Geography Journal

ISSN-0011-7269

THE DECCAN GEOGRAPHER

Volume 62 □ Number 10 □ December 2024

(UGC Care Listed: A Peer Review and Refereed Journal)

Chief Editor

Professor B. C. Vaidya

THE DECCAN GEOGRAPHICAL SOCIETY, INDIA

(ESTD : 1962)

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Partially financial assistance received from ICSSR, New Delhi for this publication. Opinions Expressed in the articles are those of the contributors and do not necessarily reflect the policy of the DGSI Society.

The Deccan Geographer

UGC Care Listed: A Peer Review and Refereed Journal

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SPATIAL ANALYSIS OF VOTER TURNOUT, CAUSES, CONSEQUENCES, STRATEGIES AND SUGGESTIONS: LOK SABHA ELECTION 2024 IN INDIA

Professor Anupama Verma

Abstract

India, as the world's largest democracy, has a uniquely diverse electorate that provides fascinating opportunities to study voter behaviour. The largest electorate in the world, 96.88 crores, registered to vote for the General Elections of India in 2024 (Election Commission, PIB, Delhi, 2024). This study analysed the spatial distribution of voter turnover in India's Lok Sabha election 2024, highlighting the causes of spatial variations in voter turnout across different regions of the country. The total voter turnout percentage for the Lok Sabha election in India is 65.79% (Election Commission of India). This study is based on secondary sources of data. This study reveals that there are regional variations in voter participation, which is a complex phenomenon influenced by many social, economic and political factors. Remarkably, Lakshadweep witnessed the highest voter turnout at 84.16%, accompanied by Assam at 81.56%. In contrast, Bihar faced the lowest voter turnout at 56.19% (Chakravarty, 2024). This study provides insight to researchers and the general public to comprehend the political dynamics of the 2024 Lok Sabha elections in India within a geographical context.

Introduction

Voter participation or turnout describes the percentage of eligible electors participating in an election. High voter turnout indicates a strong democracy, while low turnout reflects voter apathy and distrust of the socio-political system (The Hindu, 2019, April 10). The 2019 Indian general election saw a record-breaking voter turnout of over 67%, the highest ever, with significant participation of women voters (Yogasundraam, 2009). In comparison, in the General Elections 2024, voter turnout was 65.79%, indicating lower participation (Election Commission of India). This study focused on the patterns and factors influencing voter turnout. These encompass geographic, demographic, social, economic, and political elements.

Additionally, turnout may also be influenced by external factors like political stability and public confidence in the electoral process, which can vary by region and election. The Election Commission of India is working to maintain the integrity and inclusiveness of the electoral process, but it faces a significant challenge: declining voter participation. This trend raises concerns about the health of India's democracy. Voter turnout in Lok Sabha elections varies greatly across regions and demographics. While some constituencies see high levels of voter participation, other constituencies see apathy and disinterest among voters (The New Indian Express, 2024, April 15). This study aims to illustrate the spatial distribution of voter participation, the reasons behind low and high voter participation, and their implications.

Study Region

A total of 543 Lok Sabha constituencies have been selected to study voter participation in the 2024 elections in India. These constituencies are allocated based on population, with larger states like Uttar Pradesh and Maharashtra having more constituencies while smaller states and union territories like Goa and Sikkim have fewer. The Indian Parliament's composition reflects a commitment to inclusive representation, as evidenced by the allocation of 84 seats to Scheduled Castes (SCs) and 47 seats to Scheduled Tribes (STs) within its 543-member structure. This distribution of seats, established by the Delimitation Commission in 2008, aims to ensure the participation of marginalised communities in the nation's legislative processes (https://www.mea.gov.in).

Objectives

(1) To understand the spatial variations in voter turnout across India in the 2024 Lok Sabha elections in India.
(2) To analyse the causes of spatial variations in voter turnout and their consequences, along with strategies and suggestions to improve it.

Database and Methodology

This research is predicated on secondary data sources obtained from the Election Commission of India. Data have also been collected from websites, newspaper articles, Journals, etc. Geographical Information Systems tools have been used to show the spatial distribution of voter turnout. This study applied areal structural and aggregate data analysis approaches to show spatial variations in voting participation.

Result and Analysis

India's elections are recognised as the largest democratic exercise in the world. More than 96.88 crore voters formed the government in the 2024 general election (Election Commission, PIB, Delhi, 2024).

Table-1: Lok Sabha Elections in India

Electors	2019	2024
Total Electors	89.6 Cr.	96.8 Cr.
Male Electors	48.5 Cr.	49.7 Cr.
Female Electors	43.1 Cr.	47.1 Cr.
Third Gender Electors	39683	48044
PwD Electors	45.64 Lkh	88.35 Lkh
Electors under 18-19 age group	1.5 Cr.	1.85 Cr.

Source: Election Commission of India, PIB, Delhi, 9 Feb. 2024
https://pib.gov.in/PressReleasePage.aspx?PRID=2005189

Table-1 presents a comparative analysis of data from Lok Sabha elections regarding the number of electors in 2019 and 2024. The analysis indicates an increase in the number of electors for 2024, rising to 96.8 crore compared to 2019. It also showed an increase in 2024 in gender-specific data. The number of male and female electors has also shown a significant increase compared to 2019. In this election, the number of first-time voters in the 18-19 age group is around 1.85 crore, up from 1.5 crore in 2019. Additionally, the number of voters in the 20-29 age group is over 19 crores in 2024. This trend reflects the increasing youth participation in the electoral process compared to previous elections. The growing youth participation underscores a significant concern among young people about the importance of quality education, skills development, job opportunities and economic stability– which they see as essential for their future. The emphasis on employability also points to the need for policies that promote job creation and support young professionals entering the workforce. Fig. 1 shows the spatial distribution of voter participation in India. Lakshadweep witnessed a very high voter turnout at 84.16%, adhering to Assam at 81.56%, Andhra Pradesh at 80.66%, and Tripura at 80.93%. In contrast, Bihar recorded the lowest voter turnout at 56.19%. Other states with low voter turnout include Uttar Pradesh (56.92%), Mizoram (56.87%) and Nagaland (57.72%) (Election Commission of India). If we compare the 2024 Lok Sabha elections to 2019,

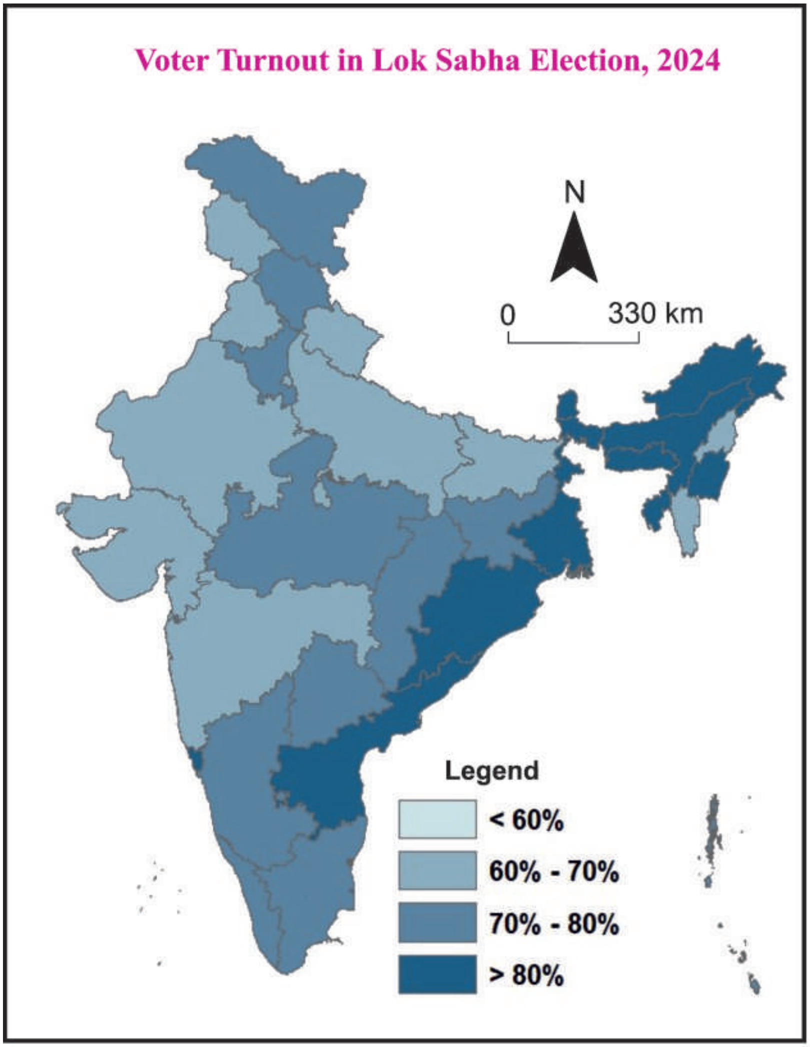
Voter Turnout in Lok Sabha Election, 2024
N
0
330 km
Legend
< 60%
60% - 70%
70% - 80%
> 80%

Fig. 1

it was observed that voter turnout declined in 351 constituencies compared to 2019. Nagaland witnessed the highest drop in polling at 25.35 per cent, while Shillong witnessed the most significant increase of 8.33% points, see map 1 (The Indian Express, June 6, 2024). In the Lok Sabha Elections 2024, the five seats in Jammu and Kashmir (J&K) recorded a voter turnover of 58.58%, according to the Election Commission of India. The Anantnag-Rajouri constituency in the Valley went to polls on May 25, concluding the elections for all five Lok Sabha seats in Jammu and Kashmir. The other four constituencies—Udhampur, Jammu, Srinagar and Baramulla—polled in earlier phases of the 2024 Lok Sabha elections (Jeelani, 2024). Participation in the 2024 general election in India's northeastern states has been at varying levels. Voter participation was high in some states, while other states had moderate or low participation. Tripura led the polling in the first phase with an impressive voting turnover of 80.93%. In comparison, Meghalaya had a polling turnover of 76.6%. Mizoram and Nagaland reported lower figures at 56.87% and 57.72%, respectively.

According to the Election Commission of India, Arunachal Pradesh saw a polling rate of 77.68%, while Assam also reported a high polling turnover of 81.56%. Voter turnout in India's southern states for the 2024 Lok Sabha elections showed a mixed response compared to the 2019 figures. Kerala recorded a voter turnout of around 70.21%, down from 78% in 2019. Many areas faced challenges such as heatstroke incidents due to intense temperatures, which may have contributed to the low turnout (Outlook India, April 30, 2024). Voting patterns varied across Tamil Nadu, with constituencies such as Coimbatore and Salem seeing marginal increases; however, the state's overall turnout saw a marginal drop compared to 2019 (Hindustan Times, 2024). Karnataka recorded a voter turnout of over 69%, similar to the 2019 figures. However, low participation was seen in urban areas such as Bengaluru, where the polling percentage was a little over 50%, reflecting the continuing trend of apathy among urban voters. Significant voter participation was witnessed in various regions of Andhra Pradesh, where several local elections were held simultaneously, with 80.66% of voters participating, resulting in an increase in polling percentage (Outlook India, 2024). Fig. 2 shows gender-based voter turnout data for each state. Nineteen states have more female voters than males. The top five states with the highest number of female voters are Bihar, Jharkhand, Meghalaya, Arunachal Pradesh, and Himachal Pradesh. Bihar saw 59.39% women and 53.28% men voting, which aligns with the state's long-standing trend. In contrast, Gujarat saw 63.52% men voting and 56.56% women voting, showing a difference of nearly seven percentage points.

Notably, Meghalaya achieved a remarkable 100% polling rate for the 'other gender' category. Lakshadweep registered the highest 85.47% voting participation among females and 82.88% in male voters. Besides this, Andhra Pradesh, with 80.3%, Assam 81.71%, West Bengal 80.18%, and Tripura 80.57%, reported very high voting participation above 80%. Mizoram reported a very low 55.67% female voting participation (Fig. 2).

Causes and Consequences of Spatial Variations in Voter Turnout

The 2024 elections saw a decline in voter turnout compared to 2014 and 2019, largely due to an intense heat wave that made voting uncomfortable and difficult. Long queues under the scorching sun discouraged many citizens from participating. Disappointment with divisive campaigns and unfulfilled promises fueled this trend. Changing dynamics within the electorate also played a key role in influencing voter participation. First-time voters often show apathy, yet they are crucial to energising democracy (Gosh, CNBC, 2024). Migrant populations face barriers that impede their voting participation, and feelings of marginalisation among certain caste and community groups further impacted turnout (Gosh, CNBC, 2024). Voters from rural areas and slums, who depend heavily on government policies, remain more numerous than those in urban regions. Poverty continues to be a significant hurdle for voter turnout, especially in high-poverty states (Singh, 2024). In the 2024 Lok Sabha elections, Bihar, Mizoram, Nagaland, Uttar Pradesh, the NCT of Delhi, and Uttarakhand had turnout rates below 60%. If we examine the causes of high and low voter turnout, northeastern states provide the best example for understanding the causes. For example, Tripura reported high voter turnover, with 80.93%, among the Northeastern states. One reason for this high voter turnout is the strong motivation among women. Such motivation is possible only in an environment of peace and development (Hindustan Times, 2024). Mizoram saw a low voter turnout of 56.87% in the Lok Sabha elections, a 12.7% drop from 2019. Additional Chief Electoral Officer H. Lianzela cited a lack of significant political agendas and ineffective voter mobilisation by parties as key reasons for this decline. Urban apathy has also been identified as contributing to low voter participation. Individuals working or studying outside of Mizoram often have little incentive to return to vote. Additionally, the influence of national politics on the daily lives of people in Mizoram is minimal, resulting in an apolitical atmosphere (Northeast Live, 2024). Similarly, Nagaland also recorded low voter participation in this election. No votes were cast in six eastern districts of Nagaland due to a shutdown call by the eastern Nagaland people’s organisation (The Hindu, 2024).

