. They put on Mukhota masks and shout in a frightening tone to scare passing tourists. Customers at the mela generally did not bargain much and were willing to pay a fair price. When the mela concludes, they return to Banaras with their belongings. In this way, they take darshan at Allahabad and sell their metal crafts.

Lack of Transparency in the Government's Aid

The government provided 5 kg of food grains per person, which could be either rice or wheat, and 1 kg of gram per family to BPL cardholders through the Public Distribution System (PDS) during the lockdown. If their card covers four or five units, they are eligible for 20 kg or 25 kg of food grains, respectively (Table 1). If an artisan's family consumes 40 kg of rice, then the total government aid is ₹200, while a Mahatma Gandhi

National Rural Employment Guarantee Act (MGNREGA) worker's one-day wage is ₹202. Then, on what basis could the government assure the artisan of food grains for a whole month? In truth, the government's aid is ₹200 per month, which is barely enough for survival; however, the announcement was misleading, implying they were providing aid of ₹1 lakh per month. The government was widely promoting the relief package, but in reality, it offered nothing to the informal sector's artisans.

Those who have a Jan Dhan account in their name received ₹500 per month. This ₹500 was transferred only to the female member's account and that amount of money can be used to feed 2 ½ days of their family. What about the remaining 27½ days? Where will they source their food?

Under the Pradhan Mantri Ujjwala Yojana, a liquefied petroleum gas (LPG) cylinder was provided in the name of a woman registered as Below Poverty Line (BPL). Under the scheme, one cylinder per family per month was distributed, which is sufficient for BPL families (Table 1). The yojana was extended to needy families for the next four months (March-July) amid the coronavirus pandemic and nationwide lockdown.

Mockery of Intangible Heritage: Incredible India

Artisans were confused and raised valid questions about the basis on which the government was identifying coronavirus patients. Thermal screening or testing was not being carried out in their locality, known locally as a mohalla, and tests were conducted in only a few clusters. If the body temperature was less than 100°C, the person was considered safe, as the standard is 98.6°C, and a temperature more than 1°C above this is considered a feve r. If the temperature exceeds 100°C, the person might experience mild coronavirus symptoms, including cough, breathlessness, body aches, and fatigue.

Table 1
Comparative Analysis

Variables	Value (₹)	Day and Month
Government's Aid		
1. Public Distribution System (PDS) 5 kg grain	₹200	1 Month
2. Pradhan Mantri Jan Dhan Yojana	₹500 (Female)	1 Month
3. Pradhan Mantri Ujjwala Yojana 1 cylinder	₹700 (Female)	1 Month
Mahatma Gandhi National Rural Employment Act (MGNREGA)		
1. Wage	₹202	1 Day
Construction Wage		
1. Labour	₹400	1 Day
2. Mistry (Master)	₹600	1 Day
3. Artisan turns Labour	₹200	1 Day

Source: Field Survey, 2021

Artisans were running their furnaces without work, as it was crucial to keep them operational after a few days. If this practice is not maintained at certain intervals, there is a risk of rusting in the metal repousse craft equipment (Figure 4). The demand for Banaras metal repousse craft reached its lowest point during the festival season, and although there was significant demand during weddings, the coronavirus pandemic had decimated the market. The nationwide lockdown lasted from March to September. Several festivals, including Holi, Ram Navami, Mahavir Jayanti, Buddha Jayanti, Good Friday, Eid-ul-Fitr, and Eid-ul-Azha, occurred during this period, which is usually the peak selling time for handicraft products. Artisans had no work and were largely idle throughout the lockdown.

Coronavirus Cases

Varanasi/Banaras was one of the leading districts in Uttar Pradesh, India, in terms of confirmed COVID-19 cases (Figure 5).

Lucknow has the highest number of confirmed cases in the district, followed by Kanpur Nagar, Gautam Buddha Nagar (GBN), Ghaziabad, and Varanasi, as these are densely populated districts. These districts rank among the highest in the Human Development Index (HDI) in the state of Uttar Pradesh, India. The number of active cases was the highest in Lucknow, followed by Kanpur Nagar, Ghaziabad, Allahabad, and GBN (Figure 6). The number of tests in these districts was high because medical facilities were more advanced than those in other districts in Uttar Pradesh, India.

The highest number of deaths was reported from Kanpur Nagar, followed by Lucknow, Agra, Varanasi, and Allahabad. After analysing the data, it was concluded that the local administration reported coronavirus deaths more promptly than other districts.

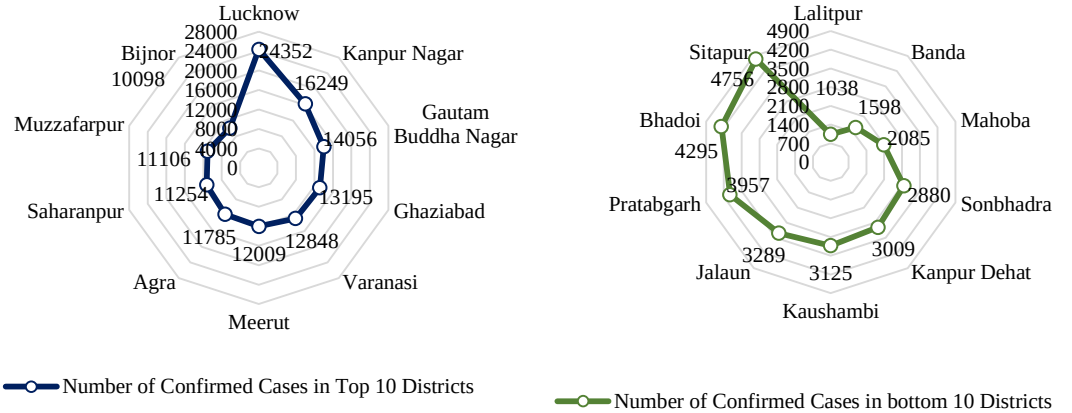
Figure 4

Focused Group Discussion with Metal Repoussé Craft Artisans

Source: Field Survey, 2021

Figure 5

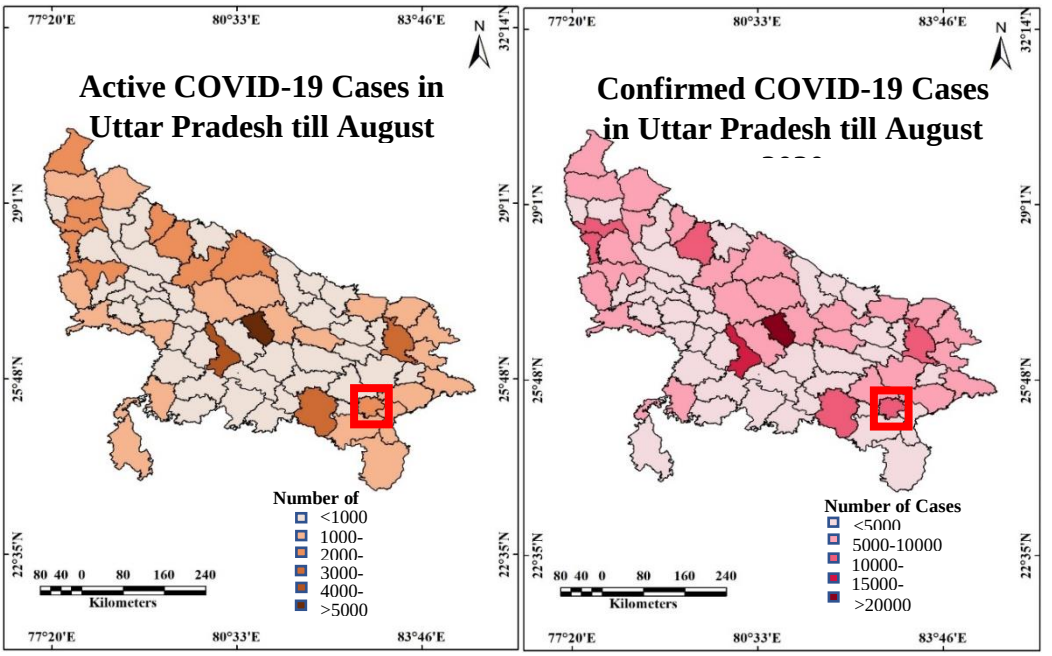
Number of Confirmed Cases in Top and Bottom 10 Districts of Uttar Pradesh till August 2020



Source: Ministry of Health and Family Welfare, 2020

Figure 6

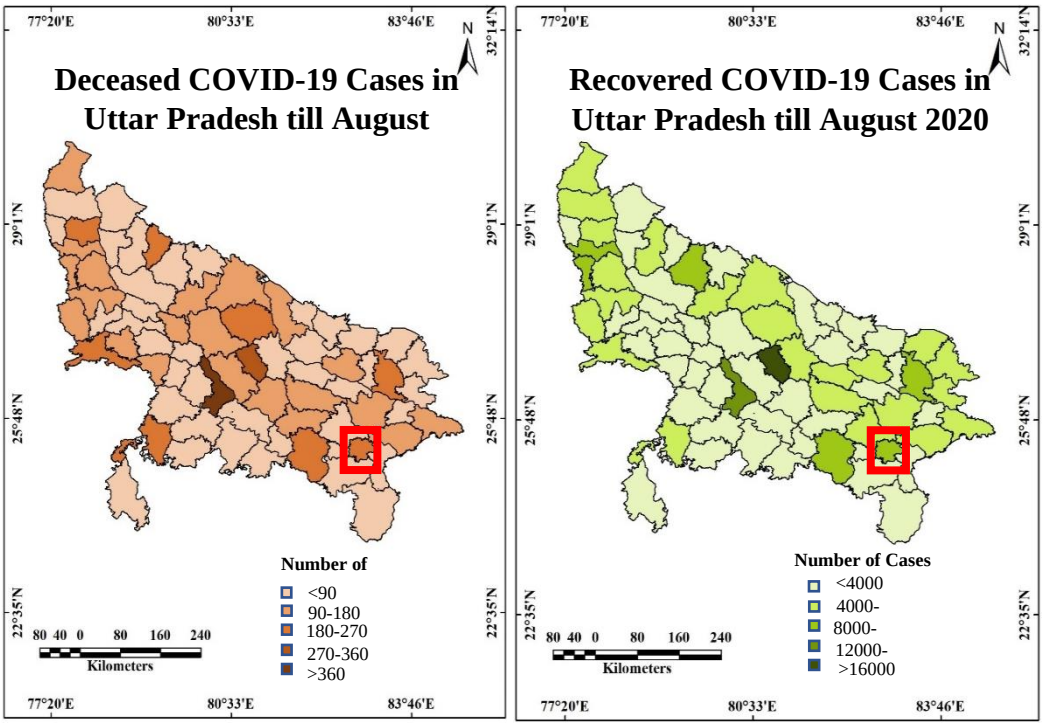
COVID-19 Cases in Varanasi



Source: Ministry of Health and Family Welfare, 2020

Figure 7

COVID-19 Cases in Varanasi



Source: Ministry of Health and Family Welfare, 2020

The highest number of recoveries was recorded in Lucknow, followed by Kanpur Nagar, Ghaziabad, Gautam Buddha Nagar (GBN), and Varanasi (Figure 7). The analysis further indicated that districts with the highest number of confirmed cases also tend to have the highest recovery rates, and vice versa.

Result and Discussion

The situation persisted for a long time, causing more deaths not only from the coronavirus but also from hunger, poverty, and starvation. While the coronavirus pandemic harmed society, it also brought about several positive changes. It has taught everyone to adopt healthy habits in daily life, such as washing hands regularly before and after meals and after using the toilet. In this regard, the Government of India's Swachh Bharat Mission played a vital role in promoting hygiene practices among the public. The fight against the coronavirus involves the government's responsibility to care for all sections of society, especially the vulnerable, marginalised, informal, and disadvantaged groups. The government failed to manage the pandemic effectively at various levels. However, it was committed to transforming the healthcare system, recognising that the latest technology could play a crucial role in strengthening it. The right to health is

neither a statutory nor a fundamental right, unlike the right to education. According to the Constitution of India, health is a state subject, and all decisions made by the state government take precedence, just like decisions on law and order.

Incompetent Machinery

There was an urgent need to establish additional COVID-19 hospitals across the entire state of Uttar Pradesh (UP), India, as cases continued to rise daily. The doctor-to-patient ratio in UP is 1:19,962, the second-lowest in India after Bihar at 1:28,391. The national average is 1:11,082, and the WHO ratio is 1:1,000 (Figure 8). Even at the national level, this proportion is ten times higher than the World Health Organisation (WHO) recommendation. In this context, COVID-19 hospitals could only treat patients with severe symptoms, not those with mild symptoms. Patients with mild symptoms could quarantine at home, as hospitalisation was not necessary given the limited number of hospital beds. Special war rooms have been established to facilitate easy tracing of COVID-19 patients within a certain radius. Those advised to quarantine also received proper surveillance through Global Positioning System (GPS) chips and mobile phones. The designated authorities were contacted once or twice daily to review the health status of quarantined patients. Whether their condition was improving or worsening, if worsening, they would be hospitalised; otherwise, they would continue in home quarantine. When the quarantined patient attempted to leave the designated area, they were instructed to stay in their location and return to their original position. The authorities delivered a clear, moral message: if you go out, you not only endanger your own life but also others'.

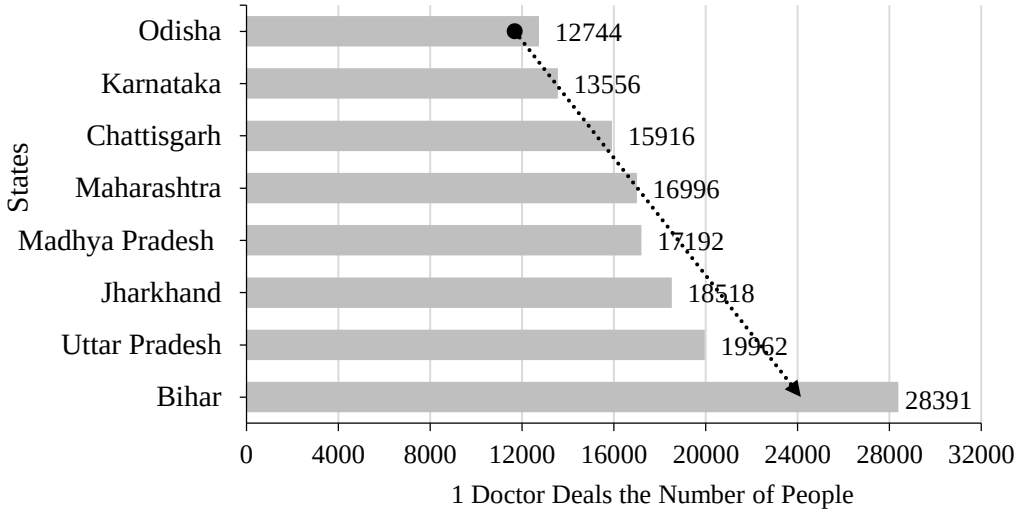
Miserable Economic Condition of Artisans

The coronavirus pandemic has profoundly affected humanity, especially vulnerable groups. Humanity is facing the worst pandemic in history as the virus continues to outrun us. The global community has responded through international partnerships and reliance on science and technology. Although the pandemic has affected everyone, its effects have not been uniform. Both the first and second waves of COVID-19, between 2020 and 2021, worsened artisans' conditions from difficult to dire.

This includes low-budget allocations, poor infrastructure, inadequate logistics, and delayed sector responses. Artisans face considerable stress due to challenges such as rising healthcare costs and the loss of primary earners in their families. The coronavirus has severely disrupted local supply chains, manufacturing, markets, and products.

Figure 8

Number of People Served by a Single Doctor in Different States



Source: Maurya and Goswami, 2020

Artisans' incomes declined during the pandemic. The full extent of the impact on the handloom and handicraft sector remains to be assessed. However, all indicators suggest severe consequences, including artisans being unable to sell their products due to decreased customer demand. Not all factors were affected; some problems pre-existed and worsened during the crisis. Artisans are considered daily wage earners because their daily income supports their families. During the pandemic, a sharp decline in income was observed due to lockdown measures that prevented them from leaving their homes and engaging in economic activities. These unnatural conditions caused numerous difficulties for families in securing bread and butter for their children.

Psychology of an Administrator

Police behaviour during the early stages of the coronavirus pandemic was severe, involving brutal treatment of innocent artisans. They chased every violator, even into their mohallas or localities, warning them that anyone found guilty would face consequences. This pandemic was not a time to neglect the poor artisans, but rather a time to appreciate them. Perhaps they left their homes to feed their children or buy food for their families. Officers should assist by explaining the importance of staying at home during the pandemic and, if possible, delivering essential food items to their homes to prevent outside movement. Beating helpless artisans with sticks would be unjust and only worsen their issues. This process of pursuit and evasion continued for several months, as it was necessary for the welfare of all sections of society. Later, artisans

learnt to avoid unnecessary trips on streets and roads, except to buy essential goods at designated times. During the lockdown, there was no demand for Banaras metal repoussé craft products because people chose to stay at home for their safety and that of others. Consequently, the police recognised the artisans' behaviour, which played a vital role in breaking the chain of coronavirus transmission within society.

Structural Change

The government had an opportunity to implement structural changes whenever such an emergency arose. The lockdown was an ideal chance for the government to take appropriate action without delay. Not only was immediate relief provided to those in need, but a long-term, manageable plan was devised. The government of India should exempt artisans from paying rent, electricity bills, water bills, and other related expenses during the pandemic. It should transfer a substantial amount of money, such as ₹7,000 per family per month, to help them sustain their livelihoods during a global emergency. Those artisans have a Life Insurance Corporation (LIC) cover in their names or their families; the government should pay the premiums during the pandemic. Schools should waive students' fees, and the government should compensate schools for these costs. The pandemic was an appropriate time for the government to step forward and show its gratitude to society. Artisans have a clear idea of when their craft work will return to normal once the Prime Minister of India announces it via virtual media. Then, the lockdown will end, and everything will revert to normal. It demonstrated that the government was the main stakeholder in declaring the region free of coronavirus, or not, especially when the disease had no impact on artisans' health. They hoped the coronavirus would end soon so they could resume their usual work in metal repoussé craft.

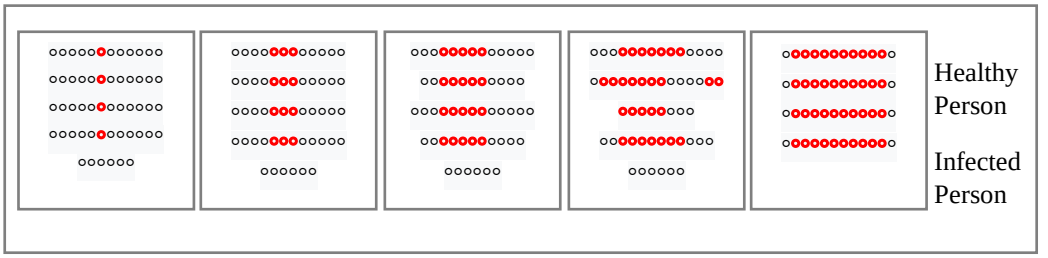
Phase-wise Approach

COVID-19 transmission begins with a single person at the initial stage (Figure 9). The coronavirus spreads very quickly as it finds a suitable host cell to reproduce, progressing from stage 2 to stage 5. The coronavirus mainly infects older people and individuals with weakened immune systems. Artisans have adopted the habit of cleaning their hands regularly to break the chain of transmission. Whenever they go outside, they should maintain a minimum distance of at least 2 yards between individuals and wear masks at all times. When they return from outside, they should sanitise themselves, as infections spread easily, and our safety ultimately depends on our own actions. The government had prepared a phased framework to manage the coronavirus pandemic as the number of cases continued to increase daily. If in any region the number of COVID-19 cases showed a decreasing trend, other activities apart from essential ones would be permitted to help the informal sector resume operations. Conversely, if the number of cases indicated a rising trend, an aggressive lockdown would continue. More extensive testing was

required to break the coronavirus transmission chain in districts. Special guidelines, including a more stringent lockdown targeting hotspots, were followed.

Figure 9

COVID-19's Transmission Process



Source: Prepared by Authors, 2022

Conclusion

Artisans faced existential threats as bankruptcy worsened in the handicraft sector. The right to live with dignity has been sidelined, as artisans had no food to eat due to superficial promises made by the administration. It became very hard to imagine the lives of metal repoussé craft artisans during the pandemic, as few measures were taken to preserve their humanity. Increased expenditure on health and the informal sector is essential, as they form the backbone of the Indian economy. India needs employment, education, and dignity for all, regardless of caste, religion, sex, race, or birthplace. The intangible cultural heritage of Banaras faces an existential threat even after the pandemic, as its glory diminishes because artisans are dying of hunger, poverty, and malnutrition. The government, along with civil society, NGOs, and industry, should work together to revive heritage during such times. Every crisis offers a chance to show compassion towards the poor, informal, and vulnerable segments of society. We have a heart for the welfare of these unique artisans and will continue supporting them even after the pandemic ends. It is our duty to ease their suffering during uncertain times and remember that compassion should come first, as the wealthy can manage themselves. Artisans are not the only ones facing hardship; the entire country is, too. However, hardship often sparks creativity, which in turn drives the overall progress of human civilisation.

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Socioeconomic Inequalities and Utilisation of Maternal Health Services in India: Evidence from the National Family Health Survey

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Abstract

Maternal mortality remains a pressing issue in developing nations. This research investigates how socio-demographic factors impact the utilisation of maternal healthcare among Indian women, using data from the 2019–2021 National Family Health Survey. Significant discrepancies are evident in various aspects, including urban-rural locations, educational levels, religious affiliation, economic status, and geographic distribution. Through the application of multivariate analysis, the research establishes meaningful correlations among socioeconomic and demographic variables. It is imperative to tackle these disparities to improve access to maternal healthcare and mitigate health-related risks. Key determinants of maternal and child healthcare utilisation among married women include education, wealth status, and regional location. While India's National Health Mission has reduced maternal mortality, inequalities persist. The findings emphasise the importance of healthcare programs improving education, providing financial support, raising awareness, and offering counselling to households with married pregnant women.

Keywords: Inequality, maternal mortality, maternal healthcare, socio-demographic factors, multivariate analysis

Introduction

Addressing maternal health has been a key goal, emphasised by its inclusion among the Millennium Development Goals (WHO, 2005). The inadequate utilisation of maternal and child healthcare services poses a serious threat to the well-being of women and their children, increasing the risk of death (Tsawe et al., 2015). In 2017, approximately 295,000 maternal deaths were recorded globally, with the majority (around 86%) occurring in Sub-Saharan Africa and Southern Asia. Notably, two countries, Nigeria and

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India, contributed significantly to this figure, collectively accounting for over one-third of all maternal deaths worldwide in 2017, with about 67,000 (22%) and 35,000 (11%) maternal deaths, respectively.

A key aim within the Sustainable Development Goals (SDGs) framework is to reduce the global maternal mortality ratio (MMR) to below 70 per 100,000 live births by 2030. Over the past 20 years, the MMR has fallen by 34%, from 342 maternal deaths per 100,000 live births in 2000 to around 223 in 2020 (UNICEF, 2023). According to the latest report from the National Sample

Registration System (SRS), India's maternal mortality ratio for 2018-20 was 97 per 100,000 live births, a decrease of 33 points from 130 in 2014-16 (MHFW, 2022). India is making steady progress towards this goal, ahead of schedule, through policies focused on women's health and well-being. The initiatives implemented by the Central Government have driven significant progress in several states, with eight already achieving the SDG target. These include Kerala (19), Maharashtra (33), Telangana (43), Andhra Pradesh (45), Tamil Nadu (54), Jharkhand (56), Gujarat (57), and Karnataka (69). Efforts to improve maternal and newborn care have emphasised antenatal care, nutrition for pregnant women, and a positive birthing experience. For example, Pradhan Mantri Surakshit Matritva Abhiyan aims to enhance the quality and reach of diagnostic and counselling services while providing comprehensive, high-quality antenatal care free of charge (MHFW, 2022).

Furthermore, research has shown that antenatal care (ANC) serves as a vital foundation for adopting various healthy practices during and after pregnancy (Khan et al., 2010). These practices include institutional delivery, newborn care, exclusive breastfeeding, supplementary feeding, and numerous other aspects. A study conducted in Madhya Pradesh in 2011 indicated that using antenatal care (ANC) increases the likelihood of skilled attendance during childbirth, thereby enhancing the utilisation of postnatal care (PNC). Women who attended at least one ANC session during pregnancy had 3.52 times the odds of receiving skilled assistance at delivery compared to those who did not receive any ANC (Jat et al., 2011). The rise in institutional deliveries is expected to reduce maternal and newborn mortality rates. This positive effect is associated with the presence of qualified birth attendants, supported by appropriate infrastructure and accessible referral services when necessary (Randive et al., 2012 & 2013; Lim et al., 2009). The period immediately following childbirth is critical for both mothers and newborns. Recommending postnatal care services for mothers and infants within 42 days after delivery aims to lower maternal and neonatal deaths by promptly identifying and managing postpartum problems and potential complications. Skilled healthcare professionals provide this care to ensure timely treatment (Titaley et al., 2010). The timing of the postnatal check-up and the level of attention provided during this phase are crucial factors influencing the survival, health, and overall well-being

of both mothers and their newborns (Penh, 2013).

Numerous research studies have established that socio-economic and demographic factors significantly influence the utilisation of maternal health care services (Abbas & Walkar, 1986; Bhatia & Cleland, 1995; Celik & Hotchkiss, 2000; Navaneetham & Dharmalingam, 2002; Obermeyer & Potter, 1991; Ochako et al., 2011; Singh et al., 2012a, b; Tarekegn et al., 2014). Many studies highlight the importance of household-, village-, and community-level factors in determining the use of maternal health care services (Babalola & Fatusi, 2009; Navaneetham & Dharmalingam, 2002; Paul & Chouhan, 2019). These factors include education, household economic status, caste, religion, and women's level of autonomy. The findings consistently show that women's education, social standing, household wealth, and decision-making power are closely linked to their likelihood of seeking maternal health services, ultimately impacting maternal well-being (Subbaras & Rancy, 1995; Caldwell, 1993; Basu et al., 2005; Bloom et al., 2001; Mistry et al., 2009; Paul & Chouhan, 2019; Ali et al., 2021). Based on this literature, the current study has selected appropriate variables. Additionally, this research aims to provide up-to-date insights into the factors influencing the utilisation of maternal healthcare services in India. These findings will be valuable for informing policies that enhance access to maternal healthcare, particularly within marginalised socio-economic communities.

Materials and Methods

Data Source

This study used data from the most recent round of the National Family Health Survey (NFHS-5), conducted between 2019 and 2021. The NFHS is India's Demographic and Health Survey (DHS), which employs a periodic cross-sectional survey design and multistage stratified sampling to ensure a nationally representative sample of women aged 15 to 49 years. NFHS-5 is a comprehensive nationwide survey covering 636,699 households, 724,115 women aged 15-49 years, and 101,839 men aged 15-54 years. The primary aim of the 2019-21 edition of the National Family Health Survey is to provide vital information on health and family welfare, along with insights into emerging aspects within these areas. This includes topics such as fertility rates, infant and child mortality rates, maternal and child health, and other indicators relevant to health and family welfare.

These insights are broken down by demographic characteristics at the national, state, and district levels. Each district is divided into urban and rural segments. Within each rural stratum designated for sampling, a set of villages was selected as the Primary Sampling Units (PSUs). Similarly, within each urban stratum, Census Enumeration Blocks (CEBs) were chosen as the PSUs. Before selecting PSUs, the units were arranged according to the proportion of SC/ST population. In the next phase, a consistent count of 22 households per cluster was selected using a systematic method with equal probabilities. Overall, 30,456 PSUs were carefully

selected across 707 districts in 2017 for NFHS-5. The fieldwork covered 30,198 of these PSUs, where data collection was successfully carried out. The detailed sampling methodology is thoroughly described in the national report of the National Family Health Survey (NFHS) for the years 2015-2016, published by the International Institute for Population Sciences (IIPS) and the Inner City Fund (ICF) in 2017. This research is based on data from 176,843 women aged 15 to 49 years, all of whom have been married at some point and have given birth to at least one child within the five years prior to the survey.

Outcomes Variables

Maternal healthcare utilisation has been evaluated using indicators such as antenatal care (ANC), intrapartum care, and postnatal care (PNC). Assessing ANC care typically involves measuring the number of ANC visits and the timing of the first ANC visit (WHO, 2016). Antenatal care (ANC) is the support provided by skilled health professionals to pregnant women and adolescent girls to promote optimal health for both mother and baby during pregnancy (WHO, 2016). Attending at least four ANC visits during pregnancy is considered adequate. The ideal time for the first ANC visit is within the first trimester, the first three months of pregnancy. Meeting these standards ensures a "safe delivery," as defined by the World Health Organization, which involves either having a trained professional attend the delivery or conducting it in an institutional setting.

The "delivery by a trained person" category applies to cases where the delivery was assisted by a medical professional, such as a doctor, an ANM/nurse/midwife, or another qualified health worker. Conversely, "delivery by an unskilled person" includes situations where assistance was provided by a traditional health worker (Dai), friends or relatives, or an individual without formal medical training.

Besides, "institutional deliveries" occur within a medical establishment, such as a government hospital, dispensary, primary health centre, community health centre, sub-centre, non-governmental hospital, or private clinic. The postnatal period, recognised here as the phase immediately after the baby's birth and extending up to six weeks (42 days), is a vital time for women, newborns, partners, parents, caregivers, and families (WHO, 2022).

Explanatory Variables

This study included socio-demographic variables as factors of interest. These covariates covered the sex of the household head (male or female), the type of residence (urban or rural), social classifications (Scheduled Caste (SC), Scheduled Tribe (ST), Other Backward Classes (OBC), and others), religious affiliation (Hindu, Muslim, and others), mothers' age groups (15–24, 25–34, and 35–49 years), age at marriage (below 18 and 18 years or above), the number of living children (None, 1-2, 3-4, 5 or more), maternal education levels (no education, primary, secondary, and higher education). In the absence of income and expenditure data, the study utilised a wealth index derived from household asset information and housing characteristics. The NFHS-5

provides this wealth index divided into five categories: poorest, poorer, middle, more prosperous, and most affluent. Women's exposure to mass media was also considered. This exposure was evaluated based on the frequency of engagement with different media sources, including reading newspapers and magazines, listening to the radio, and watching television, each week. Based on these three media, women were categorised into three groups: those with no exposure (no engagement with any of the three media sources at least once a week), partial exposure (engaging with any two media sources at least once a week), and full exposure (engaging with all three media sources at least once a week).

Statistical Analysis

The assessment of women's utilisation of maternal health care services during pregnancy was performed using univariate analysis. To examine the relationships between maternal health care types and key factors, a bivariate analysis was conducted using chi-square tests to assess independence. For a more comprehensive insight, a multivariate logistic regression analysis was employed, encompassing all socio-demographic variables as explanatory factors influencing the utilisation of maternal health care services. The regression analysis results were presented as estimated odds ratios (ORs) with corresponding 95% confidence intervals (CIs). The process of estimating results accounted for sample weights, ensuring accurate representation and the generalizability of the findings. All analytical procedures were performed using Stata version 15.1 (Stata Corp., College Station, TX, USA).

Results

Descriptive results

Table 1 provides an overview of the participants' socio-demographic attributes. The majority of respondents resided in households led by males. Approximately 30% of women who had given birth recently were married before turning 18. A significant portion of them lived in rural settings, identified as part of the Other Backward Classes, and adhered to the Hindu faith. More than half of the women were middle-aged, and a substantial number had attained higher levels of education. Meanwhile, over a quarter of the women had not received any formal education. The majority had one or two living children. Nearly half of the women in the lowest wealth quintile had limited exposure to mass media.

Table 1

Socio-Demographic Characteristics of Women aged 15-49 Years who had at least One live Birth in the Past 5 Years Preceding the Survey in India, NFHS-V (2019-2021)

Variables	Number	Percent
Sex of household		
Male	150,221	84.95
Female	26,622	15.05
Place of residence		
Urban	37,975	21.47
Rural	138,868	78.53
Religion		
Hindu	129,944	73.48
Muslim	25,234	14.27
Other	21,665	12.25
Caste		
Schedule Caste	35,271	19.94
Scheduled Tribe	35,379	20.01
Other Backward Caste	67,024	37.90
Others	37,990	21.48

Do not know/missing	1,179	0.67
Age-group		
15 to 24	53,635	30.33
25 to 34	104,032	58.83
35 to 49	19,176	10.84
Age of marriage		
< 18	53,629	30.33
≥ 18	122,987	69.55
Do not know/missing	227	0.13
Number of living children		
No children	1,566	0.89
1 – 2	125,461	70.94
3 – 4	41,042	23.21
5 & more	8,774	4.96
Education		
No education	35,976	20.34
Primary	21,737	12.29
Secondary	92,624	52.38
Higher	26,506	14.99
Wealth index		
Poorest	44,867	25.37
Poorer	40,481	22.89
Middle	34,569	19.55
Richer	31,054	17.56
Richest	25,872	14.63
Expose to mass media		
No exposure	48,997	27.71
Partial exposure	125,440	70.93
Full exposure	2,406	1.36

Source: National Family Health Survey, 2019-21 & Computed by Author

Utilisation of Maternal Healthcare Services by Women

Table 2 demonstrates the relationships between various maternal healthcare services accessed by married and pregnant women and a range of socio-demographic factors. The results reveal significant associations between these explanatory variables and each type of violence, except for place of residence and PNC visit. Among women who had given birth within the last 5 years before the survey, the study found that 42% had received at least 4 ANC visits, 75% had their first ANC visit within the first trimester, 88% opted for institutional delivery, 89% experienced delivery by skilled

health personnel, and 92% underwent PNC check-ups within 6 weeks of delivery. Notably, the percentages of all five indicators of maternal healthcare service utilisation were considerably lower among women married before 18 years of age, often due to a lack of knowledge and awareness about maternal care.

Use of maternal healthcare services was generally higher among women with male heads of household. Age also influenced utilisation, with women under 24 years showing lower use of ANC and PNC services but higher rates of institutional delivery. Women with one or two children used all types of facilities except PNC visits. Educational attainment was a key factor, as women with no education had lower utilisation of maternal care services compared to those with higher education. Religious and caste differences showed higher healthcare utilisation among Hindus and women from the Other Backward and unreserved categories.

Interestingly, maternal healthcare services were available across all wealth levels, with utilisation increasing significantly with higher wealth. Urban residents demonstrated better awareness and easier access to healthcare services. The study also identified notable variations in maternal healthcare service utilisation based on women's socio-economic and demographic characteristics.

Table 2

Percentage of Women Aged 15 to 49 Years who have Utilised Maternal Health Care Services by Socio-Demographic Characteristics, India, NFHS-V (2019-2021)

Variables	≥ 4 ANC Visits	P (Chi-square)	ANC visit within the first trimester	P (Chi-square)	Institutional delivery	P (Chi-square)	Delivery by skilled health personnel	P (Chi-square)	PNC check-ups within 6 weeks	P (Chi-square)
Sex of household										
Male	42.19	<0.001	75.27	<0.001	88.44	<0.001	89.27	<0.001	96.68	<0.1
Female	39.57		72.57		85.52		86.44		96.31	
Place of residence										
Urban	54.23	<0.001	80.03	<0.001	94.55	<0.001	94.41	<0.001	96.67	>0.5
Rural	38.40		73.41		86.21		87.32		96.61	
Religion										
Hindu	42.89	<0.001	75.21	<0.001	90.44	<0.001	90.55	<0.001	96.91	<0.001
Muslim	42.80		76.07		86.32		88.17		96.92	
Other	34.04		71.13		75.34		79.41		93.50	
Caste										
SC	39.31	<0.001	74.07	<0.001	88.83	<0.001	89.39	<0.001	97.04	<0.001
ST	35.95		71.76		77.37		80.84		95.55	
OBC	42.37		75.51		91.26		91.20		97.02	
Others	48.67		77.26		92.67		91.72		96.47	
Do not know	36.98		72.86				86.68		93.60	
Age-group										
15 to 24	40.30	<0.001	74.59	<0.001	89.89	<0.001	90.05	<0.001	96.48	<0.1
25 to 34	43.04		75.50		88.28		89.16		96.70	
35 to 49	39.21		72.10		81.18		83.77		96.57	
Age of marriage										
< 18	34.10	<0.001	71.14	<0.001	83.18	<0.001	84.89	<0.001	96.60	<0.5
≥ 18	45.15		76.45		90.11		90.58		96.63	
Do not know	39.65		71.64		84.14		84.58		97.22	
Number of living children										
No children	34.48	<0.001	75.51	<0.001	88.12	<0.001	87.68	<0.001	98.89	<0.001
1 – 2	46.22		76.84		92.14		92.11		96.49	
3 – 4	32.83		70.64		80.31		83.00		97.08	
5 & more	21.81		64.27		64.75		69.67		96.32	
Education										
No education	27.31	<0.001	68.69	<0.001	75.50	<0.001	78.91	<0.001	96.35	<0.001
Primary	34.09		70.84		81.81		83.75		96.41	
Secondary	45.19		76.09		91.52		91.70		96.58	
Higher	55.89		81.41		97.77		96.52		96.62	
Wealth index										
Poorest	26.97	<0.001	67.50	<0.001	74.56	<0.001	77.95	<0.001	96.51	<0.01
Poorer	36.33		71.22		86.65		87.74		96.47	
Middle	45.48		76.39		92.64		92.55		96.32	
Richer	53.02		80.21		95.75		95.19		96.85	
Richest	57.66		83.57		97.92		96.88		97.10	
Expose to mass media										
No exposure	27.09	<0.001	68.10	<0.001	77.71	<0.001	80.25	<0.001	96.56	<0.5
Partial exposure	47.29		77.23		91.86		92.05		96.65	
Full exposure	54.61		78.98		96.05		96.51		96.81	

Source: National Family Health Survey, 2019-21 & Computed by Author

Table 3 provides a comprehensive analysis using multivariate logistic regression to explore the socio-demographic factors associated with the utilisation of maternal healthcare services. In comparison to urban-dwelling women, those residing in rural areas exhibited a lower likelihood of accessing all types of maternal health care services except for postnatal care (PNC). Women belonging to the Scheduled Tribes (ST) and those not affiliated with any specific caste were found to have a higher likelihood of utilising antenatal care (ANC) services compared to the Scheduled Castes (SC) and Other Backwards Classes (OBC).

Table 3

Multivariate Logistic Regressions for Socio-Demographic Factors Associated With the Utilisation of Maternal Health Care Services in India, NFHS-V (2019-2021)

Variables	≥ 4 ANC Visits	ANC visit within the first trimester	Institutional delivery	Delivery by skilled health personnel	PNC check-ups within 6 weeks
	OR [95% CI]	OR [95% CI]	OR [95% CI]	OR [95% CI]	OR [95% CI]
Sex of household					
Male (Ref.)					
Female	0.97[0.93,0.98]	0.91[0.88,0.93]	0.90[0.87,0.94]	0.87[0.84,0.91]	0.97[0.86,1.06] †
Place of residence					
Urban (Ref.)					
Rural	0.81[0.79,0.83]	0.97[0.94,1.00] †	0.94[0.89,0.99]	0.90[0.85,0.95]	1.12[1.00,1.25]
Religion					
Hindu (Ref.)					
Muslim	1.05[1.02,1.09]	1.10[1.06,1.14]	0.70[0.66,0.73]	0.84[0.80,0.88]	0.79[0.70,0.91] †
Other	0.62[0.60,0.65]	0.78[0.75,0.82]	0.36[0.35,0.38]	0.45[0.43,0.47]	0.49[0.44,0.56]
Caste					
SC (Ref.)					
ST	1.21[1.16,1.25]	1.08[1.04,1.13]	0.77[0.73,0.80]	0.82[0.78,0.86]	0.79[0.70,0.91]
OBC	0.97[0.95,1.00] †	0.97[0.94,1.00] †	1.08[1.03,1.13]	1.01[0.97,1.06] †	0.94[0.84,1.05] †
Others	1.12[1.09,1.16]	0.97[0.84,1.12] †	0.99[0.93,1.05] †	0.95[0.90,1.01] †	0.81[0.71,0.92]
Respondent Age Group					
15 to 24 (Ref.)					
25 to 34	1.14[1.11,1.17]	1.04[1.01,1.07]	1.03[0.99,1.08] †	1.07[1.02,1.11]	1.00[0.91,1.10] †
35 to 49	1.32[1.27,1.38]	1.01[0.96,1.05] †	1.12[1.05,1.19]	1.18[1.11,1.26]	0.97[0.83,1.14]
Age of marriage					
≥18 (Ref.)					
<18	0.89[0.87,0.91]	0.92[0.90,0.95]	0.85[0.83,0.88]	0.89[0.86,0.92]	0.93[0.85,1.03] †
Number of living children					
No children (Ref.)					
1 – 2	1.39[1.24,1.54]	0.98[0.86,1.10] †	1.26[1.07,1.48]	1.34[1.15,1.57]	0.31[0.17,0.84]
3 – 4	0.98[0.88,1.10] †	0.82[0.73,0.93]	0.69[0.58,0.81]	0.82[0.69,0.96]	0.37[1.14,1.00] †
5 & more	0.71[0.63,0.81]	0.72[0.63,0.82]	0.48[0.41,0.57]	0.55[0.47,0.65]	0.31[0.11,0.85]
Education					
No education (Ref.)					
Primary	1.15[1.11,1.20]	1.00[0.97,1.05] †	1.22[1.16,1.27]	1.15[1.10,1.21]	1.05[1.00,1.10]
Secondary	1.36[1.32,1.40]	1.08[1.04,1.12]	1.72[1.66,1.79]	1.55[1.49,1.62]	1.68[1.57,1.81]
Higher	1.43[1.38,1.50]	1.13[1.08,1.19]	3.13[2.85,3.44]	2.03[1.87,2.20]	1.73[1.66,1.79]
Wealth index					
Poorest (Ref.)					
Poorer	1.23[1.20,1.28]	1.09[1.06,1.13]	1.63[1.56,1.69]	1.52[1.46,1.58]	1.06[0.95,1.20]
Middle	1.54[1.50,1.61]	1.34[1.29,1.39]	2.46[2.33,2.59]	2.12[2.01,2.23]	1.06[0.93,1.20]
Richer	1.84[1.77,1.91]	1.60[1.54,1.67]	3.53[3.30,3.77]	2.79[2.62,2.98]	1.30[1.13,1.51]
Richest	1.93[1.85,2.01]	1.94[1.84,2.04]	5.75[5.20,6.35]	3.65[3.35,3.99]	1.58[1.33,1.86]
Expose to mass media					
No exposure (Ref.)					
Partial exposure	1.51[1.48,1.56]	1.19[1.16,1.23]	1.39[1.34,1.44]	1.38[1.34,1.43]	1.05[0.94,1.19]
Full exposure	1.53[1.41,1.68]	1.10[0.99,1.22] †	1.57[1.27,1.95]	2.03[1.62,2.54]	1.09[1.05,1.14] †
Constant	0.26	2.23	3.49	3.72	1.55
Log Likelihood	-113117.54	-91309.69	-54171.83	-54760.48	-51403.17
LR X^2	14137.25	3857.65	21423.46	14187.02	1178.35
Pseudo R^2	0.06	0.02	0.17	0.11	0.01

Source: National Family Health Survey, 2019-21 & Computed by Author

Notes: All odds are significant at p ≤ 0.01 except indicated by †; OR, Odds ratio; CI, Confidence interval; Ref.: Reference category of the variable.

Meanwhile, OBC women demonstrated a greater tendency toward institutional delivery care. Muslim women, in contrast, were less likely than Hindu women to opt for institution-assisted delivery and skilled health personnel, as well as PNC care. Maternal health care service utilisation showed a positive correlation with age, with older women having higher odds of accessing these services than their younger counterparts, reflecting the increasing age at marriage. Notably, women who married before the age of 18 had significantly lower odds of utilising all five indicators of maternal health care services compared to those who married at 18 years or older.

Furthermore, women with one or two living children displayed a higher likelihood of utilising various facilities than those with no children or more than three children. Education emerged as a crucial factor, with higher-educated women being approximately 1.4, 3.1, and 1.73 times more likely to have ≥4 ANC visits, opt for institutional delivery, and undergo PNC check-ups, respectively, than less educated women. Socio-economic status also played a pivotal role. Women from the wealthiest quintile were approximately 1.9 times more likely to receive ≥4 ANC visits and have an initial ANC visit within the first trimester compared to women in the poorest wealth quintile. Similarly, the odds of institutional delivery and of being assisted by medical practitioners were 5.8 and 3.7 times higher among the wealthiest women than among the poorest. This trend extended to PNC, with richer women more likely to access such care. Access to mass media significantly influenced maternal health care service utilisation. Women with partial or complete exposure to mass media had notably higher odds of utilising maternal health care services compared to those with no exposure. In essence, Table 3's findings underline the intricate interplay of socio-demographic factors in shaping maternal health care service utilisation.

Discussion

The current research provides valuable insights into how socio-demographic characteristics influence the utilisation of maternal healthcare services in the Indian context. Disparities in access to maternal healthcare are evident across different layers of society, affecting both the quality of care and socioeconomic gradients in India (Singh et al. a,b). These disparities lead to circumstances that make certain women more vulnerable to maternal mortality than others. In low-income countries like India, marrying young and having lower educational attainment increase the lifelong risk of pregnancy-related mortality among economically disadvantaged women.

Maternal healthcare inequalities are not limited to international borders; they occur within countries and reflect differences between wealthy and poorer women living in rural areas, urban centres, and slum communities (Gwatkin et al., 2007; Goldenberg et al., 2012; Gupta et al., 2017).

The results of our investigation indicate a significant correlation

between various socio-demographic factors and the utilisation of antenatal care (with a minimum of four visits and visits during the first trimester of pregnancy), childbirth care (institutional delivery and assistance by skilled healthcare personnel), as well as postnatal care (post-delivery check-ups within 42 days). Cross-national studies of maternal healthcare consistently demonstrate that living in urban areas provides a protective advantage. This suggests that women with higher levels of education and economic status tend to use healthcare services more effectively than their rural counterparts (Anmed et al., 2010). Our own research findings align with this pattern, showing that women living in urban areas are more likely to seek antenatal care (ANC) and give birth in healthcare facilities compared to women residing in rural areas. However, in a multivariate analysis of postnatal care (PNC) usage, no significant association with rural-urban residence was observed. Similar trends have been identified in India's context (Paul & Chouhan, 2020; Bharti & Raj T.P., 2019) as well as in other developing countries (Ononokpono et al., 2019).

The religious affiliation of women, especially those belonging to the Muslim faith, significantly influences the utilisation of safe delivery and postnatal care (PNC) services. However, this affiliation does not appear to affect the use of antenatal care (ANC) or child immunisation. A similar finding was observed in an Indian study that examined the relationship between women's religious affiliation and their use of ANC services. Interestingly, this result contradicts an earlier study suggesting that Muslim women are less likely to access maternal healthcare services (Kumar et al., 2011; Singh et al., 2012; Hazarika, 2010; Ali et al., 2021). Likewise, caste does not influence the utilisation of antenatal care services. Notably, scheduled tribes mainly benefit from the primary healthcare programme, which allocates a large share of government funding (Rao et al., 2005). However, the use of safe delivery services is significantly lower among women from scheduled tribes. The availability of skilled birth attendants—crucial for ensuring appropriate and timely delivery care within the community—has been inadequate, particularly affecting delivery practices among scheduled tribes (Saroha et al., 2008). To address this issue, substantial efforts are needed to increase the number of trained birth attendants in tribal communities.

Women who entered into marriage before the age of 18 showed a significantly lower likelihood of utilising maternal healthcare services compared to those who married at 18 or older. Research also highlights that limited decision-making power within the household is a notable barrier to young married women's access to healthcare services (Bloom et al., 2001; Mistry et al., 2009; Rai et al., 2012). The use of maternal healthcare services was more common among women aged 35 to 49 years, those with at least

secondary education, living in households headed by men, and those exposed to mass media, according to studies by Goland et al. (2012) and Srivastava et al. (2014). Additionally, higher utilisation was seen among women with one or two living children, those belonging to the Other Backward Classes (OBC), and the Hindu religion.

Education plays a crucial role in improving the quality of maternal healthcare and increasing access to and use of antenatal (ANC) and postnatal care (PNC) services. Pregnancy outcomes and ANC coverage are poorer among women experiencing poverty, limited education, and living in rural areas, as noted by the World Health Organization (WHO, 2015). Educated mothers are more likely to utilise public health services, actively seek better care options, and have greater ability to use healthcare resources to achieve better outcomes, compared with women with no education (Shawky & Milaat, 2001; Celik & Hotchkiss, 2000; Mistry et al., 2009). Additionally, an educated woman can subtly influence her in-laws' decisions and introduce new ideas about the advantages of skilled healthcare (Furuta & Salway, 2006).

Beyond women's education, economic status emerged as another significant factor influencing the utilisation of the selected maternal and child healthcare services in India. This trend vividly illustrates the substantial inequality across economic strata. Earlier research similarly concluded that the gap in the utilisation of maternal and child healthcare services between the impoverished and affluent has grown wider, with programs inadequately reaching the economically disadvantaged segments of society. Upon deconstructing the disparities in maternal health services utilisation, the study found that higher levels of education, exposure to media, and elevated wealth status were the primary contributors to the observed inequality, findings corroborated by Pallikadavath et al. (2004), Mohanty & Pathak (2005), and Pathak et al. (2010). This divergence likely stems from the fact that economically disadvantaged households lack the financial resources to cover healthcare costs, as they focus on meeting basic daily needs. In contrast, wealthier households can allocate a larger share of their income to healthcare expenses (Singh et al., 2012).

Conclusion

In conclusion, this comprehensive study provides valuable insights into the complex factors influencing the use of maternal healthcare services in India. The research highlights notable disparities in access and utilisation across different socio-demographic and economic groups. These inequalities perpetuate situations that make certain women more vulnerable to maternal mortality, emphasising the urgent need for targeted interventions. Notably, the findings stress the crucial role of education as a foundation for improving the quality, accessibility, and utilisation of maternal and child healthcare services. This leads to better health outcomes for both women and their children. The analysis of

healthcare disparities shows that higher education, media exposure, and greater wealth significantly reduce inequalities. However, the widening gap in healthcare service utilisation among economic groups presents a challenge, with implications for policy and programme development to ensure fair access to quality care. The findings act as a call to action for policymakers, healthcare providers, and communities alike. By recognising and addressing the complex interplay of factors such as education, economic status, and socio-demographic characteristics, sustainable improvements can be made. It is essential to prioritise investments in education, healthcare infrastructure, and resources for marginalised communities to close existing gaps and build a more equitable maternal and child healthcare system in India.

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Socioeconomic and Demographic Status of Tribes in Mayurbhanj, Odisha: An Analysis of Select Blocks

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Abstract

This study offers a detailed socioeconomic profile of 5,075 individuals from 1,175 households across three blocks in Mayurbhanj district, highlighting the diverse spread of tribal communities and gender dynamics. The analysis shows a higher proportion of females (51.9%) than males (48.1%), with notable gender differences across blocks ($p < 0.05$). Specifically, Baripada has a significant female majority of 53.5%, while Khunta and Samakhunta display slight male majorities. Additionally, the average annual income and expenditure of the tribe are both 82,763 rupees, with statistically significant differences ($p < 0.01$ for income, $p < 0.05$ for expenditure). However, disparities in expenditure across the blocks are evident: Baripada, Khunta, and Samakhunta recorded contributions of 52,414, 64,440, and 53,400 rupees, respectively. These findings emphasise the complexity and diversity within tribal communities, underscoring the need for tailored economic strategies and resource allocation to address local socio-economic dynamics effectively.

Keywords: Demography, socio-economic, tribe, livelihood

Introduction

Scheduled Tribes are among the most vulnerable communities in Odisha, particularly in regions such as Mayurbhanj (Dungdung & Pattanaik, 2020). In these areas, including Rayagada, Nabarangpur, Mayurbhanj, Koraput, Malkangiri, and Sundargarh, tribal communities constitute a significant majority (Rath, 2018). They uphold a distinctive societal framework, viewing themselves as self-contained units within an ideal state (Garada, 2012).

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The forest holds significant cultural and economic value for these tribes, who regard it as their mother and depend on its resources for their livelihood (Rout et al., 2010). Their sustenance mainly comes from agricultural produce, minor forest products, and hunting wild game. Mayurbhanj District alone accounts for about 58% of the district's population, which belongs to various tribes (Mohanty, 2017), including Santhal, Mahali, Saunti, Bhumji, Bathundi, Munda, Gond, Kol, Mankirdia, Lodha, Baiga, and Hill Kharia, among others. Notably, the Kol and Bhumji tribes are prominently concentrated in this region (Ota & Mohanty, 2021).

While communities like Santhal and Bhumji are present in every block of the district, others, such as Lodha, Mankirdia, and Kharia, are primarily found in the hilly regions of Simlipal, Morada, and Suilapada blocks around Baripada (Sahoo, 2023). Their livelihoods depend on collecting forest resources, such as nuts, flowers, and leaves from Sal trees (Maharana & Nayak, 2017). Furthermore, many tribes engage in daily wage labour, contributing to agricultural work and small-scale industries in the region (Mohanty, 2017; Majhi & Puhan, 2017). Their traditional practices extend beyond subsistence farming and forest gathering to include handicrafts and other forms of artisanal work, which are vital to their economic activities (Jana et al., 2022).

In essence, these tribes showcase a rich cultural heritage closely linked to their natural environment (Hansda & Sachan, 2019). Their sustainable practices and detailed knowledge of local ecosystems are crucial for their survival and the conservation of biodiversity in the region.

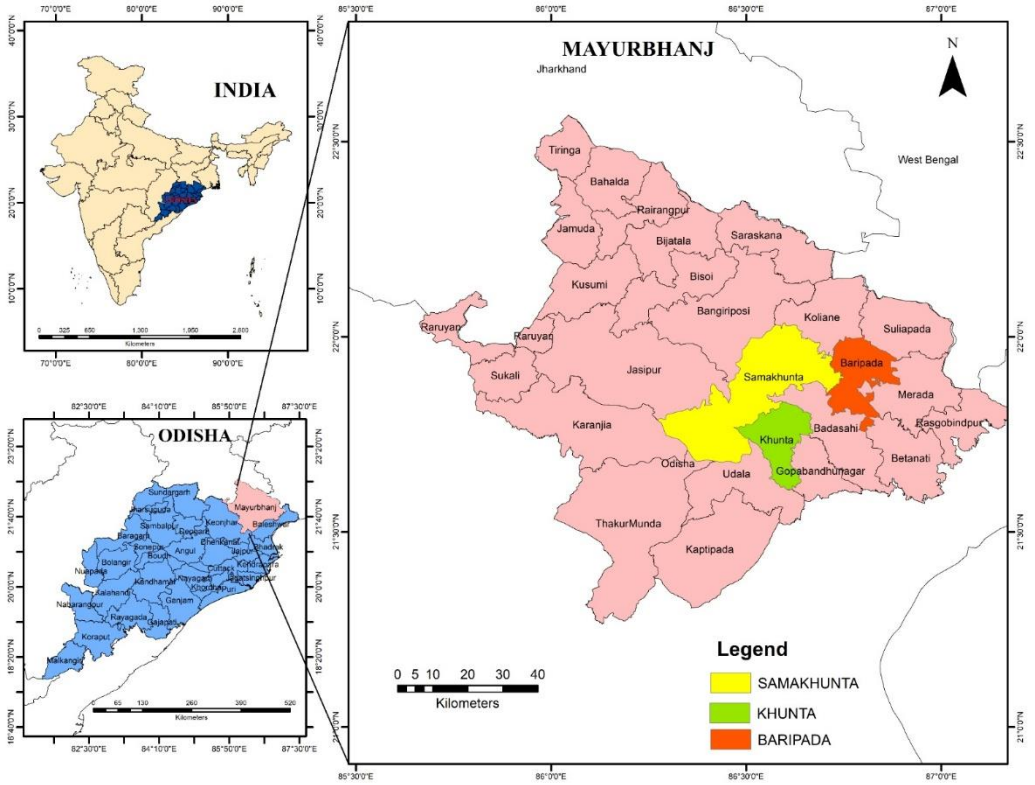
Study Area

Mayurbhanj, a district in northern Odisha, covers an area of 10,418 square kilometres. Its administrative centre is Baripada, situated between 21°17' and 22°34' North latitude, and 85°40' and 87°10' East longitude (Figure 1). This district is landlocked and borders the Midnapore district of West Bengal to the northeast, the Singhbhum district of Jharkhand to the northwest, the Balasore district to the southeast, and the Kendujhar district to the southwest. Three blocks with a tribal population exceeding 70 per cent were examined in this study: Baripada, Khunta, and Samkhunta. The region's economy is mainly driven by agriculture, forestry, and small-scale industries, with tribes playing a vital role in the area's socio-economic fabric.

Overall, Mayurbhanj stands out not only for its natural beauty and geographical diversity but also for its rich cultural tapestry and the resilience of its communities in the face of various socio-economic challenges.

Figure 1

Location of Study Area



Data and Methodology

To achieve the study's objectives, a thorough investigation was carefully planned and carried out across three distinct blocks: Khunta (classified as rural), Baripada (classified as urban and densely populated), and Samakhunta (also rural but with moderate population density). These blocks were strategically selected to provide a comprehensive understanding of diverse demographic and geographic conditions within the Mayurbhanj District.

Using a structured questionnaire, the study gathered data from 1,175 respondents across 14 tribal villages in the targeted blocks. This methodological approach ensured a robust sampling framework, allowing for a comprehensive analysis of the socio-economic and demographic factors influencing tribal communities in the region.

To understand the various demographic features and socio-economic conditions, SPSS was used to analyse the questionnaire data.

The gathered data were coded and entered into MS Excel spreadsheets and SPSS files. Analysis of socio-academic, socio-economic, and socio-cultural characteristics, traditional beliefs, and cultural practices

utilised descriptive statistics, including Chi-square tests and ANOVA for comprehensive evaluation.

Demography

The term "demography" was coined by Guillard in his work titled "Elements de statistique humaine, ou demographie compare (Carmichael, 2016). It originates from the Greek word 'Demos', meaning people, and broadly encompasses the study of population composition, structure, distribution, change, and growth across various locations and periods.

Population Composition

It illustrates a unified yet diverse distribution of tribal communities. Despite belonging to the same community, they vary. Specifically, the Santal community is predominantly located in Baripada and Khunta Block, whereas the Bhumija clan is concentrated in Samakhunta. The demographic data from 5,075 individuals across 1,175 households in the three selected blocks of Mayurbhanj district reveal a noticeable gender pattern. Overall, females constitute a slightly higher proportion of the population (51.9%) compared to males (48.1%). Statistical analysis further shows a significant association between gender distribution and the specific blocks ($p < 0.05$), indicating that population composition varies meaningfully across the study area.

Table 1

Sex Composition in Major Tribal Blocks of Mayurbhanj District

		Block			Total	χ2
		Baripada	Khunta	Samakhunta		
Male	Count	1400	555	485	2440	7.286a*
	% within Block	46.5	50.5	50.3	48.1	
Female	Count	1610	545	480	2635	
	% within Block	53.5	49.5	49.7	51.9	
Total	Count	3010	1100	965	5075	
	% within Block	100.0	100.0	100.0	100.0	

(Chi-square analysis table of sex composition) *Significant, ** Highly significant

Statistical analysis further shows a significant association between gender distribution and the specific blocks ($p < 0.05$), indicating that population composition varies meaningfully across the study area. A closer look at block-wise distribution shows contrasting gender patterns. Khunta and Samakhunta blocks have a marginal male majority, suggesting a relatively balanced but slightly male-dominated population. In contrast, Baripada block stands out with a distinctly higher proportion of females, where females outnumber males by about seven percentage points (53.5% females vs. 46.5% males). This makes Baripada the only block with a clear female-dominant demographic trend (Table 1).

The demographic pattern suggests that the gender distribution in Mayurbhanj is not uniform and varies

significantly across blocks. While the overall population leans slightly toward females, block-level differences highlight localised social, economic, or migration-related factors that may shape gender composition. The strong female presence in Baripada may reflect better retention of women, men's migration for livelihoods, or other socio-demographic influences. These insights are important for planning and implementing block-specific development policies, particularly in health, welfare, and resource allocation.

There exist visible differences in the age composition of the tribal population across Baripada, Khunta, and Samakhunta. Baripada has a noticeably larger child population, suggesting higher dependency and a younger demographic structure (Figure 2). Samakhunta, on the other hand, shows a more substantial presence in the 16–30 and 30–45 age groups, suggesting a more active working-age population. Khunta displays a relatively balanced distribution across most age groups but does not lead in any particular category. The 45–60 age group is most concentrated in Samakhunta, while all three areas show a small elderly population (60+), reflecting limited life expectancy or out-migration of older adults.

Overall, the pattern suggests differing demographic pressures: Baripada may require more child-focused services, while Samakhunta's workforce concentration may influence economic and livelihood dynamics. Khunta remains relatively stable across categories, with slight variation.

Figure 2

Age-Wise Distribution of Tribal Population

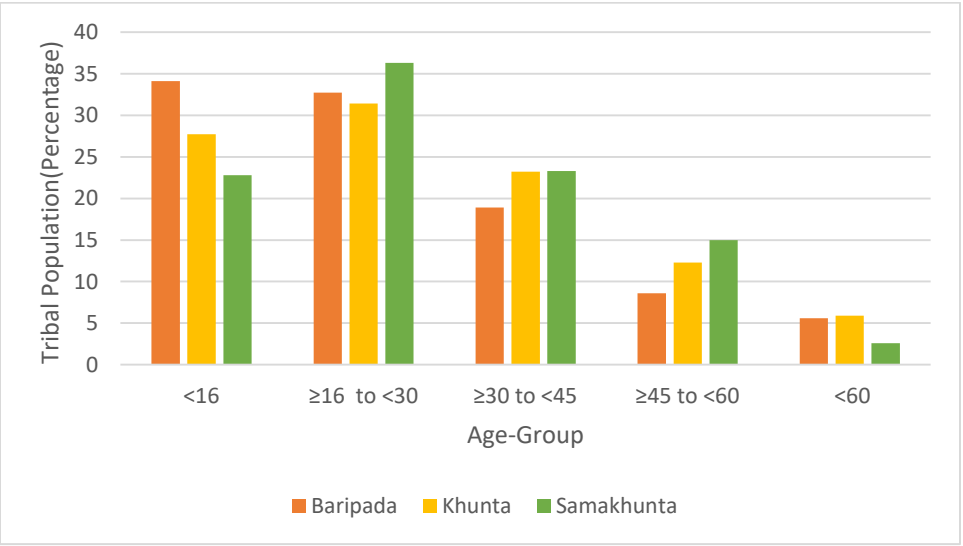


Table 2

Educational Status of Selected Blocks

			Block			Total	χ2
			Baripada	Khunta	Samakhunta		
Educational status	Literate	Count	1805	765	430	3000	1.692E2a **
		% within Block	60.0	69.5	44.6	59.1	
	Illiterate	Count	1035	305	505	1845	
		% within Block	34.4	27.7	52.3	36.4	
	Below the age group 6	Count	170	30	30	230	

(Chi-square analysis table of educational status) *Significant, ** Highly significant

The study reveals that 59.1% of the tribal population in the sample is literate, while 36.4% remains illiterate. Block-wise analysis shows notable variation: literacy levels stand at 44.6% in Samakhunta, 69.5% in Khunta, and 60% in Baripada. Although Baripada is categorised as an urban area, its educational advantages appear to have only a modest influence on improving literacy among tribal communities. This indicates that urban proximity alone does not necessarily translate into better educational outcomes for tribal populations.

The chi-square value shown in Table 2 (χ^2 = 1.692E2**) indicates a statistically significant association between educational status and block, meaning the differences observed across the three blocks are not due to chance. Instead, the variation reflects genuine disparities in educational access, awareness, or infrastructural support within these regions.

Social Status

Religion. The majority of tribes follow Hinduism, accounting for 94.6% of the total sample. The chi-square value (χ^2 = 71.538**) confirms a statistically significant association between religion and block, suggesting that the observed variation in religious composition across the three areas is meaningful and not due to chance (Table 3). Overall, the results indicate that while the tribal population is predominantly Hindu across the region, the degree of religious diversity differs noticeably among the blocks, with Baripada showing the highest level of variation.

Table 3

Table Showing Different Religions in Selected Blocks of Mayurbhanj

			Block			Total	χ2
			Baripada	Khunta	Samakhunta		
Religion	Hindu	Count	2785	1090	925	4800	71.538a**
		% within Block	92.5	99.1	95.9	94.6	
	Christian	Count	225	10	40	275	
		% within Block	7.5	0.9	4.1	5.4	
	Total	Count	3010	1100	965	5075	
		% within Block	100.0	100.0	100.0	100.0	

(Chi-square analysis table of religion) *Significant, ** Highly significant

Language. Only 5% of respondents from the Santal, Bhumija, and Kolha tribes are proficient in reading, writing, and speaking their respective languages, while 75% cannot read or write in their script. Despite all members being able to speak their native language, just 4% are familiar with Odia, Hindi, and English. Understanding Odia is widespread among them, highlighting communication challenges that hinder their integration into mainstream society.

Marital Status. They exhibit a preference for endogamous marriages and selective mating when selecting life partners. On average, boys marry between 15 and 25, while girls tend to marry later, generally between 20 and 30. The graph (Figure 3) indicates that marriage is almost universal among the tribal population once individuals reach adulthood. While the younger age group (<16) is naturally unmarried, marriage rates rise rapidly after age 16 and remain high throughout adulthood and older age groups. This pattern highlights the strong cultural importance of marriage among tribal communities and reflects a social structure in which early, near-universal marriage is common.

Figure 3

Age-Wise Marital Status Distribution Among the Tribal Population

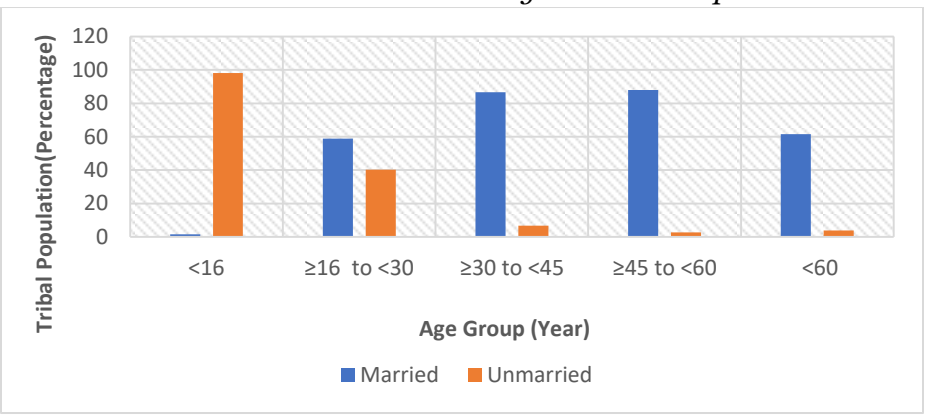


Figure 4

Field Photograph Showing Tribal Housing Structures

House Type. According to the survey findings, 61% of respondents live in traditional kutcha houses, 20% in pucca houses, and 13% in semi-pucca dwellings (Figure 4).

Toilet Facility. In the tribal villages, cleanliness is diligently upheld by residents, who maintain tidy homes. However, it is noteworthy that only a minority, approximately 18% of households, possess pit toilet facilities. Surprisingly, the vast majority, around 75% of the sampled households, lack any form of toilet facilities altogether, 4% had septic tanks and only 3 % modern facilities.

Drinking Water and Health Facility. Drinking water is a basic need for human beings, and 57.17% of the total tribal participants reported problems with drinking water. In contrast, more than 60 % of the people depend upon their traditional treatment methods, and more than 70 % of the tribes still believe in Blackmagic, superstition, witch-hunting, etc.