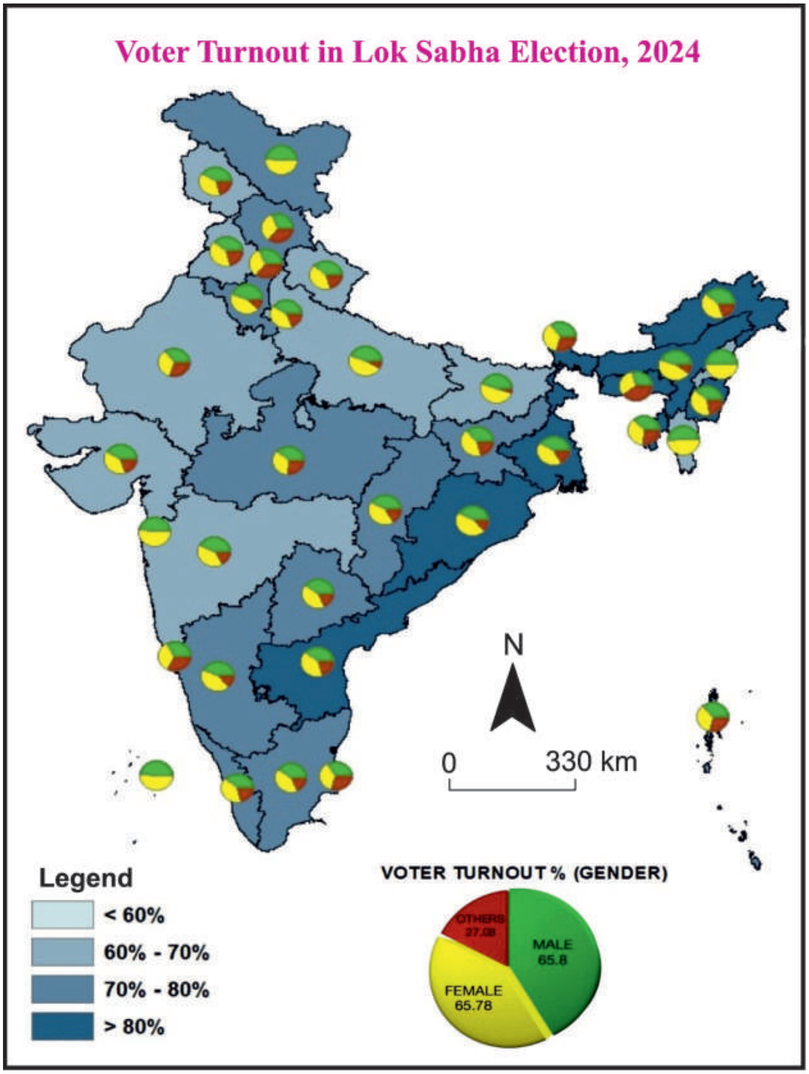
Voter Turnout in Lok Sabha Election, 2024
N
0
330 km
Legend
< 60%
60% - 70%
70% - 80%
> 80%
VOTER TURNOUT % (GENDER)
OTHERS
27.08
MALE
65.8
FEMALE
65.78

Fig. 2

Voting percentage in states like Uttar Pradesh (U.P.) and Bihar has traditionally been low, and there are many reasons for this. One important reason could be that there are a large number of migrants from these states who live in other areas and are unable to vote in their home states (Hindustan Times, 2024). In large cities like Delhi, urban apathy stems from an “apolitical atmosphere” and the belief that “nothing can change.” This leads to disinterest in important issues such as poverty, crime, and environmental degradation. Many people, especially the middle class, see Election Day as an opportunity for vacation, often travelling or visiting family if the election falls on weekends. This attitude contributes significantly to urban apathy in metropolitan areas like Delhi (The New Indian Express, 2024). The study highlights the effects of voter participation on democracy. Low voter turnout can reduce accountability and lead to political elites exploiting resources for their own interests (The Indian Express, 2024). High turnout indicates a healthy, inclusive democracy, while low turnout often signifies public distrust or apathy. Low participation can result in an unrepresentative government, decreased legitimacy, and the marginalisation of minority groups. In this situation policies may favour specific voter interests rather than addressing the needs of all citizens, especially those from communities facing socioeconomic challenges. In contrast, high voter turnout involves a diverse range of voters, ensuring that policies reflect a broader spectrum of interests. This inclusivity fosters equitable development and reinforces public engagement in democratic processes, encouraging further civic activism and participation.

Major Observations

Voter turnout for the 2024 Lok Sabha elections was 65.79%, marginally lower than the 67.40% recorded in 2019 (Indian Express, 2024). Lakshadweep reported the highest voter turnover at 84% and Assam at 81.56%, while Bihar had the lowest at 56.19%. Nineteen states exhibited higher female voter participation compared to male, with Bihar, Jharkhand, Meghalaya, Arunachal Pradesh, and Himachal Pradesh demonstrating the highest rates of female voter turnout (Indian Express, 2024). Urban voter apathy is cited as one reason for the lower turnout. Potential reasons for low voter turnout include heatwave, fatigue, and shifting electorate demographics. This election saw high voter turnout across various demographics, including women, youth and senior citizens. Jammu and Kashmir registered its highest voter turnout in 35 years, exceeding 58% (PIB Delhi, 2024). Many socio-economic, political and geographic factors played an important role in influencing voter turnout across India.

Strategies for Increasing Voter Turnout and Suggestions

There are many effective strategies that can be implemented to increase participation, and voter education is one of them. Providing clear information about candidates and political issues and spreading awareness about the voting process can help voters make their choices. Organising voters is also a very effective strategy for policymakers to reach different communities easily. This can increase participation, especially among marginalised groups. Emphasising the importance of voting develops a culture where high voter turnout is the norm. Holding elections on weekends or holidays allows more people to vote without work-related conflicts. Youth engagements and introducing civic education in schools and colleges can motivate young people to participate in elections. It is necessary to adopt a multi-pronged approach to overcome barriers and encourage wider electoral participation. We can also implement several strategies to address the pressing issue of low voter participation. For instance, engaging influential people to educate voters on the importance of participating in elections can be effective. Additionally, introducing compulsory voting and online voting can increase voter turnout. Voting apps allow users to check and apply for new voter cards and change addresses. They also help voters quickly access information about their constituencies and polling stations, making it essential to encourage people to adopt advanced technology for this purpose. In contemporary times, AI and social media platforms also play a vital role in electoral processes.

Conclusion

This study investigates voter turnout, its contributing factors, the implications of low voter participation, and potential strategies to enhance civic engagement in the electoral process. Elector participation represents the proportion of eligible voters who cast their ballots on Election Day. It serves as an indicator of political participation in democratic societies. High voter turnout is generally considered a positive indicator, suggesting that citizens actively participate in voting and exercise their democratic rights. Conversely, low voter turnout may indicate voter apathy or a general disinterest in political affairs. Voter turnout can be affected by factors, including the competitiveness of the election, the perceived significance of the issues addressed in political campaigns, and the accessibility of polling locations. Election officials attempt to raise voter participation through various initiatives such as voting education and digital campaigns. They also develop other strategies to motivate citizen participation in the electoral process through telephone communication, social media platforms, etc. In India, high voter participation fosters legitimacy, balanced governance, and a strong democracy, while low turnout can lead to biased representation, reduced accountability, and political instability. As one of the largest democracies globally, India's democratic health depends significantly on encouraging inclusive and high voter participation.

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The Deccan Geographer
Vol. 62, No. 10 December, 2024, pp. 12-21
(ISSN-0011-7269)
UGC Care Listed Geography Journal

MAPPING AND ANALYSING THE DECADAL AGRICULTURAL LANDUSE IN TEHRI GARHWAL DISTRICT, UTTARAKHAND

Veer Singh, Ashwani, Raiz Ahmed and Anita Rudola

Abstract

This study provides a detailed assessment of agricultural landuse changes in the Tehri Garhwal district of Uttarakhand, India over a 30-year period from 1991 to 2021. The analysis examines the spatio-temporal dynamics and driving forces behind the observed transformations in landuse patterns. The results reveal several key trends in agricultural landuse during this time. Cultivable barren lands decreased in absolute terms but increased as a percentage of total land, potentially indicating improved land management or reclassification of land types. Barren and uncultivable lands also saw a slight rise, which could be attributed to environmental factors, soil degradation, or better monitoring of wastelands. Interestingly, land designated for non-agricultural uses such as urban expansion contracted over the study period, suggesting a shift towards increased agricultural and environmental conservation. Similarly, pasture lands declined, possibly due to changing livestock practices. In contrast, areas under orchards and trees expanded, demonstrating a move towards more diversified and sustainable agricultural systems. Analysis of fallow lands revealed a reduction in both present and other fallow categories, implying improved land utilization through practices like crop rotation. However, the most concerning trend was the significant decline in net sown area, which fell from 41.93 units in 1991 to 27.39 units in 2021. This could be linked to factors such as urbanization, desertification, or shifts in economic activities away from traditional agriculture. Overall, the landuse dynamics in Tehri Garhwal reflect a complex interplay of socioeconomic, environmental, and policy-driven changes. The findings underscore the need for comprehensive land management strategies that balance agricultural productivity, ecological conservation, and sustainable development in the Himalayan region.

Introduction

Understanding changes in agricultural landuse over time is critical for effective land management and sustainable development, particularly in regions undergoing rapid transformation. (Mirkatouli et al., 2015) The Tehri Garhwal district of Uttarakhand, India, located in the foothills of the Himalayas, has experienced significant socioeconomic and environmental changes in recent decades (Schürings et al., 2022). Analyzing the dynamics of agricultural landuse in this region can provide valuable insights to inform policies and guide future landuse planning. The human race has been engaged in agriculture for nearly ten thousand years (García-Llorente et al., 2018), A shift in landuse from agriculture to other sectors will be encouraged by unchecked growth and development, which will have negative effects on efforts to maintain independence from agriculture and sustainable development (Aryadi et al., 2021) Social, economic, and political variables impact how people develop specific rural landuses, such as agricultural landuses. (Santiphop et al., 2011), Apart from their need to ensure their own survival, farmers' monetary rewards are frequently the driving forces behind changes in agricultural landuse. (Appelt et al., 2022). Several studies have examined agricultural landuse changes in the Indian Himalayan region. Maikhuri et al. (2001) investigated landuse/land cover changes in the Nanda Devi Biosphere Reserve of Uttarakhand and found a decline in agricultural land accompanied by an increase in forest cover and grasslands over a 27-year period (Selmy et al., 2023). The role of outmigration, abandonment of agricultural practices, and expansion of cash crops as contributors to landuse transitions in the Nanda Devi Biosphere Reserve have been observed (Maikhuri et al., 2001). Analysing drivers of landuse change, population growth, urbanization, and changes in livelihood patterns are key factors influencing agricultural landuse in the Indian Central Himalayan region (Karale et al., 2024). At the district level, the landuse/land cover dynamics in Tehri Garhwal between 1976 and 2006, reported a decline in agricultural land and an increase in forest cover and built-up areas (Pandey and Joshi, 2011). The present study aims to fill this gap by analyzing the spatio-temporal dynamics of agricultural landuse in Tehri Garhwal from 1991 to 2021, a period that encompasses significant socioeconomic and environmental transformations in the region. By incorporating a longer time frame and a detailed examination of the driving forces, this research can contribute to a deeper understanding of the agricultural landuse transition and inform sustainable land management strategies in the Himalayan region. Continued monitoring and in-depth research on the underlying drivers of landuse change in the Tehri Garhwal region can provide valuable insights to inform policy decisions and guide the development of sustainable landuse strategies.

Study Area

The district Tehri Garhwal of Uttarakhand stretches between latitudes 30º03' and 30º53' N and longitudes 77º56' and 79º04' E, almost all Area of district covers lofty mountains, The district is bounded by Rudra Prayag district in the east, Dehradun district in the south, Uttarkashi district in the north, and Pauri Garhwal District in the south, the slope of district is from north to south. The climate of Tehri Garhwal district is sub-temperate to temperate. Tehri Garhwal district covers wide range of natural vegetation, varying from sub- tropical species to alpine type of vegetation in the north, as height increases vegetation cover deceases. The total population of district Tehri Garhwal is 616,409 (2011, Census of India), in which total male population is 297,986 (Census 2011) and total female population is 320,945 (Census 2011), the primary crops of agriculture include rice, wheat, millets, and pulses. Agriculture is a major economic activity. Because of the mountainous landscape, terrace farming is widespread.

Objectives

(1) To prepare agricultural landuse maps over three decades.
(2) To analyse changes in agricultural landuse over three decades.

Database and Methodology

The spatial resolution of Landsat 5 is 30 meters, this indicates that every pixel in the picture encompasses a 30 × 30 m area, the spatial resolution of Sentinel 2 is 10 meters, this shows that sentinel 2 pixel covers 10 × 10 m area (Table-1). This research is primarily based on secondary data sources obtained from various satellites images, multi spectral remote sensing satellites data obtained for preparing agricultural landuse maps from 1991 to 2021, base year of agricultural landuse is 1991, Landsat 5 Series data used by researcher for preparing maps of 1991, 2001 and 2011 and 2021 map prepared with the help of sentinel 2 series satellite data. All the data is taken from USGS platform and after that radiometric and geometric corrections performed, after that Image classification and supervised classification performed by researcher for prepared agricultural landuse maps, Google Earth images also used for rectifying agricultural landuse.

Table-1: Satellite Data Used in Study Area

Map Year	Satellite Sensor	Path/Row	Acquisition Date	Spatial Resolution
1991	Landsat 5	146/39	April 1991	30 M
2001	Landsat 5	72/61	May 2001	30 M
2011	Landsat 5	71/91	April 2011	30 M
2021	Sentinel 2	44R	May 2021	10 M

Source: NRSC, Hydrabad

Results and Discussion

The present analysis provides a detailed assessment on landuse changes covering a period of 30 years, which is 1991 to 2021. These results depict the alterations brought about by agricultural activities, ecology, and socio-economics as they pertain to landuse.

Culturable Barren Lands

The expanse classified as cultivable barren land continuously decreased during the period, with lands decreasing from 1991 and 2021 being 42.05 units and 34.98 units respectively. In spite of the reduction in absolute terms, the share of total land that can be referred to as cultivable barren land experienced a rise from 35.4 percent in 1991 to 39.1 percent in 2021 (Table-2). This implies that even though the overall amount of cultivable barren land has diminished, the value has increased concerning the rest of the land's composition. This could indicate either better land husbandry techniques that rehabilitate previously unproductive land or periods when the type of land used was different. The slight proportional increase may suggest the reclassification of other land types or regional policies on landuse where certain lands are designated as off-limits for agricultural activities (Fig. 1).

Barren and Uncultivable Land

This category exhibited some minor variations, initiated with 4.98 units in 1991, reaching the maximum of 5.01 units in 2001, later falling to 4.14 units in 2011, and lastly increasing to 4.90 units in 2021. The proportion of the total land covered by barren and uncultivated land increased slightly from 4.2% in 1991 to 5.5% in 2021. The variations in the area of land that is left uncultivated or barren can be attributed to environmental factors, soil quality or even lessened recovery of such lands. The increase in its share means either land available has worsened in quality or there is growing awareness and recording of such waste lands. Such a situation might be brought about by climate change, overuse or even mismanagement of the land resources (Table-2 and Fig. 1).

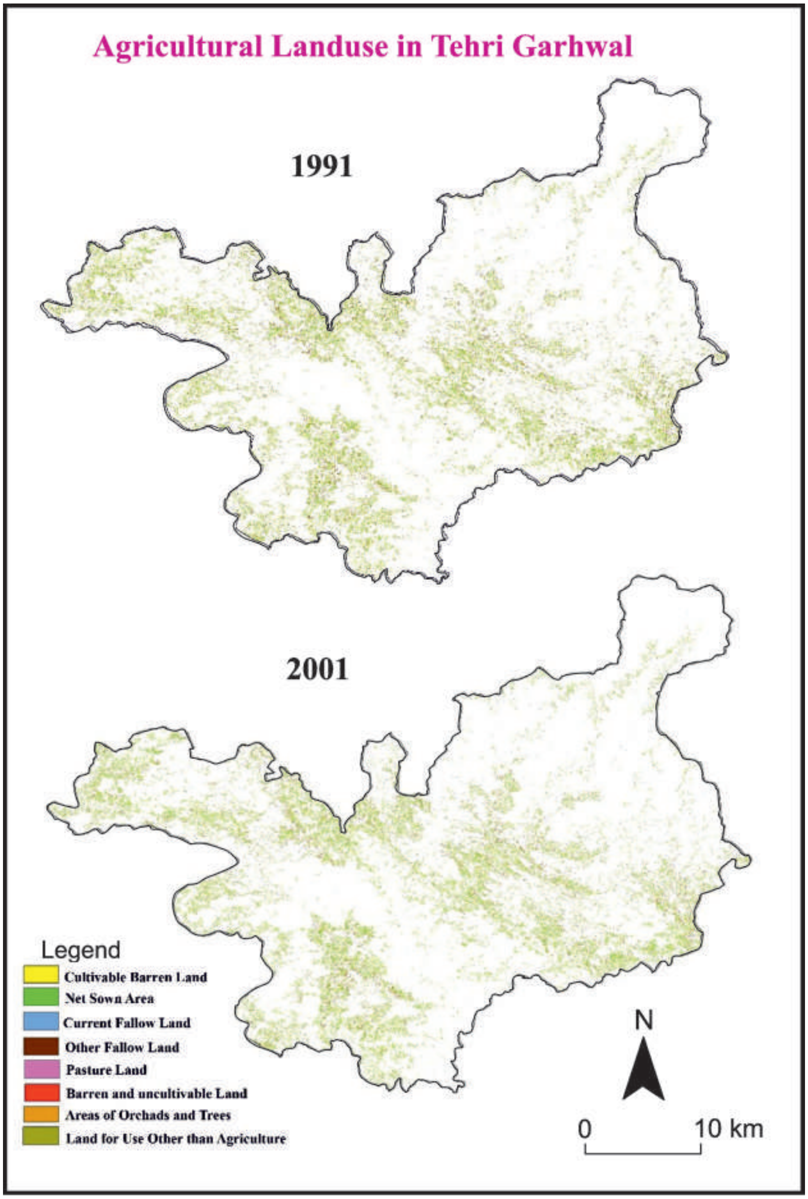
Agricultural Landuse in Tehri Garhwal
1991
2001
Legend
Cultivable Barren Land
Net Sown Area
Current Fallow Land
Other Fallow Land
Pasture Land
Barren and uncultivable Land
Areas of Orchads and Trees
Land for Use Other than Agriculture
N
0
10 km

Fig. 1

Land for Other Uses than Agricultural Purposes

The land provided for purposes other than agriculture also shrank gradually over time from 7.36 units in 1991 to 3.30 units in 2021, the percent share also reducing from 6.2% to 3.7%. This prolonged interplay indicates that land reserved for non-agricultural use for instance, land designated for urban expansion is likely to have been used transformation to agricultural or environmental advancement. This change may be to encourage further conservation measures or a reduction in the development of new construction in some locations. The decrease may also suggest that some of these lands may be returned to agriculture or conversion back to forests.

Table-1: Area of Agricultural Landuse

		1991	2001	2011	2021
1	Cultivable Barren Land	42.05	38.3	35.32	34.98
2	Barren and Uncultivable Land	4.98	5.01	4.14	4.90
3	Land for use other than Agriculture	7.36	5.76	4.32	3.30
4	Pasture Land	1.66	1.28	1.19	1.16
5	Areas of Orchards and Trees	2.13	2.24	2.48	2.85
6	Present Fallow Land	10.57	9.82	8	7.58
7	Other Fallow Land	8.07	7.79	7.72	7.31
8	Net Sown Area	41.93	36.6	28.88	27.39
	Total	118.8	106.74	92	89.25

Source: Authors

Pasture Land

The total area of pasture land has shown a declining trend from 1.66 units in the year 1991 to 1.16 units in the year 2021. The proportion of this category during the period in question remained relatively the same at approximately 1.3 percent. The decreasing span of grassland areas may suggest that there is less emphasis placed upon the traditional tethering and grazing of livestock, perhaps as a result of changing agricultural practices, urban encroachment, or increased use of industrial forms of animal husbandry. While absolute area has decreased, the lingering for many steady percentage use indicates the country's unchanging position on the matter that can be augmented with other feed sources.

Areas of Orchards and Trees

This category has grown from 2.13 units in 1991 to 2.85 units by 2021, reflecting an increase in its share from 1.8% to 3.2% of the total land. The increase in orchards and tree areas highlights a move towards diversified agricultural practices and sustainable landuse, likely driven by market demand, economic incentives, or environmental conservation policies. This growth suggests efforts to increase biodiversity and promote agroforestry, which can contribute to long-term ecological balance and potentially higher economic returns compared to traditional cropping (Fig. 2).

Present Fallow Land

Present Fallow Land decreased from 10.57 units in the year 1991 to 7.58 units in the year 2021, its proportion has slightly changed over the years and its greatest value was in 2001 when it reached 9.2% with 8.5% by the year 2021. The reduction in current fallow areas can perhaps be explained by better landuse practices in which areas that were once left vacant have been put into active use. Nevertheless, the constant percentage share indicates that such practices in agriculture as crop rotation have been adopted to improve soil nutrients (Table-2). This situation indicates that they are able to carry out land management practices that are consistent with farming practices that are sustainable.

Other Fallow Land

This category showed slight stability, with minor decreases from 8.07 units in 1991 to 7.31 units in 2021. The percentage share of total land fluctuated but remained around 8%. The stability in other fallow land implies consistent agricultural practice to leave some land fallow for a longer time for soil to recover. It shows that there is also a balance that can be achieved by increasing the amount of land under cultivation and at the same time adopting practices that do not degrade the soil.

Net Sown Areas

Store of net sown areas suffered a great deal of loss from 41.93 sites in 1991 to 27.39 units in 2021. Unemployment rates percentage fell also from 35.3 % to 30.7 % of all occupied areas. This decline in net sown area is alarming and could be related to a number of reasons such as: the growth of urban centres, encroachment of desertification on cropland or changes in the economic practices associated with agriculture. The drop indicates the risk of the sustainability of agriculture and food production systems and even external risk factors like climate change or the

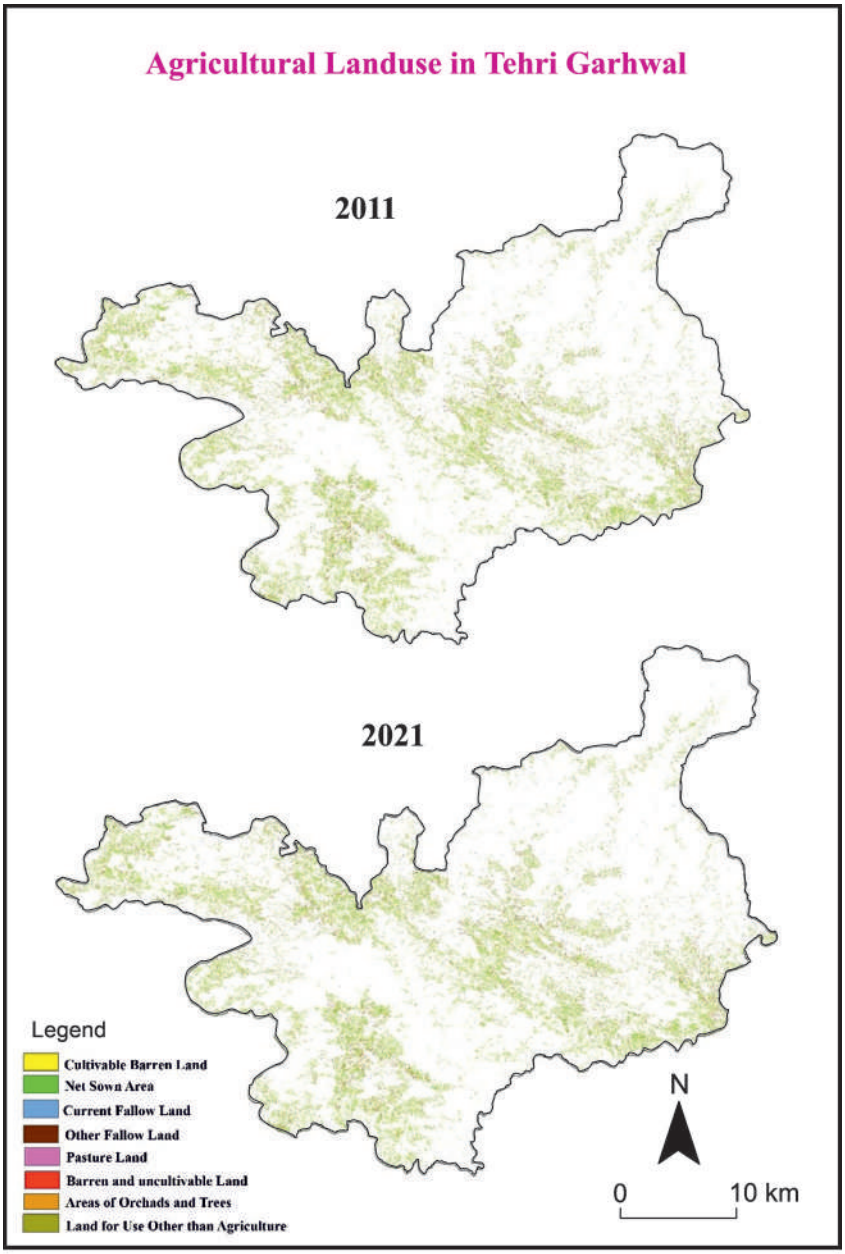
Agricultural Landuse in Tehri Garhwal
2011
2021
Legend
Cultivable Barren Land
Net Sown Area
Current Fallow Land
Other Fallow Land
Pasture Land
Barren and uncultivable Land
Areas of Orchads and Trees
Land for Use Other than Agriculture
N
0
10 km

Fig. 2

Table-2: Change in percentage of agricultural landuse

		1991	2001	2011	2021
1	Cultivable Barren Land	35.4%	36.1%	38.4%	39.1%
2	Barren and Uncultivable Land	4.2%	4.6%	4.5%	5.5%
3	Land for use other than Agriculture	6.2%	5.3%	4.6%	3.7%
4	Pasture Land	1.4%	1.2%	1.3%	1.3%
5	Areas of Orchards and Trees	1.8%	2.1%	2.7%	3.2%
6	Present Fallow Land	8.9%	9.2%	8.7%	8.5%
7	Other Fallow Land	6.8%	7.2%	8.4%	8.2%
8	Net Sown Area	35.3%	34.3%	31.4%	30.7%
	Total	100%	100%	100%	100%

redirection of economic activity to other sectors like manufacturing. The overall results suggest a recession in the extent of traditional agriculture alongside a slight expansion in area under orchards and plantations. Notable also is the decrease of the net sown area, which could indicate some issues like soil exhaustion, change in the direction of the economy or urban sprawl leading to a diminished amount of land for food crops. The expansion of orchards and tree areas, on the other hand, is a good sign, a sign towards more sustainable practices, which could be due to environmental policies, more agroforestry schemes, or profit making. At the same time, the changes in areas of fallow lands by type reveal the underlying strategy to control landuse intensification and soil degradation in a managed way.

Conclusion

The analysis of agricultural landuse changes in Tehri Garhwal from 1991 to 2021 reveals a complex and dynamic landscape shaped by a variety of socioeconomic, environmental, and policy-related factors. While some positive trends, such as the expansion of orchards and tree cover, indicate efforts towards more sustainable landuse practices, the significant decline in net sown area is a concerning development that warrants further investigation. Landuse changes from 1991 to 2021 are indicators of coping mechanisms to and modifications of various socio-economic, environmental and policy environments. These patterns indicate the relevance of land management techniques that are sustainable in dealing with issues like loss of arable lands in the context of food and ecological security. The broad focus has to be towards finishing understanding of main reasons and underlying principles of those transformations and for how long maintaining those landuse practices will be feasible.

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The Deccan Geographer
Vol. 62, No. 10 December, 2024, pp. 22-30
(ISSN-0011-7269)
UGC Care Listed Geography Journal

SPATIO-TEMPORAL ANALYSIS OF FERTILIZER CONSUMPTION IN AZAMGARH DIVISION

Karmjit Kumar and Dr. Ankit Singh

Abstract

With India's population projected to reach 1.668 billion by 2050, the demand for increased food production has surged significantly. Fertilizers play a crucial role in enhancing agricultural efficiency and product quality. The adoption of synthetic fertilizers during the green revolution, which introduced high-yielding varieties seeds, has been pivotal for Indian agriculture. This research analyzes the spatio-temporal variation in chemical fertilizer consumption in the Azamgarh Division of Eastern Uttar Pradesh, focusing on nitrogen (N), phosphorus (P), and potassium (K). From 1998 to 2018, Azamgarh's fertilizer use rose by 98.57%, Mau's by 41.14%, and Ballia's by 39.99%. Significant growth was observed in NPK fertilizer consumption, reflecting improved agricultural practices and better access to inputs due to government schemes like the Soil Health Card and Kisan Credit Card. However, extensive use of chemical fertilizers poses threats to health, ecological balance, and biodiversity, leading to pollution and environmental degradation. An integrated approach, combining chemical fertilizers with organic manures, bio-fertilizers, and slow-release fertilizers, is recommended to promote sustainable agriculture, enhance soil health, and ensure long-term productivity in the Azamgarh Division.