Figure 5

Workforce Distribution Among Tribal Communities in Selected Blocks of Mayurbhanj

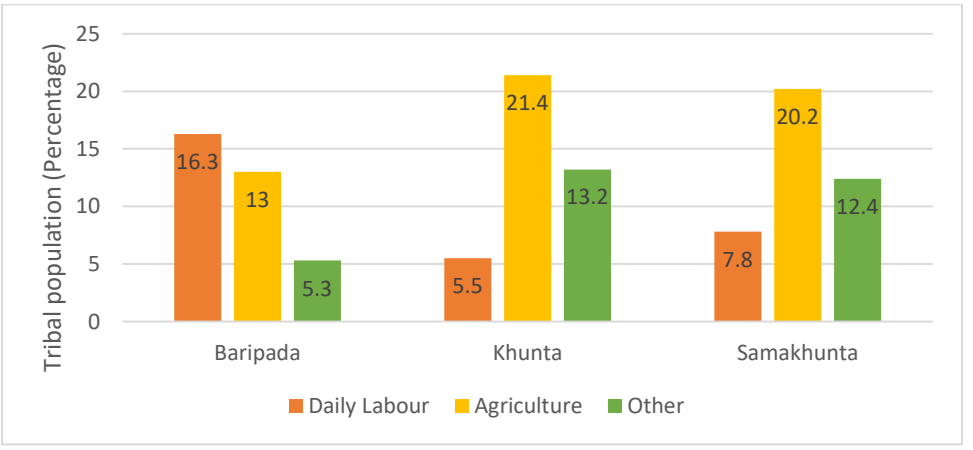
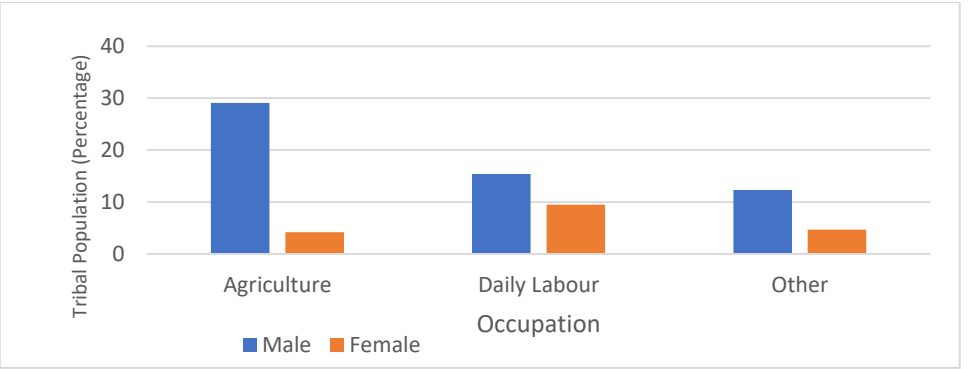


Figure 6

Gender-wise Occupational Distribution in the Study Area



Economics Status

Occupation. The tribes mainly depend on agriculture for their livelihood. 82% of households in the study region have agricultural land; 13% are landless, and only 3% cultivate leased land. More than 85% of the tribe depends on agriculture for its livelihood.

In Mayurbhanj, the results from the sample collected showed that the percentage of daily labourers was higher in the Baripada block at 16.3% than in the Khunta and Samakhunta blocks at 5.5% and 7.8%, respectively. Figure 4.9 shows that 47% of tribes in Baripada earn their livelihood as Daily Labourers, whereas in Khunta and Samakhunta, 53% and 50% of the working population depend on Agriculture, respectively (Figure 5). Earnings from daily labour were higher than in agriculture in Baripada because it is an urban region, and people earn more as daily labourers than in agriculture.

The workforce distribution clearly indicates that agriculture remains the backbone of livelihoods in Khunta and Samakhunta, reflecting their more rural, agrarian character. In contrast, Baripada shows higher dependence on daily wage labour, suggesting limited agricultural engagement and possibly fewer stable livelihood opportunities for tribal households. Overall, the graph highlights variations in economic dependency: rural blocks rely heavily on farming, while areas influenced by urban areas push tribal communities toward wage-based, diversified work.

Urbanisation and access to wage work shape livelihood choices, leading to a greater emphasis on labour-oriented occupations in Baripada. At the same time, traditional farming continues to sustain rural tribal communities in Khunta and Samakhunta. This difference underscores how location and economic environment influence the survival strategies of tribal households. Figure 6 presents the distribution of male and female workers across three major occupational categories—Agriculture, Daily Labour, and other activities. A clear gender gap is visible in all sectors. Agriculture shows the highest male participation, indicating that farming remains a male-dominated livelihood. Female involvement in agriculture is noticeably low, which may reflect limited access to land, tools, or decision-making roles.

In the category of daily labour, although males still make up the majority, the female share is relatively higher than in agriculture. This suggests that women participate more in wage-based informal work, possibly because alternative livelihood options are unavailable to them.

The "Other" occupation category also shows a similar pattern, with males outnumbering females. Overall, the graph conveys the message that tribal and rural communities still experience gendered divisions of labour. Men engage more in primary and regular income-earning activities, while women are concentrated in limited or low-paid opportunities. This highlights the need for skill development, livelihood diversification, and gender-inclusive employment programs to enhance women's economic participation.

Dependency ratio = (number of people aged 0-16) +(Number of people above age 60) +Total number of non-worker/Total number of working population x 100

As the dependency ratio increased, economic stress affected people's living conditions. From the analysed data, the dependency ratio for the tribes was 58.34%, indicating a moderate economic condition in the region.

The study reveals that rice is the primary crop cultivated by tribal households in the region, with nearly 68% of them engaged in rice farming. Another significant source of livelihood is Sabai grass, grown by about 26% of the tribal population, reflecting its importance as a cash crop for income generation.

Livestock rearing is also a significant part of their livelihood system. A large number of tribes keep poultry (82%), while 58% domesticate cows, along with some pigs in smaller quantities. These practices not only boost their income but also ensure food security and support traditional ways of life. It clearly indicates that tribal livelihoods are deeply connected to agriculture and livestock rearing, with rice cultivation and poultry farming forming the backbone of their daily sustenance. This demonstrates their strong reliance on natural resources and traditional methods to maintain economic stability and household well-being.

Table 4 indicates that the tribe's average annual income amounted to 82,763 rupees, a statistically significant figure ($p > 0.01$). Conversely, their average annual expenditure, also totaling 82,763 rupees, was deemed significant ($p > 0.05$). Despite this balance between income and expenditure, the allocation of expenditure at the block level showed notable disparities. The data shows noticeable variation in household income and expenditure across the three blocks of Mayurbhanj. Although the mean household income appears highest in Samakhunta (₹9303.6), followed by Khunta (₹8086.9) and Baripada (₹7899.3), the statistical test ($F = 2.522$) indicates that these differences are not significant. This suggests that tribal households across the three blocks have broadly similar income levels despite their geographical or socio-economic differences. However, household expenditure shows a more distinct pattern. The average expenditure is highest in Khunta (₹6440.5), while Baripada (₹5241.4) and Samakhunta (₹5340.0) report

lower spending. The F-value of 18.985, which is statistically significant, indicates that the difference in expenditure across blocks is meaningful and not due to chance.

All components of total expenditure were significant and positively associated with total expenditure, with the lowest coefficient of 0.067 for Handia and the highest of 0.817 for food (Table 5). The degree of association among the components of expenditure in the present study was all positive, ranging from 0.003 between food and Handia expenses to 0.285 between food and other expenses.

Income and Expenditure

Table 4

Income and Expenditure Details of the Tribes of Selected Blocks of Mayurbhanj

		Number of Households		Mean	F
Block	Baripada	650	Income	7899.3[a]	2.522**
	Khunta	245		8086.9[a]	
	Samakhunta	280		9303.6[a]	
Total		1175		8276.3[a]	
	Baripada	640	Expenditure	5241.4[a]	18.985*
	Khunta	245		6440.5[b]	
	Samakhunta	280		5340.0[a]	
Total		1175		8276.3	

(Income and Expenditure) *Significant, ** Highly significant

Table 5

Table Showing the Correlation Between the Different Consumer Expenditures of Tribes

		Capital	Food	Cloth	Handia	Others	Total Expenditure
Capital	Correlation	1.000	.093	.062	.039	.150	.628
	Significance		.001	.035	.185	.000	.000
Food	Correlation		1.000	.259	.003	.285	.817
	Significance			.000	.930	.000	.000
Cloth	Correlation			1.000	.081	.235	.315
	Significance				.005	.000	.000
Handia	Correlation				1.000	.025	.067
	Significance					.393	.022
Others	Correlation					1.000	.439
	Significance						.000
Total Expenditure							1.000

N.B.- Handia is an alcoholic drink prepared from fermented rice. It is also called Rice beer, and it is a fashionable drink among the Northern tribes of Odisha (Panda et al., 2014).

Capital expenses showed a non-significant association with Handia but significant, low correlation coefficients with food and other expenses. The degree of association between food and Handia was the lowest among all correlations; however, significant, moderate correlation coefficients of 0.259 and 0.285 were obtained with cloth and

other expenses, respectively. Cloth was found to have a positive and significant association with Handia and other expenses, with estimates of 0.081 and 0.235, respectively. Handia showed a very low correlation coefficient of 0.025 with other expenses, indicating that expenses incurred in Handia accounted for only 2.5% of the variation in miscellaneous expenses, yet remained significant.

Conclusion

The diverse distribution of tribal communities highlights both unity and distinct regional concentrations. While the Santal community predominantly resides in Baripada and Khunta Block, the Bhumija clan is notably concentrated in Samakhunta, underscoring the nuanced geographical patterns within the broader tribal landscape. This spatial analysis underscores the complexity and diversity inherent within tribal communities, despite their shared cultural identity. In summary, the socio-academic profile of 5,075 individuals from 1,175 households across three blocks in the Mayurbhanj district reveals a notable gender distribution. Females constitute a higher proportion at 51.9% compared to males at 48.1%. The analysis further indicates a statistically significant gender dependency across the blocks ($p < 0.05$). Specifically, the Khunta and Samakhunta blocks exhibit a slight male majority, whereas Baripada stands out with 53.5% females, indicating a 7% higher female population compared to males. This variation underscores the importance of considering local contexts and demographics in understanding gender dynamics within the studied communities.

In conclusion, while the tribe's average annual income and expenditure both totalled 82,763 rupees, each figure was statistically significant in its own right ($p > 0.01$ for income and $p > 0.05$ for expenditure), the distribution of expenditure across Baripada, Khunta, and Samakhunta revealed substantial variation. Baripada contributed 52,414 rupees, Khunta 64,440 rupees, and Samakhunta 53,400 rupees, illustrating distinct spending patterns among these regions. These disparities emphasise the need for localised economic strategies and resource allocations that account for the unique socio-economic dynamics within each block of the tribal community.

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Emerging Vulnerability to Climate Change and its Impact on Human Migration Patterns in India

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Abstract

Climate change vulnerability is a global phenomenon that leads to catastrophic conditions, including shoreline erosion, coastal floods, and agricultural disruptions. These factors are altering migration patterns and impacting human lives. As per the United Nations' International Organisation for Migration report 2024, disasters linked to climate change are the main drivers of human migration, with over 200 million people expected to be displaced within their countries by such crises by the middle of the century. India is one of the worst-affected countries by climate-driven migration, placing fourth in the State of India's Environment Report 2022. Migration is increasing due to the impacts of rapid and slow-onset climate change events on agriculture, water resources, and infrastructure. The study examines the relationship between climate change-induced migration and human security through an analytical lens. It raises concerns about climate-driven migration from various parts of India, and advocates increased planning at all levels of governance.

***Keywords*:** Climate change, migration, human security, governance, India

Introduction

Environmental experts have already warned that the human race is approaching a tipping point beyond which a return is impossible. The adverse impacts of changing climatic conditions are visible in every nook and corner of the world, with different manifestations. However, some parts are more vulnerable to climate insecurity due to their geographical location, dependence on nature-based livelihoods, and limited adaptive capacity. Almost all developing countries fall in this category.

According to studies, climate change is a 'threat multiplier' that exacerbates other issues, such as food and water scarcity, depletion of natural resources, heightened risks of pandemics and other health issues, housing crises, and political conflicts.

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The devastating impacts of climate change are a pressing matter that already affects a considerable segment of the global population (United Nations [UN], 2019). Prompt action is required to avert or mitigate the effects of the climate catastrophe. It is important to note that the terms migration, displacement, mobility, and movement are used as synonyms in this study, and only internal migration is investigated. The first section of this article examines the nexus between climate change, migration, and human security, while the second investigates climate-driven migration in India.

Nexus Between Climate Change, Migration, and Human Security

The connection between climate change, migration, and human security is clear.

To develop practical solutions, it is essential to understand how these three elements interact. Before addressing this triad, it is important to highlight some climate change impacts to better understand the relationship. The sixth assessment report (2022) of the Intergovernmental Panel on Climate Change (IPCC) states that extreme weather events such as heatwaves, severe floods, droughts, and wildfires are becoming more frequent and intense due to the unprecedented rise in temperature and altered weather patterns. Furthermore, climate change has significantly increased the frequency of coastal floods, sea-level rise, and salinisation of coastal cultivable land, thus increasing survival risks for coastal residents. Additionally, there is a notable disparity in the effects of climate change across the planet, which is another concern. Areas already struggling with issues such as poverty, governance, limited access to basic amenities, and reliance on nature-based livelihoods are currently facing the adverse effects of a changing climate. According to the report, floods, droughts, and storms have claimed more lives in these regions over the last decade than in less vulnerable areas. (Intergovernmental Panel on Climate Change [IPCC], 2022)

Climate Change and Migration

Throughout history, environmental factors have been the primary drivers of human migration. Climate change has recently emerged as a prominent ecological driver of migration. There is considerable evidence linking climate change and migration. However, the relationship between the two is intricate and varied. Climate change's increasingly severe repercussions are driving more people to relocate. Rising sea levels have caused flooding, coastal erosion, and salinisation of agricultural land, demonstrating how climate change impacts migration patterns. Apparently, individuals are compelled to leave places where there is constant danger to their lives or where opportunities for livelihoods are dwindling. (Hauer et al., 2020). Additionally, people's decisions to move may be indirectly influenced by how climate change affects their means

of subsistence. Those who rely on nature-based sectors to earn a living are more likely to move away from places that have become infertile due to salinisation or drought. (Cattaneo & Peri, 2016).

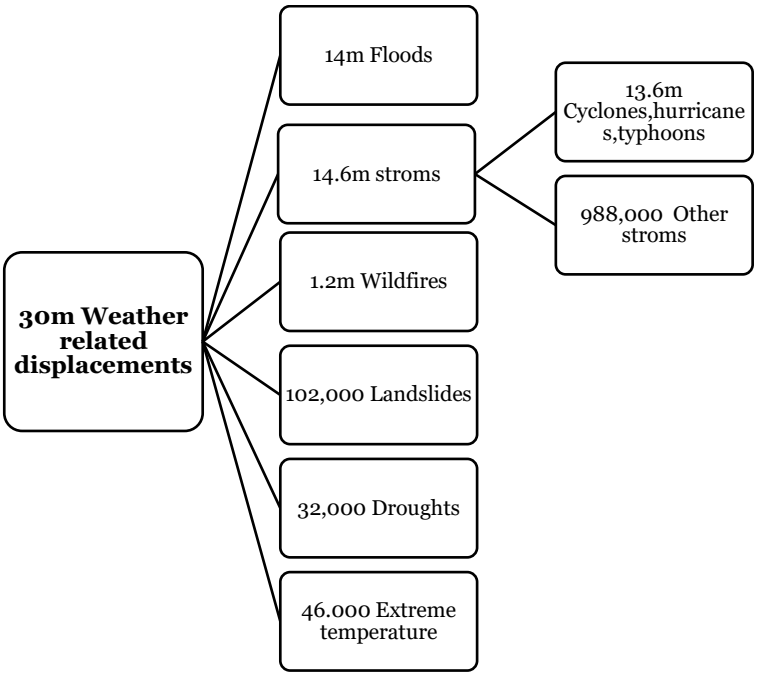
Natural events that occur gradually (slow-onset events) or abruptly (sudden-onset events) over a short period of time influence human migratory patterns. Studies reveal that slow processes, such as rising sea levels, are already driving people to leave their homes. Furthermore, the irreparable loss of land may uproot many people. (Greenpeace Germany, 2017). According to the Glacier Monitoring Service, melting of glaciers, one of the primary causes of rising sea levels, has doubled in recent years. The incursion of the sea into human habitable land forced millions of people to flee coastal areas. The climate catastrophe was the biggest driver of displacement, affecting 25 million people in the mid-1990s. (Brown, 2008). This number increased to more than 170 million between 2008 and 2015. Weather-related disasters uprooted nearly ninety per cent of people from their homes in 2015 (Bilak et al., 2016). The average annual displacement of people has remained around twenty-five million since 2008 (Global Report on International Displacement [GRID], 2021). As per the latest report of the Internal Displacement Monitoring Centre (IDMC), the world witnessed the displacement of approximately 30.7 million people by the end of 2020; floods and storms remained major drivers (GRID, 2021: p. 12) (fig.1). Climate vulnerability and change are the major contributors to these figures.

Weather-related events caused around 31.8 million internal displacements worldwide in 2022. This represents an increase of 1.8 million from 2020. Floods, storms, and droughts caused ninety-eight per cent of these displacements. (fig.2).

Undoubtedly, weather-related extremes play an important part in people's decisions to move; nevertheless, they are not the only factor. Economic factors, military conflict, disaster management strategies, and social linkages with climate change all contribute to a more severe pattern of mobility. Government policies and institutional frameworks have a substantial impact on immigration decisions. Migration rates tend to be lower in regions with high adaptive capacity and higher in areas with low adaptive ability. Numerous studies have shown that government measures that address the needs of vulnerable groups can help strengthen their adaptive skills and prevent migration.

Figure 1

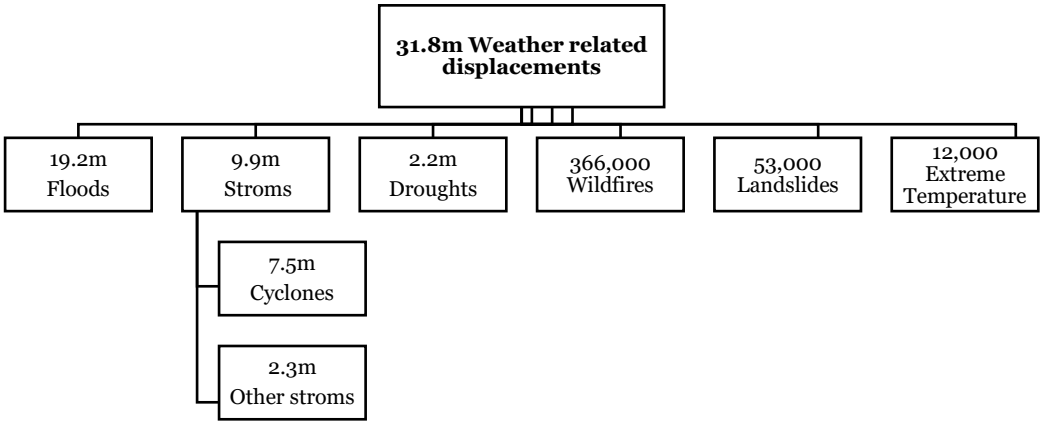
Weather-Related Displacements in 2020



Source: Internal Displacement Monitoring Centre (IDMC). https://www.internal-displacement.org/sites/default/files/publications/documents/grid2021_idmc.pdf

Figure 2

Weather-related Displacements in 2022



Source: Internal Displacement Monitoring Centre (IDMC). https://www.internal-displacement.org/global-report/grid2023/

Migration and Human Security

Migration involves leaving one's home to move to a new place. People migrate for various reasons, but this study focuses solely on climate change. Anticipated and well-organised migration can be managed effectively. However, sudden and large-scale migration can cause significant challenges, as seen during the COVID-19 pandemic in 2020. According to the IDMC's latest report, sudden-onset climate change events have triggered large migration flows within a short period. These events reduce the time available for evacuation and resettlement, leading to unplanned mobility. People lose their jobs, shelter, and other assets, which worsens issues like limited access to healthcare, schooling, and educational opportunities, resulting in high mortality, more child labour, and widespread poverty. Research indicates that climate migrants are mainly unskilled and impoverished populations (Food and Agriculture Organization [FAO], 2022), vulnerable to exploitation by unscrupulous employers, often willing to accept difficult and hazardous jobs. Sadly, these jobs typically pay low wages, continuing the cycle of exploitation. The lack of secure and safe shelter heightens the risks of human trafficking and sexual abuse. According to the 2016 Global Report on Trafficking in Persons, the most trafficked individuals are those in low-paying jobs and belonging to vulnerable groups, such as women and children (United Nations Office on Drugs and Crime [UNODC],2016). Slow-onset events, like sea-level rise and desertification, often lead to the complete relocation of affected communities. The destination faces challenges in managing the large influx of people due to limited natural and economic resources, often resulting in conflicts and violence.

Human security, which encompasses the absence of fear and threats from conflict, crime, natural disasters, diseases, and similar factors, as well as the fulfilment of basic needs such as freedom from poverty, malnutrition, inadequate education, and poor health, is negatively affected by climate-driven migration (United Nations Development Programme [UNDP], 1994). These migrants have no choice but to select a place where they can live happily and with dignity. However, another group of researchers views migration as an effective strategy for adaptability (Jha, 2017). People often turn to migratory measures to reduce their vulnerability and diversify their financial resources, thereby enhancing human security. In fact, for strategies to qualify as this, they must be planned and voluntary. Unfortunately, current studies indicate that changing climatic conditions often force people to migrate as a last resort when they lose access to essential services in their native environment.

Undoubtedly, there are complexities in the nexus mentioned above. However, we should not dismiss this vital connection simply because the exact cause-and-effect relationship remains unknown. We are now observing the impacts of anthropogenic climate change, and scientific evidence indicates that the severity will continue to escalate. Historically, threats to life and the loss of livelihoods have been major drivers of migration, and climate

change exacerbates both. The traditional approach to migration-related studies largely overlooked the impact of climate change on migration. Nevertheless, most discussions of migration and climate today focus on the harmful effects of changing climatic conditions on human displacement, and it is widely recognised that climate change will disproportionately affect the most vulnerable regions (IPCC, 2022a).

Climate Change and Migration in India

India is currently facing severe environmental problems, and environmental stress is evident in every aspect of life. The melting glaciers and increasing issues of avalanches, flash floods, and landslides have become more common in mountainous regions on the one hand (Kajal, 2021), while significant drought and desertification in arid and semi-arid parts of the country ("Desertification: Drought reduced", 2022) and rising sea levels and salinisation in coastal areas are common problems now (Sangomla, 2022). This evidence is enough to show that India is exposed to climate change on multiple fronts. The adverse effects of recent climate change accentuate the vulnerabilities of Indian populations, who are strongly reliant on nature-based sectors and reside in susceptible regions. According to the IPCC's 2021 assessment, climate change and extreme weather are increasing global population displacement, especially in vulnerable areas (IPCC, 2021). In India, nearly three million people were displaced by extreme weather in 2020–2021(Krishnan, 2023). Unfortunately, these figures are projected to rise further in the future. To better understand the instances of climate-induced migration, we have examined three distinct topographical areas of the country: coastal, plain, and mountainous.

Migration in Coastal Areas

India's extensive coastal land, which spans 7,500 kilometres and includes thirteen states and union territories (Jha, 2022a), is experiencing shoreline erosion, flooding, salinisation of freshwater and agricultural land, and increased storm hazards as sea levels rise. It poses a significant danger to the millions of residents who rely on this ecosystem for their existence. According to studies, the decrease in landmass and the increase in inundation fuelled the migration of coastal dwellers. Though the land's deterioration began decades ago, the inhabitants encountered its bitter reality in the last decade of the twentieth century. Studies conducted over the past two decades suggest that about 30 per cent of Odisha's 485 kilometres of coastline has been experiencing erosion (Sebastian, 2022). Initially, the severity experienced by the inhabitants of *Sanagahiramatha, Mohanpur, Habeli Chintamanipur, Gobindpur, Kaduanasi, Saheb Nagar,* and *Paramanandapur* villages of the *Satabhaya gram panchayat* of the *Kendrapara* district, which at one time covered about 900 acres of land (excluding farmland). The continuous seawater intrusion into these villages, along with the region's retreating coastline, renders them uninhabitable. Hundreds of households relocated to *Kanhupur*, *Satabhaya*, *Barahipur*, *Rabindrapalli*, and *Magarakanda*,

which were only a few kilometres away. After a few decades of serving as a home for the earlier displaced population, these villages were unable to survive; *Satabhaya* is the only one that remains. The most recent submersion occurred in 2011, when *Kanhupur* disappeared under the water (Sahu, 2018).

In response to the area's growing sensitivity to climate change and its effects on people, the state government began managing retreat in 2008. At present, over 500 families have been effectively rehabilitated in *Bagapatai*, a destination situated twelve kilometres away from the original site. The recent studies indicate that more areas are emerging that require similar solutions. In March 2023, the state administration of Odisha disclosed that sixteen villages from various coastal regions had either submerged into the sea or were experiencing severe erosion, prompting people to evacuate the area and raising the figure of climate-driven population.

When compared with coastal villages in Odisha, the Sundarbans in its adjacent state of West Bengal confronts more severe climate change-related threats owing to the region's dense population and a faster rate of sea-level rise than other coastal parts of the country (Ghosh, 2017). It is evident that more people need more land to survive; nevertheless, this region's population is increasing while its land area is shrinking. The submergence of the habitable islands Lohachara and Bedford in recent decades compelled thousands of people to move to the already densely populated islands Ghoramara and Sagar, thereby posing a significant threat to the area's carrying capacity (Ghosh et. al, 2014). The figures show that Ghoramara lost half of its land area over a four-decade period, resulting in the submersion of five villages and the permanent departure of around 4,000 people from the island have been reported (Ghosh, et. al, 2014a). Many people left in search of livelihoods, as most islanders depend on water and land resources that are rapidly depleting. Storms caused by rising sea levels damage embankments and increase soil salinisation, which is devastating for crops. The decision of islanders to migrate has also been influenced by the disappearance of uninhabitable islands, as these areas provide essential natural services for their survival. Due to its proximity to vulnerable regions, Sagar Island is currently experiencing a rapid population growth. In recent years, about 1100 families have relocated from Lohachara to Sagar. However, rising sea levels have also reduced the land area of Sagar Island from 246.76 to 230.98 square kilometres over the past two decades (Bera et. al 2021: p. 222).

The increasing intensity and frequency of cyclones have also worsened human displacement from the coasts, which, unlike rising sea levels, allows little opportunity for planned retreat. They cause more destruction in a shorter period. In 2020, two deadly cyclones, Amphan and Nisarga, struck India's shores within a month, displacing nearly 2.5 million people (GRID 2021a: p. 53). Cyclone Amphan severely impacted West Bengal, destroying 2.8 million houses (GRID 2021b: p. 78). India is only beginning to address the destruction caused by these disasters;

the following year (2021), its coasts experienced three more cyclones: Yaas, Tauktae, and Gulab, with one being a category four storm (Tauktae). In addition to claiming thousands of lives and demolishing homes, these regions saw the displacement of about 2.5 million people (GRID, 2022a). In 2022, cyclones Asani, Sitrang, and Mandous forced approximately 80,000 people to evacuate their homes (GRID, 2023a). There are few well-devised strategies to manage such large-scale migration. Though these movements are generally temporary, repeated risks can solidify them as permanent. The gradual inundation of islands and the rapid reduction in land area, coupled with their connection to climate change, are key issues for policymakers, especially as future climate forecasts suggest increasingly catastrophic scenarios.

Although climate change is often blamed for coastal erosion, many analysts believe that development efforts in these regions are also exacerbating the problem. The loss of mangroves, which shield the coastline from cyclones and storms, paves the way for extensive damage to the coastal regions. Many studies confirm that the shoreline has become significantly vulnerable due to developmental activities. The correlation between the construction of the *Paradip* port and the escalating erosion in the *Satabhaya* region is hard to overlook. Studies largely confirm that this structure produces larger sea waves, which worsen the erosion of the area (Sahu, 2018c). Nevertheless, these findings have little impact on the government's development initiatives; since the beginning of the twenty-first century, the country's coasts have witnessed the construction of massive infrastructure.

Migration in the Plain Areas

In 2021, researchers from the International Institute of Environment and Development (IIED) surveyed Rajasthan, Uttar Pradesh (UP), and Madhya Pradesh (MP). The findings showed that nearly 30% of the population studied in these states had to leave their homes due to drought. Rajasthan, UP, and MP had respective shares of 28.33 per cent, 8.08 per cent, and 8.30 per cent. There is a high likelihood that these figures will rise in the future, as the survey results indicate that, among environmental factors influencing migration, every respondent in Rajasthan expressed a desire to migrate due to increasing droughts. Meanwhile, eighty per cent of participants in UP and nearly fifty per cent in MP shared similar intentions (Bharadwaj, 2021). When a drought occurs, the supply of food and water is most affected, followed by people's ability to earn a living. India is highly vulnerable to drought, with around 30% of its land area susceptible to this phenomenon (Salas, 2024). Climate change is worsening the issue, and its impacts are visible across the country. India is currently facing its worst water crisis ever. Every year, thousands of lives are lost due to a lack of access to clean water, while millions experience high to severe water stress (Ministry of *Jal Shakti* [MoJS] & Ministry of Rural Development [MoRD], 2019).

In an effort to address this situation scientifically, the government is imple menting a number of policies and strat

egies, including the Jal Jeevan Mission. The mission's goal is to provide safe, adequate drinking water to each household by the end of this year (MoJS).

However, there is little planning for dwindling water resources, which are critical to the success of the above-mentioned schemes. Furthermore, the plans focus solely on human consumption, even though human survival depends on a variety of other necessities, such as food production and livestock raising, which are not covered by these schemes.

The monsoon plays a vital role in addressing water-related challenges and managing water resources in a country. However, in the current era, the regularity of this phenomenon is being disrupted by climate change. It becomes increasingly unpredictable and erratic. There is a drop in overall rainfall, along with an increase in extreme rainfall events. More short-duration rain gives rise to floods in most plain areas in India. Floods are well-known disasters that displace large numbers of people every year. The IDMC's 2023 report indicates that South Asia accounts for 90% of its disaster-related displacements due to floods. (GRID, 2023) In fact, floods account for over 50 per cent of all natural disasters in India, making them the most prevalent in the country. India ranks second only to Bangladesh in terms of flood impact (Chowdhury, 2022).

The frequency of extreme rainfall events in central India has increased by a factor of 3 over 66 years (1950–2015). The country saw 268 flooding incidents during this period, affecting around 825 million people and leaving 17 million homeless, in addition to 69,000 fatalities (Roxy, 2017). Recently, floods have increased in intensity and frequency. Almost five million people in the northeastern state of Assam were impacted by the floods in May 2022. An estimated 742,000 people were displaced by flooding between mid-May and mid-July, following flooding in the same areas in June 2022 (GRID, 2022b). More rain in a short period is increasing the threat to regions already prone to floods. Many regions of the country are facing more than one natural disaster, and these disasters are becoming more complex as climatic conditions change.

Migration in the Indian Himalayan Region

A 2500-km-long stretch that provides refuge to 50 million people and is one of four biodiversity hotspots, the Indian Himalayan Region (IHR) is highly vulnerable to the effects of climate change. The region is among those experiencing rapid global warming, leading to the rapid melting of seasonal snow, the retreat of glaciers, and altered seasonal patterns of glacier melt. Furthermore, a phenomenon that is becoming more noticeable in this area is the shortening of the snowfall period. (Matta, 2024) The water supply, which is dependent on snowmelt and glacier runoff, is currently facing two main challenges. Firstly, excessive runoff in a short period can cause downstream rivers to swell. Secondly, there is a risk of a long-term acute water shortage.

Water shortages and shifting precipitation patterns adversely affect people who depend on agriculture.

There has been a massive exodus from rural areas as people lose their traditional means of livelihood and are forced to seek work in cities. In such a scenario, the growing tourism industry poses an additional risk to the area with limited resources. Financially speaking, it undoubtedly helps, but its advantages are limited to certain groups, whereas the effects of ecological disruptions are more widespread. Coordination between the government and the local population seems like an ideal choice in this circumstance.

The impact of climate change on agriculture and other nature-based practices in the region adds to the region's already-livelihood-deficient status. Increasing climate change-induced seasonal irregularities, extreme events, and regular crop failures contribute to rural outmigration from several other parts of the region.

A study carried out in the *Ramgad* watershed area of Uttarakhand identifies the leading causes of rural migration as a lack of livelihood opportunities, declining agricultural production, and an increase in extreme weather events and natural disasters. The first two factors are among the main contributors to rural exodus since independence (Sati, 2021); the rising frequency and severity of natural catastrophes have been a more recent development. Additionally, climate change is accelerating the downward trend in crop output, which is detrimental to the region's livelihood options. Over 12 years, from 2001 to 2013, the number of people who left the region increased fivefold, from 401 to 2,425. Additionally, more than 700 villages in the state have been totally abandoned in the last two decades (Biella, 2022). Notably, a sizable fraction of these people were transient migrants.

In the field of climate research, the link between human migration and climate change is often seen as a vulnerability. Due to its geographical location, the region (IHR) and its residents are particularly at risk from climate change. Migration is unavoidable in areas more affected by its negative impacts. Besides the region's high sensitivity and exposure to climate change, the widespread inability of its residents to adapt further exacerbates the danger. Most people in this region rely on agriculture and related work, with limited alternatives. The mounting adverse effects of climate change on agriculture make it increasingly difficult for people to sustain themselves with the income sources they once had.

Undoubtedly, factors such as better economic benefits, improved health, and greater educational opportunities play a crucial role in driving migration in these regions. But new factors, such as the frequency of landslides, forest fires, flash floods, and declining water and other resource availability, are becoming more important and must be considered.

Finding Solutions: Institutional Response to Climate-Induced Migration

Livelihood Schemes

The assessment of the aforementioned areas reveals that the impact of climate-induced factors on livelihood is a leading driver of migration decisions. The Mahatma Gandhi National Rural

Employment Guarantee Act of 2005 (MGNREGA) would offer a solution in this case. Research indicates that persons associated with nature-based livelihoods constitute the bulk of distressed migrants (GRID, 2023b: p. 18). Compared to people who depend on agriculture, the population associated with the MGNREGA has a low intention to migrate (GRID, 2023c). This act guarantees 100 days of work annually to unskilled rural workers and provides for an unemployment allowance if work is not provided within fifteen days. To enhance the efficacy of the act for climate change-affected populations, the central government implemented an additional 50 days of work in areas prone to drought in 2015 ('Government Says 50 Days', 2015a). Several state governments also allocate additional employment days to workers under the MGNREGA scheme, specifically in regions affected by drought.

Resettlement and Rehabilitation

The Resettlement and Rehabilitation (R&R) Policy, initiated by the Indian plan in 1985 to address the needs of those displaced by developmental projects, was approved in 2003 and implemented the following year. It was later revised as the National Rehabilitation and Resettlement Policy (NRRP) in 2007 (Samling,2015). The policy gives preference to low-displacement options. Those who are involuntarily displaced due to land acquisition or other reasons are provided with appropriate benefits and compensation (MoRD, 2007). The Lok Sabha introduced the Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation, and Resettlement Bill in 2011 after incorporating R&R provisions. Implemented in 2014. This statute prioritises the resettlement and rehabilitation of the landowner and the families who relied on it (Tiwari, 2023).

After the 2001 Gujarat earthquake and 2004 Indian Ocean Tsunami, the Disaster Management Act (DMA) 2005 was passed. The law created national, state, and district disaster management authorities to collaborate on disaster management. It shifted government priorities from relief to prevention, mitigation, restoration and reconstruction. The NRRP focuses on development-driven displacements, whereas DMA is more pervasive. It encourages research on climate change-related disasters and the development of novel solutions. In addition to extending the DMA, most Indian states have institutional and financial mechanisms for disaster-related relocation ('Government Says 50 Days', 2015b). By anticipating disasters, resettling seasonal migrants, and rehabilitating permanently displaced people, DMA helps climate-induced displacement-related issues.