Introduction

Fertilization is essential for enhancing agricultural efficiency and improving product quality. With India's population projected to reach approximately 1.668 billion (166.8 crore) by 2050, the demand for increased food production has surged significantly. Historically, the industrial and green revolutions have boosted crop yields per unit area, primarily through the adoption of synthetic fertilizers. The green revolution, in particular, introduced high-yielding, dwarf cereal varieties that relied on chemical fertilizers to achieve their full potential, making these fertilizers a cornerstone of Indian agriculture. Fertilizers are substances of natural or synthetic origin (excluding liming materials) that are applied to soil or plant tissues to provide essential nutrients for plant growth or to address nutrient deficiencies. They contain varying proportions of essential major nutrients such as nitrogen, phosphorus, and potassium, as well as secondary nutrients like calcium, magnesium, and sulphur, and micronutrients including copper, iron, manganese, molybdenum, zinc, boron, silicon, cobalt, and vanadium. However, the extensive use of chemical fertilizers now poses serious threats to human and animal health, ecological balance, and biodiversity. Over-fertilization leads to pollution of water, soil, and air. As plants absorb these fertilizers through the soil, excessive amounts can enter the food chain, causing a range of environmental issues. Chemical fertilizers often contain heavy metals, such as Cadmium and Chromium, and high concentrations of radionuclides, which contribute to the accumulation of inorganic pollutants. The overuse of these fertilizers, especially during peak seasons in greenhouses and aquaculture, has resulted in dangerously polluted groundwater and degraded crop production in terms of both quality and quantity. In India, the average consumption of major chemical fertilizers was 135.76 kg/hectare in 2015-16, dropped to 123.41 kg/hectare in 2016-17, but increased again to 133.44 kg/hectare by 2019-20. This trend underscores the urgent need to promote sustainable agricultural practices and reduce reliance on chemical fertilizers. While fertilizers have contributed to increased food production, their overuse presents significant environmental challenges. The Indian government, along with other nations, has introduced policies and action plans to curb excessive fertilizer use and promote more efficient agricultural practices. These measures aim to reduce environmental pollution, lower carbon emissions, and encourage farmers to adopt sustainable fertilization methods, ensuring the long-term health and productivity of agricultural ecosystems.

Study Region

Azamgarh Division is located in the lower Ganga-Ghaghra Doab in Eastern Uttar Pradesh, between 25°38' to 26°27' North latitude and 82°42' to 84°39' East longitude. The division's east-west length is 160 km, and its north-south maximum width is 80 km. To its north lies the Ghaghra River and beyond it, the districts of Gorakhpur and Deoria (Uttar Pradesh), and Siwan and Chhapra (Saran) in Bihar state. To the south, it borders the Gazipur district of Uttar Pradesh and Buxar and Bhojpur districts of Bihar state. The western boundary touches the districts of Sultanpur, Ambedkar Nagar, and Jaunpur in Uttar Pradesh. According to the Surveyor General of India, the total geographical area of Azamgarh Division is 9,130 square kilometers. This division is divided into three districts: Azamgarh, Mau, and Ballia. This division is further divided into 17 tehsils (Phoolpur, Budanpur, Lalganj, Sagri, Azamgarh, Nizamabad, Mehnagar, Muhammadabad, Mau, Ghosi, Madhuban, Belthara Road, Rasi, Sikandarpur, Bansdih, Ballia, and Bairia) and 48 development blocks.

Objectives

(1) To analyse the Spatio-Temporal variation in consumption of Chemical Fertilizer in Azagram Division.
(2) To make Comprehensive Analysis on consumption of NPK (Nitrogen, Phosphorus, Potassium) in Azamgarh Division.

Database and Methodology

The present research paper is based on secondary data sources. In this research paper, data regarding chemical fertilizer usage in Azamgarh division has been sourced from the Uttar Pradesh District Statistical Handbook of 1998 and 2018. The study utilizes GIS (Geographic Information System) and cartography methodologies to create spatio-temporal maps.

Results and Discussion

The current agricultural strategy emphasizes the need for a balanced and optimal utilization of fertilizers to enhance soil fertility, which is crucial for the long-term sustainability of crop production (Tiwari and Tiwari, 2011). Since the implementation of this strategy in the 1960s, there has been a significant rise in the use of chemical fertilizers across the country. Fertilizers play a vital role in intensive land cultivation as crop yield is directly influenced by soil fertility (Desai, 1979). However, the continuous decline in soil fertility and productivity has posed significant challenges in various regions. It is essential to comprehend the appropriate application of chemical fertilizers while also improving irrigation facilities and cultivating enhanced varieties of crops such as wheat, paddy, sugarcane, and pulses to achieve optimal yields.

Spatio-Temporal Variation in Consumption of Chemical Fertilizer

The table shows the district-wise variation in fertilizer consumption in the Azamgarh Division between 1998 and 2018. In Azamgarh, fertilizer consumption increased from 81.18 kg/hectare in 1998 to 161.2 kg/hectare in 2018, marking a 98.57% rise. Mau's consumption grew from 111.48 kg/hectare to 157.34 kg/hectare, reflecting a 41.14% increase. Ballia saw a rise from 106.51 kg/hectare to 149.1 kg/hectare, a 39.99% increase. Several factors have contributed to this significant increase in fertilizer use. The implementation of the Soil Health Card Scheme has helped farmers understand the nutrient status of their soil, leading to more informed and increased use of fertilizers. The development of Regional Rural Banks (RRBs) has improved farmers' access to credit, enabling them to invest more in agricultural inputs, including fertilizers. The Kisan Credit Card Scheme has provided farmers with timely and adequate credit to purchase fertilizers and other inputs. Enhanced awareness about soil health and various government schemes aimed at improving agricultural productivity have also played a crucial role in boosting fertilizer usage in this division. Additionally, the use of High-Yielding Variety seeds, which respond positively to chemical fertilizers, has encouraged farmers to use fertilizers on a larger scale (Table-1 and Fig. 1). The high population density in these districts has necessitated the large-scale cultivation of cereal crops to ensure food security, further driving the increased use of fertilizers to maximize yields.

Table-1: Fertilizer Consumption in Azamgarh Division (1998 and 2018)

Districts	1998 (kg/ hectares)	2018 (kg/ hectares)	Change (%)
Azamgarh	81.18	161.2	98.57%
Mau	111.48	157.34	41.14%
Ballia	106.51	149.1	39.99%

Source: Data obtained from District Statistical Handbook, 1998 and 2018

Consumption of NPK (Nitrogen, Phosphorus, Potassium) in Azamgarh Division

NPK fertilizers are important for crop growth and development. Nitrogen is essential for leaf and stem growth, phosphorus supports root development and flowering, and potassium enhances the plant's overall health and disease resistance. Balanced use of these nutrients improves crop yield and quality, contributing significantly to agricultural productivity and food security.

The data on the variation in the consumption of Nitrogen, Phosphorus, and Potassium fertilizers in three districts—Azamgarh, Mau, and Ballia—1998 and 2018. For Nitrogen, Azamgarh saw an increase from 65.41 kg/hectare in 1998 to 109.48 kg/hectare in 2018, marking a 67.38% rise. Mau's Nitrogen consumption rose from 89.79 kg/hectare to 106.82 kg/hectare, an 18.97% increase, while Ballia's usage went from 89.71 kg/hectare to 101.09 kg/hectare, showing a 12.69% increase (Table-2). In terms of Phosphorus, Azamgarh experienced a substantial rise from

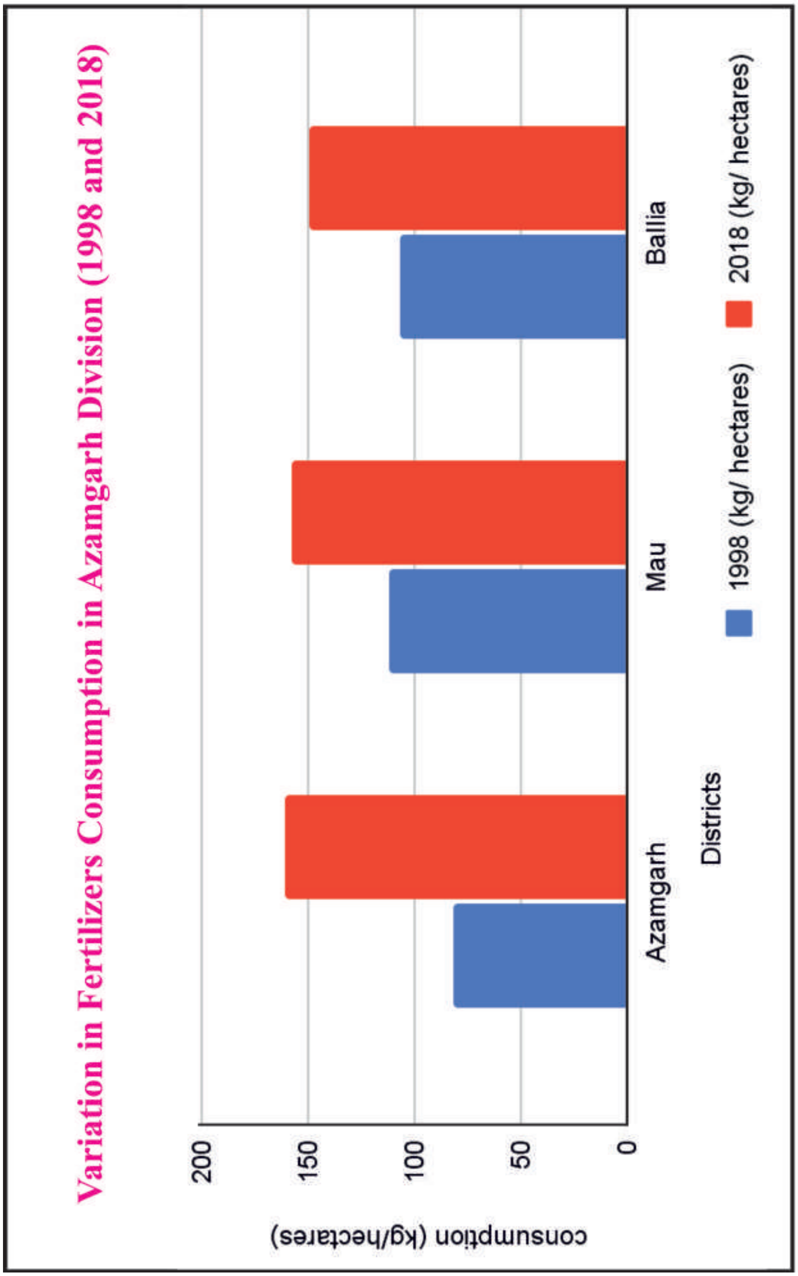
Variation in Fertilizers Consumption in Azamgarh Division (1998 and 2018)
consumption (kg/hectares)
200
150
100
50
0
Azamgarh
Mau
Ballia
Districts
1998 (kg/ hectares)
2018 (kg/ hectares)

Fig. 1

Table-2: District-wise Variation in NPK (Nitrogen, Phosphorus, Potassium) Consumption in Azamgarh Division (1998 and 2018)

NITROGEN			
Districts	1998 (kg/ hectares)	2018 (kg/ hectares)	Change (%)
Azamgarh	65.41	109.48	67.38%
Mau	89.79	106.82	18.97%
Ballia	89.71	101.09	12.69%
PHOSPHORUS			
Districts	1998 (kg/ hectares)	2018 (kg/ hectares)	Change (%)
Azamgarh	13.83	42.65	208.39%
Mau	19.65	41.7	112.21%
Ballia	14.42	39.59	174.55%
POTASSIUM			
Districts	1998 (kg/ hectares)	2018 (kg/ hectares)	Change (%)
Azamgarh	1.93	9.05	368.91%
Mau	2.03	8.81	333.99%
Ballia	2.37	8.31	250.63%

Source: Based on data obtained from District Statistical Handbook, 1998 and 2018

13.83 kg/hectare to 42.65 kg/hectare, a 208.39% increase. Mau's consumption increased from 19.65 kg/hectare to 41.7 kg/hectare, a 112.21% rise, and Ballia's use grew from 14.42 kg/hectare to 39.59 kg/hectare, a 174.55% increase. Potassium consumption in Azamgarh increased from 1.93 kg/hectare to 9.05 kg/hectare, a 368.91% rise. In Mau, it went from 2.03 kg/hectare to 8.81 kg/hectare, marking a 333.99% increase, while Ballia's usage rose from 2.37 kg/hectare to 8.31 kg/hectare, showing a 250.63% increase (Fig. 2). These figures suggest improvements in nitrogen fertilizer application, possibly due to enhanced agricultural practices, increased subsidies, or better access to fertilizers, contributing to the overall agricultural development in these districts.

Conclusion

The spatio-temporal analysis of fertilizer consumption in the Azamgarh Division reveals significant increases in the use of chemical fertilizers over the past two decades. While these fertilizers have played a vital role in boosting agricultural

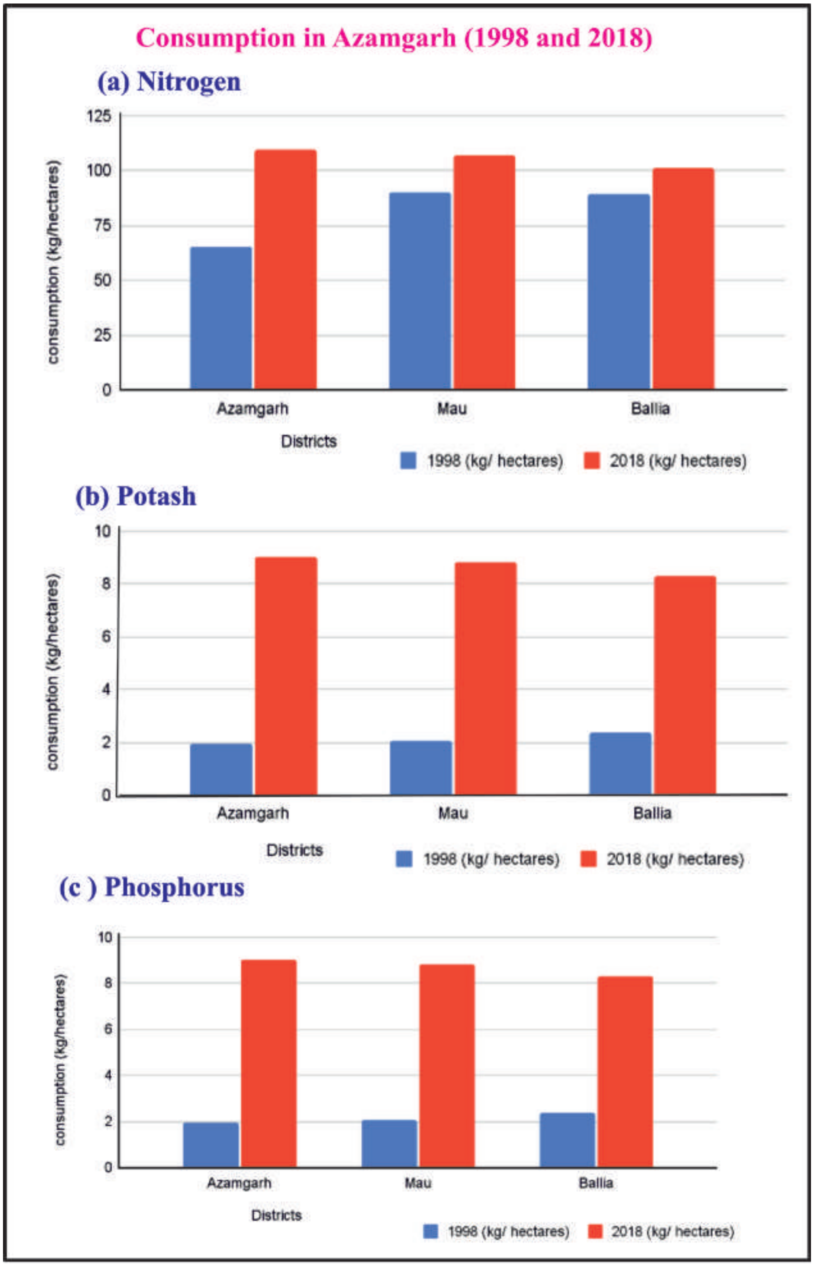
Consumption in Azamgarh (1998 and 2018)
(a) Nitrogen
125
100
75
50
25
0
consumption (kg/hectares)
Azamgarh
Mau
Ballia
Districts
1998 (kg/ hectares)
2018 (kg/ hectares)
(b) Potash
10
8
6
4
2
0
consumption (kg/hectares)
Azamgarh
Mau
Ballia
Districts
1998 (kg/ hectares)
2018 (kg/ hectares)
(c) Phosphorus
10
8
6
4
2
0
consumption (kg/hectares)
Azamgarh
Mau
Ballia
Districts
1998 (kg/ hectares)
2018 (kg/ hectares)

Fig. 2

productivity to meet the demands of a growing population, their extensive use poses serious environmental and health risks. The data indicates substantial increases in the consumption of nitrogen, phosphorus, and potassium fertilizers, driven by improved agricultural practices and enhanced access to inputs facilitated by government initiatives.

The utilization of fertilizers, whether chemical or organic, is crucial for enhancing agricultural productivity and meeting food demands. Chemical fertilizers, despite their immediate nutrient supply benefits and rapid crop growth, pose several drawbacks. They contribute to soil compaction, degradation, and acidification, leading to reduced soil health and environmental degradation. The excessive use of chemical fertilizers has also been linked to negative impacts on human health, including potential risks of cancer, heavy metal accumulation, and environmental pollution. On the other hand, organic fertilizers, while promoting soil health and microbial diversity, may not provide nutrients as rapidly as chemical counterparts. To address these challenges and ensure sustainable agricultural practices, an integrated approach to fertilizer usage is recommended. This includes combining chemical fertilizers with organic manures, bio-fertilizers, and slow-release fertilizers. Slow-release fertilizers offer controlled nutrient release, reducing environmental risks. Nano fertilizers and bio fertilizers contribute to improved soil fertility and crop quality without the adverse effects associated with chemical fertilizers. Additionally, adopting efficient application techniques and considering soil analysis before fertilizer application can enhance productivity while minimizing environmental hazards. In conclusion, while chemical fertilizers offer immediate benefits, their long-term usage requires careful consideration due to potential soil, environmental, and health risks. Integrating various fertilization methods can promote sustainable agriculture by maintaining soil health, enhancing nutrient efficiency, and mitigating adverse effects on ecosystems and human health.

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The Deccan Geographer
Vol. 62, No. 10 December, 2024, pp. 31-42
(ISSN-0011-7269)
UGC Care Listed Geography Journal

LAND AS A FACTOR OF PRODUCTION FOR PROSPEROUS STATE AND LOKAKALYĀṆA: INSIGHT FROM KAUṬILYA'S ARTHAŚĀSTRA

Dr. Pratima Kumari and Dr. Dheerendra Singh

Abstract

Ancient Bhāratavarṣa has a long tradition of rich intellectual heritage, and its fundamental contribution has been in spiritual, philosophical, economics, and other scientific fields. Kauṭilya has articulated essential economic ideas profourdly in the Arthaśāstra for the state's security, public welfare and prusperity. He has consideredas land is the foundation for the production and the prusperity of the economy and its people of the state. The factors of production include land, labour, capital and entrepreneurship. These four factors of production jointly produce goods and services. Out of all these factors, land is a major factor, and it is the basis of most natural resources. First of all, land and other natural resources like water, forests and minerals are required for production. Kauṭilya has presented his ideas in economics to achieve maximum production by planning and managing the land and through optimal use. Most states need to change the current economic concepts for a prosperous and sustainable developed economy. The economy of Bhāratavarṣa during Kauṭilya's time was prosperous, developed and public welfare-oriented. Its primary source was land and other natural resources that had been organized for production so that power and prosperity increased. Therefore, Kauṭilya's Arthaśāstra is still relevant today. In this research paper, the ideas of planning and management of land contained in Kauṭilya's economics to achieve maximum production through optimal use of agriculture, animal husbandry, forest-sanctuaries, pastures, mining, establishment of villages and cities, enterprises, public use and essential infrastructure development have been studied. This research paper studies how Kauṭilya's economics is useful in making the economy of modern India prosperous, developed and public welfare-oriented. This research paper draws insights from Kauṭilya's Arthaśāstra to explore the importance of land and natural resources as major factors of production. It provides the text for the curriculum based on National Education Policy (NEP) 2020.

Introduction

The Indian knowledge system has collected a vast repository of knowledge and expression in various fields. It has produced great scholars such as Charaka, Susruta, Vagbhaṭa, Aryabhata, Bhaskaracharya, Kauṭilya, Panini, Patanjali, Pingala, Maitreyi, Gargi and Thiruvalluvar etc., who made seminal contributions to world knowledge in diverse fields such as mathematics, medical science and surgery, civil engineering, architecture, shipbuilding and navigation, yoga, fine arts, chess, as well as governance, politics, economics and more (National Education Policy, 2020). For centuries, the people of India derived knowledge from close observation of nature and the environment and developed their ideas not only in the field of spirituality but also in the worldly. They propounded insights into sustainable life by using natural resources with spirituality sustainably. Many Ṛṣi and scholars have described three objectives of human life in this world - Dharma, Artha aura Kāma. They believe that the success of life was considered only in the accomplishment of these three. Scholars have prepared independent literature on the three objectives of life. Economic literature has existed in India since ancient times, so much so that it is even mentioned in the Vedas and archaeologically in the Siṃdhu-Sarasvatī civilisation. We find the conclusion of all the principles of the previous Acharya tradition and their works, which are currently unavailable, in Kauṭilya's Arthaśāstra. From the introduction of this ancient Acharya tradition, it appears that the creation of economics had started much earlier and it was mentioned with respect in various books, whose extensive explanation can be found in Kauṭilya's Arthaśāstra. The Puruṣārthacatuṣṭaya are the foundation of pure Indian religion, philosophy and culture. In the Puruṣārthacatuṣṭaya, Dharma, Artha, Kāma and Mokṣa have been mentioned. Kauṭilya has considered Artha the most important of the three - Dharma, Artha and Kāma, and Dharma and Kāma are based on Artha. Kauṭilya writes in Arthaśāstra –

"Manuṣyāṇāṃ vṛttirarthaḥ, manuṣyavatī bhūmirityarthaḥ, tasyāḥ pṛthivyā lābhapālanopāyaḥ śāstramarthaśāstramiti" (Gairola, 2009:765).

That is, humans' livelihood is called Artha, and the earth consisting of humans is also called Artha. The śāstra written for the measures to obtain and protect this type of earth has been called Arthaśāstra by Kauṭilya. He has written "Deśa: Pṛthivī" that mean the earth is called country. The sustainable development and welfare of the citizens is based on the economic production of the nation and the state. Sarvasādhanasampanna state called is the developed state, for this the production capacity of the state should be high. The four major factors of production are land, labour, capital and entrepreneurship, and all these produce goods and services necessary for a developed and welfare economy. According to Kauṭilya, most of the enterprises and industries of the state are the source of economic development; the land is the base for all of these. Kauṭilya's India was flourished and developed. It has established "World-class institutions of ancient India such as Takshashila, Nalanda, Vikramshila, Vallabhi, set the highest standards of multidisciplinary teaching and research and hosted scholars and students from across backgrounds and countries" (National Education Policy, 2020). After Harshvardhan till the time of independence, India lagged behind the world in economic and intellectual development. In the initial period after independence, India's land use and production system was planned and managed in the Mughal and British systems, due to which the land was deprived of its optimum production, and its impact has shown till the present time. India's land use in 1950-51 and 2022-23 is shown in Fig. 1. Agricultural land decreased by 9659 thousand hectares in 2022 compared to 1950. Fallow land increased by 2819 thousand hectares and non-agricultural land increased by 18488 thousand hectares (Ministry of Agriculture and Farmers, 2024). The total number of cultivators in the total population of agricultural workers was 71.9 per cent in 1951, which decreased by 45.1 per cent, while the number of agricultural labourers increased from 28.1 per cent in 1951 to 54.9 per cent in 2011. Sugarcane yield in Tamil Nadu was 105860 kilogram per hectare while in Uttar Pradesh was 81500 kilogram per hectare; the southern Indian region has produced a high sugarcane yield compared to the northern region in 2021-22 (Ministry of Agriculture and Farmers, 2023).

The western region has a high yield of rapeseed and mustard, while the other regions have a low yield. Wheat yield is high in Punjab and Haryana, while in others is low. Land production has variations; land uses are changing, agricultural land is decreasing, and non-agricultural, barren, and unculturable land is increasing. Therefore, India must use wisely to maximise land production until optimum use. Indian land faces many challenges in producing maximum production and requires more planning and management for optimum use. The research paper explains how the economic ideas of the Indian knowledge tradition, contained in Kauṭilya's Arthaśāstra, related to land as a factor of production and provides insights for maximise land production for sustainable development and prosperous state of its citizens and how these ideas are still relevant in the present times.

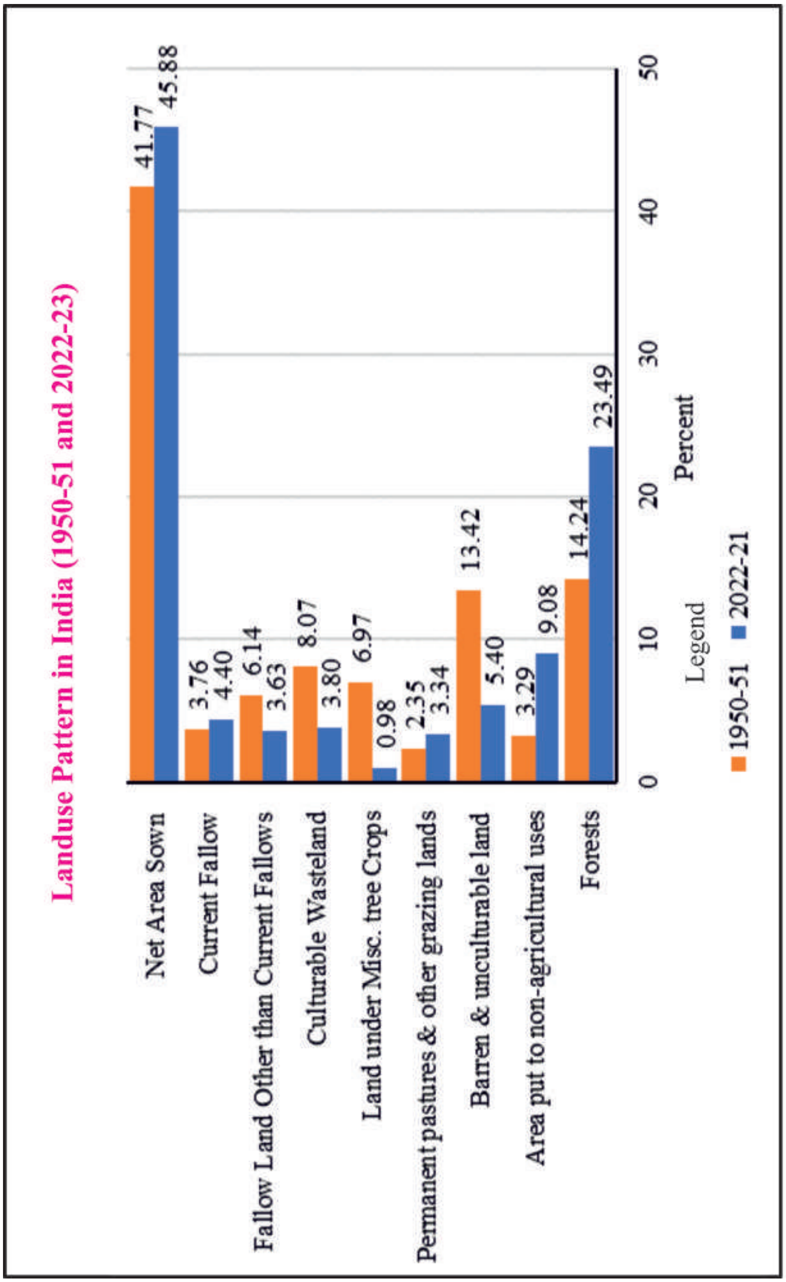

Landuse Pattern in India (1950-51 and 2022-23)
Net Area Sown
Current Fallow
Fallow Land Other than Current Fallows
Culturable Wasteland
Land under Misc. tree Crops
Permanent pastures & other grazing lands
Barren & unculturable land
Area put to non-agricultural uses
Forests
41.77
45.88
3.76
4.40
6.14
3.63
8.07
3.80
6.97
0.98
2.35
3.34
13.42
5.40
3.29
9.08
14.24
23.49
0
10
20
30
40
50
Percent
Legend
1950-51
2022-21