Timely Evacuation and Early Relief

The detrimental consequences of disasters linked to climate change-induced displacement can be prevented or significantly reduced with the use of an early warning system. An early warning system can help people avoid involuntary displacement. *Biparjoy*, a severe cyclonic storm, recently hit Gujarat, causing substantial damage to infrastructure, injuries, and livestock losses. Nonetheless, casualties were kept to a minimum, illustrating the

efficiency of the IMD's (Indian Meteorological Department) early warning system. Authorities successfully evacuated over 1,00,000 people from vulnerable areas of Gujarat during four days ('Preparedness Pays Off', 2023), averted a major loss of life. When Cyclone Fani hit India's eastern coast in 2019, an early warning system helped evacuate 1.2 million people in Odisha within 24 hours (Jha, 2022b).

According to research conducted over the last fifteen years, India has successfully reduced cyclone-related mortality by 90%. Clearly, India's early warning system has improved. The system safeguards against floods, droughts, and heat waves. An early warning system makes it feasible to plan an evacuation in a timely manner. The Central Water Commission is currently providing a five-day flood forecast for 20 major river basins in the country (MoJS, 2022). Statistics show that the early warning system has enormous potential for mitigating the effects of severe weather events.

Summing Up

Climate change is directly or indirectly displacing many people within India, and surprisingly, no institutional arrangement exclusively addresses this threat. The legislation mentioned above was established primarily to fulfil other purposes but is proving useful for this new and drastic driver of migration. Apart from the need for amendments to already established laws, like an increase in days of work under MGNREGA during other natural calamities besides drought and a spike in wages, as the current wage rate is not helping the workers cope with increasing prices of basic amenities, the issue of climate-driven migration needs new policies at every level of governance. Employment must be available at the new location. Separating the area more susceptible to catastrophes caused by slow-onset events from that more susceptible to catastrophes caused by rapid-onset events is necessary to increase the effectiveness of the relocation and rehabilitation program. Undoubtedly, the intricate connection between migration and climate change has kept this work on hold until now; yet it makes no sense to overlook this problem. It is time for India to build an institutional system that focuses solely on this issue.

According to the Global Risk Report 2023, large-scale involuntary migration is a severe short- and long-term concern that climate change may intensify. The 2020 COVID-19 pandemic served as a stark warning of the harmful effects of unmanaged human movements. Climate-driven migration has far-reaching consequences for the lower strata of society, including negative social and economic ramifications.

Until now, the complicated and multidimensional nature of climate-induced migration has served as a practical justification for inaction. Currently, area-specific research is playing a critical role in increasing policymakers' attention and concern for this issue. India is taking proactive initiatives to address the issue; the most recent is the inclusion of questions about natural catastrophes as a cause of migration in its next census. (Singh, 2023) It is a great start, but to fully address the impact of

climate change on migration, these natural hazards must be further broken down into weather-related and geophysical hazards, as the IDMC does. Collecting migrants' data immediately after disasters will also be beneficial. This issue necessitates a combination of research and policy, and integrating both is critical to overcoming it.

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Ageing in India: Mapping the Interstate Variation of Demographic, Socioeconomic and Health Variables Using LASI Wave 1 Data

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Abstract

This study used data from the Longitudinal Ageing Study in India (LASI) 2017-18 to examine the socio-demographic, economic, and health characteristics of older adults (60 years and above) in India. Using a multistage stratified sampling design, the analysis included 31,464 individuals across 35 states and union territories. Key findings highlight significant regional disparities in socio-demographic factors, such as age, gender, caste, religion, living arrangements, educational level, and economic status. For instance, most older adults reside in rural areas, where educational levels are notably lower. Economically, older adults in states like Chhattisgarh are often classified as poor, whereas Goa and Punjab report higher wealth indices. Health issues also vary, with high rates of depressive symptoms (33.94%) and disabilities in Activities of Daily Living (ADL) and Instrumental Activities of Daily Living (IADL) across the country. Regions such as Kerala and Tamil Nadu show a high prevalence of depressive symptoms and ADL/IADL disabilities, while states like Nagaland and Meghalaya demonstrate lower rates of health challenges. Life satisfaction is greatest in states such as Himachal Pradesh, with notable regional differences in mental and physical health. The findings emphasise the urgent need for region-specific policies and interventions to address the diverse challenges faced by older adults in India, including mental health support, disability care, and socio-economic development.

Keywords: Older adults, interstate variation, self-rated health, depressive symptoms, disability (ADL & IADL), and life satisfaction

Introduction

According to United Nations data, India has overtaken China to become the world's most populous country, with a population of 1.42 billion. China's population is also reported as

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1.42 billion by the UN World Population Dashboard (United Nations, 2015). India, one of the most populous countries in the world, is undergoing a significant transformation in its demographic landscape. Over the years, various socio-economic factors, improved healthcare, and changing societal dynamics have contributed to shifts in the age structure of the population, leading to an ageing population in India (Jamuna, 2000).

This ageing population presents unique challenges and opportunities for India that require careful consideration and planning by policymakers, healthcare providers, and society as a whole (World Population Ageing, 2019). An increasing median age characterises population ageing, driven by declining fertility rates and rising life expectancy. Developed countries such as Japan, Italy, Finland, Portugal, and Germany exemplify this trend.

As countries develop, they enter the fourth stage of demographic transition, characterised by declines in both birth and death rates, resulting in an ageing population. In contrast, developing countries often have high birth rates and low death rates, leading to a predominantly young population. For instance, India boasts the highest youth population, with 356 million individuals. Meanwhile, among the elderly population, China leads with 167 million, followed by India with 103 million (LASI, 2017).

Population ageing results from declines in mortality and fertility rates and is closely linked to demographic transitions. This shift can significantly alter a population's age structure by increasing the proportion of older individuals and decreasing the proportion of children. As mortality rates decrease, life expectancy rises, and the number of survivors increases, thereby directly contributing to the growth of the aged population. Conversely, a decline in fertility changes age ratios, further contributing to population ageing (Bhagat & Kumar, 2011).

The consequences of this demographic shift are extensive. A broader base in the age pyramid raises concerns about potential labour shortages and increased dependency ratios, necessitating innovative workforce strategies and robust social security systems. Ageing also presents unique challenges for healthcare systems, as there are rising costs associated with chronic non-communicable diseases and mental health issues (Kastor et al., 2018).

On a global scale, the elderly population (aged 60 and above) is projected by the UN Population Division to grow from just under 800 million today (11% of the total population) to over 2 billion by 2050 (22% of the total population). While the world population is expected to increase 3.7 times from 1950 to 2050, the number of individuals aged 60 and above will rise nearly tenfold (World Population Ageing, 2019).

According to the 2011 Census of India, there were 103 million people aged 60 and above, representing 8.6% of the country's total population. By 2050, this number is projected to rise to 319 million, with an annual growth

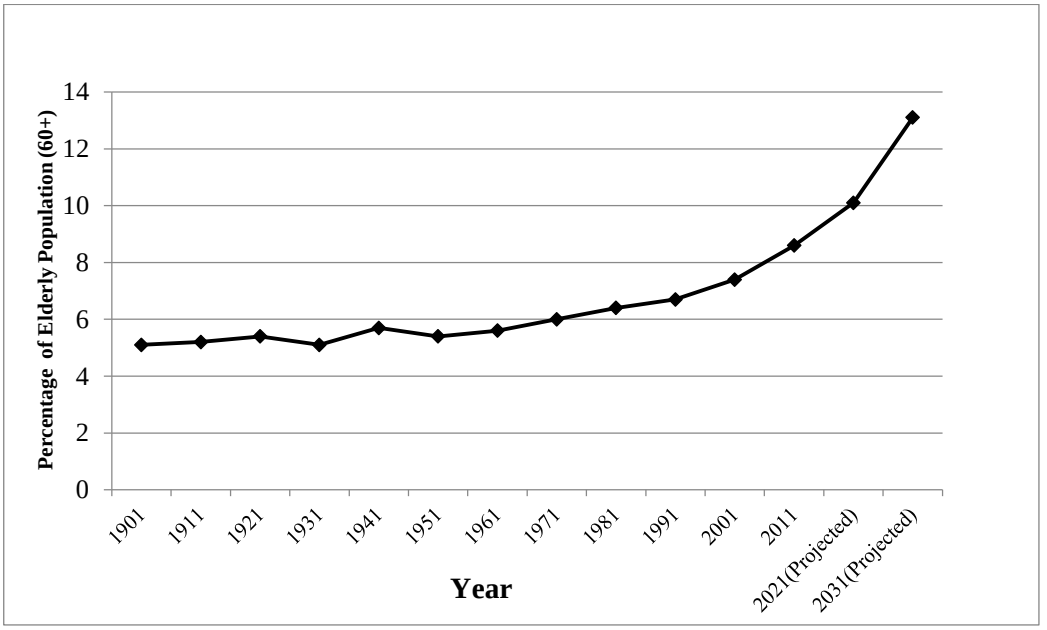
rate of 3% (World Population Ageing, 2019).

This study is motivated by several factors. Over the past 20 years, demographic, economic, and epidemiological changes have increased the proportion of Indians aged 60 and older (Kastor et al., 2017). However, the rate of this demographic shift varies across different geographic regions and socio-economic groups. Despite numerous extensive surveys, there is limited information on socio-demographic, economic, and health characteristics at the state level in India.

Additionally, socio-economic development and demographic transition stages differ significantly across states. Understanding the spatial distribution of older adults, along with variations in their socio-demographic, economic, and health characteristics, is therefore crucial. This study aims to investigate these spatial variations across India's states. India has experienced a change in trends in the elderly population (aged 60 and above) from 1901 to the projected figures for 2031, highlighting the broader demographic shift towards an ageing population (Figure 1).

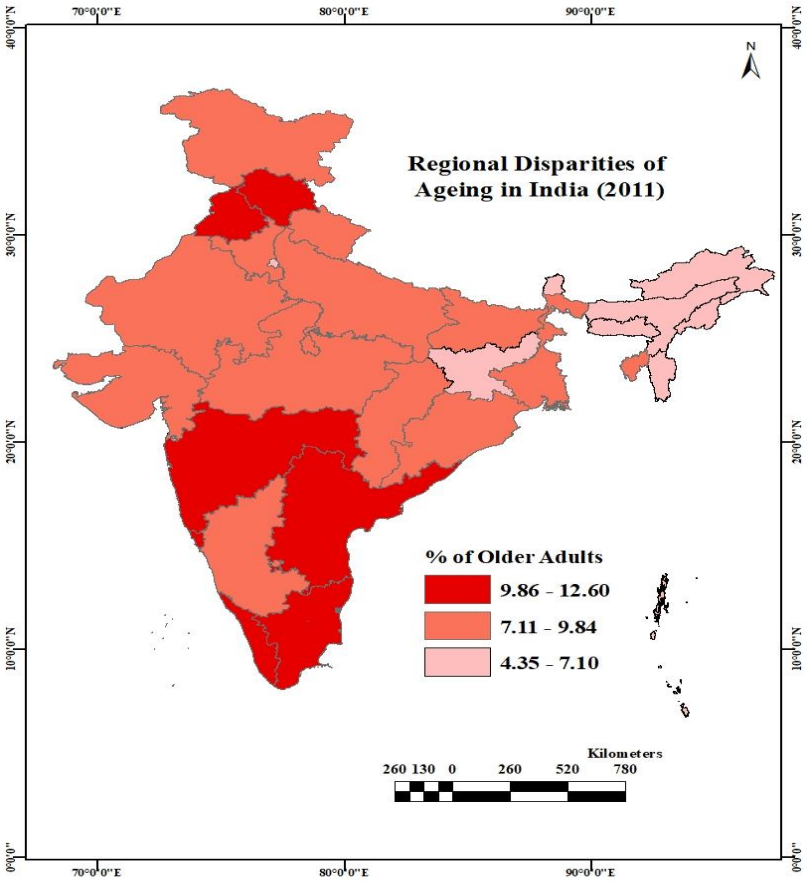
Figure 1

Trends of the Elderly in India



Source of Data: Up to 2011, Population Census Data, for 2021 and 2031 Report of the Technical Group on Population Projections, November 2019, Population Projections for India and States 2011-2036, (*Projected Figure)

Figure 2



Source of data: Census of India (2011)

Regional Disparities of Ageing in India

A picture illustrating regional disparities in ageing across Indian states, using a choropleth map (Figure 2) to show the percentage of the elderly population (60+) exhibits states with high percentages, such as Kerala, Goa, Andhra Pradesh, Maharashtra, Punjab, and Himachal Pradesh, alongside those with the lowest percentages, including Meghalaya, Arunachal Pradesh, Mizoram, Nagaland, Dadra & Nagar Haveli, Daman & Diu, Bihar, Sikkim, Assam, and Delhi. The latter group reflects earlier stages of ageing, attributed to higher fertility rates and younger populations. Kerala stands out for its high life expectancy and healthcare standards, which contribute to its larger elderly population.

Data and Methods

Study Design and Sample

We used data from Wave 1 (2017–18) of the Longitudinal Ageing Study in India (LASI), the first nationwide survey to provide comprehensive information on ageing, social relationships, family support, and life

satisfaction among older adults in India. While LASI covers individuals aged 45 and above, our analysis focused on respondents aged 60 years and older (IIPS, 2017). LASI employed a multistage, stratified, area-probability cluster sampling design. Primary sampling units (PSUs)—sub-districts or Tehsils/Talukas—were selected using Probability Proportional to Size (PPS), followed by the selection of secondary sampling units (SSUs) from rural villages and urban wards (IIPS, 2017). In the final stage, a fixed number of households were chosen from each selected village and census enumeration block (CEB). Wave 1 of LASI included 72,250 individuals aged 45 and above. For this study, we analysed a subsample of 31,464 adults aged 60 and older from 35 Indian states and Union Territories (excluding Sikkim) (IIPS, 2017).

Tools & Techniques

Centre for Epidemiological Studies-Depression Screening Tool (CES-D)

The abbreviated Centre for Epidemiological Studies-Depression (CES-D) scale was created by Andresen et al. (1994). One on the CES-D-10 means "rarely or never (less than one day)," two means "sometimes (1 or 2 days)," three means "often (3 or 4 days)," and four means "most or all of the time (5–7 days)." All ten items on the test had the same rating system. The cut-off scores for depressed symptoms were 19 or higher, while total scores might vary from 10 to 40 (Andresen et al., 1994).

Satisfaction with Life Scale

To measure life satisfaction, LASI employed five items: (i) I am happy with my life; (ii) I have excellent circumstances; (iii) I am almost ideal in most parts of my life; (iv) I now have the main things I want in life; and (v) If I could go back in time, I would change very little. All five questions were answered using a Likert scale with a range of 1 to 7, and the codes "Strongly disagree," "Somewhat disagree," "Slightly disagree," "Neither agree nor disagree," "Slightly Agree," "Somewhat Agree," and "Strongly Agree" followed. The internal consistency of the five items was evaluated using Cronbach's alpha. An extremely high level of internal consistency and reliability was indicated by the Cronbach's alpha value of 0.90. The five items listed above were combined to get the final life satisfaction variable. The continuous life satisfaction variable has a mean of 23.93, a standard deviation of 7.25, and a range of 5 to 35. Older adults who scored less than 20 were considered to be low satisfied, those who scored between 20 and 25 as medium satisfied, and those who scored 26 or more as highly satisfied.

ADL and IADL Disability

The study's outcome variables, Activities of Daily Living (ADL) and Instrumental Activities of Daily Living (IADL), are binary and dichotomous measures. ADLs encompass difficulties in getting in and out of

bed, dressing, eating, bathing, using the toilet, and moving around the room. IADLs include challenges with shopping, making phone calls, preparing meals, tending to gardens, managing finances, taking medication, and adjusting to new situations. The assessment of these outcome variables is derived from a self-reported health questionnaire that asks, "Do you have any difficulty related to ADLs and IADLs?" Responses are coded as "Yes" (1) and "No" (0).

ADL scores were converted to a scale of 0 to 6, with higher scores indicating increased dependence (Cronbach's Alpha: 0.93) (Joe et al., 2020). Arokiasamy (2016) observed that a score of 0 signifies complete independence in ADLs, while a score of 6 indicates complete dependence. Similarly, the IADL scale ranges from 0 to 7, with higher scores indicating greater dependence on instrumental activities of daily living. A score of 2 or above indicates high IADL dependence, while a score of 1 or less suggests low IADL dependence. In this context, a score of 7 signifies complete dependence for IADLs, whereas a score of 1 or lower indicates independence.

Study Covariates

The study's variables have been categorised based on previous research in the field. Living arrangements are divided into two groups: Non-Empty Nesters (those living with husband and children or with children) and Empty Nest older adults (those living alone, with a spouse, or with others). Additional variables include age (60–64, 65–69, 70–74, and 75 years and older), sex (male and female), caste (SC, ST, OBC, and General), religion (Hindu, Muslim, Christian, and Others), and place of residence (rural and urban). Marital status is categorised into two groups: currently married and others (includes never married, widowed, divorced / separated /or deserted). Educational status includes No education, Primary, Upper Primary, and Secondary. Employment status is recorded as Yes or No. The wealth index for monthly per capita consumption and expenditure is classified into three categories: poor, middle, and rich. Self-rated health is divided into Poor, Fair, and Good. Table 1 provides full details of each explanatory variable.

Statistical Analysis

The study utilised Stata 16 to compute descriptive statistics for the target population, including cross-tabulations and univariate analyses to explore variable relationships. Choropleth maps provided a clear visual representation of interstate variation, aiding geographic comparisons and identifying regions that need targeted interventions based on observed disparities.

Table 1

Definition/Codes of the Variables

Variables	Code/Definition
Age Group	0 = 60-64 Years, 1 = 65-69 Years, 2 = 70-74 Years, 3 = 75 and above Years
Sex	0 = Male, 1 = Female
Caste	0 = SC, 1 = ST, 2 = OBC, 3 = General
Religion	0 = Hindu, 1 = Muslim, 2 = Christian, 3 = Sikh, 4 = Others
Residence	0 = Rural, 1 = Urban
Marital Status	0 = Currently Married, 1 = Others
Living Arrangement	0 = Empty Nesters (living alone or with spouse and others), 1 = Non-Empty Nesters (living with spouse and children or with children)
Educational Status	0 = No Education, 1 = Primary, 2 = Upper Primary, 3 = Secondary
MPCE	0 = Poor, 1 = Middle, 2 = Rich
Working Status	0 = Currently Working, 1 = Not Working
Financial Support	0 = No, 1 = Yes
Self-Rated Health	0 = Poor, 1 = Fair, 2 = Good
Depressive Symptoms	0 = Not Depressed, 1 = Depressed
Life Satisfaction	0 = Low Satisfied, 1 = Medium Satisfied, 2 = High Satisfied
ADL Difficulty	0 = No, 1 = Yes
IADL Difficulty	0 = No, 1 = Yes

Results

Background Characteristics of the Study Participants

A comprehensive overview of the background characteristics of the elderly population (aged 60 and older) in India in 2017–18 is presented in Table 2. The sample reflects a diverse representation of socio-demographic, economic, and health-related factors that shape the lives of older adults.

The majority of the elderly population falls within the younger age brackets, with 32.2% aged 60–64 years and 28.1% aged 65–69 years, together accounting for over 60% of the sample. Additionally, 21.45% are aged 75 and above. Females slightly outnumber males, constituting 52.02% of the population.

In terms of caste distribution, Other Backward Classes (OBC) make up the largest group at 37.85%, followed by the General category at 29.32%. The Scheduled Castes (SC) and Scheduled Tribes (ST) groups together account for approximately 33%.

Religiously, Hindus dominate the sample at 73.22%, followed by Muslims at 11.86%, Sikhs at 10.01%, Christians at 3.11%, and others at 1.8%. The majority of older adults reside in rural areas (65.87%), while 34.13% live in urban settings.

Regarding living arrangements, 69.55% live with family members (classified as non-empty nesters), while 30.45% are classified as empty-nesters, indicating a significant proportion live independently or without direct family support. Over half of the elderly population (53.68%) has no formal education, while 18.56% have completed primary education and 18.18% have attained secondary education.

In terms of economic status, 41.19% belong to the poor income group, followed by 38.42% in the rich category and 20.39% in the middle-

income category. The majority of participants (63.31%) are currently married, while 36.69% fall into other categories, including widowed, separated, or never married.

About employment, 41.04% are currently employed, while 58.96% are not. Health-related data show that 23.1% rate their health as poor, 43.45% as fair, and 33.46% as good. Depressive symptoms are prevalent among 33.94% of participants, indicating a significant mental health burden. Life satisfaction is reported as high among 45.61% of the elderly, while 23.78% express low satisfaction.

Disabilities related to Activities of Daily Living (ADL) and Instrumental Activities of Daily Living (IADL) also vary within the population; 21.36% experience ADL disabilities, whereas IADL disabilities affect a larger portion at 33.33%. Notably, an overwhelming majority (85.32%) of older adults receive no financial support, highlighting potential economic vulnerability within this demographic.

Table 2

Background Characteristics of the Older Adults (60 Years and Above)

Variables & Category	Frequency	Percentage (%)
Age Group		
60-64 Years	10,132	32.20
65-69 Years	8,842	28.10
70-74 Years	5,741	18.25
75 and above	6,749	21.45
Sex		
Male	15,098	47.98
Female	16,366	52.02
Caste		
SC	5,140	16.37
ST	5,173	16.47
OBC	11,886	37.85
General	9,208	29.32
Religion		
Hindu	23,037	73.22
Muslim	3,731	11.86
Christian	979	3.11
Sikh	3,150	10.01
Others	567	1.80
Residence		
Rural	20,725	65.87
Urban	10,739	34.13
Living Arrangements		
Empty Nest	9,581	30.45
Non-Empty Nesters	21,883	69.55
Educational Status		
No Education	16,889	53.68
Primary	5,840	18.56
Upper Primary	3,015	9.58
Secondary	5,720	18.18
MPCE		
Poor	12,961	41.19
Middle	6,416	20.39
Rich	12,087	38.42
Marital Status		
Currently Married	19,920	63.31
Others	11,544	36.69
Working Status		
Currently Working	9,307	41.04
Not Working	13,373	58.96
Financial Support		
No	26,430	85.32
Yes	4,549	14.68
Self-Rated Health		
Poor	7,113	23.10
Fair	13,381	43.45
Good	10,304	33.46
Depressive Symptoms		
Not Depressed	10,315	33.94
Depressed	20,074	66.06
Life Satisfaction		
Low Satisfied	7,222	23.78
Medium Satisfied	9,295	30.61
High Satisfied	13,853	45.61
ADL Disability		
Not Disabled	24,642	78.64
Disabled	6,694	21.36
IADL Disability		
Not Disabled	20,863	66.67
Disabled	10,432	33.33

Interstate Variation of Socio-Demographic Aspects Among the Older Adults in India (2017 –18)

Considerable differences exist in socio-demographic variables among older adults across various states and union territories in India, based on 2017-18 data (Table 3). The percentages of older adults are divided into four age groups: 60-64, 65-69, 70-74, and 75 and above. For instance, Himachal Pradesh has the highest percentage (31.56%) of older adults in the 60-64 age group, while Nagaland has the largest proportion (32.24%) of those aged 75 and above. States like Jammu & Kashmir and Punjab exhibit a relatively even distribution across all age groups.

Most older adults in many states live in rural areas, with Himachal Pradesh (90.5%) and Bihar (89.99%) having the highest rural populations. In contrast, union territories such as Chandigarh (98.98%) and Delhi (98.38%) are predominantly urban. The gender ratio also varies, with females outnumbering males in states like Manipur (56.93%) and Meghalaya (60.19%). Conversely, males make up a slightly higher percentage in Jammu & Kashmir (52.26%) and Dadra & Nagar Haveli (43.68%).

Educational attainment is classified into four levels: no education, primary, upper primary, and secondary. States such as Arunachal Pradesh (83.33%) and Rajasthan (69.67%) report high percentages of older adults with no formal education. In contrast, union territories like Chandigarh (46.45%) and Kerala (33.09%) have relatively high proportions of older adults with secondary education. States such as Mizoram (45.57%) also show a notable percentage of older adults with primary education. This data highlights significant regional disparities. Rural areas dominate in most states, while urban centres such as Delhi and Chandigarh exhibit a high concentration of older adults. Educational levels are markedly lower in many rural states, whereas urban areas and southern states such as Kerala have higher educational attainment among older adults. Additionally, gender distribution reveals diverse patterns, with some northeastern states exhibiting a higher proportion of females.

Similarly, Table 4 shows differences in other socio-demographic aspects among older adults in India for 2017-18. The data reveal significant variation across states in social groups, religious affiliations, living arrangements, and marital status. For social groups, Punjab has the highest proportion of Scheduled Castes (40.74%), while Nagaland records the lowest (0.82%). Scheduled Tribes are most prominent in Nagaland (97.7%) and least represented in Punjab (1%). Tamil Nadu has the highest proportion of Other Backward Classes (81.38%), whereas Arunachal Pradesh reports none. The general category is most common in Jammu & Kashmir (73.31%) and least represented in Dadra & Nagar Haveli (9.09%).

Regarding religion, Himachal Pradesh has the highest percentage of Hindus at 97.1%, while Lakshadweep

has the lowest at 0.6%. Lakshadweep also has the highest proportion of Muslims at 99.4%, with Mizoram reporting none. Christianity is most prevalent in Mizoram at 99.81% and is absent in Bihar. Sikhs constitute the largest group in Punjab at 76.39%, but are underrepresented in several other states. The "Others" religious category, which includes indigenous faiths, is highest in Arunachal Pradesh at 28.93% and lowest in Jammu & Kashmir and Punjab, where it is 0%.

Living arrangements also differ considerably. Tamil Nadu has the highest percentage of older adults living alone (50.78%), while Lakshadweep records the lowest (17.73%). Conversely, Lakshadweep has the highest proportion of non-empty nesters (82.27%), with Tamil Nadu showing the lowest (49.22%). In terms of marital status, Bihar has the highest percentage of married older adults (71.02%), whereas Meghalaya has the lowest (50.73%). The "Others" category, which includes widowed, separated, or never-married individuals, is most common in Meghalaya (49.27%) and least common in Bihar (28.98%).

Figure 3 highlights significant interstate differences in sex composition, representation of backward classes, empty-nesters (those living alone), rural populations, and uneducated older adults in India between 2017 and 18. Northern and eastern states such as Uttar Pradesh and Bihar have a higher proportion of elderly residents living in rural areas. In contrast, southern and western states like Tamil Nadu and Maharashtra place greater emphasis on urban regions. The gender distribution shows that central and northern states have a larger share of elderly men, whereas states like Kerala and Tamil Nadu have a higher proportion of elderly women. The spatial distribution reveals distinct regional patterns: central, eastern, and southern states exhibit higher concentrations of older adults from lower socioeconomic backgrounds, while northern and northeastern states report relatively lower proportions. A similar regional divide is evident in educational attainment, with most central, northern, and eastern states recording a higher share of older adults with no formal education.

These findings demonstrate substantial state-level disparities in the socio-demographic composition of older adults in India. The diversity reflects varying cultural, religious, and social norms across the country, emphasising the need for tailored policies and programs for older adults. Figure 4 illustrates the educational status and living arrangements of older adults across different states in India. The figure shows that educational attainment among older adults varies significantly across states, with some regions, such as Kerala, having a higher proportion of educated older adults, while others, such as Bihar and Uttar Pradesh, report a larger proportion of older adults with no education.

Similarly, the living arrangements of the elderly are examined, revealing considerable differences in the

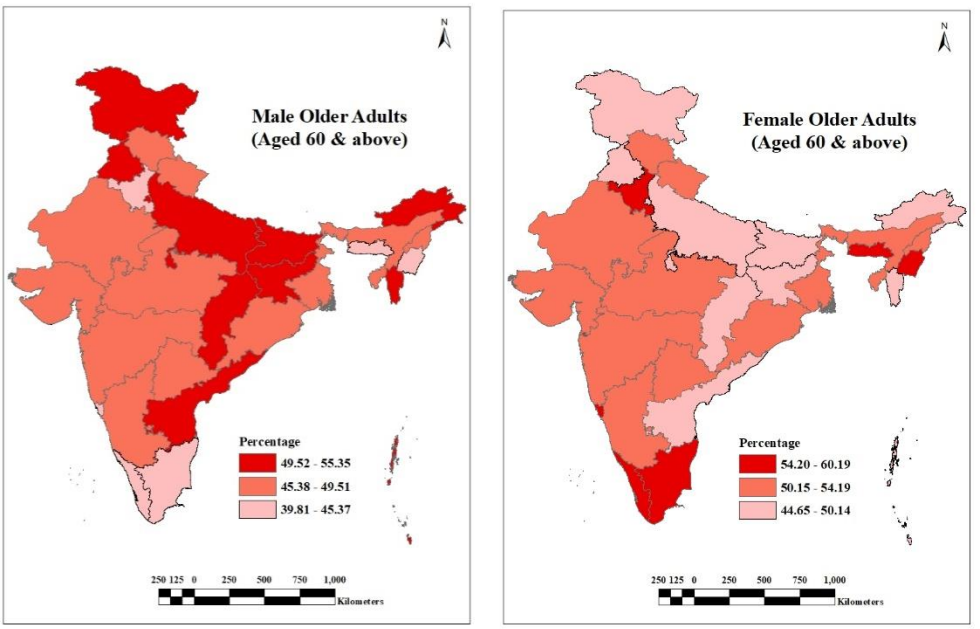
proportion of empty-nest and non-empty-nest older adults across states. States such as Kerala, Goa, and Tamil Nadu show a higher prevalence of non-empty-nest older adults. In contrast, states like Rajasthan and Uttar Pradesh have a higher proportion of older adults in the empty nest. These regional variations underscore the diverse social and educational conditions of older adults, underscoring the need for tailored interventions tailored to local contexts.

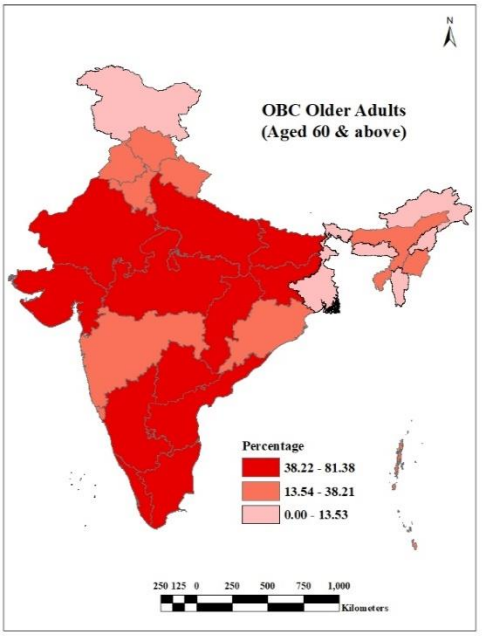
Interstate Variation of Economic Inequalities Among the Older Adults in India (2017-18)

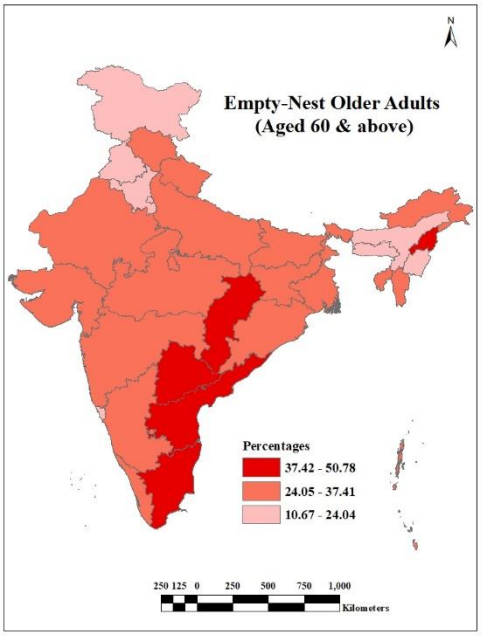
Table 5 presents state-wise variation in economic indicators among older adults in India for 2017–18, highlighting disparities in monthly per capita consumption expenditure, employment status, and financial support. The proportion of older adults categorised as "poor" varies significantly across states. Chhattisgarh reports the highest percentage of poor individuals at 75%, while Chandigarh has the lowest at 13.96%. The middle-income group is most prevalent in Mizoram at 25.8% and least prevalent in Chhattisgarh at 11.15%. In terms of wealth, Goa leads with 62.01% of older adults classified as rich, while Chhattisgarh has the lowest proportion at 13.85%.

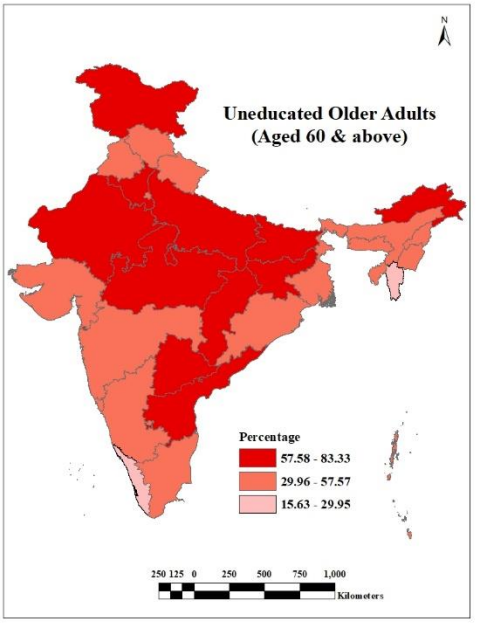
Figure 3

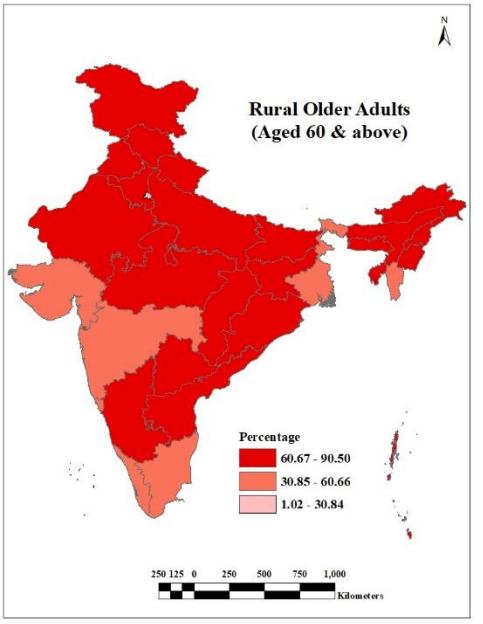
State Level Patterns of Sociodemographic Characteristics Among the Older Adults in India (2017–18)











Source of data: LASI Wave 1 (2017-18)

The employment status of older adults varies considerably across states. Arunachal Pradesh has the highest percentage of working older adults at 74.27%, whereas Lakshadweep records the lowest at 12.5%. Conversely, the highest proportion of non-working older adults is found in Lakshadweep at 87.5%, while Arunachal Pradesh has the lowest at 25.73%.