Fig. 1

Study Area

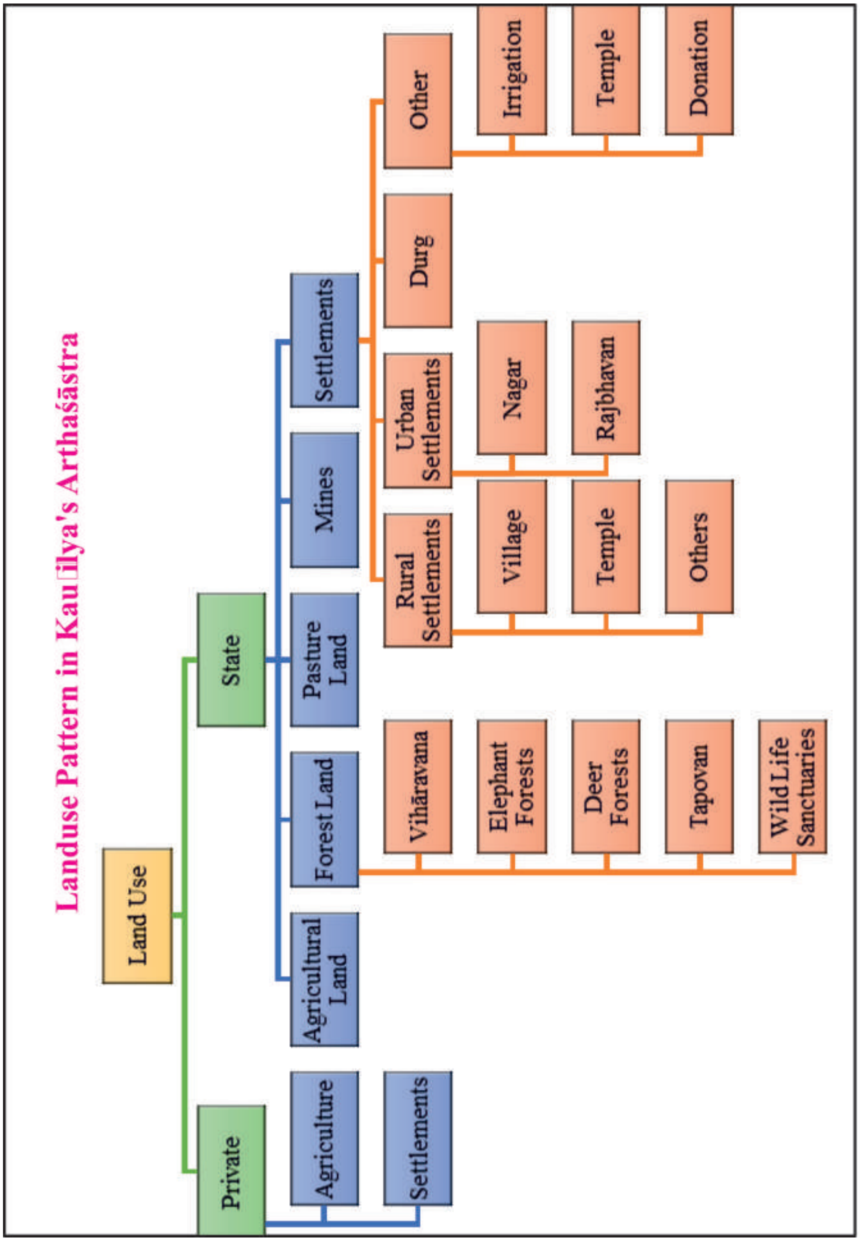
The southern part of Jambūdvīpa was called Bhāratavarṣa; it extended from the Himalayas in the North to the sea in the south and a thousand yojanas from east to west. That is known today as India or Bharat was much larger than today's India. Kauṭilya chose this Greater Bhāratavarṣa as the study area as the basis of his Arthaśāstra so that it could be made a prosperous and welfare state. In the present study, contemporary India has been chosen as the study area so that by gaining insights from Kauṭilya's Arthaśāstra, the economy of present India can again be made prosperous and welfare state. India has 28 states and eight union territories. It is located between 6°45' North and 37°6' North latitudes and 68°7' and 97°25' East longitudes. All States/UTs of India have reported 306650 thousand hectares of total land use area, which is about 93.28 per cent against the total geographical area of 328755 thousand hectares (Ministry of Agriculture and Farmers, 2024). Indian land is rich in natural resources; by re-planning and managing these resources, the production of land can be maximised through optimum utilisation so that India can again become a developed economy for the welfare of the people.

Objectives

(1) To analyse Kauṭilya's view on achieving maximum production through planning and managing land and its optimal utilisation.
(2) To study the relevance of Kauṭilya's economic ideas in contemporary India.

Database and Methodology

This research attempts to gather more information about the topic by interpreting data collected from primary and secondary sources. The main data sources for this research are manuscripts, books, historical documents, research journals, and news magazines and newspapers. It is primarily based on Kauṭilya's (350–275 BC) Arthaśāstra, which was written around 2500 years ago. In contemporary times, various translations of this scripture are available, but the work of Shamashastry and Vachaspati Gairola has been used as a major source of information for this research. The original language of the text used in the research is Sanskrit; therefore, necessary words have been transliterated to reflect linguistic understanding and original meaning. Secondary data on land use and production of different sectors have been taken from statistical reports from the Ministry of Agriculture and Farmers Welfare and other ministries of the Government of India. Data have analysed using STATA 14.1 software, and graphs and tables were computed using MS Excel. This research has used qualitative analysis methods, which are analytical and explanatory in nature.



Landuse Pattern in Kau□ilya's Arthaśāstra
Land Use
Private
State
Agriculture
Settlements
Agricultural Land
Forest Land
Pasture Land
Mines
Settlements
Vihāravana
Elephant Forests
Deer Forests
Tapovan
Wild Life Sanctuaries
Rural Settlements
Urban Settlements
Durg
Other
Village
Temple
Others
Nagar
Rajbhavan
Irrigation
Temple
Donation

Fig. 2

Result and Discussion

All the nation's activities depend on the nation's treasury; therefore, the treasury should be enriched, and the entire land of the state should be developed for economic production. Kauṭilya has mentioned the optimum use of the state's entire land to make Cakravartī state and to the welfare of the people of the state so that the state's treasury can be enriched. The economic industrial base of Kauṭilya's state is mainly based on land. Mentioning the characteristics of the land of the state, Kauṭilya writes that it should produce a lot of food grains with little labour, it should be equipped with rivers and ponds, it should have agriculture, mines, forests for woods and elephants, it should be beneficial for cows, its climate should be good, it should be free from predators, it should have all the valuable things like cow, buffalo, river, canal, water, land, etc., where the farmers are very hardworking, where the population of the productive class is high and where loving and pure people live, a land having these qualities is a prosperous land. Therefore, Kauṭilya has managed and planned the optimum land use to make the state's land more economically prosperous. In Kauṭilya's Arthaśāstra, the production obtained from major land-based economic enterprises can be studied in the following manner.

Land for Agricultural Production and Irrigation System

Kauṭilya has given the first place to agriculture in enriching the state treasury and in the means of livelihood of the people. According to him, all unauthorized land belongs to the state, and Sītāadhyakṣa manages it (Gairola, 2009:197). The individual owns the land that is not controlled by the state. The king should give cultivable land only to the farmer who pays the tax. After the farmer's death, the land becomes the state's property. However, the king never took back the barren land that the farmer had made cultivable by his hard work. Farmers have full rights on such land (Gairola, 2009:78). Kauṭilya has mentioned in the Sītāadhyakṣa chapter in Arthaśāstra that if a farmer keeps the cultivable land fallow without ploughing or sowing, then the king should take away that land from such a farmer and give it to another needy farmer. If such a needy farmer is not available, the village head or a trader should cultivate that land (Gairola, 2009:197). If someone takes land on the condition of cultivation and does not cultivate it, then a penalty should be recovered from him. King should continue to help the farmers by giving them grains, seeds, bulls and money etc. and the farmers should also return the borrowed things to the king gradually as per their convenience after the harvest. Kauṭilya thinks that the king should keep giving the farmers limited money to improve their health and prevent illness. Kautilya considered the best cultivable land to be that which depends not only on rain but also on means of irrigation. Rivers, waterfalls, ponds, wells, and dams are the main means of irrigation. For irrigation of the land, the king should build big dams on the rivers or get the rainy season water filled in big reservoirs. If the people want to do such work, then the king should do them a favour by giving them land for the reservoir, path for the canal, wood, etc., as per their requirement. In this way, the state prepares a record of all the cultivable land through the Samāhartā and his assistant officers and keeps a complete watch on the sowing and harvesting of the crop (Gairola, 2009:101). These policies make it easier for the state to collect taxes and keep track of land production and fallow land. This type of system should also be in place in modern India to solve problems related to agricultural land. This type of system can be helpful in determining policies related to farmer welfare and agricultural insurance.

Landuse for Forests and Sanctuaries

Kauṭilya said that the barren land of the state should be developed as forests and sanctuaries and the state treasury should be increased by earning income from the products of forest resources. In the chapter Bhūmicchidra-Vidhānam, Kauṭilya has said that for the security of the state, elephant forests should be established under the protection of the Kupyādhyakṣa on the border of the Janapada (Gairola, 2009:76). It is necessary for the heads of elephant forests to keep a good watch on the routes leading to elephant forests from mountains, rivers, reservoirs and any water body with the help of their fellow forest guards. Every person who kills elephants should be given death penalty. The king should prepare deer forests and Vihāravana for his entertainment and for public welfare, public forests and deer forests should be prepared under the ownership of the state, in which animals should be brought from different countries and kept. Kauṭilya has said that the land left in the barren land for trees, creepers and deer etc. for religious studies, such a forest extending up to two kos should be given to the Pandits studying Vedādhyayana and Somayāga; similar should be given to Tapovans (Gairola, 2009:75). The Kupyādhyakṣa should establish dedicated forests for valuable trees like sandalwood, palash, and ashoka to generate state revenue. The Kupyādhyakṣa, along with the forest-guards, should be responsible for managing all timber-producing forests (Gairola, 2009:169). The work of the Vivītādhyakṣa is to manage the grass, wood and coal etc. of the Dravyavanoṃ and elephant forests. The tax for going to the fort, the tax for protection from thieves, the tax for cow protection and the arrangement for the purchase and sale of all these things should also be done by the Vivītādhyakṣa (Gairola, 2009:268). Kauṭilya has also mentioned the establishment of forests, sanctuaries, deer forests, elephant forests and Vihāravana to make the unproductive land useful for the state and to earn revenue.

Pasture, Animal Husbandry and Wasteland

Kauṭilya has mentioned in the Bhūmicchidra-Vidhānam chapter of Arthaśāstra that to make the wasteland of the state fertile, the land on which agriculture cannot be done should be developed as pasture for animal husbandry (Gairola, 2009:75). Kautilya has discussed cows, horses, elephants, and other animals in detail and made laws for their rearing and punishment for animal torture. According to Arthashastra, animals were owned by both the state and the individual. The state got income from animals, and people used animals for farming and transportation. Milk and ghee were obtained from cows, buffaloes etc. The state got less profit from animals than from agriculture and trade, but it is clear that animals were necessary for agriculture, trade and human life. An officer called Gau-adhyakṣa was appointed in the state to take care of animals (Gairola, 2009:217). He kept accounts of the animals with him, and there was a system for their rearing and protection. Therefore, the rearing and protection of animals was the responsibility of both the state and the individual. Animals like deer, calves, bulls and cows should never be killed. Anyone who kills any one of these should be punished with fifty Paṇas. Those who kill other animals by torturing them should also be punished with fifty Paṇas. Efforts were also made to improve the state's livestock. Pastures were established for them so that agricultural land was not harmed, people lived on animal husbandry, and the state got income. At that time, there was a system of paying taxes to the state on the use of pasture by animal husbandry. Today, animal husbandry and related systems should be improved. Some cities are facing ruralisation due to unplanned cities. Animal husbandry has started happening in cities as well as villages, and the problems arising from it can be solved by making some arrangements like the establishment of Gau-Adhyaksha in Kautilya's Arthshastra, should be established in outside of cities, a pasture or smaller house for animals.

Landuse for Mines and Mining

Kauṭilya has mentioned various types of mines and industries. He says that the development of the state's treasury depends on the mines; a strong army can be prepared from the prosperity of the treasury. This treasury-bearing earth can be obtained only from the treasury and the military. Thus, the state discovers new mines and develops old mines. The Ākārādhyakṣa manages the mines (Gairola, 2009:137). The state is the owner of all the mines. The state cannot operate all the mines by itself.

It itself looks after the mines operated with less expenditure and labour and leaves the mines with higher expenditure to the management of a person. The Lohādhyakṣa opens factories for the production of metals like iron, brass, copper, lead etc. and manages the trade of the goods produced from them. The Khanyādhyakṣa manages the trade of diamonds, gems, pearls etc. The Suvarṇādhyakṣa looks after the mines of gold and silver. The Lavaṇādhyakṣa manages the trade of salt. Kauṭilya said in Ākarakarmāntapravartanam chapter that the production from mines situated on the state land should be developed as a means of earning income for the state.

Rural, Urban Landuse and Trade and Commerce

Kauṭilya has mentioned the establishment of villages in Janapadaniveśa: in Janapada, establishment of fort of the state in Durgavidhānam and development of highways, waterways, canals for the city and construction of big local cities at the confluence of rivers as the main centres of wealth production, establishment of city in Durganiveśa: and development of Saṃyānīya (trade markets) on big highways for trade and construction of cantonment for the security of the state in Skaṃdhāvāraniveśa: Kauṭilya appoints officers like Samāhartā, Nāgarika, Paṇyādhyakṣa, Śulkādhyakṣa and Saṃsthādhyakṣa for the work of Janapada, city, trade and commerce (Gairola, 2009:78, 82, 85, 638). According to him, the state should have control over all trade. Paṇyādhyakṣa, is the trade officer of the state. Kauṭilya has mentioned the urban and rural planning of the state land and optimum use of land for earning revenue from it in Arthaśāstra, and has created source of income for the state and welfare of the people using texes collection. Most of the cities in India generate revenue for the state, but the consumption of state funds to solve their many problems exceeds the income received from them. Due to this disorder, problems of urbanization are increasing in India and in the absence of policies and planning, we can understand the solution to these problems through Kauṭilya's planning with rules and policies for the establishment and operation of cities and villages.