Regarding financial support, the percentage of older adults not receiving any assistance is highest in Chandigarh at 95.32% and lowest in Nagaland at 67.6%. Conversely, the proportion of older adults receiving financial support is highest in Nagaland at 32.4% and lowest in Chandigarh at 4.68%.

These findings reveal significant regional disparities. For instance, states such as Bihar (56.42%) and Odisha (54.89%) have a high proportion of poor older adults, while wealthier states like Goa (62.01%) and Punjab (60.36%) show a higher representation in the affluent category. Working status is more common in northeastern states like Arunachal Pradesh (74.27%) and Nagaland (58.44%), whereas union territories such as Lakshadweep (12.5%) and Goa (23.01%) have fewer working older adults.

Overall, these findings highlight substantial state-level disparities in the economic conditions faced by older adults across India. Figure 5 illustrates the economic inequalities among older adults across different Indian states.

The graph illustrating variations in monthly per capita consumption and expenditure shows that states like Kerala and Goa have higher consumption rates. This suggests relatively better economic conditions for older adults in these regions.

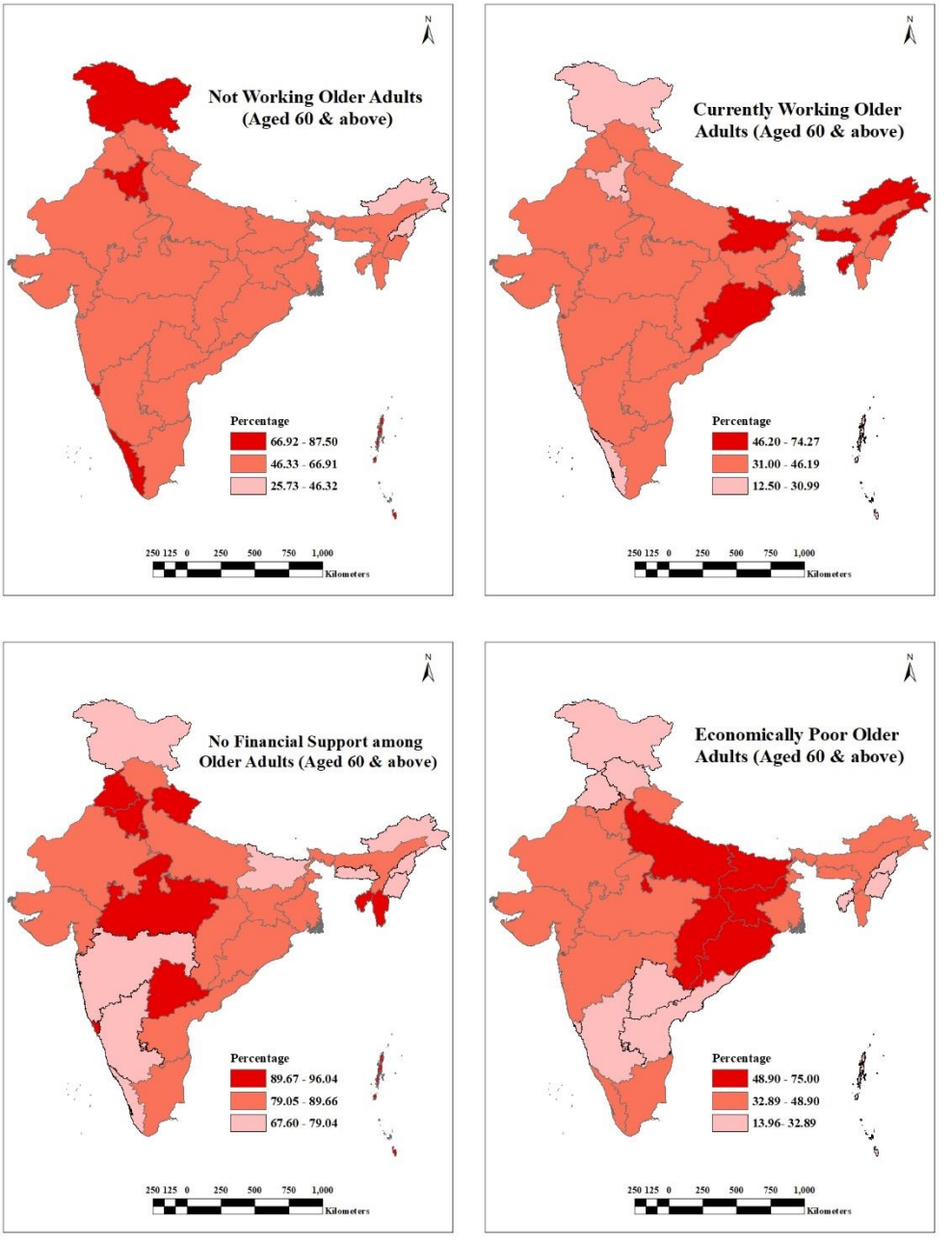
Additionally, the graph reveals the employment status of older adults; many remain employed or engaged in economic activities in states such as Gujarat and Maharashtra, while regions like Bihar and Uttar Pradesh exhibit lower employment rates among older adults.

The availability of financial support is another crucial aspect highlighted in Figure 5. It indicates that a larger proportion of older adults in states like Delhi and Punjab receive financial assistance.

In contrast, states such as Jharkhand and Assam have lower levels of financial support for their older populations.

Figure 5

State-Level Patterns of Economic Inequalities Among Older Adults in India (2017–18)



Source of data: LASI Wave 1 (2017-18)

Interstate Variation of Various Health Issues Among the Older Adults in India (2017-18)

Table 6 presents state-wise variations in health indicators among older adults in India for 2017–18. It covers self-rated health, depressive symptoms, life satisfaction, and disabilities related to Activities of Daily Living (ADL) and Instrumental Activities of Daily Living (IADL).

Self-rated health among older adults differs across states. Meghalaya has the highest percentage of individuals rating their health as "good" at 67.07%, while Tamil Nadu reports the lowest at 10.81%. States such as Kerala (50.85%) and Tamil Nadu (50.2%) have a large proportion of older adults rating their health as "poor," indicating significant health difficulties in these regions.

The prevalence of depressive symptoms also varies. Lakshadweep (87.6%), Andhra Pradesh (72.69%), and Tamil Nadu (62.99%) report higher rates of depression, while Jammu & Kashmir (40.43%) and Chhattisgarh (56.94%) have lower rates.

Life satisfaction, categorised into low, medium, and high levels, shows significant differences across states. Himachal Pradesh has the highest percentage of older adults with high life satisfaction at 74.09%, while Kerala (40.02%) and Tamil Nadu (46.39%) show lower levels. States like Telangana (36.84%) and Andhra Pradesh (39.81%) also have a significant proportion of individuals reporting low life satisfaction.

The prevalence of ADL disabilities is lowest in Nagaland (6.1%) and highest in West Bengal (36.08%), indicating varying levels of dependence on others for basic daily tasks. Gujarat (25.13%) and Bihar (24.58%) show moderate levels of ADL disability.

IADL disability rates, which reflect limitations in performing more complex tasks, are highest in Tamil Nadu (41.73%) and West Bengal (43.67%). In contrast, states like Nagaland (17.3%) and Arunachal Pradesh (16.67%) report much lower levels of IADL disability.

Significant disparities exist across regions. Northeastern states like Meghalaya and Nagaland show better self-rated health and lower disability rates. In contrast, southern states like Kerala and Tamil Nadu report higher rates of poor health, depressive symptoms, and IADL disabilities. States such as Himachal Pradesh and Puducherry exhibit higher life satisfaction compared to regions like West Bengal and Andhra Pradesh.

These findings underscore the diverse health challenges faced by older adults across India, highlighting the need for targeted health interventions to address state-specific issues effectively.

Figure 6 focuses on the physical, functional, and mental health of older adults across different states. The map illustrates distinct interstate variations in poor self-rated health among older adults in India. Southern states, particularly Kerala and Tamil Nadu, report the highest prevalence of poor self-rated health, while many

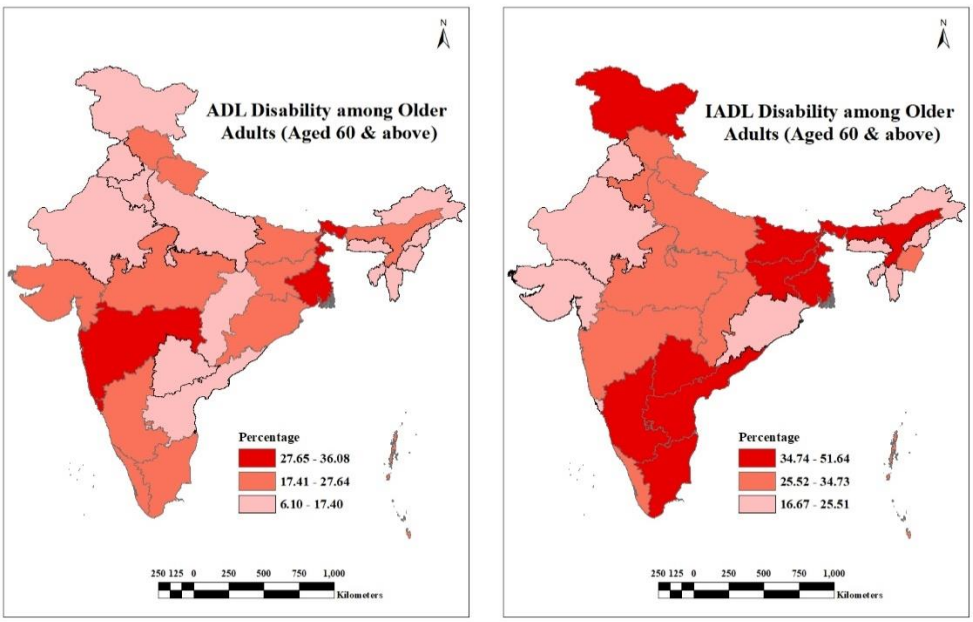
northern and central states lie in the moderate range. In contrast, several eastern, northeastern, and western states demonstrate relatively lower levels of poor self-rated health among older adults.

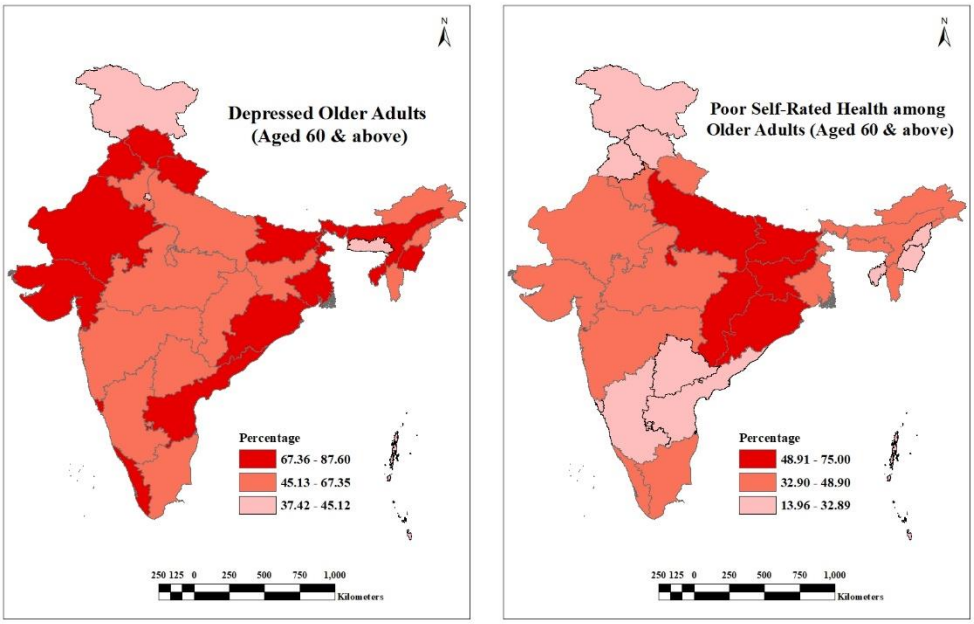
The accompanying figure shows variations in the prevalence of functional health issues (such as ADL and IADL disabilities) and mental health challenges (such as depressive symptoms). States like Kerala and Goa show lower levels of disability, possibly due to better healthcare and social support systems. Conversely, states like Bihar, Uttar Pradesh, and Madhya Pradesh exhibit higher levels of disability, indicating significant challenges in terms of functional health. Mental health is another critical aspect explored in this figure, revealing that states with higher levels of disability, such as Uttar Pradesh and Bihar, also have higher levels of depressive symptoms. This indicates a correlation between physical limitations and mental health challenges among older adults, emphasising the need for integrated healthcare strategies that address both physical and mental health needs.

Figure 7 examines low life satisfaction among older adults across various Indian states. Low life satisfaction is highest in southern and eastern states, moderate across northern India, and lowest in a few central and western states. Bihar and Uttar Pradesh have a particularly high percentage of older adults reporting low life satisfaction.

Figure 6

State-Level Patterns of Physical, Functional & Mental Health Among Older Adults in India (2017– 18)

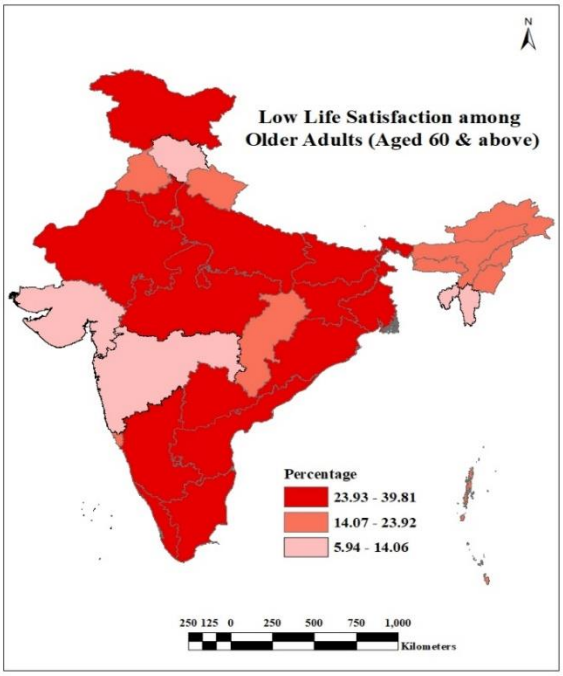




Source of data: LASI Wave 1 (2017-18)

Figure 7

State Level Patterns of Low Satisfaction With Their Life Among Older Adults in India (2017–18)



Source of data: LASI Wave 1 (2017-18)

These findings highlight how regional healthcare infrastructure, socio-economic conditions, and social support systems impact the overall well-being of older adults. States with better access to healthcare, social support, and favourable economic conditions tend to report higher life satisfaction and better health outcomes among older adults.

This emphasises the importance of investing in healthcare, social policies, and community support systems to improve the quality of life for older adults in less advantaged regions. Together, Figures 3 to 7 provide a comprehensive overview of the regional disparities in socio-demographic factors, economic conditions, health status, and mental well-being of older adults across India. The findings reveal significant variations at the state level in educational attainment, economic status, health issues, and levels of physical, functional, and mental health, as well as life satisfaction.

These disparities highlight the need for region-specific interventions and policies that address the unique challenges faced by older adults across India.

Strength & Limitation

This study highlights several important issues. First, the prevalence of Activities of Daily Living (ADL) and Instrumental Activities of Daily Living (IADL) problems is based on self-reported data, which may be influenced by memory bias. Second, since the data is cross-sectional, we cannot determine a causal relationship between the independent and dependent variables. Additionally, the study considered only variables available in the dataset, potentially leading to omitted-variable bias.

Depression symptoms were self-reported using the CES-D scale, which means older adults might exaggerate or underreport their level of depression. Since the scale is subjective, responses may also be biased because of cultural interpretations. Additionally, the CES-D scale gathered data over the previous twelve months, making the results vulnerable to recall bias and inaccuracies. Social desirability may also have influenced responses regarding life satisfaction, potentially leading to inflated self-reports due to societal stigma.

Overall, the study utilises LASI Wave 1 data to examine both health and socio-economic aspects of ageing, while accounting for regional disparities. This approach, combined with its potential to inform targeted policy measures, is a significant strength. These aspects make the study a valuable contribution to understanding ageing in India and to tackling the challenges posed by an increasingly ageing population.

Conclusion

The findings of this study reveal considerable differences across Indian states in the socio-economic, demographic, and health characteristics of older adults. Using data from the Longitudinal Ageing Study in India (LASI) Wave 1, we have highlighted several key aspects that vary significantly across states and

union territories, emphasising the complex landscape of ageing in the country.

There are clear regional differences in factors such as educational attainment, living arrangements, and gender composition. States in the northern and northeastern regions show lower levels of education, with a higher percentage of older adults lacking formal schooling. Conversely, urban centres like Delhi and Kerala have a greater proportion of older adults who have completed secondary education.

Living arrangements also vary considerably; for example, Tamil Nadu reports a higher proportion of elderly living without children, indicating different caregiving and support dynamics across states. Economic conditions show wide disparities as well—states like Goa and Punjab have higher levels of wealth among the elderly, whereas states like Chhattisgarh report a larger percentage of elderly individuals living in poverty.

The employment status and financial support for older adults also vary, with northeastern states such as Arunachal Pradesh and Nagaland reporting higher employment rates among their elderly populations. In contrast, regions like Lakshadweep and Goa have a greater number of older adults relying on financial assistance.

Health indicators—such as self-rated health, depressive symptoms, life satisfaction, and disabilities related to Activities of Daily Living (ADLs) and Instrumental Activities of Daily Living (IADLs)—differ notably across states. For example, Meghalaya reports better self-rated health and lower disability rates, whereas southern states like Tamil Nadu and Kerala exhibit higher levels of poor health, depression, and IADL disabilities.

These findings highlight the diverse health challenges faced by older adults across different regions of India and emphasise the importance of region-specific health interventions. Mental health, as indicated by depressive symptoms and life satisfaction, also varies significantly by region. Himachal Pradesh stands out for its high life satisfaction, while states like Kerala and Tamil Nadu report lower satisfaction levels and a higher prevalence of depressive symptoms.

These disparities emphasise how social, economic, and health factors influence the overall well-being of older adults and highlight the need for targeted mental health and support services.

In conclusion, the study emphasises the importance of recognising regional differences in the socio-economic and health conditions of the ageing population. Given the diverse nature of India's elderly residents, state-specific policies and interventions are crucial to meet the unique needs of older adults across various regions. Customised programmes, improved healthcare services, and enhanced economic support systems can significantly improve the quality of life for elderly people across the country. Effective measures should focus on reducing

inequalities in education, health, financial stability, and social support, ensuring that ageing in India is marked by dignity, independence, and well-being for everyone.

List of Abbreviations

LASI: Longitudinal Ageing Study in India

ADL: Activities of Daily Living

IADL: Instrumental Activities of Daily Living

MPCE: Monthly Per Capita Consumption Expenditure

CESD: Centre for Epidemiological Studies-Depression

LS: Life Satisfaction

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Table 3

State-Wise Socio-Demographic Characteristics of Older Adults in India (2017–18)

States	Social Group				Religious Group				Living Arrangement (%)	
	SC	ST	OBC	General	Hindu	Muslim	Christian	Sikh	Empty Nest	Non-Empty Nester
Jammu & Kashmir	8.67	12.79	5.23	73.31	24.35	74.28	0.27	1.09	10.67	89.33
Himachal Pradesh	26.25	4.51	16.75	52.5	97.1	0.64	0	1.93	24.32	75.68
Punjab	40.74	1	16.53	41.73	22.81	0.6	0.2	76.39	20.52	79.48
Chandigarh	14.25	0.51	19.59	65.65	71.83	3.81	0.76	23.35	24.87	75.13
Uttarakhand	18.28	5.31	14.84	61.56	87.83	10.76	0.94	0.47	36.66	63.34
Haryana	20.87	0.12	32.78	46.23	90.57	6.25	0	2.71	18.75	81.25
Delhi	18.22	0.81	22.27	58.7	75.15	16.57	1.62	5.86	15.96	84.04
Rajasthan	21.17	14.95	42.8	21.08	93.78	3.34	0	1.58	33.02	66.98
Uttar Pradesh	26.83	1.94	43.43	27.8	85.2	13.97	0.05	0.28	26.23	73.77
Bihar	22.36	2.05	51.02	24.57	81.47	18.47	0	0	30.48	69.52
Arunachal Pradesh	5.03	77.67	0	17.3	17.61	0.31	53.14	0	27.04	72.96
Nagaland	0.82	97.7	0.33	1.15	1.48	0.66	97.86	0	42.11	57.89
Manipur	9.41	38.12	20.46	32.01	42.24	4.95	38.61	0	22.28	77.72
Mizoram	0.19	98.87	0.75	0.19	0.19	0	99.81	0	24.48	75.52
Tripura	27.33	31.24	22.78	18.66	85.25	0.43	6.29	0	31.02	68.98
Meghalaya	2.68	94.63	0.24	2.44	9.47	0.73	83.01	0	16.99	83.01
Assam	8.6	15.97	38.21	37.22	75.86	22.18	1.35	0	16.3	83.7
West Bengal	23.72	3.77	10.14	62.38	80.51	18.39	0.32	0.06	30.31	69.69
Jharkhand	11.9	18.24	52.91	16.95	80.82	10.79	4.11	0.34	26.63	73.37
Odisha	18.92	21.58	37.67	21.83	91.35	0.81	7.84	0	32.9	67.1
Chhattisgarh	12.82	31.41	46.67	9.1	96.79	1.67	1.15	0.13	37.69	62.31
Madhya Pradesh	12.41	12.26	54.84	20.49	92.61	5.56	0.08	0.3	34.5	65.5
Gujarat	12.65	14.18	44.69	28.47	87.99	10.6	0.81	0.2	30.17	69.83
Daman & Diu	17.02	17.95	44.06	20.98	92.63	4.84	2.07	0	36.87	63.13

Dadra & Nagar Haveli	0.89	76.5	13.53	9.09	82.04	5.32	6.65	0	27.72	72.28
Maharashtra	15.54	7.66	34.15	42.65	76.03	13.74	1.62	0.06	26.31	73.69
Andhra Pradesh	21.9	6.02	50.27	21.81	81.18	4.89	13.85	0	46.24	53.76
Karnataka	12.59	4.2	70.83	12.39	88.05	11.25	0.2	0	29.18	70.82
Goa	2.2	10.71	20.47	66.61	72.06	4.08	23.39	0.16	23.08	76.92
Lakshadweep	1.99	92.63	4.98	0.4	0.6	99.4	0	0	17.73	82.27
Kerala	6.47	1.66	51.58	40.3	57.82	18.44	23.66	0	37.3	62.7
Tamil Nadu	16.07	0.98	81.38	1.57	88.4	3.91	7.5	0	50.78	49.22
Puducherry	17.81	0.94	69.06	12.19	88.13	6.09	5.63	0	37.5	62.5
Andaman & Nicobar	14.97	23.22	19.19	42.61	54.11	7.27	38.43	0.19	28.3	71.7
Telangana	16.87	5.37	65.79	11.97	84.64	10.46	3.77	0.66	47.13	52.87
Total	16.37	16.47	37.85	29.32	73.22	11.86	10.01	3.11	30.45	69.55

Table 4

State-Wise Socio-Demographic Characteristics of Older Adults in India (2017–18)

States	Age Group (%)				Residence (%)		Sex Composition (%)	
	60-64	65-69	70-79	75 & above	Rural	Urban	Male	Female
Jammu & Kashmir	28.73	30.51	17.51	23.26	73.6	26.4	52.26	47.74
Himachal Pradesh	31.56	23.83	18.68	25.93	90.5	9.5	48.95	51.05
Punjab	29.48	28.78	21.02	20.72	72.61	27.39	49.9	50.1
Chandigarh	33.5	26.14	17.77	22.59	1.02	98.98	48.22	51.78
Uttarakhand	37.75	27.3	20.12	14.82	76.76	23.24	47.27	52.73
Haryana	33.84	26.65	19.22	20.28	70.75	29.25	42.81	57.19
Delhi	35.76	29.09	16.77	18.38	1.62	98.38	50.71	49.29
Rajasthan	34.23	25.32	16.6	23.84	79.31	20.69	46.85	53.15
Uttar Pradesh	30.66	29.09	19.23	21.02	80.22	19.78	51.59	48.41
Bihar	33.96	28.87	18.36	18.81	89.99	10.01	51.16	48.84
Arunachal Pradesh	33.33	27.04	17.61	22.01	86.16	13.84	55.35	44.65
Nagaland	25.82	24.51	17.43	32.24	74.34	25.66	49.51	50.49
Manipur	27.72	29.21	18.48	24.59	66.5	33.5	43.07	56.93
Mizoram	30.7	26.74	16.57	25.99	51.04	48.96	49.91	50.09
Tripura	37.31	24.3	15.18	23.21	78.96	21.04	49.24	50.76
Meghalaya	32.52	23.3	17.72	26.46	84.95	15.05	39.81	60.19
Assam	30.88	29.41	18.75	20.96	85.54	14.46	47.55	52.45
West Bengal	31.74	26.1	17.36	24.81	49.81	50.19	48.7	51.3
Jharkhand	37.76	24.83	17.21	20.21	79.54	20.46	50.09	49.91
Odisha	33.79	26.35	17.06	22.8	84.32	15.68	48.59	51.41
Chhattisgarh	38.08	28.08	16.54	17.31	81.54	18.46	50.26	49.74
Madhya Pradesh	31.99	26.35	16.07	25.59	74.87	25.13	49.05	50.95
Gujarat	36.02	31.48	17.46	15.04	58.32	41.68	45.81	54.19
Daman & Diu	30.88	29.26	21.66	18.2	35.48	64.52	42.4	57.6
Dadra & Nagar Haveli	32.37	33.48	19.96	14.19	66.52	33.48	43.68	56.32
Maharashtra	29.16	29.66	21.06	20.11	52.85	47.15	46.31	53.69
Andhra Pradesh	34.75	32.13	15.93	17.19	75.11	24.89	49.86	50.14
Karnataka	29.58	31.18	17.23	22.01	70.32	29.68	47.71	52.29
Goa	30.46	27.47	19.62	22.45	38.62	61.38	45.37	54.63
Lakshadweep	38.45	28.69	16.73	16.14	19.72	80.28	47.81	52.19
Kerala	28.78	27.46	18.28	25.48	52.94	47.06	44.5	55.5
Tamil Nadu	31.23	27.44	19.56	21.77	43.22	56.78	44.65	55.35
Puducherry	30.94	28.13	19.69	21.25	27.66	72.34	42.97	57.03
Andaman & Nicobar	35.95	26.58	15.87	21.61	63.1	36.9	52.77	47.23
Telangana	26.96	32.23	20.08	20.74	68.71	31.29	47.31	52.69
Total	32.2	28.1	18.25	21.45	65.87	34.13	47.98	52.02

Table 5

State-Wise Socio-Economic Characteristics of Older Adults in India (2017–18)

States	MPCE Quintile (%)		Working Status (%)		Financial Support (%)	
	Poor	Rich	Working	Not Working	Not Getting	Getting
Jammu & Kashmir	14.36	68.81	30.95	69.05	78.56	21.44
Himachal Pradesh	26.73	52.5	44.05	55.95	86.83	13.17
Punjab	17.33	60.36	37.45	62.55	93.71	6.29
Chandigarh	13.96	65.74	26.03	73.97	95.32	4.68
Uttarakhand	41.03	34.48	38.59	61.41	94.98	5.02
Haryana	36.32	41.27	30.99	69.01	93.55	6.45
Delhi	44.44	34.75	30.69	69.31	95.91	4.09
Rajasthan	42.49	38.4	39.02	60.98	86.44	13.56
Uttar Pradesh	52.51	25.54	46.19	53.81	86.74	13.26
Bihar	56.42	24.72	49.04	50.96	69.15	30.85
Arunachal Pradesh	39.62	42.14	74.27	25.73	68.55	31.45
Nagaland	27.3	51.32	58.44	41.56	67.6	32.4
Manipur	20.63	59.9	45.14	54.86	75.93	24.07
Mizoram	46.89	27.31	41.46	58.54	96.04	3.96
Tripura	32.32	44.03	50.45	49.55	93.99	6.01
Meghalaya	44.66	34.71	50.0	50.0	78.38	21.62
Assam	48.9	31.86	42.72	57.28	88.85	11.15
West Bengal	42.16	36.27	41.74	58.26	86.0	14.0
Jharkhand	52.14	24.57	45.47	54.53	85.09	14.91
Odisha	54.89	23.93	50.54	49.46	87.85	12.15
Chhattisgarh	75	13.85	39.71	60.29	84.54	15.46
Madhya Pradesh	43.95	38.61	41.45	58.55	90.83	9.17
Gujarat	39.96	39.66	40.94	59.06	89.66	10.34
Daman & Diu	30.65	51.15	30.06	69.94	85.37	14.63
Dadra & Nagar Haveli	57.21	24.39	59.38	40.63	91.28	8.72
Maharashtra	43.46	35.31	39.7	60.3	76.57	23.43
Andhra Pradesh	29.41	50.32	38.51	61.49	87.8	12.2
Karnataka	26.69	47.11	42.17	57.83	77.7	22.3
Goa	18.21	62.01	23.01	76.99	93.94	6.06
Lakshadweep	60.36	20.32	12.5	87.5	83.17	16.83
Kerala	37.8	44.33	24.86	75.14	79.04	20.96
Tamil Nadu	42.44	37.35	42.02	57.98	88.75	11.25
Puducherry	55.94	25.78	33.59	66.41	83.94	16.06
Andaman & Nicobar Island	30.97	48.76	21.78	78.22	94.98	5.02
Telangana	32.89	47.6	36.62	63.38	92.53	7.47
Total	41.19	38.42	41.04	58.96	85.32	14.68

Table 6

State-Wise Health Profile of Older Adults in India (2017–18)

	Self-Rated Health (%)		Depressive Symptoms (%)		Life Satisfaction (%)		ADL Disability (%)		IADL Disability (%)	
States	Poor	Good	No	Yes	Low	High	No	Yes	No	Yes
Jammu & Kashmir	26.75	34.87	59.57	40.43	26.95	26.95	82.6	17.4	48.36	51.64
Himachal Pradesh	26.11	30.05	28.88	71.12	5.94	74.09	76.18	23.82	65.48	34.52
Punjab	21.8	21.7	23.1	76.9	19.67	53.86	83.92	16.08	75.42	24.58
Chandigarh	16.49	42.53	38.01	61.99	6.81	75.2	81.25	18.75	77.55	22.45
Uttarakhand	18.84	23.7	28.28	71.72	17.03	55.21	78.78	21.22	70.2	29.8
Haryana	24.31	34.85	32.65	67.35	25.97	43.57	86.66	13.34	69.19	30.81
Delhi	12.12	43.64	62.58	37.42	23.11	41.72	76.52	23.48	75.51	24.49
Rajasthan	20.49	39.66	22.24	77.76	32.7	32.05	92.2	7.8	76.14	23.86
Uttar Pradesh	25.29	28.77	35.91	64.09	26.58	36.44	82.68	17.32	65.27	34.73
Bihar	21.37	33.47	30.51	69.49	25.43	43.23	75.42	24.58	57.23	42.77
Arunachal Pradesh	9.49	54.75	45.86	54.14	17.46	40	88.68	11.32	83.33	16.67
Nagaland	8.12	52.96	38.54	61.46	23.16	41.23	93.9	6.1	82.7	17.3
Manipur	15.45	40.92	21.11	78.89	23.92	42.46	88.93	11.07	66.61	33.39
Mizoram	12.42	47.45	38.04	61.96	6.94	57.96	83.99	16.01	78.34	21.66

Tripura	23.97	17.65	14.57	85.43	14.06	43.97	84.75	15.25	74.51	25.49
Meghalaya	5.12	67.07	62.1	37.9	15.65	54.28	89.54	10.46	75.18	24.82
Assam	21.18	29.95	26.61	73.39	20.05	44.14	79.73	20.27	60.39	39.61
West Bengal	31.65	17.65	27.86	72.14	31.21	28.8	63.92	36.08	56.33	43.67
Jharkhand	19.25	37.21	34.97	65.03	30.51	38.37	80.1	19.9	62.09	37.91
Odisha	22.85	24.17	24.69	75.31	32.42	34.74	79.43	20.57	81.46	18.54
Chhattisgarh	10.26	42.37	43.06	56.94	21	43.59	82.93	17.07	70.99	29.01
Madhya Pradesh	23.18	42.25	46.42	53.58	28.17	46.83	75.23	24.77	65.32	34.68
Gujarat	14.26	51.55	21.17	78.83	6.84	78.85	74.87	25.13	74.49	25.51
Daman & Diu	13.18	55.53	25.24	74.76	9.4	75.42	66.28	33.72	71.19	28.81
Dadra & Nagar Haveli	17.04	49.55	21.94	78.06	12.04	59.49	78.03	21.97	65.95	34.05
Maharashtra	15.55	30.48	38.22	61.78	13.64	64.44	64.94	35.06	66.91	33.09
Andhra Pradesh	22.67	34.47	27.31	72.69	39.81	41.87	84.79	15.21	60.77	39.23
Karnataka	11.04	44.27	48.11	51.89	30.81	38.17	80.98	19.02	51.55	48.45
Goa	32.96	38.93	23	77	16.99	44.44	64.2	35.8	77.76	22.24
Lakshadweep	21.41	39.19	12.4	87.6	10.66	41.6	75.6	24.4	72.4	27.6
Kerala	50.85	13.63	23.5	76.5	27.34	40.02	75.39	24.61	68.66	31.34
Tamil Nadu	50.2	10.81	37.01	62.99	28.61	46.39	75.6	24.4	58.27	41.73
Puducherry	41.12	15.52	33.12	66.88	21.43	38.8	81.16	18.84	69.07	30.93
Andaman & Nicobar	9.72	52.63	54.88	45.12	23.58	49.59	72.36	27.64	71.59	28.41
Telangana	21.51	37.38	39.86	60.14	36.84	41.81	84.16	15.84	56.01	43.99
Total	23.1	33.46	33.5	66.5	23.78	45.61	78.64	21.36	66.67	33.33

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Migration and Urbanisation in North East Indian Cities

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Abstract

Migration and natural population growth drive global urban expansion, including in Northeast India. However, studies often overlook city-specific migration patterns. This paper analyses migration trends in major Northeast Indian cities, using data on migrant stocks, inter-state migration streams, urban demographics, and statistical techniques like correlation and regression. In 2011, 1.5 million migrants made up 42% of the urban population, with intra-district and inter-district migration contributing 45% and 34%, respectively. Agartala and Nagaon saw over 100% growth in migration, while Shillong declined. Urban-to-urban migration surpassed rural-to-urban migration, with employment being the primary driver (25%). Agartala and Imphal had annual urban growth of over 4%, whereas Tezpur experienced negative growth. The study finds a moderately positive relationship between migration and urbanisation. Migration influences urban growth but has a moderate effect on urbanisation. Policies should enhance infrastructure in fast-growing cities and create regional job opportunities for balanced urbanisation.

***Keywords*:** Migration streams, interstate migration, reasons for migration, urban growth, North East India.

Introduction

Migration is defined as a movement from one migration-defining area to another, typically crossing administrative boundaries during a specific migration period and involving a change of residence (UN, 1993). Migration is a natural process that frequently occurs and is influenced by socio-economic, demographic, cultural, political, and environmental factors affecting migrant populations. It is not merely a shift of people from one place of residence to another, but is essential for understanding the constantly changing spatial content and relationships among different areas (Gosal, 1961). Migration and urbanisation are key processes that shape regional development, especially in areas with diverse socio-

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political and cultural landscapes such as North East India. This region, comprising eight states—Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, and Tripura—has experienced rapid urbanisation in recent decades. This transformation is largely driven by migration, both internal and external, which is reshaping the region's socio-economic and demographic structure (Baruah, 2020; Singh & Das, 2019). Major cities like Guwahati, Imphal, and Shillong are emerging as economic centres, attracting migrants from within the region's rural areas as well as from neighbouring countries, including Bangladesh, Myanmar, and Nepal (Datta, 2020; Gogoi, 2019). The drivers of migration in North East India are varied and complex. Internal rural-to-urban migration is mainly motivated by economic factors, such as limited employment opportunities and declining agricultural productivity in rural areas (Mitra & Banerjee, 2019; Saikia & Bhuyan, 2021).

Environmental issues such as flooding and soil erosion further exacerbate these challenges, pushing rural populations towards urban centres in search of better livelihoods (Das & Nath, 2021). Additionally, cross-border migration from neighbouring countries also plays a significant role, increasing urban populations and amplifying the demand for infrastructure and services (Singh, 2020).

Urbanisation in North East India, while fostering economic growth and modernisation, also brings considerable challenges for urban planning and governance. The region's cities are expanding rapidly, often in an unplanned and haphazard manner, leading to various infrastructure problems, including insufficient housing, traffic congestion, and inadequate sanitation (Barua & Goswami, 2020). Additionally, the strain on natural resources such as water and land has resulted in environmental degradation, raising concerns about the sustainability of these urban systems (Sharma, 2018; Das & Nath, 2021). Socially, the region's distinctive ethnic makeup adds another layer of complexity to the urbanisation process. Northeast has been known for in-migration and conflicts stemming from the influx of migrants, yet research on outmigration from the region remains scarce (Lusome & Bhagat, 2020). The arrival of migrants has sometimes caused tensions between local populations and newcomers, especially in areas with fragile socio-political settings (Phukan & Dutta, 2017; Baruah, 2020). In many cases, rapid urban growth has intensified competition over resources, jobs, and public services, further straining inter-ethnic relations (Saikia & Bhuyan, 2021). This has made managing migration and urbanisation an essential issue for policymakers, who need to balance the economic advantages of urbanisation with the imperatives of social cohesion and environmental sustainability (Gogoi, 2019; Datta, 2020).

Despite these challenges, urbanisation also presents significant

opportunities for regional development. The expansion of urban centres can stimulate economic diversification, improve access to services, and increase connectivity with other parts of India and neighbouring countries (Barua & Goswami, 2020; Mitra & Banerjee, 2019). Cities such as Guwahati have become commercial and educational hubs, attracting investment and enhancing residents' quality of life (Singh, 2020; Phukan & Dutta, 2017). However, realising these benefits requires a coordinated approach to urban planning, infrastructure development, and migration management that addresses the specific needs of North East India's urban systems (Das & Nath, 2021; Baruah, 2020). Migration and urbanisation are transforming the major urban networks of North East India, offering both opportunities and challenges. The region's diverse socio-political and environmental contexts demand a nuanced approach to urban planning and policy making that considers not only economic growth but also social and environmental sustainability. Understanding the drivers and effects of migration and urbanisation in this region is essential for fostering inclusive and sustainable urban development in the future.

Objectives of the Study

The main objectives of the study are to analyse:

1. The migration process into the major urban systems of North East India, 2001–2011.

2. The demographic characteristics of the major urban systems of North East India during 2001–2011, and to examine their relationships with migration.

Materials and Methodology

The primary data source for this study is the Census of India. According to the 2001 and 2011 censuses, Northeast India had 11 Class-I Urban Agglomerations (UAs) or towns in 2001, increasing to 13 in 2011. These towns are regarded as the major urban centres in Northeast India for those years. Migration data, including types, streams, and reasons, for these cities were collected from the Census of India for both 2001 and 2011. Additionally, demographic

data for these urban centres were also obtained from the Census. To ensure consistency in comparing the two census years, only the 11 towns classified as Class-I UAs in both 2001 and 2011 were included in the analysis.

Various formulas have been used in the study, which include the following:

To calculate the percentage share of a specific category in relation to a total, the following formula is used:

$$\text{Percentage Share} = \left(\frac{Part}{Total}\right) \times 100$$

Where *Part* = specific value for which to find the percentage share.

Total = the overall value or sum to which the part is being compared.

This formula has been used to find percentage shares of various types and streams of migration, as well as various reasons for migration. Additionally, it is used in migration rate, and SC/ST%, where migration

rate equals total migrants, and SC/ST% equals SC/ST population, both divided by total population.

To calculate the growth rate, the following formula is used:

Growth Rate = $\left(\frac{Value\ at\ End\ of\ Period - Value\ at\ Start\ of\ Period}{Value\ at\ Start\ of\ Period}\right) \times 100$

Where *Value at End of Period* = value at the end of the time period being measured.

Value at Start of Period = value at the beginning of the time period.

This formula has been used to determine growth rates of various types and streams of migration, as well as the reasons for migration, to assess change over time. Additionally, it is used in the annual urban growth rate by which the urban growth rate (decadal) is divided by 10.

The literacy rate is the percentage of the population aged 7 years and above who can read and write.

Literacy Rate = $\left(\frac{Number\ of\ Literate\ Persons\ (Age\ 7+)}{Total\ Population\ (Age\ 7+)}\right) \times 100$

The work participation rate is the percentage of the population that is part of the labour force (i.e., either employed or actively seeking employment).

Work Participation Rate = $\left(\frac{Total\ Labor\ Force\ (Employed+Actively\ Seeking\ Work)}{Total\ Population\ (Age\ 15+)}\right) \times 100$

The Pearson correlation coefficient (r) measures the strength and direction of the linear relationship between two variables, X and Y.

$r = \frac{\sum(X_i - \bar{X})(Y_i - \bar{Y})}{\sqrt{\sum(X_i - \bar{X})^2 \sum(X_i - \bar{Y})^2}}$, Where X_i and Y_i are individual data points for variables X and Y, $\bar{X}$ and $\bar{Y}$ are the means of variables X and Y, and n = number of data points.

Multiple regression models the relationship between one dependent variable (Y) and two or more independent variables ($X_1, X_2, \ldots, X_n$).

$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_n X_n + \epsilon$

Where Y = dependent variable (the variable being predicted),

$X_1, X_2, \ldots, X_n$ = independent variables (the predictors),

β_0 = Intercept (the value of Y when all X variables are 0),

$\beta_1, \beta_2, \ldots, \beta_n$ = regression coefficients (change in Y for a one-unit change in X_i),

ϵ = Error term (the difference between the observed and predicted.

The paper features eleven data tables supporting the analysis, along with three clustered column charts showing growth rates by type, stream, and reasons for migration. It includes two stacked column charts and two double-clustered column combination charts that illustrate growth in interstate migration and in urban areas in major cities. A doughnut chart visualises migration stream subcategories, while a scatter plot displays the relationship between migration indicators and the annual urban growth rate. A correlation matrix highlights relationships between migration variables and urban demographics, and a map, created with ArcGIS software, shows the population size of major NE cities.

Result and Discussion

Migration Process into the Major Urban Systems of North East India, 2001-2011

The Stock of Migrants

Table 1

Percentage Share of Types of Migration into Major Cities of NE India, 2001 & 2011

Year	Cities	Total Migrants	Migration Rate	Intra-district	Inter-district	Inter-state	From Asia	From Non-Asia
2001	Agartala	65,509	24.31	48.40	13.72	7.58	30.30	0.01
	Aizawl	1,10,558	48.43	39.63	41.82	14.96	3.58	0.01
	Dibrugarh	39,305	28.55	39.94	38.49	19.34	2.23	0.01
	Guwahati	3,78,657	46.24	35.91	42.96	19.62	1.48	0.02
	Imphal	40,017	13.51	43.98	46.34	9.20	0.45	0.02
	Jorhat	50,889	37.94	65.32	19.40	14.73	0.55	0.01
	Nagaon	29,246	23.73	57.02	23.05	16.64	3.29	0.00
	Shillong	70,777	26.44	32.35	13.99	50.01	3.61	0.04
	Silchar	58,567	31.81	52.15	19.18	16.05	12.60	0.01
	Tezpur	32,754	31.08	40.42	26.19	31.22	2.13	0.04
	Tinsukia	40,066	37.06	31.76	31.52	33.54	3.17	0.01
	Total	9,16,345	34.28	40.83	33.89	20.51	4.76	0.02
2011	Agartala	1,62,858	40.71	57.72	15.00	5.93	20.87	0.45
	Aizawl	1,52,287	51.90	40.42	45.07	11.29	3.09	0.12
	Dibrugarh	66,980	43.41	54.56	27.62	16.89	0.70	0.20
	Dimapur	68,555	55.81	18.26	34.34	46.43	0.78	0.15
	Gangtok	62,161	61.98	44.22	15.92	33.39	5.86	0.47
	Guwahati	5,87,647	61.06	35.62	48.34	15.05	0.66	0.32
	Imphal	77,204	18.44	67.00	26.87	5.64	0.22	0.25
	Jorhat	74,304	48.28	67.77	19.44	12.05	0.38	0.35
	Nagaon	62,520	42.10	76.48	14.67	7.90	0.80	0.14
	Shillong	43,478	12.26	21.94	19.58	55.58	2.63	0.23
	Silchar	79,467	34.68	58.54	22.07	13.47	5.43	0.47
	Tezpur	51,775	50.51	59.77	27.69	11.54	0.83	0.16
	Tinsukia	56,246	44.50	38.64	29.05	30.92	1.10	0.26
	Total	15,45,482	42.31	45.30	34.30	16.54	3.54	0.29

Source: Computed by author from Census of India, 2001 & 2011

Table 1 summarises migrant numbers, rates, and migration types in Northeast India's major cities for 2001 and 2011. In 2001, these cities received 916,000 migrants, or 34.28% of their population, rising to 1.545 million (42.31%) by 2011. Aizawl led in migration rate in 2001 at 48.43%, while Imphal had the lowest at 13.51%. By 2011, Gangtok (61.98%) and Guwahati (61.06%) had the highest rates, with Shillong at the lowest (12.26%).

In 2001, migration into the major cities of Northeast India was predominantly driven by intra-district migration, accounting for 40.83% of the total, followed by inter-district migration (33.89%), inter-state migration (20.51%), migration from Asian countries (4.76%), and from non-Asian countries (0.02%). Intra-district migration varied significantly, ranging from 31.76% in Tinsukia to 65.32% in Jorhat. For inter-district migration, the share ranged from 13.72% in Agartala to 46.34% in Imphal. Inter-state migration was

highest in Shillong at 50.01% and lowest in Agartala at 7.58%. Agartala, the capital of Tripura, also had the highest percentage of international migrants, predominantly from Asian countries, at 30.3%.

By 2011, intra-district migration continued to dominate, increasing to 45.30%, followed by inter-district (34.30%), inter-state (16.54%), migration from Asian countries (3.54%), and from non-Asian countries (0.29%). Intra-district migration ranged from 76.48% in Nagaon to 18.26% in Dimapur. For inter-district migration, the share ranged from 48.34% in Guwahati to 14.67% in Nagaon. Inter-state migration was again highest in Shillong at 55.58% and lowest in Imphal at 5.64%. Agartala once more hosted the highest percentage of international migrants from Asian countries, with 20.87%.

As Northeastern states are located on the eastern side of the country's border, there has always been a massive influx of immigrants from the surrounding countries. Nearly 4 lakh people were international migrants in the different cities of Northeast India (Rahul & Rulu, 2023). Illegal immigration, especially from Bangladesh, has made the population dynamics worse, which increasingly reduces the number of indigenous people (Banati, 2015). The migration from present-day Bangladesh has been extensive, and its role in altering the demographic profile of the North East, particularly in cities in Assam and Tripura, has been significant (Bhaumik, 2005; Baruah, 2005; Sharma, 2012). Migration has shown significant changes in demography, economy, socio-political framework, and environment in areas adjoining Bangladesh (Nath et al., 2012; Sharma, 2015; Das, 2016); however, the economic and social manifestation of the illegal influx is also visible in interior parts of the region like Nagaland and Manipur, using major cities of Assam like Guwahati and Silchar as corridor (Singh, 2009; Singh, 2016). The issue of illegal migration from Bangladesh can be considered the major cause behind the adoption of the Citizenship Amendment Bill by the Indian Parliament in 2019 (Bhowmik, 2021).

Much movement stems from internal displacement due to natural disasters like earthquakes and floods, as well as ethnic violence, language conflict, and development policies (Phukan, 2013). Displacement affects various ethnicities and religions, with conflicts occurring both between and within tribes, such as the Brus and Mizos in Mizoram, and the Nagas, Kukis, and Paites in Manipur (Ali, 1998; Phanjoubam, 2007). The indigenous population has faced marginalisation, and ongoing ethnic conflicts have altered the land-man ratio in the region (Bhowmik, 2021).

Figure 1 highlights the migration growth rates for major cities in Northeast (NE) India across various migration types. Between 2001 and 2011, the region's major cities collectively gained an additional 498,421 migrants.

The overall migration growth rate during this period was 54.39%, though growth varied significantly by migration category. Intra-district

migration grew by 76.44%, while inter-district migration increased by 59.96%. Inter-state migration, however, recorded a much lower growth rate of 8.08%, and migration from other Asian countries increased by 15.74%.

During this period, Guwahati experienced the largest influx of migrants, with an increase of 208,990 people, while Tinsukia saw the smallest increase, with 16,180 migrants. Agartala recorded the highest percentage growth at 148.6%, whereas Silchar experienced the lowest at 35.69%. Shillong, in contrast, saw a decline in migrant numbers, losing 27,299 people, which corresponds to a negative growth rate of -38.57%. This decline was evident across most migration categories, except for migrants arriving from non-Asian countries, signalling a halt in urban growth and a shrinking urban character for Shillong.

For intra-district migration, Agartala again led with a growth rate of 196.49%, while Aizawl recorded the smallest increase at 40.5%. In terms of inter-district migration, Agartala posted a growth rate of 171.74%, with Imphal trailing at 11.87%. Agartala also led in inter-state migration with a growth rate of 94.66%, while Nagaon had the lowest at 1.54%. Tezpur saw a significant negative growth rate of -41.56%. Most major cities in NE India experienced negative growth in international migrants, except for southern cities like Agartala, which saw a considerable increase of 71.28%, and Aizawl.

Figure 1

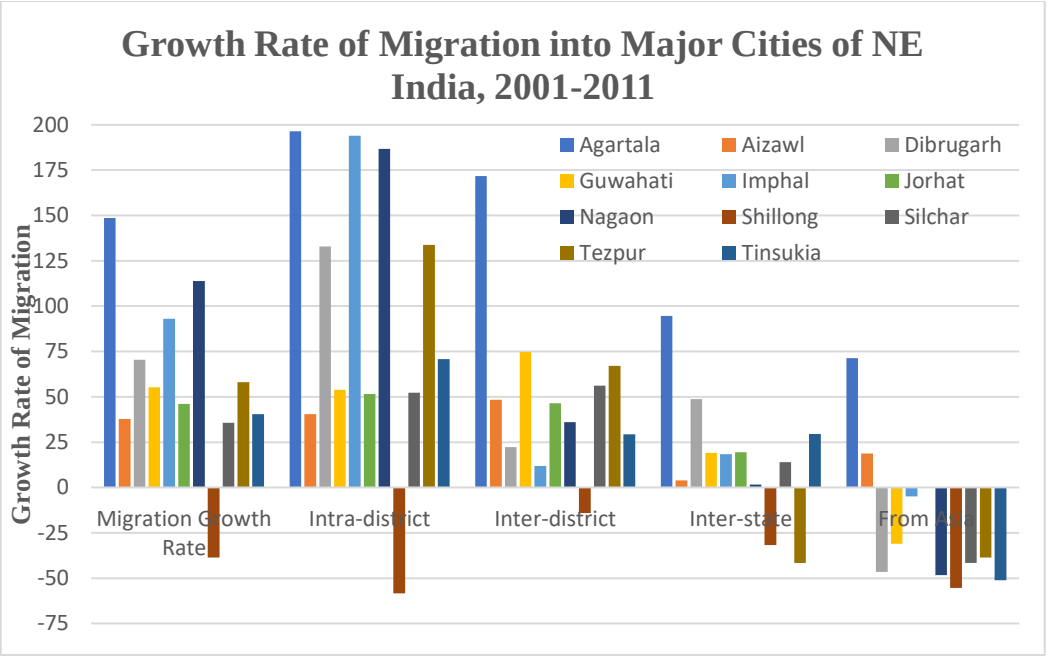


Figure 1 shows that Agartala had the highest migration growth rate across all migration categories. In contrast, Silchar and Aizawl recorded the lowest growth rates across the various migration categories. Notably, Shillong was the only city to experience negative growth across all migration categories, while Tezpur registered negative growth, specifically in inter-state migration.

Most of the migrants in Guwahati engaged in petty work in the informal sector are capable of supporting their livelihood due to the diverse work generated in the urban informal sector, which is absent in the rural areas, yet an improvement in their standard of living is doubtful (Hazarika, 2016). Inadequate investment in rural areas in Assam adversely affects livelihoods and prompts outmigration. Again, high population growth in rural areas can increase pressure on land and other resources, creating a labour surplus that drives migration (Sharma & Nath, 2021). Migration has been a very contentious issue in the state of Assam and Guwahati city in particular. This has led to a manifold increase in migration-related issues, including the creation of slum pockets, population density, the formidable growth of the informal sector, and poor living conditions, among others (Choudhury, 2024).

When we talk about rural and hill areas, illegal migrants from Myanmar come to mind. Most migrants, other than those from Myanmar, who live in Jiribam, come directly to the valley, particularly to Imphal city (Singh, 2016). The long-lasting effects of migration on Imphal are directly related to the imbalance in population growth and the rise in unemployment and welfare benefits. The rapid growth of the population due to irregular migration may lead to overpopulation with falling living standards in the receiving society (Devi & Islam, 2012). As of June 30, 2022, there were an estimated 1,086,000 Myanmar refugees and asylum seekers in neighbouring countries, with an estimated 49,600 crossing into the states of Manipur and Mizoram as of early December 2022 (UNHCR, 2022). The Myanmar conflict has unavoidably influenced the border with India, particularly in security terms, due to the geographical proximity and socio-economic ties between the people (Atchareeya et al., 2023). The migration and settlement of non-tribal populations in Agartala led to a significant population shift, which became a key factor in the region's conflicts. This demographic change, combined with cultural differences between tribal and non-tribal groups and the historical grievances faced by the tribal communities under both monarchical rule and during the transition to democracy, underscores migration as a major driver of ethnic violence in the region (Ali, 2011). In 2011, the majority of the migrants in Gangtok had come seeking better job opportunities in different sectors, especially in the tourism industry (Rai & Singh, 2022).

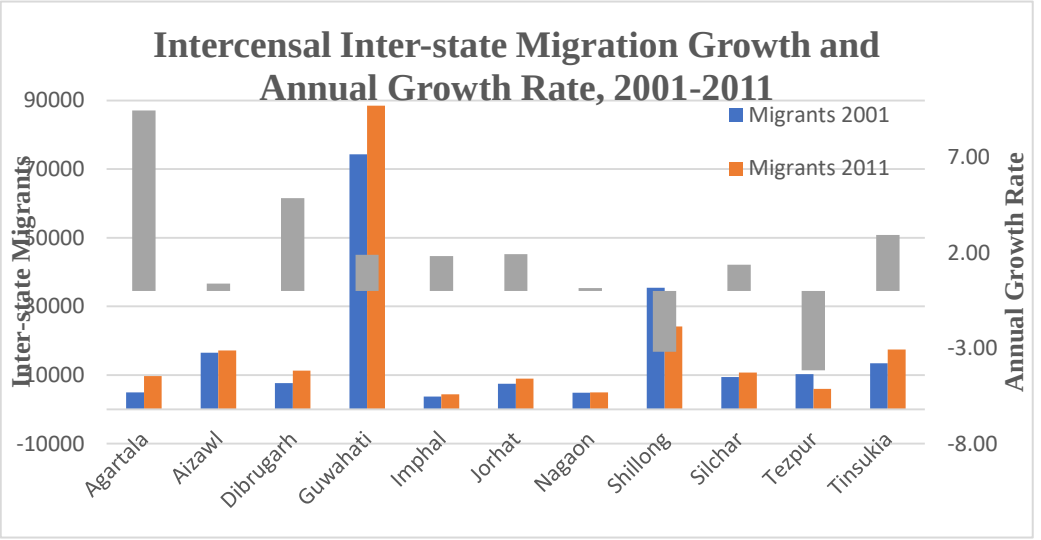
Streams of Inter-state Migration

Several studies (Davis, 1951; Chatterjee, 1977; Premi, 1990;

Zachariah, 1964; Srivastava, 2011; Bell et al., 2015; Kone et al., 2018) found that the intensity of interstate migration in India was low but pointed out the fact that it is a significant component of labour mobility. Figure 2 presents data on inter-state migration into major cities of Northeast India for 2001 and 2011, highlighting the absolute growth and annual growth rates. Among the cities, Guwahati received the highest number of inter-state migrants, with 74,303 in 2001 and 88,430 in 2011. In contrast, Imphal saw the fewest migrants, with only 3,683 in 2001 and 4,357 in 2011. Shillong also experienced significant migration, with 35,396 migrants in 2001, though this dropped to 24,166 in 2011. In absolute terms, Guwahati saw the largest increase, adding 14,127 migrants over the decade, while Nagaon had the smallest, with just 75 new migrants. Conversely, both Shillong and Tezpur experienced declines, with decreases of 11,230 and 4,250 migrants, respectively. Looking at percentage changes, Agartala recorded the highest growth rate, with a 9.47% increase in migrants, whereas Nagaon saw a modest 0.15% rise. However, both Tezpur and Shillong experienced percentage declines of -4.16% and -3.17%, respectively. The inter-migrants found in Imphal city were mostly engaged as businessmen or semi-skilled or unskilled labourers, eager to take any job and prepared to adjust to any circumstances. At the same time, native people were reluctant to take up blue-collar jobs taken by the migrants (Bharadwaj, 2020).

Economic insecurity in the region's rural areas led to increased rural-urban migration. Capital towns and cities have absorbed and accommodated most of the rural-urban streams of migration (Saitluanga, 2020).

Figure 2



Rural outmigration is the migration of people from rural areas to cities, whether voluntary or forced, to improve their standard of living (Debnath et al., 2017). Male migration (age group 15–25) rate is greater from rural to urban areas due to educational and employment opportunities (Nath & Choudhury, 1995). A large part of rural-to-urban migration into Itanagar can be explained by push factors, namely the lack of diversification of the agrarian economy, and pull factors, namely the demand for a high-skilled, semi-skilled, and unskilled workforce required for all-around development (Mandal et al., 2022).

Table 2 illustrates the rural-urban and urban-urban migration streams into the major cities of Northeast India, with percentage breakdowns across the intra-district, inter-district, and inter-state categories for 2001 and 2011. In 2001, Guwahati recorded the highest influx of migrants from both rural (220,714) and urban (75,098) areas. In contrast, Tezpur and Nagaon saw the lowest rural (13,728) and urban (4,424) migrant streams, respectively. Within the rural-urban migration stream in 2001, Agartala had the highest share of intra-district migrants (65.58%), Imphal led in inter-district migration (51.19%), and Shillong dominated the inter-state category (48.80%).

On the other hand, Tinsukia recorded the lowest share of intra-district migrants (28.16%), Nagaon had the smallest inter-district share (18.90%), and Agartala had the lowest inter-state share (9.24%). For the urban-urban migration stream in 2001, apart from Agartala (58.25%) and Aizawl (38.59%), no city reported significant intra-district migration. Imphal led in inter-district migration (72.69%), while Shillong had the highest inter-state migration share (88.47%).

Conversely, Shillong saw the lowest inter-district share (11.53%), and Aizawl recorded the lowest intra-district share (23.49%). In 2011, Guwahati again received the largest number of migrants from both rural (256,402) and urban (284,286) areas, while Tezpur and Nagaon had the smallest rural (19,548) and urban (11,291) streams, respectively. In the rural-urban stream for 2011, Nagaon had the highest percentage of intra-district migrants (71.95%), Guwahati led in inter-district migration (70.24%), and Dimapur saw the most inter-state migration (56.06%).

In contrast, Dimapur had the lowest intra-district share (6.74%), Nagaon had the smallest inter-district share (16.72%), and Agartala had the lowest inter-state share 5.37%. For the urban-urban migration stream in 2011, Nagaon recorded the highest intra-district share (78.62%), Tinsukia led in inter-district migration (35.99%), and Shillong had the highest inter-state migration share (71.12%). On the lower end, Shillong saw the smallest intra-district (18.68%) and inter-district (10.20%) shares, while Imphal had the lowest inter-state share (4.53%).

A rise in a country's urbanisation level could be caused either by migration from rural to urban areas or faster population growth in urban areas than in rural areas (Zhang &

Song, 2003). The population redistribution process might represent the restructuring of agricultural production, implying a decline in on-farm employment and the migration of young people from rural areas to towns and cities (Fielding, 1989). Mechanisation in agriculture has displaced many unskilled or low-skilled migrants, often from marginalised groups, thereby increasing rural-to-urban migration and affecting informal jobs, urban housing, slum growth, education, healthcare, and urban poverty and inequality (Parida & Raman, 2020).

In 2001, the major cities of Northeast India received a total of 463,570 migrants (70.77%) from rural areas and 191,489 migrants (29.23%) from urban areas of India, showing a significant disparity between rural-urban and urban-urban migration, as illustrated in Figure 3. Rural-urban migration outpaced urban-urban migration significantly.

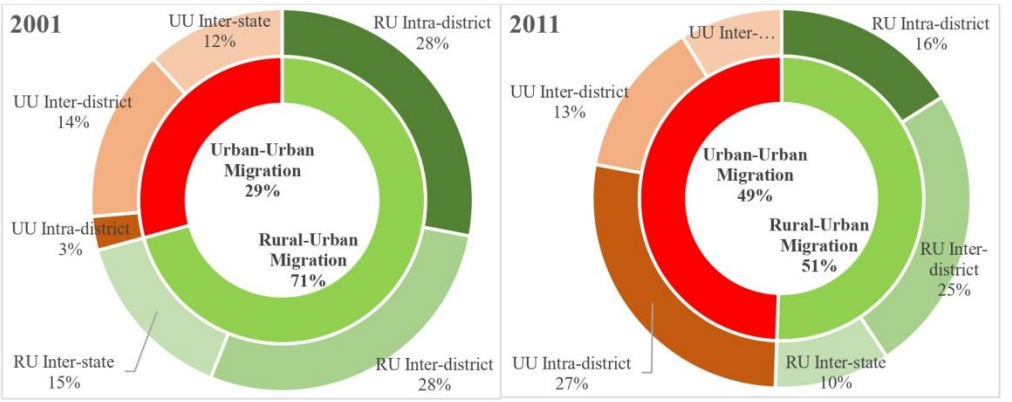
Table 2
Percentage Share of Streams of Inter-state Migration into Major Cities of NE India, 2001 & 2011

Year	Cities	Rural-Urban Migrants (%)				Urban-Urban Migrants (%)			
		Total	Intra-district	Inter-district	Inter-state	Total	Intra-district	Inter-district	Inter-state
2001	Agartala	18,817	65.58	25.18	9.24	10,828	58.25	16.91	24.84
	Aizawl	66,952	38.94	48.72	12.35	32,297	38.59	37.92	23.49
	Dibrugarh	17,497	39.30	35.35	25.35	9,701	Nil	72.91	27.09
	Guwahati	2,20,714	34.36	46.91	18.73	75,098	Nil	62.52	37.48
	Imphal	15,340	38.87	51.19	9.95	6,316	Nil	72.69	27.31
	Jorhat	24,914	60.94	21.14	17.91	5,856	Nil	60.16	39.84
	Nagaon	15,525	60.61	18.90	20.49	4,424	Nil	68.29	31.71
	Shillong	30,074	30.44	20.76	48.80	20,125	Nil	11.53	88.47
	Silchar	19,806	55.49	25.55	18.95	9,603	Nil	50.84	49.16
	Tezpur	13,728	43.63	31.65	24.72	7,972	Nil	41.73	58.27
	Tinsukia	20,203	28.16	25.77	46.07	9,269	Nil	63.21	36.79
	Total	4,63,570	39.58	39.69	20.73	1,91,489	9.80	49.94	40.26
2011	Agartala	67,198	71.35	23.28	5.37	47,366	72.31	16.00	11.69
	Aizawl	87,847	30.74	59.80	9.45	42,227	46.52	33.79	19.69
	Dibrugarh	20,760	33.94	35.70	30.36	34,874	59.10	28.56	12.33
	Dimapur	29,629	6.74	37.20	56.06	33,202	23.20	34.55	42.25
	Gangtok	26,541	35.23	25.81	38.96	20,797	47.02	10.63	42.36
	Guwahati	2,56,402	12.74	70.24	17.02	2,84,286	53.94	31.67	14.39
	Imphal	19,548	33.67	55.13	11.21	42,773	76.34	19.13	4.53
	Jorhat	32,174	65.00	21.39	13.62	28,052	64.36	22.05	13.60
	Nagaon	22,483	71.95	16.72	11.33	34,231	78.62	14.98	6.40
	Shillong	22,561	20.83	28.58	50.58	16,527	18.68	10.20	71.12
	Silchar	30,159	61.13	27.20	11.66	36,319	57.40	23.78	18.83
	Tezpur	34,473	40.75	36.33	22.91	11,291	49.95	28.06	21.99
	Tinsukia	23,836	29.02	25.17	45.80	27,312	42.82	35.99	21.19
	Total	6,73,611	31.74	48.71	19.55	6,59,257	55.25	27.05	17.70

Source: Computed by author from Census of India, 2001 & 2011

Figure 3

Graphical Breakdown of Streams of Migration, 2001 & 2011



Of the rural-urban migrants, 28.01% were intra-district, 28.09% were inter-district, and 14.67% were inter-state. For urban-urban migrants, 2.87% were intra-district, 14.60% were inter-district, and 11.77% were inter-state. By 2011, the major cities received 673,611 migrants (50.54%) from rural areas and 659,257 migrants (49.46%) from urban areas of India, indicating a near-equal balance between the two streams. Among the rural-urban migrants, 213,797 (16.04%) were intra-district, 328,140 (24.62%) were inter-district, and 131,674 (9.88%) were inter-state. For urban-urban migrants, 364,212 (27.33%) were intra-district, 178,346 (13.38%) were inter-district, and 116,699 (8.76%) were inter-state.

Figure 4 highlights the growth rates of inter-state streams of migration and their relative percentage to city population in the cities of Northeast India between 2001 and 2011. The growth rate of rural-urban migration during this period was 45.31%. In contrast, urban-urban migration had a significantly higher growth rate of 244.28%, more than five times that of rural-urban migration. Among the cities, Agartala experienced the highest growth in rural-urban migration, with an impressive 257.11% increase, while Guwahati recorded the lowest growth at 16.17%. Unfortunately, Shillong experienced a decline in rural-urban migration of -24.98%. For urban-urban migration, Nagaon recorded the highest growth rate at 673.76%, while Aizawl had the lowest at 30.75%. Shillong, once again, faced a decline, with a 17.88% decrease in urban-urban migration during the same period.

The growth rate of rural-urban migration relative to the city population was 16.16%, while urban-urban migration grew by an impressive 175.21%, more than ten times that of rural-urban migration. Among the cities, Tezpur recorded the highest growth in rural-urban migration at 158.45%, whereas Tinsukia had the lowest at 0.93%.

Notably, Shillong, Imphal, and Guwahati experienced declines in rural-urban migration. For urban-urban migration, Nagaon recorded the highest growth rate, at 542.29%, while Aizawl had the lowest, at 1.72%. Shillong once again experienced a decline in this category. Figure 4 shows that the growth rates of rural-urban migration and their percentage relative to the city population were generally lower. However, Agartala and Tezpur had the highest growth rates in rural-urban migration, while Tinsukia led in the percentage of rural-urban migration relative to the city population. In contrast, urban-urban migration and its percentage of the city population generally exhibited higher growth rates. Notably, Shillong and Tezpur had the lowest growth rates in both urban-urban migration and the percentage of rural-urban migration relative to city population.

Reasons for Interstate Migration

Table 3 presents the percentage distribution of reasons for inter-state migration into major cities of Northeast India for the years 2001 and 2011. In 2001, 23.25% of migrants moved for work or employment, 22.49% relocated with their household, and 21.20% migrated for other reasons. The percentages for migration due to moving after birth, education, business, and marriage were relatively low, accounting for 1.54%, 3.25%, 13.14%, and 15.14%, respectively.