Land for Lokakalyāṇa and Donation

Kauṭilya has also made provision for land use for public welfare; for this, he has instructed the king to donate land for temples and gardens and help the subjects by donating land to them. Land should be donated for Pandits to establish Tapovanm for Vedhadyanm and somyag for public welfare and religious ceremonies. Similarly, the king should donate land for his officers, employees and subjects like departmental heads, Sāṃkhyāyakoṃ, Gopoṃ, Sthānikoṃ, Nagara-Anikasthoṃ, Vaiddhayoṃ, Aśvaśikṣakoṃ and Janagharikoṃ etc (Gairola, 2009:72).

But the land thus obtained should be prohibited to be sold. Kautily has planned the entire land resources of the state for economically optimum use of land.

Findings and Conclusion

Kauṭilya used all of the land in production to make India a developed and prosperous country in his book Arthaśāstra. Agricultural land was classified on the basis of its production capacity and used for different purposes. If a farmer leaves fertile land fallow, he was punished for his produce or that land was given to another needy farmer and that land was kept engaged in production so that the state does not suffer any loss and the production of the land does not decrease. If a farmer has made the land fertile and cultivable from barren land by his hard work, then he was given ownership of that land as a result of his hard work so that the barren land could also be put into production by personal labour. The production of the state was increased by developing barren land or infertile land on the basis of its utility in the form of Mrigavan, Hastivan, Viharvan, Tapovan, Sanctuary and pasture and dams and canals for irrigation. By establishing forests of different types of timber trees for useful wood, Kupyadayaksh developed a source of production and income for the state from barren land. By developing mining areas in such lands where agriculture and forestry could not be established, production for the state's income was obtained and employment was paved for the people. The state's production and income were increased by engaging the land of rural areas and its residents in primary production and other enterprises and providing them employment. Urban areas were developed as economic centres of the state, markets, mandis were established and arrangements were made for import and export. Land routes and waterways were constructed for transportation in the state and a system of custom tax was made so that the state could get income from economic activities.

Income was also obtained from producers engaged in trade and economic enterprises in urban areas and from the land used in urban areas for other economic activities and its production was increased. Thus, Kauṭilya made all the land of the state useful for production and made the state prosperous. In present India, the type of planning and management done in Kauṭilya's Arthaśāstra for increasing production and optimal use of land for the continuous decrease in agricultural land, increase in barren and fallow land, illegal deforestation, illegal mining, unplanned infrastructural and economic activities in urban and rural areas such as economic activities in residential areas, chaos in the system of markets and mandis, traffic problems, and encroachment on public land use and loss of economic revenue and other types of chaos is still relevant and useful today.

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The Deccan Geographer
Vol. 62, No. 10 December, 2024, pp. 43-55
(ISSN-0011-7269)
UGC Care Listed Geography Journal

CLIMATE CHANGE AND AGRICULTURE: A REVIEW ON INDIAN PERSPECTIVE

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Abstract

The issues of climate change pose major concerns to agricultural production because many people depend on agriculture as their source of income and the agricultural activities in the developing countries like India, are very sensitive to climate change factors. This review paper examines and evaluate the changes that climate change exert on Indian agriculture including, temperature change, change in rainfall patterns, changes in the frequency of extreme weather event occurrence, and availability of natural resource. India's different agro-climate regions are expected to show different levels of vulnerability; rising temperatures and irregular rainfall are projected to negatively impact major crops such as rice, wheat and pulses. Consequently, the paper examines the impacts on yields of crops, condition of the soil, water sources, and the livestock. The review also presents other dynamic approaches currently being practiced in India apart from the challenges mentioned above. These include the development of climate-resilient food crop varieties, sustainable water management practices, and improved farming techniques like agroforestry and conservation agriculture. This paper also discusses policy support, technological development, and research investment to enhance the resilience of Indian agriculture. In view of the fact that India still has a sizeable agrarian population and is extremely sensitive to climate perturbations with regard to food security, this review calls for the urgency of adopting climate-smart agricultural practices and promoting sustainable farming methods to mitigate climate change impacts on India's food security and rural livelihoods.

Introduction

The Indian agriculture has a crucial role in the country's socio-economic structure, with nearly 60% of its population are involved directly in agriculture. Thus, the sector holds a paramount importance for the development of rural areas and as a means of ensuring national food security even today when the country has made a vast progress on the way of industrialization and diversification of the economy. But this very important sector is under increasing pressure from climate change which has become one of the most significant issues of the 21st century. The relationship between crop production and climate is complex, especially given the fact that agriculture in India is profoundly influenced by climatic parameters, with specific reference to rainfall. Hence, any changes experienced in the climatic system directly affect crops and harvest, water supply and accessibility and overall agricultural sustainability. There are multi-dimensional effects of climate change which influenced the agriculture sector in India. Fluctuations in temperature affect various internal processes of crops and hence the yield or quality of the produce. Unpredictable rains and long periods of dry seasons make water for irrigation difficult, exacerbating the problem in water-deficit areas. Also, calamities such as cyclones and other early seasons' rains wash ways taking along with them all harvests leaving the farmers in serious losses. They also worsen the effects of climate change in degrading the fertility of the agricultural land resulting from increased soil erosion, and salination. Besides these, the altering climate also has impacts on increasing pest and diseases that pose more risks to crop production. As such, Indian agriculture is going to face a huge challenge that demands a change for it to better adapt to the climate change. Positive measures are being made such as breeding of crops that can endure higher temperatures, drought and diseases. Conventional farming techniques that imply the conservation of soils including agroforestry, conservation agriculture, and organic farming are new trends that will help to minimize negative effects of agriculture to the natural environment. As another strategy, the use of climate-smart agriculture (CSA) practices that make the sector more productive with less emission of greenhouse gases, is also being encouraged. It is important that India strengthen its agriculture sector to avoid hunger, which is on the increase due to large population that needs staple crops. Hence, recognizing the uniqueness of climate change effects on the Indian agriculture and subsequent development of adaptation measures is extremely relevant in order to ensure the sustainability of agricultural sector in future India.

Objectives

(1) To analyze the impacts of climate change on Indian agriculture, focusing on crop productivity, water resources, and farm-level adaptations, also the vulnerability of different regions and crops to climate change in India.
(2) To identify effective adaptation and mitigation strategies for climate-resilient agriculture in India.

Database and Methodology

To effectively analyze the climate change impact on Indian agriculture, the following methodology is proposed, drawing from the context provided. Utilize secondary data sources such as the reports from IPCC and ICAR. This data provides a foundational understanding of the climate change scenarios and agriculture patterns. Supplement the data with information from various journals, websites, newspapers, and previous research papers, particularly focusing on the impacts of climate change on Indian agriculture. Employed a descriptive research approach to systematically describe the adaptation and mitigation strategies. For analyzing the collected data using software such as MS word, facilitating the representation of results making the findings more accessible and understandable. In summary, the proposed methodology combines quantitative and qualitative approaches, utilizing secondary data, descriptive analysis, and sustainability assessments to provide a thorough understanding of India's agriculture and climate change impacts.

Results and Discussions

Impacts of Climate Change on Indian Agriculture

The agriculture sector is of great significance for the country's economy as well as food security, but it also happens to be highly sensitive to changing climate patterns. Although not the most noteworthy, a key impact is changes in temperature and precipitation. Higher temperatures have been causing heat stress in crops, especially the primary three crops: wheat, rice, and maize. Wheat producing areas of north India are particularly vulnerable to warming. Rainfall that is inconsistent and the fluctuating patterns of monsoons have disturbed our agriculture calendar leading to droughts or floods which harm crops or lower the yields. As a result, Rabi and Kharif crops, the two main growing seasons in India, are vulnerable to climate variability. The increased temperatures during the Rabi season cause crop cycles to be shorter, thus reducing wheat yields. The erratic monsoons during the kharif season may lead to reduced rice production. In particular, long dry spells or unseasonal rains can cause significant crop loss in rice and cotton (IPCC, 2022). Water scarcity is another growing challenge exacerbated by climate change. Groundwater reserves, essential for irrigation are already over exploited in states like Punjab and Haryana, making up the heartlands of Indian agriculture are on life-support. Groundwater is getting harder to access than usual with low rainfall and excessive pumping of water for irrigation. The melting of Himalayan glaciers that supply much of India's rivers will have long-term implications for irrigation water availability particularly in northern India. Changes in agricultural suitability are affecting regions by altering climate zones as well. This mean that some traditional crops will no longer be possible to grow in those areas, but farmers can switch to other crops such as millets and pulses that are more tolerant of high temperatures. At the same time, warmer and wetter conditions are also fostering the migration of pests and disease vectors whose spread is putting crops at risk. Another crucial component associated with Indian agriculture is livestock, and it too gets affected by climate change. Higher temperatures lead to heat stress that decreases the production of milk and fertility rates. Reduced rainfall and higher temperatures also lead to diminishing grasses, which in turn leads to potential fodder shortages for livestock; all contributing factors that harm the health of grazing animals as well as broadly impacting rural economies. Diminished agricultural productivity has a direct impact on the food supply of over one billion people who rely upon agriculture for their daily needs. Crop failure is experienced by smallholder farmers who constitute the heart of Indian agriculture, leading to income losses and an upsurge in rural poverty. As fallow sweeps across the countryside, there will likely be migration from rural areas to cities, potentially posing problems for cities regarding employment and infrastructure.

Vulnerable Regions and Crops

Certain areas with specific soil conditions and dependency on seasonal rain for agriculture are going to be the worst affected by the climate change in India. States such as Punjab, Haryana and Uttar Pradesh are the states located in Indo-Gangetic Plains that ranks highest among those most at risk. This region is often referred to as the “food bowl” of India, producing large quantities of wheat and rice. But higher temperatures and declining groundwater raise questions regarding the sustainability of agriculture in this region. Wheat is especially temperature-sensitive, a 1-degree rise can result in large yield impacts. Also, extensive exploitation of groundwater for irrigation in Punjab and Haryana has led to falling groundwater levels making agriculture in these regions more susceptible during erratic monsoons.

In Central and Western India, states like Maharashtra, Madhya Pradesh, Gujarat, and Rajasthan are normally drought prone areas with fickle monsoons. These are rain-fed agriculture areas and dry spell has brought these under the grip of uncertainty. Marathwada and Vidarbha regions of Maharashtra in particular have been witnessing poor rainfall with the dry spell getting longer on account of a delayed onset monsoon when compared to other parts which significantly affect cotton, pulses and oilseed crops. This puts an additional stress on agriculture, causing heatwaves in these areas to further depress crop yields and create drought conditions. These extreme temperatures are unsustainable for both the crop yields and livestock farmers living in Rajasthan and Gujarat. Cyclone and storm surge prone coastal regions of Andhra Pradesh, Tamil Nadu, Odisha, West Bengal are affected by sea-level rise. These areas face frequent floods during the monsoon. Rising sea water levels causes saltwater intrusion in agriculture lands. Saltwater intrusion degrades fertile soil in coastal regions like Sundarbans, coastal Tamil Nadu and to some extent Andhra Pradesh. Rice is the most important crop that is specifically damaged by saltwater intrusion due to its submergence tolerance capacity. This led to a reduction in the productivity of rice crops because of the increased area under salinization. The Himalayan region is already experiencing the impacts of melting glaciers, changing patterns of rainfall and increasing landslides. Glaciers are a source of water in rivers during dry months, particularly for agriculture. As glaciers retreat, water availability is becoming less predictable. In addition, the crops like apples that are the major cash crops in Himachal Pradesh are one that is known to be sensitive to the winter weather that is changing. Warmer winters and unpredictable rains are disrupting the growing cycle of apple, reducing yields and quality of the fruit. In Eastern India, particularly the states of Odisha, Jharkhand, and Chhattisgarh, are exposed to both droughts and floods. They are the major consumers of rice, most of which is rain-fed, making them more susceptible to climate variability. In Odisha, Mahanadi River's flooding during monsoon is the major problem that almost carries away the large farm lands while the upland areas in this region frequently suffer from the drought.

The mix of regular drought and flooding patterns makes the planning process and productivity challenging in these regions, leading to periodic food security. According to the Intergovernmental Panel on Climate Change (IPCC, 2018), the accumulation of greenhouse gases (GHGs) due to increased anthropogenic emissions has driven global warming by 1.0°Cover pre-industrial levels. This warming is expected to increase by 1.5°C between 2030 and 2052, increasing the frequency of extreme weather events such as heat waves, floods, and droughts. For instance, Gornall et al., (2010), wheat yield could drop by around 10% in low-latitude regions with a 2°C local warming. In India, both the lowest and maximum temperatures have been steadily increasing over the last few decades. India's annual mean temperature rose by 1.2°C between 1901 and 2017 (CSE, 2018), and this trend is expected to continue at a faster rate (Kumar et al., 2011; Van Oldenborgh et al., 2018).

Regional investigation shows a shifting pattern of precipitation (Goswami et al., 2006; Jain & Kumar, 2012; Mallya et al., 2016). but there is no conclusive long-term evidence of shifts in rainfall at the national level (Kothawale et al., 2010; Mondal et al., 2015). Conversely, extended pauses in the southwest monsoon have resulted in a higher frequency of droughts (Udmale et al., 2015; Zhang et al., 2017, Choudhury & Sindhi, 2017), to the point where successive drought episodes are being seen in several subcontinental regions. This presents significant obstacles to the production of food as well as the livelihoods of small-scale farmers, who are already struggling due to a lack of funding and infrastructure to engage in suitable adaptation measures. (Acharya, 2006; Khan et al., 2009; Jain et al., 2015; Patnaik & Das, 2017; Udamale et al., 2015).