Figure 4

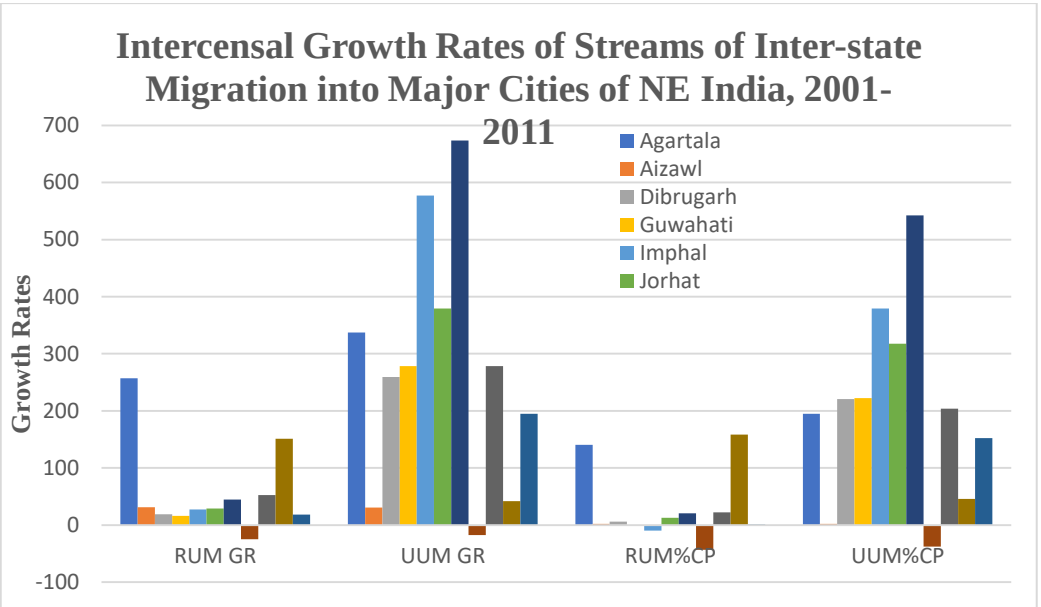


Table 3
Percentage Share of Reasons for Inter-state Migration into Major Cities of NE India, 2001 & 2011

Year	Cities	Work/ Employment	Business	Education	Marriage	Moved after birth	Moved with household	Others
2001	Agartala	23.82	4.23	2.14	20.13	1.45	27.64	20.59
	Aizawl	46.11	2.47	4.15	5.76	0.79	28.56	12.14
	Dibrugarh	17.89	21.02	1.70	21.44	1.07	15.32	21.57
	Guwahati	20.23	16.84	1.87	15.46	1.86	23.17	20.58
	Imphal	20.47	10.89	1.60	14.23	0.24	18.57	33.99
	Jorhat	17.28	22.36	2.28	11.03	1.17	20.99	24.88
	Nagaon	14.61	24.87	0.60	21.95	1.75	18.72	17.51
	Shillong	29.20	4.12	8.78	16.55	1.72	16.95	22.69
	Silchar	21.28	11.25	2.84	18.96	1.70	22.86	21.10
	Tezpur	7.21	7.61	1.23	9.53	0.84	39.48	34.10
	Tinsukia	19.72	25.12	0.33	17.50	1.44	18.07	17.82
	Total	23.25	13.14	3.25	15.14	1.54	22.49	21.20
2011	Agartala	22.82	2.45	1.72	23.60	0.98	30.35	18.07
	Aizawl	38.78	3.09	3.09	7.28	0.91	31.79	15.05
	Dibrugarh	22.45	15.69	1.25	27.73	1.62	13.57	17.70
	Dimapur	26.05	14.63	1.65	20.95	1.45	18.48	16.80
	Gangtok	34.55	5.77	2.97	21.91	2.42	15.71	16.66
	Guwahati	22.37	12.30	1.86	23.25	2.56	21.53	16.13
	Imphal	12.88	22.75	1.42	22.52	2.13	22.58	15.72
	Jorhat	19.61	22.11	0.86	20.79	2.88	15.75	18.00
	Nagaon	17.20	16.90	0.59	29.33	1.78	20.10	14.11
	Shillong	30.46	6.09	6.55	25.46	4.77	12.50	14.18
	Silchar	16.66	12.89	1.95	27.76	1.82	26.01	12.91
	Tezpur	17.85	15.81	1.42	26.61	1.99	19.29	17.02
	Tinsukia	25.15	17.10	0.94	24.55	2.17	16.67	13.42
	Total	25.19	11.68	2.28	22.58	2.32	20.09	15.86

Source: Computed by author from Census of India, 2001 & 2011

The majority of interstate migration to these cities was driven by household relocation and other factors, followed by migration for work. Migration due to moving after birth and education had the smallest shares. Notably, Aizawl saw the highest share of inter-state migrants moving for work, with 46.11% of its total. Tinsukia led in business-related migration at 25.12%, closely followed by Nagaon at 24.87%. For marriage-related migration, Nagaon and Dibrugarh topped the list with 21.95% and 21.44% respectively. Tezpur had the highest percentage of migrants relocating with their households, while Shillong received the largest share of migrants (8.78%) moving for educational purposes.

In 2011, 25.19% of migrants moved to the major cities of NE India for work or employment, 22.58% for marriage, 20.09% to relocate with their household, and 15.86% for other reasons. Migration for education, moving after birth, and business accounted for smaller percentages, at 2.28%, 2.32%, and 11.68%, respectively. The majority of interstate migration to these cities was driven by work, employment, and marriage. Household relocation and marriage made up the second-largest share, while migration for education

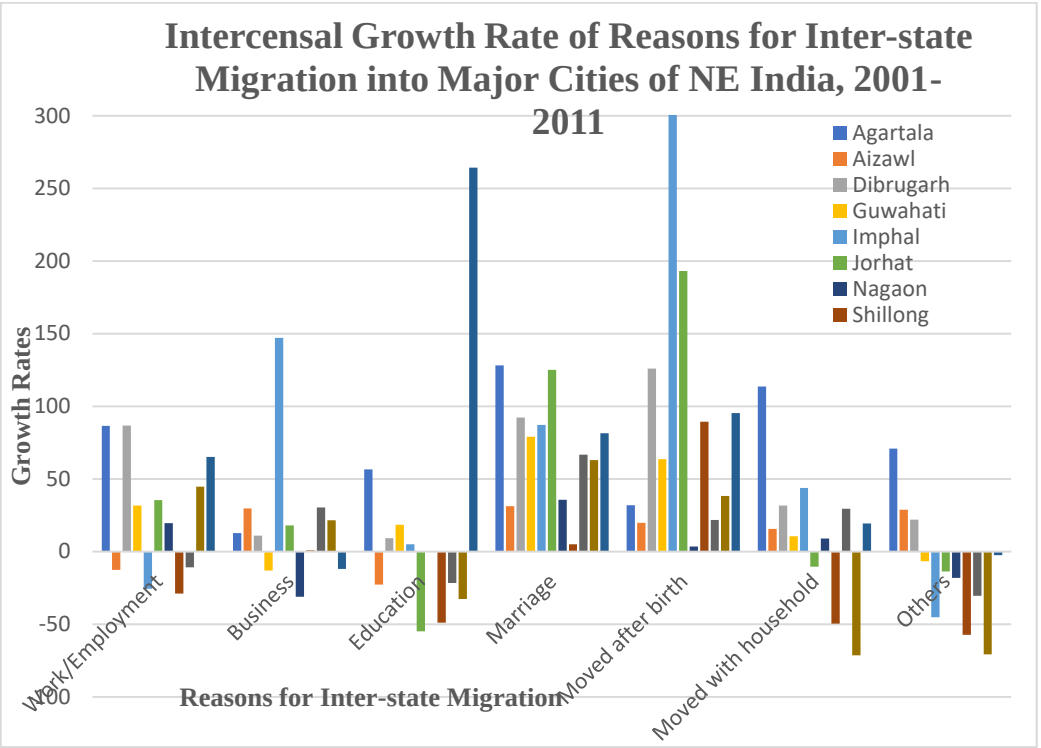
and post-birth migration had the smallest shares.

Notably, Aizawl had the highest share of inter-state migrants moving for work, with 38.78%, followed by Gangtok at 34.55%. Imphal and Jorhat led in business-related migration, with 22.75% and 22.11% respectively. Nagaon topped the list for marriage-related migration at 29.33%, closely followed by Silchar and Dibrugarh. Aizawl and Agartala had the highest percentage of migrants relocating with their household, at 31.79% and 30.35%, respectively. Lastly, Shillong received the largest share of migrants (6.55%) moving for educational purposes. The majority of students from Nagaland, Manipur, and Mizoram reported that studying in Shillong was better than studying in their hometowns, as they perceived that educational facilities in Shillong were far better than those at their home colleges, and this was an important factor motivating their decision to come and study in Shillong (Longkumer, 2015). Researchers often overlook female outmigration, associating it mainly with marriage. Premi (1980) noted that rural women migrate more frequently for short distances, whereas medium- and long-distance migrations target urban areas. Recently, women have also migrated for education, employment, and informal-sector work. In Meghalaya's matrilineal society, marriage-related outmigration has minimal impact, resulting in low female migration overall (Debnath & Ray, 2017).

Figure 5 presents the growth rates of various reasons for inter-state migration into major cities of Northeast India between 2001 and 2011. Migration due to moving after birth recorded a significant 72.01% growth, followed by migration for marriage at 63.44%, while work/employment-related migration saw a more modest 12.06% increase. In contrast, migration for education, business, moving with households, and others experienced negative growth rates of -23.27%, -2.80%, -0.09%, and -20.27%, respectively. Among the cities, Agartala showed the highest growth in several categories: marriage (125.23%), moving with households (113.70%), and others (70.84%). It also recorded the second-highest growth in work/employment-related migration at 86.55%. Imphal, on the other hand, had the highest growth in business-related migration (147.13%) and in migration that moved after birth (933.33%). Tinsukia led in education-related migration with a remarkable growth rate of 264.44%.

Jorhat recorded the second-highest growth in migration due to marriage (125.03%) but the steepest decline in education-related migration (-54.97%). Shillong experienced the largest drop in work/employment-related migration (-28.78%) and had the lowest growth in migration due to marriage (5.04%). Nagaon had the sharpest decline in business-related migration (-30.99%) and the smallest increase in migration due to birth (3.53%).

Figure 5



Note: The graph of Imphal's growth rate with Moved after birth is shortened more than three times to highlight other small details.

Lastly, Tezpur saw the most significant migration-related losses: moving with households (-71.44%) and others (-70.83%). Figure 5 illustrates that most cities experienced higher migration growth rates due to marriage and post-birth moves. In contrast, migration related to education and other reasons generally showed a negative growth trend.

Demographic Characteristics of the Major Urban Systems of North East India and their Relationships with Migration, 2001-2011

Table 4 summarises the demographics of major cities in Northeast India for 2001 and 2011, while Table 5 highlights the changes during this period. In 2001, these cities had a combined population of 2.7 million, with Guwahati being the largest at 818,809 residents and Tezpur the smallest at 105,377. The total urban area was 644.18 sq. km., with Guwahati covering 216.79 sq. km. and Nagaon just 15.86 sq. km. Guwahati represented 30.63% of the population and 33.65% of the urban area. Imphal had the highest sex ratio at 1,019 females per 1,000 males, while Tezpur had the lowest at 760. Tezpur also boasted the highest literacy rate at 83.01%, while Nagaon was the lowest at 74.74%. Shillong

had the highest percentage of Scheduled Caste and Scheduled Tribe populations at 57.87%, with Tinsukia having the lowest at 6.39%.

By 2011, the population of the major cities had grown to 3.3 million. Guwahati remained the largest city, with 962,334 residents, while Tezpur, with 102,505 people, became the least populous. The total urban area increased to 729.84 sq. km, with Guwahati covering 219.06 sq. km. Nagaon, at 18.21 sq. km., remained the smallest city by area. Guwahati accounted for 28.78% of the population and 30.01% of the urban area of major cities. Imphal continued to lead in sex ratio, with 1,050 females per 1,000 males, while Tinsukia had the lowest, at 875 females per 1,000 males. Aizawl had the highest literacy rate at 86.29%, followed closely by Agartala at 86.18%. Nagaon had the lowest literacy rate at 78.34%. Aizawl also had the highest percentage of SC/ST population (92.02%), while Tinsukia had the lowest, at 6.94%. Additionally, Aizawl recorded the highest work participation rate, at 46.49%, followed by Imphal at 45.10%, with Silchar having the lowest rate, at 38.44%.

If a city's population grows at an annual rate of more than 2 per cent for more than 10 years, it becomes very difficult to maintain the city's health and quality (Kojima, 1996). Between 2001 and 2011, the major cities experienced an average annual urban growth rate of 2.51%. As shown in Figure 6, Agartala recorded the highest growth rate of 4.84% per year, followed by Imphal at 4.18%. Conversely, Tezpur experienced a population decline of -0.27% annually. While Aizawl, Dibrugarh, and Jorhat showed no change in urban area, Shillong experienced the largest expansion, increasing by 33.77 sq. km. Silchar saw the smallest expansion, with just a 0.01 sq. km. increase, followed by Tinsukia with 0.38 sq. km.

Tezpur recorded the largest improvement in sex ratio, increasing by 199 females per 1,000 males, while Agartala had the smallest rise, with just a 5-female increase. In terms of literacy, Guwahati had the highest improvement, with an increase of 5.81%, while Tezpur was the only city to see a decline, with a drop of -1.49%. Silchar recorded the largest increase in the percentage of the SC/ST population, rising by 4.17%, while Nagaon and Imphal experienced slight decreases of 1.00% and 0.16%, respectively.

Table 4

Demographic Characteristics of Major Urban Systems of NE India, 2001 & 2011

Year	Cities	City Population	Area	Sex Ratio	Literacy Rate	SC/ST %	WPR
2001	Agartala	2,69,492	34.38	993	-	-	
	Aizawl	2,28,280	128.98	968	-	-	
	Dibrugarh	1,37,661	25.83	878	78.57	12.13	
	Guwahati	8,18,809	216.79	835	77.07	8.68	
	Imphal	2,96,239	55.51	1019	78.07	8.94	
	Jorhat	1,34,117	59.64	880	77.11	8.37	
	Nagaon	1,23,265	15.86	899	74.74	9.73	
	Shillong	2,67,662	27.05	990	76.45	57.87	
	Silchar	1,84,105	30.38	952	75.96	10.00	
	Tezpur	1,05,377	23.47	760	83.01	8.57	
	Tinsukia	1,08,123	26.29	815	75.72	6.39	
	Total	26,73,130	644.18	907	-	-	
2011	Agartala	4,00,004	58.84	999	86.18	24.36	39.91
	Aizawl	2,93,416	128.98	1025	86.29	92.02	46.49
	Dibrugarh	1,54,296	25.83	935	80.92	12.51	41.60
	Guwahati	9,62,334	219.06	931	82.88	10.32	43.14
	Imphal	4,18,739	74.79	1050	79.43	8.78	45.10
	Jorhat	1,53,889	59.64	934	81.32	9.49	44.19
	Nagaon	1,48,496	18.21	969	78.34	8.73	40.96
	Shillong	3,54,759	60.82	1007	80.59	61.96	42.22
	Silchar	2,29,136	30.39	984	81.21	14.17	38.44
	Tezpur	1,02,505	26.61	959	81.52	10.48	40.19
	Tinsukia	1,26,389	26.67	875	80.17	6.94	41.03
	Total	33,43,963	729.84	973	82.28	24.59	42.57

SCST%-Scheduled Caste/Scheduled Tribe Percentage & WPR-Work Participation Rate
Source: Computed by author from Census of India, 2001 & 2011

Table 5

Demographic Changes of the Major Urban Systems of NE India, 2001-2011

Cities	Annual Urban Growth Rate	Increase in Area	Increase in Sex Ratio	Increase in Literacy Rate	Increase in SC/ST %
Agartala	4.84	24.46	5	-	-
Aizawl	2.85	0	57	-	-
Dibrugarh	1.21	0	57	2.35	0.38
Guwahati	1.75	2.27	96	5.81	1.64
Imphal	4.14	19.28	31	1.36	-0.16
Jorhat	1.47	0	54	4.21	1.12
Nagaon	2.05	2.35	69	3.60	-1.00
Shillong	3.25	33.77	17	4.14	4.09
Silchar	2.45	0.01	32	5.25	4.17
Tezpur	-0.27	3.14	199	-1.49	1.91
Tinsukia	1.69	0.38	60	4.45	0.55
Total	2.51	85.66	67	-	-

Source: Computed by author from Census of India, 2001 & 2011

Figure 6

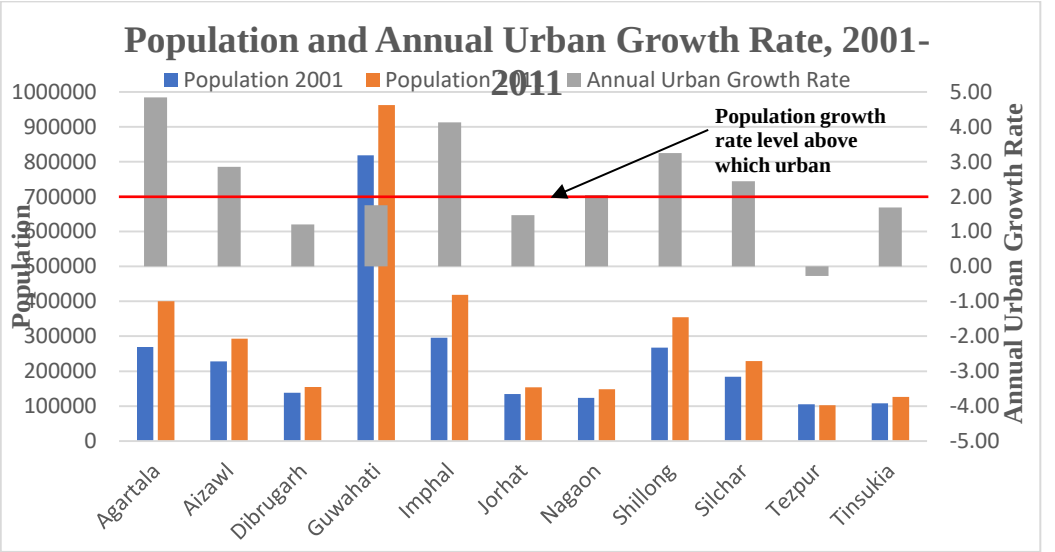


Table 7 presents the results of Pearson's Correlation Test, analysing the relationship between various migration growth rates and annual urban growth rates from 2001 to 2011. Overall migration growth shows a weak positive correlation with urban growth (r = 0.265), though it is not statistically significant (P = 0.432), indicating a limited influence on urban expansion. Inter-state migration exhibits a moderate positive correlation (r = 0.489) but is not statistically significant. In contrast, migration from Asia has the strongest positive correlation with urban growth (r = 0.607) and is statistically significant (P = 0.047), suggesting that regions receiving Asian migrants experienced notable urban growth. Non-Asian migration shows a moderate positive correlation (r = 0.364), though it is not significant. Rural-urban migration presents a weak positive correlation (r = 0.207), while urban-urban migration shows a slightly stronger correlation (r = 0.252), but neither is statistically significant. Moreover, rural-urban migration as a percentage of the city populations reveals a very weak negative correlation (r = -0.145), implying minimal impact on urban expansion.

Among the reasons for migration, moving with households has the strongest positive correlation with urban growth (r = 0.684) and is statistically significant (P = 0.020), highlighting its critical role in driving urbanisation. Migration for work shows a weak negative correlation (r = -0.278), while migration for business exhibits a moderate positive correlation (r = 0.397), though neither is statistically significant. Migration for education and marriage displays minimal or no correlation with urban growth. Overall, while migration from Asia and migration with households have a strong association with urban expansion,

other forms of migration show weaker or insignificant correlations. Figure 8 displays various scatter plots between annual urban growth rates and different types, streams, and reasons for migration growth rates, 2001-2011.

Figure 7

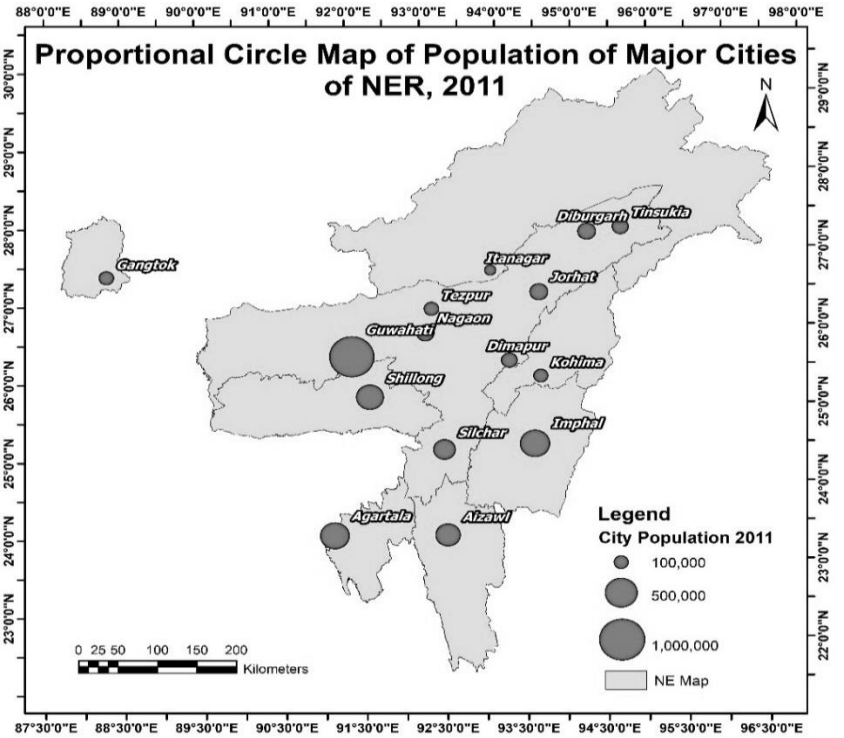


Table 6

Correlation Matrix of Key Variables of Major Cities of North East India, 2011

Variables	MR	TM	TMIS	TMNE	RUM	UUM	Pop.	Area	SR	LR	SCST	WPR
MR	1											
TM	0.379	1										
TMIS	0.400	0.890	1									
TMNE	0.118	0.543	0.725	1								
RUM	0.420	0.991	0.887	0.584	1							
UUM	0.339	0.985	0.909	0.523	0.961	1						
Pop.	0.151	0.917	0.878	0.742	0.889	0.912	1					
Area	0.376	0.904	0.860	0.814	0.924	0.867	0.897	1				
SR	-0.548	-0.148	-0.270	0.200	-0.138	-0.201	0.133	0.105	1			
LR	0.396	0.367	0.207	0.446	0.436	0.208	0.303	0.465	0.237	1		
SCST	-0.141	-0.042	0.011	0.604	0.055	-0.146	0.048	0.284	0.510	0.559	1	
WPR	0.035	0.195	0.168	0.331	0.229	0.171	0.264	0.544	0.329	0.194	0.473	1

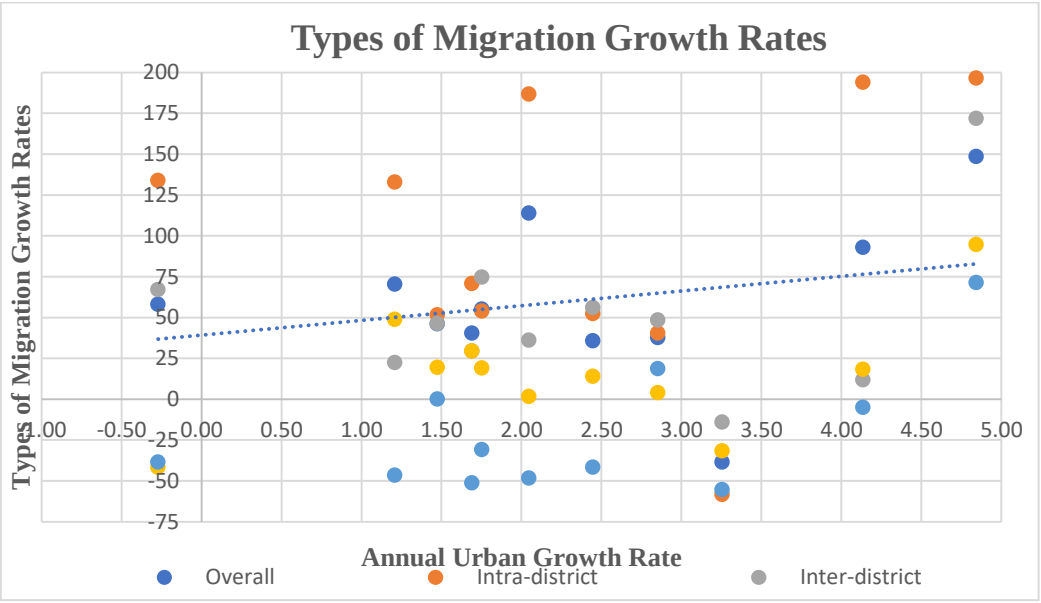
MR-Migration Rate, TM-Total Migrants, TMIS-Total Migrants Inter-State, TMNE-Total Migrants North-East, RUM-Rural-Urban Migration, UUM-Urban-Urban Migration, Pop.-Population, SR-Sex Ratio,
LR-Literacy Rate, SCST Scheduled Caste/Scheduled Tribe Percentage, and WPR-Work Participation Rate.

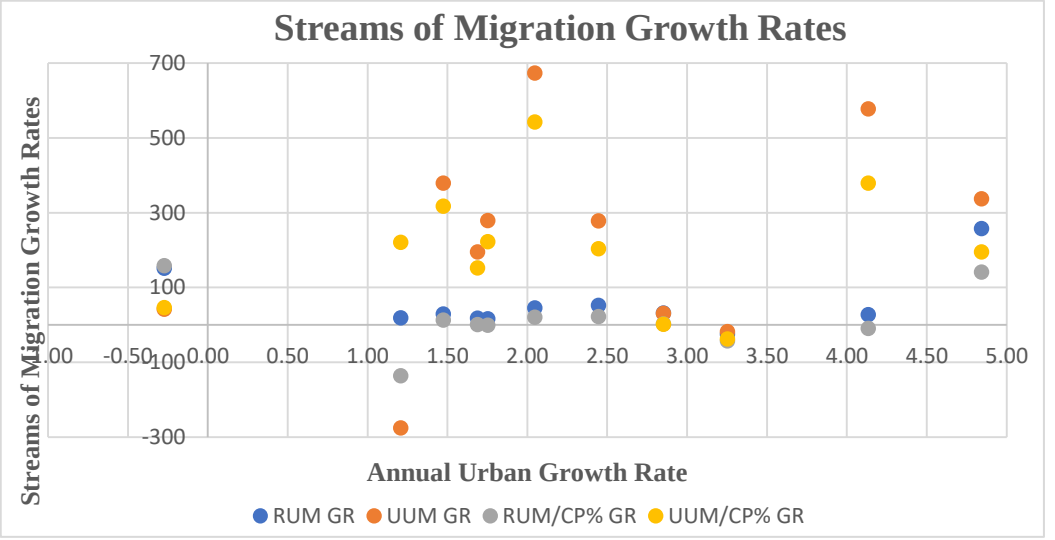
Table 7
Pearson's Correlation Test Results with Annual Urban Growth Rate, 2001-11

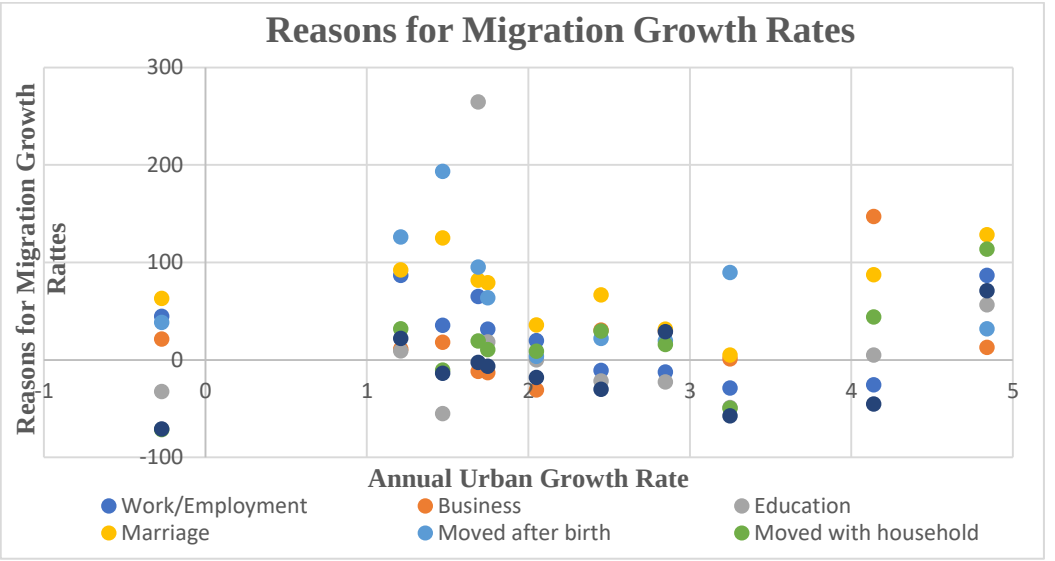
Category	Variables	r	P-value
Types of Migration	Overall Migration GR	0.265	0.432
	Intra-district Migration GR	0.147	0.670
	Inter-district Migration GR	0.251	0.456
	Inter-state Migration GR	0.489	0.127
	From Asia Migration GR	0.607	0.047**
	From Non-Asia Migration GR	0.364	0.271
Streams of migration	Rural-Urban Migration GR	0.207	0.541
	Urban-Urban Migration GR	0.252	0.454
	Rural-Urban Migration/CP% GR	-0.145	0.670
	Urban-Urban Migration/CP% GR	0.079	0.818
Reasons For Migration	Work/Employment GR	-0.278	0.407
	Business GR	0.397	0.227
	Education GR	0.029	0.933
	Marriage GR	0.074	0.828
	Moved after birth GR	0.366	0.269
	Moved with household GR	0.684	0.020**
	Others GR	0.401	0.222

GR-Growth Rate, CP-City Population & **Statistical significance at 95%.
Source: Calculated by the author

Figure 8
Scatter Plots between Annual Urban Growth Rate and Various Migration Growth Rates, 2001-2011







The Correlation Matrix (Table 6) reveals several key relationships among variables related to migration and demographics in the major cities of Northeast India in 2011. Starting with the Migration Rate, it shows a moderate positive correlation with Total Migrants (r = 0.379), indicating that as the number of migrants increases, the overall migration rate also tends to rise. Migration Rate also exhibits a positive correlation with Rural-Urban Migration (r = 0.420), suggesting that higher migration rates are linked to greater rural-urban migration. However, the Total Migrants show strong positive correlations with several migration-related variables. It is highly correlated with Total Migrants Inter-State (r = 0.890) and Urban-Urban Migration (r = 0.985), indicating that both inter-state and urban-urban migration strongly influence the overall migrant population. Total Migrants also show a strong positive

correlation with population (r = 0.917), suggesting that cities with larger populations tend to attract more migrants. Furthermore, Total Migrants are strongly correlated with area (r = 0.904), suggesting that larger cities, in terms of land area, tend to have more migrants.

The correlation of Total Migrants into the North-East (TMNE) with other variables highlights some unique regional dynamics. TMNE has a moderate positive correlation with population (r = 0.742) and a strong positive correlation with area (r = 0.814), indicating that cities with larger populations and land areas tend to attract more migrants into the Northeast. TMNE also shows a moderate correlation with RUM (r = 0.584), suggesting that rural-urban migration is somewhat related to migration into the North East.

Lastly, other variables, such as the Scheduled Caste/Scheduled Tribe Percentage (SC/ST) and Work Participation Rate (WPR), show weaker correlations with migration-related variables. However, SCST has a moderate positive correlation with TMNE (r = 0.604), suggesting that regions with a higher SCST population tend to attract more migrants into the North-East. WPR has weak-to-moderate correlations with most migration variables, with the strongest being with area (r = 0.544), indicating that larger cities may offer more employment opportunities for migrants.

Table 8 presents the multiple regression results examining factors influencing the Total Migrants and Total Migrants Inter-State in major cities of North East India. Both models have very high R-squared values (0.98 for Total Migrants and 0.99 for Inter-State Migrants), indicating that the independent variables explain nearly all the variation in the migration outcomes.

The intercept for Total Migrants (757,873.57) is not statistically significant, indicating the baseline migration level is close to zero. The population has a small positive coefficient (0.05) with no significant effect. However, area size has a significant positive effect (coefficient = 2,687.09, P = 0.0365), suggesting larger cities attract more migrants. The Sex Ratio shows a negative, non-significant relationship (coefficient = -291.88), indicating little impact on migration. Other factors, such as Literacy Rate, SCST Percentage, and Work Participation Rate, also show no significant relationships with total migrants, although they do indicate some trends.

For Total Migrants Inter-State, several key predictors emerge. The intercept (472,990.99) is significant (P = 0.0011), reflecting a strong baseline level of migration. Population has a marginally significant positive effect (coefficient = 0.04, P = 0.0507), indicating that larger cities attract more migrants. Area positively influences migration (coefficient = 289.28, P = 0.0175). In contrast, the Sex Ratio shows a significant negative effect (coefficient = -181.53, P = 0.0026), suggesting higher female ratios lead to lower migration. Higher Literacy Rates also negatively impact migration (coefficient = -2,415.54, P = 0.0100).

Additionally, SCST Percentage positively influences migration (coefficient = 220.83, P = 0.0135), while Work Participation Rate shows a negative relationship (coefficient = -2,800.21, P = 0.0186).

Table 8
Multiple Regression Results of Total Migrants from Urban Statistics

Dependent Variable (Y)	*Total Migrants*		*Total Migrants Inter-State*	
Independent Variables (*X*)	Coefficients	P-value	Coefficients	P-value
R Square	0.98	0.0017***	0.99	0.0002***
Intercept (β_0)	757873.57	0.3165	472990.99	0.0011***
Population (β_1)	0.05	0.7874	0.04	0.0507*
Area (β_2)	2687.09	0.0365**	289.28	0.0175**
Sex Ratio (β_3)	-291.88	0.4105	-181.53	0.0026***
Literacy Rate (β_4)	2864.18	0.6656	-2415.54	0.0100**
SCST Percentage (β_5)	-1058.31	0.1596	220.83	0.0135**
Work Participation Rate (β_6)	-17777.98	0.1065	-2800.21	0.0186**

The sample size is 13. *, ** & ***- Level of statistical significance at 10%, 5% & 1% respectively.
Source: Calculated by the author from the Census of India, 2011.

Conclusion

Migration in Northeast India has reshaped its demographic and socio-political landscape. Intra-district migration is dominant, particularly in cities such as Nagaon and Dimapur, while Agartala and Guwahati experience significant growth in migration. Illegal immigration, especially from Bangladesh, has altered the region's population, contributing to ethnic conflicts and resource competition. Migration from Myanmar due to conflict has added to these pressures, especially in Manipur and Mizoram. Urban centres in Assam and Tripura face overcrowding and the growth of the informal sector, making migration a key and contentious issue in the region. In Northeast India, cities like Guwahati and Agartala experienced the highest influx of migrants, with rural-urban migration outpacing urban-urban streams. Migration is driven by economic insecurity, rural stagnation, and better opportunities in urban centres. Rural-urban migration was most prominent in Guwahati, while urban-urban migration surged in Nagaon. However, cities like Shillong and Tezpur saw declines in both migration streams. The overall shift has impacted labour markets, urban growth, and living conditions across the region. By 2011, Guwahati had the largest number of inter-state migrants (88,430), while Imphal had the fewest (4,357). Most migrants came from Eastern India (48.39%), followed by Northeast India (32.74%). A lack of educational infrastructure, unemployment, and sociopolitical unrest drove migration. Key cities such as Guwahati, Dimapur, and Shillong received the highest inflows, particularly from Assam and Meghalaya. The push factors included labour displacement, floods, and ethnic conflicts. Migration patterns in Northeast India reflect survival

strategies rather than upward mobility, impacting labour markets and city growth. In 2011, 25.19% of migrants to Northeast Indian cities moved for work, 22.58% for marriage, and 20.09% relocated with their household. Smaller percentages migrated for education (2.28%) or business (11.68%). Aizawl had the highest share of work-related migrants (38.78%), while Nagaon had the highest share of marriage-related migrants (29.33%). Migration due to moving after birth saw the largest growth (72.01%) between 2001 and 2011, followed by marriage-related migration (63.44%). Work-related migration grew modestly (12.06%), while migration for education and business declined significantly. Female migration, often tied to marriage, is increasing for educational and employment reasons, especially in urban areas.

By 2011, the population of major cities in Northeast India had grown to 3.3 million. Guwahati remained the largest city, with 962,334 residents. Guwahati accounted for 28.78% of the population and 30.01% of the urban area, with its land area expanding to 219.06 sq.km. Imphal had the highest sex ratio (1,050 females per 1,000 males), while Tinsukia had the lowest (875). Aizawl had the highest literacy rate at 86.29% and the largest percentage of the SC/ST population (92.02%), while Nagaon had the lowest literacy rate at 78.34%. Between 2001 and 2011, the cities experienced an average urban growth rate of 2.51% per year, with Agartala showing the highest growth (4.84%) and Tezpur experiencing a decline (-0.27%). Imphal and Aizawl had the highest work participation rates, while Silchar had the lowest. Migration trends showed that inter-state migration had a moderate positive correlation with urban growth, and migration from Asia had a significant impact on urban expansion. The study's analysis revealed strong correlations between migration patterns, city size, and demographic factors such as sex ratio and literacy rates. While migration from Asia and household relocation were key drivers of urban growth, other factors, such as education and marriage, had minimal influence.

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A Conversation on Deltas

Geo-Reflections-8

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- GS: What made you decide to study deltas around the world?

❖ SF: I pursued my Master's dissertation in 1982 on the Yapatera River Valley of Peru, which is located within the coastal desert of Peru. This research aimed to understand the role of the river and water in the development of the region's rich agricultural economy and a prosperous farming society.

In that programme, we were four students working under the supervision of a professor, a specialist in the geography of Peru, who had developed a partnership with the University of Lima. The Yapatera valley had very fertile soil and plenty of water. It was a place with lots of greenery, like a river oasis in the middle of a desert. When we arrived there, it was about six months after the terrible river flood caused by that year's active El Niño. The whole valley was destroyed, including mud houses, roads, and orchards. People were helpless and distressed, waiting for someone to come to their aid. The flood exposed the fact that those communities were not merely highly dependent on the river; they were completely unorganised and unable to rescue themselves from the crisis of a big flood.

I was 22, a young researcher, a bit naïve. I could not understand why the local people did not do anything to get over the crisis, leaving everything in a devastating condition, as it was, following the flood. They just waited for six months for the situation to resolve itself. This community was a mixture of Native Americans, descendants of enslaved Africans, and many other mixed-race people who had been working under the latifundia system controlled by white large landowners during the colonial Spanish regime in Peru. Afterwards, although the latifundia system was replaced by cooperatives, these communities remained unorganised because they lacked a strong community spirit. Therefore, they could not recover from major natural

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disasters such as the devastating flood.

I was supposed to do my PhD there in Peru, but I thought I could not stay in a place where people were not organised and lacked a sense of community spirit. They lived in a rich valley where intensive farming of fruits and cereals was practised, but they could not organise themselves. They had been living there for generations, but could not build their community strength because of their diverse roots and the continued violence of colonisation and slavery. This Master's dissertation taught me that a geopolitical perspective is vital for understanding the societal organisation of a hydraulic system and its development over time.

- GS: Why did you decide to work on the Nile Delta for your PhD?

❖ SF: I was pretty shocked at the observations from my earlier study on Yapatera valley, where, instead of benefitting from living in a rich environment, the people could not organise themselves to repair the damage caused by the flood in a collective way. At that stage, I wanted to study a similar environmental condition around rivers and water, where people were better organised at the local and regional levels, covering the entire river valley, and had developed a strong hydraulic society by working together over a long time. The Nile Delta in Egypt was an example of such a site. Along with another batchmate from the same laboratory, I decided to go to Egypt for my PhD. It was one of the world's most ancient hydraulic civilisations, which had survived for centuries thanks to the Nile floodplain farming community, their scientific and technical knowledge, and the state's centralised control over water and land. My batchmate decided to work on hydro-politics and conflicts over the Nile River between the upstream riverine countries, and I decided to continue understanding the river and the hydraulic society in the Nile delta.

At that point, I realised that local-level geopolitics (meaning politics around the distribution and conflicts over land and water) matters a lot in understanding social organisations in riverine environments. I requested one professor from my university, i.e. Paris 8, to supervise my PhD on the Nile Delta.

- GS: Who did you request to be your mentor for your PhD?

❖ SF: The professor was Yves Lacoste, a renowned geographer and the founder of the School of Geopolitics in France, who had already written his book *Le Géographie ca sert d'abord a faire la guerre* (Geography serves, first and foremost, to wage war) in 1976. The core argument was that Geography is the discipline that teaches how to control people and territory to wage war. For him, geopolitics is the study of conflicts and competition over land and water at different scales. Because of his expertise in geopolitics, especially in the Red River delta of Vietnam, I considered approaching him to supervise my PhD on hydraulic societies and deltas in Egypt.

- GS: Why do you think that geopolitics matters so much in studies of Deltas?

❖ SF: The idea that the environment determines everything does not work for Deltas. If it did, all the deltas in the world, which are rich in land and water resources, could be transformed into thriving farming, fishing, and trading regions. However, some deltas in Europe are empty, while others in Asia are overpopulated. This means that only the politically powerful empires and states could exploit the deltas' water and soil. Many states or kingdoms lacking that geopolitical power could not develop other deltas into rich hydraulic or fluvial societies.

This geopolitical approach provided me with the opportunity and methodology to understand how and why some of the most developed civilisations emerged and flourished in delta environments. Delta dynamics is not an issue that can be studied solely by physical and environmental scientists; instead, it requires interdisciplinary research combining three perspectives—biophysical (land and water), socio-demographic, and politico-historical. Deltas have historically been at the centre of contestations between power regimes (e.g., empires, states and localised power groups like pirates) due to their physical resources and their location at the frontiers of ocean- and river-based trade routes. In the study of deltas, the scale of analysis matters a lot. To better understand deltas, we need to analyse various kinds of conflicts over water control and river management, not only at the local scale of the actual delta, but also between upstream and downstream countries, provinces, and communities. These water conflicts are embedded in broader conflicts, sometimes leading to war that ultimately harms the deltas.

- GS: Can you tell us from your research what precisely the role of geopolitics is in the Nile Delta? Is it because the river flows through several African states?

❖ SF: I tried to understand how the process of densification has happened in a place like the Nile Delta, which faced high floods almost every year. It flourished as a civilisation in the midst of a desert because of floods that brought water and silt, making the area highly productive. For millennia, people in the Nile delta under state control developed a well-organised irrigation system to transform the entire territory into productive agricultural land. The role of geopolitics lies here in the power equations of the state to control the land through the organisation of the hydraulic system. It is a desert area and used to get hardly any rain. Only a well-organised hydraulic system could implement intensification of the agricultural system, followed by population densification. The Nile delta is the most densely populated; its population density is twice that of the Bengal delta. Indeed, geopolitics was everywhere in the Nile Delta, especially over control of the canals, the Nile, and its many distributaries, as these were integrated into international trade routes before the construction of the Suez Canal.

- GS: Did you look into the changes in the Hydraulic systems of both the period before and after the Aswan Dam was built on the Nile?

❖ SF: No, it was not just before and after the Aswan Dam; my work focused on the historical changes in the Nile Delta over a more extended period, and on understanding how the population, settlements, and agriculture changed during different historical regimes under other kingdoms. Egypt has always been a hydraulic society in the middle of the desert, which scholars have studied for more than two millennia, and these studies are recorded and preserved. Herodotus invented the term 'delta' 2500 years ago to describe the lower reaches of the Nile valley because of the triangular shape of that area, which resembles the Greek letter 'Delta'. I collected maps of the different political regimes from the archive and compared the territories under cultivation and the locations of cities along the Nile and its branches under those regimes.

- GS: What kind of changes in the delta did you notice from studying those maps?

❖ SF: I observed that the territories occupied by the settlements and agriculture in this delta have expanded and shrunk many times under different rulers. During Roman rule over the Nile Delta, the territory expanded considerably, and many cities emerged where water and trade administration were concentrated.

- GS: Could you explain how early cities grew around the hydraulic system?

❖ SF: Cities emerged along the seven branches of the Nile and its canals, to take control of the riverine trade and to maintain the irrigation system, which required the accumulation of money, power, technology, and labour. Taxes were collected from boats and ships using the rivers and canals, as well as from the trade in agricultural products, and were used to finance hydraulic and territorial management. The cities were where the administrative offices for all these activities were located. During the Roman period, as trade and hydraulic engineering flourished on a larger scale, the number of cities grew. These cities were all connected by riverine trade routes to Alexandria, the world's largest port city for centuries.

- GS: So, the Roman period was an example of a period of territorial expansion in the Nile delta. Could you please tell us about a period when the territories in the delta shrank?

❖ SF: In the 14th century, Egypt was ruled by the Mamluk Sultanate. They were not interested in agriculture and, consequently, in maintaining the irrigation system. The number of cities decreased from 48 during the Roman period to 12 during this regime. The size of the populated territory decreased to half its size during the Roman period. This expansion and contraction also underscore the importance of geopolitics and the control it exerts over water, population, and land in the delta region.

- GS: You mentioned a question of scale in geopolitics; can you explain that?

❖ SF: Before arriving in Egypt, the Nile River nourishes the lands of nine other countries with its water and silt

in its upper reaches. If those countries had been powerful enough to control the Nile hydraulically, Egypt could not have flourished in its downstream areas. Because of its very high geopolitical power, Egypt controls the water distribution of the entire river. Until 2011, Egypt could prevent any other upstream country from building a dam on the Nile. Therefore, to develop hydraulic societies in the delta, you need to deal with local, national, and sometimes international geopolitics.

- GS: What is the role of the Egyptian government and the Aswan Dam in the geopolitics of the Nile Delta?

❖ SF: Since the British era of colonisation, Egypt has played a very important role in the Africa and West Asia region due to the location of the Suez Canal adjacent to the east of the delta. The British also wanted access to and control over petroleum in West Asia. Therefore, they needed Egypt to be stable and developed. They granted Egypt control over the Nile's water. When the Great Aswan Dam was built in 1970, Egypt gained a larger share of water at the expense of Sudan and other riverine countries, which were forbidden from building dams upstream on the Nile. Since the Arab Spring revolution in 2011, the Egyptian government has become weak, and the Ethiopian government has seized the opportunity to build the Renaissance Dam on the Blue Nile. It was their dream project for a long time, but it could not be undertaken because of the strong Egyptian government under President Mubarak. The construction of this dam could lead to a water war on the Nile once it comes into operation, significantly reducing flow to the Nile Delta.

- GS: After your PhD on the Nile Delta, which delta did you work on?

❖ SF: After my PhD, Yves Lacoste, my mentor, advised me to study the Red River delta in North Vietnam.

- GS: Why did he tell you to go there? What was the specificity of that delta to look into?

❖ SF: This suggestion came from his earlier study on the Red River delta during the Vietnam War against America. As a renowned expert on geopolitics, he had been invited by the communist government of Vietnam to provide evidence that the US army had been bombing the dykes in 1972. He studied the Red River delta and its hydraulic structures at great length and made a comprehensive assessment of the river dykes, based on the maps prepared by the geographer Pierre Gourou. He demonstrated how the US army had targeted the most vulnerable parts of the dykes and the eastern flood-prone areas, and bombed the immediate bases of the dykes near the high meander curve of the river, where the current of the river was strong. This made the dykes highly vulnerable to breach during floods. His research showed that the US Army's destruction of hydraulic structures would make the Red River delta vulnerable to flooding again. According to international rules of war, no bombing is allowed of hydraulic infrastructure such as dams and dykes. After mapping and

analysing those bombing spots, he went back to France and wrote a report for the Vietnam government, explaining the incidence of bombing in the vicinity of the dykes in the densely populated parts of the Red River delta, and also published an article at length for France's famous newspaper, called *Le Monde*. However, due to the highly sensitive diplomatic context, the US military continued to deny Yves Lacoste's allegations, claiming that they had only bombed weapons depots or anti-aircraft batteries.

- GS: Do you think that this incident made a lasting impression on Yves Lacoste about the importance of geopolitics and associated hydraulic control of the state in a fragile and rich area like the Red River delta?

❖ SF: Maybe that was the case. However, I could not start that research immediately after completing my PhD, as I had joined the Institute for Research and Development as a researcher and was supposed to work on integrating cattle farming with crop farming in Senegal. I worked on that issue for six years. Once that assignment was over, I turned back to deltas again, because the highly populated delta was living in my heart. I then followed my mentor, Yves Lacoste's, earlier advice and went to Vietnam to study the Red River delta.

- GS: Did you look at the geopolitics of the Red River delta as you did for the Nile?

❖ SF: No, it was challenging to work on local hydro-politics in Vietnam, because the country was sensitive to research on any geopolitical issues due to its authoritarian Marxist regime. Another problem with such research in Vietnam was the lack of local partners willing to take the risk of addressing these kinds of questions. Most institutes and scholars working on rivers and deltas focused on physical issues of rivers, leaving out the social and political aspects. I had to find another way to understand that issue.

- GS: What were the other issues you looked at in your research on the Red River delta?

❖ SF: At first, I wanted to experiment and see whether the methodological framework I had developed in the Nile delta would work in the case of the Red River delta. I wanted to understand how that fragile delta, highly vulnerable to floods, could be so densely populated. I started with the history of population settlement in the lower and upper parts of the delta, and I realised that, despite a very intensive system of rice farming with three crops a year, agriculture could not explain such high density. Then I looked into the other livelihood activities in the delta and observed that, besides farming, a large proportion of people were engaged in artisanal activities and the related trade in raw materials and finished products. Those activities were more concentrated in the low-lying areas affected by floods and near waterways, facilitating trade. After considerable fieldwork and mapping of the empirical data, I also observed that many villages engaged in craft

activities and were organised in clusters.

- GS: Why did these artisanal activities flourish in low-lying areas?

❖ SF: In Monsoon Asia, the micro-topography of the delta matters a lot, as the lower parts can be highly flooded, making it impossible to produce three rice crops in a year. There is high diversification of activities in these low-lying spaces. Even in the intensive agricultural production system practised on relatively higher ground, there are lean seasons between transplanting and harvesting, when people have to find other work to survive. This diversification of the economy, high population density, and labour-intensive agriculture led to in-situ urbanisation in this delta. I started drawing a map of population density at the commune scale. After mapping, I realised that some areas were highly populated but remained rural, meaning the state did not designate them as urban. In both the Nile and the Red River deltas, urban status has nothing to do with density or people's activities, as in India. 'Urban' in these countries refers to places where state administrative activities, especially those related to land, water, and taxes, are located. They are all just headquarters of different provinces/districts.

- GS: What kinds of crafts did you notice, and how were they linked to the hydraulic system?

❖ SF: As Vietnam had been under the rule of China for a thousand years, at the beginning of the independent regime, it had followed the Chinese system of urbanisation. Because of that colonial legacy, Vietnam followed the Chinese model for organising hydraulic cities and villages. Therefore, in Vietnam, cities were developed as headquarters of the hydraulic state and as the centres of trade and commerce. The industries were scattered across specialised craft villages in the hinterland of big cities. They would supply cities with food and other durable goods, such as ceramics, textiles, paper, metal goods, art, and cultural items, as well as artisans and their skills. Some skills were also inherited from China.

- GS: How would you explain the link between the development of craft activities and the organisation of the delta?

❖ SF: Some clusters were located along the Red River and its distributaries because of the ease of transportation, for carrying both the raw materials and the finished products. Because of the dense network of waterways, the Red River delta could flourish in both production and trade. Before roads and railways, deltas were the most important junction points for connecting inland territories with the outside world through coastal harbours. Even after China stopped ruling the country, Vietnam had to pay tribute in the form of bricks, silk, and ceramics. It was part of the deal to gain independence from Chinese rule. This condition stimulated the craft industry and led to the innovation of higher-quality goods to be supplied to the former rulers.

- GS: What is your key message from the study of the Nile and Red River deltas, especially on geopolitics and scales?

❖ SF: Studying the Red River delta confirmed the methodology I had experimented with in the Nile delta. What I deduced from the studies of these two deltas is that a multi-scalar approach to time and space is needed to understand the role of the state and geopolitics in the deltas, where the entire environment is shaped by water, both as a resource and a threat.

- GS: So, what was the next delta you worked on after the Red River?

❖ SF: I carried on my work on the Red River delta in the process of undertaking many other projects during my seven-year stay in Hanoi. But in 2006, Yves Lacoste gave me the opportunity to edit a special issue of his renowned journal, *Herodote*, on the geopolitics of deltas worldwide. This assignment helped me learn about other deltas and connect with many other researchers working on these issues. After reading extensively about other deltas, I became interested in understanding the Ganga–Brahmaputra–Meghna delta. While comparing the histories of settlement and water control across several Asian deltas, what struck me was that the world's most dangerous deltas in terms of flooding are also the most densely populated in Monsoon Asia.

- GS: From your extensive experience of researching different deltas, how would you like to categorise them?

❖ SF: We can create different typologies based on themes such as population density, occupation, and economic activities**.** Let us start with the population density. To understand this category, we have to go back to the history of settlement, because the densely populated deltas have been developed since ancient times, such as the Nile in Africa and the Red and Yellow Rivers in Asia. They are the cradle of ancient civilisations. We have to ask ourselves why highly developed civilisations emerged in deltas with such dangerous rivers. The answer lies in those dangerous rivers themselves, which brought vast amounts of sediment to the deltas, making the land fertile and providing opportunities for agriculture. People perceived the risk of muddy water destroying villages and fields as worth it for the benefits of good crops in other seasons and for building cities for trade and hydraulic administration.

In developing these affluent hydraulic communities, there was a need for rulers or governments who were financially strong, politically powerful, and technologically sound. There was also a need for an integrated, well-organised society capable of implementing the state's strategies for developing the deltas. These societies prospered based on mutual trust and respect for the knowledge of both the state/ruler and the local village leaders. Although there were hierarchies within the hydraulic network of rivers and canals, there was a mutual understanding of the role of the various actors at every level and scale, from macro to micro. The deltas'

hydraulic networks were also social networks. Even a small gap or break in that big network could cause the entire system to collapse. These actors understood the traditional system of the hydraulic society very well, and that is why they prospered to a great extent even in ancient times and the Middle Ages. Yves Lacoste used to say that these systems continued over a long period of time because of their strongly connected ethnic communities, such as the Viet in Vietnam and the Han in China. They could also easily integrate smaller communities living in the deltas' peripheral areas into their own hydraulic system. Ethnic homogeneity was necessary for the development of strong hydraulic societies. In contrast, the less populated deltas, such as the Mekong, Irrawaddy, and Niger, were home to diverse ethnic communities with different ways of understanding and living alongside the rivers and floods. These societies can be defined as fluvial rather than hydraulic societies (Son Nam, quoted by Bourdeaux, 2013). The difference lies in the fact that all riverine communities know how to live with floods in their own way, whereas hydraulic societies build a coherent water network and system not only to protect them from floods, but also to maximise the use of the rivers' water and silt for their own benefit. To analyse the organisation of water distribution and flood protection, it is necessary to understand the role of each (big and small) actor within the entire network.

- GS: Can you explain the different typologies of deltas based on the second theme, i.e., the occupation or economic activities of the people?

❖ SF: Yoshiro Kaida (2000), Japanese expert on deltas, has identified three types of deltas in Monsoon Asia based on the occupation of the delta inhabitants. These are the mercantile deltas, the rice production- and export-oriented deltas, and the nourishing deltas with diverse economies, including agriculture and small-scale industrial production catering to local and regional demand. An example of a mercantile delta is the Pearl River Delta in China, the world's largest industrial region in terms of trade. One of the strengths of the Pearl River Delta is the diasporic movement from the Delta towards Hong Kong and other trade centres. This movement helped the delta connect to the global economy in the 1970s. However, this delta had been engaged in mixed activities under imperial rule for a long time, right up to the revolution led by Mao Tse-tung. It had extensively diversified its economy through craft, trade, and agriculture for ages. One process of economic diversification under state initiative was the creation of polders to extend land over the sea by building artificial deltas. This process integrated mulberry cultivation, silkworm rearing, and fish farming in a harmonious, mutually beneficial way. The process was called the Mulberry-Dyke and Fish-Pond System. In that process, they first built numerous ponds over a long time with the help of dykes. Then the ponds were desalinated by bringing in sweet water through canal networks from

the Pearl River and its distributaries. Thereafter, they started planting mulberry trees along the dykes to feed the silkworms and developed the silk industry, as well as fish farming in the big ponds. The silkworm waste on the dykes also fed the fish in the ponds. These labour-intensive activities provided employment opportunities for local people and facilitated the global trade in silk by developing a mixed, localised production system. They simultaneously extended the delta towards the sea. This is an excellent example of how people perceive the benefits of a delta and build a mixed and diversified economic network to prosper. It is also an example of how an integrated network of people and the state operating at different scales can build a prosperous hydraulic society.

- GS: How do you see the local physical environment being negotiated by the people in many different ways to settle and to prosper in the delta areas?

❖ SF: Different categories of people and institutions are involved in the process of building delta communities at different scales: the state, the regional institutions, and the local communities. Along with the hydraulic hierarchy of rivers, distributaries, and canals, the geopolitical power reaches the territory at different scales. I want to explain this using the cases of Vietnam. Vietnam has two important, densely populated deltas—the Red River Delta in the north and the Mekong Delta in the south. When the historical development of delta communities took place in these two areas, they were not part of the same country as they are now.

The Red River delta was the cradle of the Vietnamese civilisation before it expanded southwards into the territories of other independent kingdoms. As it was under Chinese control for a long time, it adopted the Chinese model of organising cities and villages in the Red River delta through centrally controlled state-run hydraulic engineering. This kind of state-controlled development occurred because of the river's physical condition, which used to cause dangerous floods. The steep terrain and rapid flooding were beyond the capacity of local people to adapt. The intervention of the state was essential to control the rivers through building embankments and canals. To finance such initiatives, the state taxed agricultural and trade activities through waterways and controlled the population through 'corvée', i.e., forced, unpaid labour for the maintenance of hydraulic structures, including the dykes. The state used *corvée* labour to build large infrastructure projects, but the maintenance of the water distribution organisations and the repair of local infrastructure were carried out by the powerful family lineages at the village level. In other words, we can say that the power of the empire would stop at the door of the village bamboo hedge. Terry Rambo (1973) in his PhD thesis defined the village communities of the Red River delta as 'closed corporate' communities, meaning self-sufficient farming communities with a strong sense of solidarity during natural events such as floods and economic

crises such as famine. These kinds of societies are built on a common understanding of the entire hydraulic system, but with a strong hierarchy at the local level. That is why the Red River delta communities can be defined as hydraulic communities.

- GS: How would you explain the other category called 'fluvial societies' with reference to the Mekong delta, and how is this system different from that of the Red River delta?

❖ SF: The Mekong River is less dangerous than the Red River, as the floods are of lower magnitude due to the low gradient of the river channel, and partial natural regulation of the flood water by the Ton Le Sap Lake of Cambodia, located upstream of the Mekong. These societies never needed comprehensive river control measures, as they could organise agricultural production and trade without major hydraulic infrastructure. They could clear the forest, settle and grow crops (rice) independent of state support. The term' fluvial societies' is used by the Vietnamese scholar Son Nam as quoted by Pascal Bourdeaux (2013). Son Nam defines fluvial societies as diverse and heterogeneous communities that develop their habitats independently, without state-controlled large hydraulic infrastructures.

The nature of the flood in the Mekong Delta was different from that of the Red River Delta. It was slow and low-level. Through their own observations over generations and indigenous knowledge of nature, water, topography, and natural vegetation, people developed their own habitats in the Mekong Delta. Here, I would like to highlight an example of how a closed community became open when people moved to different hydraulic conditions. The Viet used to live in a closed community in the Red River delta, but when they moved to the Mekong delta, they no longer needed the same level of community organisation. Instead, they began living in smaller, separate settlements. Thus, the Mekong delta became an agglomeration of open and multicultural societies, focused more on commercial production for international trade. The development of multiple activities through diverse communities made the Mekong Delta the rice bowl of Vietnam.

- GS: You said that different ethnic communities are living in the Mekong delta. How many communities are there?

❖ SF: There are four different communities: the Khmer who originally settled in the delta and belonged to the Khmer kingdom of Angkor; the Viet who came from the North of Vietnam; the Chinese who were traders living in small towns; and the Cham, a Muslim community coming from the Champa kingdom located in central Vietnam. Over centuries, they developed different ways to live with the water and to occupy, settle, and flourish in the delta. Initially, the delta communities developed their diverse activities over a longer period at a slower pace, which was more sustainable and in harmony with the river's natural rhythm, such as floating rice farming. However, with colonisation, the speed

of territorial expansion significantly changed the entire delta environment. During the French colonial era (1858–1954), the administration built numerous canals for two reasons: to create waterways for territorial expansion and to bring in sweet water to newly constructed village settlements for agricultural expansion. During this period, many people migrated to the Mekong Delta because the French expanded rice farming there, which required a large workforce.

- GS: You have probably analysed how differently people perceive the delta environment and how they live with floods in Vietnam. Could you tell us more about the different ways in which people perceive the delta environment?

❖ SF: In the Red River delta, dykes were built to protect the villages from flooding, but they also prevented rainwater from draining from the plains and created a massive problem of waterlogging. Because of this, people settled in villages on higher grounds, especially on the levees along the river or on artificial mounds. This kind of development required a central organisation to build settlements in such vulnerable environments. In contrast, in the Mekong delta, small migrant communities could settle collectively or individually on existing higher ground, such as dunes (called Phno), which were earlier created by the sea but became part of the delta as the delta prograded. Some of these dunes are 40 kilometres long and are occupied by dense Khmer villages clustered around Buddhist temples. Later, as the French excavated canals, people began building houses on the canal embankments, which offered higher ground for flood protection. People in the Mekong Delta understood the micro-topography very well. Philip Taylor (2014), in his book The Khmer Lands of Vietnam: Environment, Cosmology and Sovereignty, asked the question: 'What makes local populations so sensitive to micro-topography of a few tens of centimetres, in such a flat world?'

- GS: How would you differentiate between the closed societies and the open societies in deltas with reference to Vietnam?

❖ SF: Closed hydraulic societies were composed of nucleated villages surrounded by dense bamboo hedges, which protected them not only from floods but also from local pirates and dacoits. They were organised around water distribution and the maintenance of the dykes, which were mainly delegated to them by the state. They were not open to outsiders who migrated there. Families who had lived in the same village for more than five generations were eligible for access to community-owned land. These close communities were built on internal solidarity. This is why some community-owned lands were redistributed to low-income families.

In contrast, open fluvial societies were composed of migrants, which is why they were also open to newcomers. They were kind of like frontier societies that established new territories and communities along canals. They also built houses on stilts or floating houses on small rivers and

canals so they could move from one place to another, rather than being tied to a single community. This is another reason why they are called open societies. These societies developed their knowledge of how to live with floods through experience. They developed diverse economies, including farming, fishing, and floating markets for community trade, as well as international trade through the delta's canals and rivers.

- GS: What changes did the communist government of Vietnam bring to the Mekong Delta when it took over the south and brought the Mekong Delta under the state of Vietnam?

❖ SF: In 1975, after pushing the Americans out of Vietnam, North and South Vietnam reunited. The communist government of Vietnam wanted to replicate the Red River's river control system in the Mekong Delta to intensify agriculture. This was a very wrong step taken by Vietnam. They began controlling floods by building full and semi-dykes to increase the number of crops each year, but this process fundamentally changed the way of life of the local people, a system that had been practised for generations. Trying to control the Mekong Delta in the same way they did for the Red River had catastrophic effects, damaging the historical system of sustainable living along the river and with the floods.

They developed a strategy called 'living with floods', but in doing so, they abandoned earlier resilient practices that the people of this delta had developed over generations, such as floating houses, floating markets, and houses on stilts. Now they are drying out some land by building dykes and draining water to increase the number of crops per year and to settle people there to escape floods. The government prevents people from living along the canals because they are vulnerable to floods caused by both rain and tides, and they want to relocate them to the newly created dry areas. By removing people from flooded areas, they claim to be helping them live with floods. But for people whose livelihoods entirely depend on the water, what will they do in drier areas? The people would also have to buy these new lands. To escape these state-driven hazards, people often migrate to Ho Chi Minh city to work as labourers. This is an excellent example of how the state-controlled top-down approach to the hydraulic system is changing the fluvial system of the Mekong Delta.

- GS: While working in the Red River delta, you also went to study the Niger delta in Africa for a year, on the invitation of the French Institute for Research in Africa. What kinds of information would you like to share with us on the Niger Delta? Is the Niger Delta an example of a fluvial or a hydraulic society?

❖ SF: The Niger is the third longest river in Africa after the Nile and the Congo. Because of its numerous branches, it was the natural waterway through which European colonisers entered the West African mainland. The process of colonisation began in the Niger Delta to conquer the river basin and drain its resources (Fanchette, 2006). This was possible because the Niger River flows through low-gradient terrain and is not severely affected by floods. It was an

easily navigable river, and 40 ethnic communities lived along its banks. Each community had its own territory and engaged in various activities, such as farming, fishing, and trade. It was a perfect example of 'fluvial society'. The communities in this delta developed independently, with little help from engineers or the state. Local kings built city-states on the mouths of the various branches of the river. Those cities and states were the places where trade in resources, including enslaved people, flourished.

At first, the colonisers did not take the initiative to build infrastructure to develop this region. They were only interested in draining the resources through the waterways. However, the local river trade, which was based on communities trading with one another, was severely affected by the British colonisers. They took control of all trade in the entire delta (both upper and lower reaches), including enslaved people, from the earlier local kingdoms of coastal city-states. City-states located at the mouths of rivers served as intermediaries, draining resources from the delta and handing them over to the colonisers for export to the outer world. The city-states lacked the capacity to conduct international trade via ocean routes.

After Nigeria's independence in the 1960s, companies like British Petroleum and Shell began drilling wells to extract petrol across the delta, destroying the original habitat, including the houses and farmlands of local communities. Consequently, a legacy of violence started in Nigeria. Extracting more oil, transporting it through pipelines across land, paying the host communities (where petrol is extracted), and oil leakage and stealing have caused a lot of conflicts and violence, which continues till now, destroying a rich trading delta that was developed using an open fluvial system. The environmental and social costs of the oil industry are very high and have altered the future course of the Niger Delta. This delta can also be considered a collapsed or dead delta.

- GS: What was your experience when you went and observed a different kind of delta, like the Ganga–Brahmaputra–Meghna (GBM) Delta?

❖ SF: I was excited to observe the GBM delta, because it is the biggest delta in the world and is created by the confluence of three big and mighty rivers. In the GBM delta, Bangladesh is entirely a delta. This is the only such case in the world. Most other deltas are just parts of a country, but in this case, they make up the whole country. The country's economy and territorial development are both linked to the delta and its water management. The GBM delta is a place that reflects the compound hazards of flood, cyclone, and erosion. It floods for many reasons, such as heavy monsoon rain, massive tidal waves, and cyclonic events. Everything is at its extreme in this delta—the scale of the flood and the loss of lives and resources, water conflict between countries due to the partition, and the involvement of international agencies. These agencies were involved earlier to alleviate poverty, for so-called development initiatives, and now in the name of climate change. Bangladesh is known as the cemetery of failed embankment

projects by Western countries, and is now considered by international funding and donor agencies as a laboratory for climate change adaptation.

- GS: What is your opinion on the development of a discourse crisis by international agencies on deltas, through climate change?

❖ SF: After extensive reading about climate change adaptation in the GBM, I realised that the subject is highly biased by the climate change narratives. There are many other issues to consider, but climate change commands the whole attention in delta research. It is a way to hide the mismanagement of the delta in the name of development and to distract people from the real causes of the vulnerabilities in the GBM delta to raise funds for research and for so-called development projects. Deltas have to adapt to future hazards, and to ensure that kind of preparedness, we need to analyse the causes of these hazards more effectively. By giving so much importance to climate change issues such as sea level rise, increased frequency of cyclones and floods, changes in the rainfall regime, etc., we justify our hard infrastructure-based development initiatives and the mismanagement of the delta. By following developers' and experts' suggestions, such as introducing shrimp farming as an alternative livelihood and building higher dykes, we are increasing hazards to a large extent rather than reducing those.

The considerable environmental repercussions of the so-called development in river basins must be studied and disseminated. Such repercussions include the construction of neoliberal cities characterised by high-rise buildings and extensive groundwater pumping, the construction of dams that alter the siltation regime, increase saline water intrusion, and riverbank and coastal erosion. Delta ecologies are highly complex, and we have substantially modified them. We are now facing the double exposure to environmental externalities and climate change. We can give an example here. The subsidence rate in deltas is higher than the rate of sea-level rise. This is happening because there is not enough silt behind the dykes, and groundwater pumping is extensive. However, very few experts mention this when they discuss climate change and rising sea levels.

- GS: What are you proposing to do, to give us some hope, based on your extensive knowledge of the deltas around the world?

❖ SF: For more than 40 years, I have been engaged in understanding deltas and their territorial dynamics. Now is the time for me to write a book using the comprehensive knowledge I have gathered through research into different deltas around the world. I have started writing it, and the central questions of the book are: Why are the Asian and African deltas endangered and facing enormous social and environmental crises, even though they are the richest regions of their countries, producing rice and cereals, and hosting large metropolises? Why do their national governments, along with international agencies, implement development policies that increase the vulnerability of these deltas, risking the collapse of the entire hydraulic structure? It is

like killing the hen that lays golden eggs! I hope my book will offer some hope by showcasing cases of people developing strategies based on local environmental knowledge and water-related wisdom to minimise the devastating impacts of rivers and their deltas.

- GS: What would you like to say about the future of deltas?

❖ SF: The only hope is to accept our failure to control nature and to identify all the misdeeds we have committed in the deltas. Only when we accept our failures and mismanagement can we hope to save the deltas, which were the cradle of human civilisations. Now, we must address the root causes of the vulnerabilities we have created in the deltas in the name of development and management, to profit from the resources of deltas, especially by separating water from the land of these soaking ecologies, and start thinking about reversing those destructive processes. We need to move away from the river and water control approach and embrace the 'living with the river' approach by accepting the idea that the river not only gives but also takes from us.

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