Consequences on Agriculture Productivity

The impact of climate change is affecting agricultural production in India in disastrous proportions, especially through declining crop yields. This is due to increased temperatures and unpredictable rainfall. This causes the production of important staple crops such as wheat, rice, maize, and pulses to decrease because wheat is very sensitive to heat, particularly in northern India. An increase of just 1 degree celcius in the seed filling process alone can shorten planting time. This reduces grain size and overall yield. A study group from the Indian Council of Agricultural Research (ICAR) estimates that increased temperatures could reduce production of 4-5 million tons of wheat per year. Also, rice, which is a water-intensive crop, is highly dependent on consistent monsoon rains. Unpredictable monsoon patterns in the states of West Bengal, Bihar, and Tamil Nadu have disrupted the rice cultivation, resulting into reduction in the yield. Estimates suggest that rice production in India may decline by! 0-30% by 2050, posing a major threat to food security. The increasing number of crop failures due to climate change have the serious impact on food security. There has been a series of repeated crop failures in Maharashtra, Karnataka, and Rajasthan. During 2018-2019, large-scale drought struck the Marathwada region. This district suffered massive loss in cotton, pulses, and sugarcane production. Similarly in Bihar and parts of West Bengal, it caused considerable crop loss in flood-prone areas, while a rise in river water level caused large-scale destruction of crops. In 2020, floods in Assam damaged around a quarter million acres of crops directly affecting the agricultural productivity of this region. Much empirical research has been conducted in recent years to investigate and measure how India's climate affects crop output. The nation has seen a notable decline in the productivity of important crops like rice, wheat, maize, and millets under various temperature and precipitation conditions (Sanghi & Mendelsohn 2008; Guiteras 2009; Lobell et al. 2012; Auffhammer et al., 2012; Rao et al., 2014; Birthal et al., 2014a). For example, rice yields fell by about 5% to 10% between 1966 and 2002 (Auffhammer et al. 2011). According to their district-level analysis, kharif paddy yields decreased by 411–859 kg/ha/°C rise between 1971 and 2009 Rao et al. (2014). Padakandla (2016) showed, Andhra Pradesh's rice, tobacco, and peanut production were all greatly impacted by climate change between 1981 and 2010, and crops grown during the Rabi season were more vulnerable to these changes than those grown during the kharif season. Furthermore, research on future forecasts supports the idea that climate variability and change are responsible for variations in main crop yields. Saseendran et al. (2000), reported there is a constant drop in rice yield up to 5°C and a 6% yield loss for every degree Celsius that the temperature rises. By 2100, a 2-4°C increase in temperature and a rise in precipitation rate will have a detrimental effect on the production of cereal crops like rice and wheat (Mall et al., 2006). Hence, the impact of climate change on Indian agricultural productivity is significant. Falling per acre crop yields, more frequent and large-scale crop failures due to higher temperatures and water shortages as well global consideration of the seed market have put Indian food security at risk for 1 billion inhabitants who depend on rain-fed agriculture.

Adaptation and Mitigation Strategies

Indian agriculture needs to adopt the appropriate adaptation and mitigation strategies in order to protect productivity, increase resilience against climate change effects, and maintain food security while using evidence-based information for formulating policies under changing climatic scenarios. The strategies incorporated in these domains include a wide array of short- term as well as long-term interventions, which include the use of modern technology on one hand and traditional policies on the other.

(a) Climate-resilient crop varieties: Developing and promoting climate-resilient crop varieties is one of the most effective adaptation measures. Adapted for climate change, these crops are bred to grow in areas affected by drought and high temperatures variation and stave off salinity as well withstand pest outbreaks. Institutes like the Indian Council of Agricultural Research (ICAR) have managed to develop drought-tolerant crops like rice, wheat, maize and pulses. For example, DDR Dhan 42 is a drought-tolerant rice variety with wide adaptability has been popularized in the drought-prone regions of India particularly eastern part. In states of Punjab and Haryana, where major wheat cultivation is done among farmers practicing rice-wheat rotation, ICAR and IARI have developed wheat varieties with higher temperatures tolerance, such as HD 2967. In the face of encroaching salinity, causing sea levels to rise and saltwater intrusion in coastal areas, ICAR has introduced rice varieties like CSR 36 and Luna Sankhi that can withstand salty conditions.

(b) **Improved Irrigation techniques and water management:** Maintaining water security is crucial for offsetting the impacts of the unpredictable patterns of precipitation, over exploitation and diminishing ground aquifers along with imbalanced monsoons. Drip irrigation and sprinkler systems allow catchment efficacy with consuming less water. Methods like this are very useful in regions where not enough water is available, such as Maharashtra, Gujarat, and Rajasthan. It is dependent on the Pradhan Mantri Krishi Sinchai Yojana (PMKSY) for covering 28.5 million hectares under micro-irrigation schemes by government. Farmers are incentivized in using techniques like solar pumps, avoiding over pumping and broadcasting based on weather forecast which helps to save precious water.

(c) **Agroforestry and Sustainable Farming practices:** By encouraging more sustainable farming, mixed cropping, and agroforestry, we mitigate climate change by building healthier soils and reversing biodiversity decline. Integrating trees with crop cultivation can contribute to soil fertility, give shade, and act as a windbreak against harsh climates that effect crop yields. According to the National Agroforestry Policy 2014, promoting agroforestry is one choice in our adaptation and mitigation toolbox. Practices such as zero tillage, crop rotation, and residue retention help to structure the soil for better water holding capacity as well as reducing emissions of greenhouse gases. A practice of zero-tillage wheat farming in Haryana and Punjab results in higher yield and water savings. Also, organic farming helps in minimizing dependency on chemical inputs and generates an improvement in soil health.

(d) **Diversification of crops:** Farmers can avoid mono-cropping and adapt mixed cropping or inter cropping systems that help to reduces various climate risks being faced by farmers. Crop diversification in form of legumes, cereals, or oilseeds increases soil health which ultimately leads to low vulnerability against extreme weather events. Encouraging the farmers to adopt other alternative livelihoods like livestock farming, agro-processing and horticulture which cut their dependence on single-season crops. In case of crop failure, it provides additional income source as well.

(e) Policy and Institutional support: The National Action Plan on Climate Change (NAPCC) includes the National Mission for Sustainable Agriculture (NMSA) which aimed at promoting climate-resilient agriculture through comprehensive adaptation and mitigation measures by addressing issues related to soil health management, water use efficiency, and capacity building of farmers. Pradhan Mantri Fasal Bima Yojana (PMFBY) has made available insurance coverage to safeguard against such climate-induced risks that farmers face by way of compensating them for their crop loss due to natural calamities.

(f) Farmer's Training and Capacity Building: Krishi Vigyan Kendra Scheme (KVK) across India provides training on sustainable, and climate-resilient agricultural practices such as water-saving techniques in irrigation or mode of pest management, use of resilient crop varieties, etc. Farmer Producer Organizations (FPOs) is one of the ways that encourage smallholder farmers to come together so that they can pool their resources, have better technology, and market access which will increase resilience towards different climate risks.

Indian Government Initiatives

Indian government has taken various initiatives on helping the agriculture sector adjust to climate change impacts, increased productivity and ensure food security. These initiatives are designed to promote sustainable irrigated agriculture, improved water management in the scheme commands and support farming communities with climate-resilient field applications.

(a) Soil Health Card Scheme: Introduced in 2015, aimed at providing detailed information to the farmers on the health or quality of the soils. It helps to reduce the risk the excessive and uneven application of fertilizers as they can be used in balanced amounts to know soil nutrient requirements. This helps farmers to increase the productivity of crops they produce, and at the same time protect the soils from severe environment degradation. Millions of farmers have so far been given soil health cards under this initiative.

(b) Rashtriya Krishi Vikas Yojana: Launched in 2007, RKVY is a central government initiative to motivate states to arrange agricultural plans matching their own needs and climate. The fund is used to provide financial assistance for public investments in states, specifically the infrastructure development, organic farming and drought-proofing measures. It also supports the innovation of projects to improve agriculture productivity and sustainability.

(c) Paramparagat Krishi Vikas Yojana: It promotes organic farming in the country hence decreasing the use of chemical fertilizers and pesticides. Under PKVY, farmers are encouraged to increase the fertility of the soil, resulting in a reduction in green house gases emissions thus paving the way for sustainable agriculture. It also enables the establishment of organic farmer cluster and creating interest in certification and markets for organics.

(d) Kisan Credit Card Scheme: Farmers can avail direct loans at easy interest rates through the KCC scheme which help them meet their expenditure including crop production, purchase of equipment and manage unforeseen risks. It focuses directly on reducing farmer's dependency upon informal lenders and ensures timely financial help. So, it helps farmers to get credit for long-term investments in climate-resilient technologies like solar pumps or water-saving irrigation systems.

(e) Per Drop More Crop Initiative: Under the PMKSY, this scheme aims at enhancing water-use efficiency of every drop of water by adopting closed and open irrigation systems such as drip, dew, and sprinkler systems.

(f) e-NAM (National Agriculture Mission): It was launched in 2016, is a digital platform used by existing APMC (Agricultural Produce Market Committee) markets across the country. This act enables the inter-state trade and commerce of agriculture produce, providing a huge market to farmers for their crops, allowing them to sell at better prices. This initiative supports farmers in making critical decisions and fosters more direct sales of produce, a particularly valuable resource when climate conditions impact local markets.

Apart from these, KUSUM scheme (Kisan Urja Suraksha Evam Utthaan Mahabhiyan), which promotes the use of solar energy in agriculture, NICRA (National Innovations in Climate Resilient Agriculture), Green Indian Mission, Jal Shakti Abhiyan, Digital Agriculture Initiatives are the Indian government initiatives to building a resilient and sustainable agriculture sector.

Way Forward

A multi-faceted, forward-looking approach is needed to address these upcoming challenges. Future direction demands use of technology, policy reforms and climate-smart practices through capacity building to create a resilient agriculture sector. Food security will only be protected if crop diversification is encouraged so that we are not dependent on staple foods such as rice and wheat, which take more water, but instead turn to millets, pulses, oilseeds, etc. Supporting agroecological methods, such as agroforestry, crop rotation patterns that minimize water use on farms (like leguminous crops in the first season followed by cereals in the next), and mixed farming systems, will enhance resilience-building capacities among farmers so that they can cope better during erratic weather scenarios. Incorporating rainwater harvesting systems and executing effective replenishment of the groundwater for curtailing the consequences of drought periods. Financial inclusion and crop insurance will be equally important in view of the looming challenge from climate change. Further, wider dissemination and targeting of the Pradhan Mantri Fasal Bima Yojana (PMFBY), completed by faster claims and quicker indemnification through an extension coupon mechanism, will cushion farmers against catastrophic losses. Farmer training and development is a pre-requisite to make available the expertise the climate-smart agriculture practices. Reaching agricultural extension services, learning sustainable farming, and strengthening grassroots farmer organizations will improve farmers' ability to cope with the impacts of climate change. Making use of the innovation and knowledge sharing mechanism at a grass root level empowers farmers to adopt new and enhanced techniques and technologies for increasing productivity while conserving resources. Agricultural renewable energy, particularly solar irrigation systems that reduce the carbon emissions effects and enhance the sustainability of farming practices. Hence, India can make its agricultural sector climate resilient by turning to climate adaptation, water conservation, and financial inclusion through farmer empowerment to sustain the livelihood of farming community keeping food security for generations.

Conclusion

In conclusion, development of a resilient future for Indian agriculture to combat climate change requires an approach that is proactive and inclusive. The country can protect agriculture sector from erratic weather and environmental stressors by promoting climate-resilient crops, enhancing water management, adopting precise agricultural practices besides providing investment. Educating farmers about growing crops more efficiently using sustainable practices and supporting relevant technology will be a determining factor in the future of adaptation across diverse regions and crop types. To confront the socio-economic and environmental challenges, institutional support along with joint regulatory policy efforts are imperative. As India strives to balance productivity with sustainability, a strong, adaptive agricultural sector will anchor food security aspirations and support rural livelihoods ensuring sustainable development for generations.

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The Deccan Geographer
Vol. 62, No. 10 December, 2024, pp. 56-70
(ISSN-0011-7269)
UGC Care Listed Geography Journal

IMPACT OF RURAL OUTMIGRATION IN THE SOCIO-ECONOMIC LANDSCAPE OF RURAL COMMUNITY: A CASE STUDY OF EAST CHAMPARAN, BIHAR, INDIA

Abhay Kumar and Ashwani

Abstract

With the advent of industrialization and urbanization, the demand for workforce increased in urban and industrial regions which in turn attracted people from different places to work and earn more money as compared to their place of origin. This hard-earned money of the migrants at the place of destination is popularly known as remittances and the flow of remittances towards the place of origin helps in strengthening the local economy. Consequently, alters the socio-economic landscape of the rural community through the various processes and activities of rural development. The present research study is based on the first-hand information collected through the comprehensive field survey of the two blocks namely Motihari (CDB-I) and Tetaria (CDB-II) in the East Champaran district of Bihar, India. The study is focused to discuss the interlinking of rural outmigration, remittances earned at the place of destination and rural development at the place of origin. The study is majorly concerned with rural migrants working as part of workforce in unorganized sector. The study involves the discussion on occupational structure of migrants, remittances in terms of monthly salaries, use of remittances at the place of origin and also answers the question that 'how remittances alter the socio-economic landscape of the rural community of the study area?' The findings show that remittances improved the purchasing power of the households of migrants which in turn resulted in overall improvement of living standards and quality of life.

Introduction

Rural outmigration and flow of remittances have direct impact on the socio-economic landscape of rural community at the place of origin. The households of migrants have advantage of two income sources, first, 'flow of remittances' on monthly basis and second, agricultural produce harvested either quarterly (in case of three crops) or bi-annually (in case of two crops). The remittances earned by migrants contribute in gross income of family and sometimes, remittances earned through migration have overtaken the income through agricultural productions (Oberai and Singh, 1980). Agarwal et.al. (2006) was of the view that remittances increase overall income of household which in turn results more domestic savings and financial stability in family. The remittances strengthen the purchasing power of the households of migrants which in turn results in increased agricultural productions, improved structures of houses and amenities, affordability of health and medical facilities. In the past, out-migration from Bihar served as an important strategy for survival (de Haan, 2002). After India became independent, agricultural practices began changing due to introduction of the Green Revolution, the onset of the Green Revolution regions from the late 1960s in northwestern states increased the labor requirements considerably. As there were few avenues of growth and many were poor in Bihar, many agricultural workers migrated to other states such as Punjab and Haryana. This movement of labor lasted for many years (Sharma, 2005; Rodgers & Rodgers, 2011). The phenomenon of human movement across space and time has changed considerably in recent years, particularly in that urbanization is on the rise and therefore rural-urban migration is common, and people are shifting from primary sectors to other sectors. As of 2009-10, in excess of 90% of the households with migrants reported that these individuals had settled in urban areas for long period (Rodgers et al., 2013). The movement of people from rural areas has significant consequences on the socio-economic structure of communities. Regarding East Champaran, Bihar out-migration is often treated as a tool for dealing with poor job prospects, unfriendly weather conditions for agriculture, and low levels of income (Singh & Sharma, 2020). Earnings from Family Members Help In-Migration improves their household income household and living conditions (Kumar et al., 2019). Nonetheless, the targeted migration of the working-age population is double-edged; it helps to relieve pressure on job markets but undoubtedly leads to difficulty in accessing labor and modifying existing social systems (Patel, 2021). Therefore, the purpose of this study is to focus on these two aspects in order to appreciate the socio-economic prospects of migration in the region under study.

Objectives

(1) To analyse the inter-linking of rural outmigration, flow of remittances and rural development in the East Champaran district, Bihar, India.

(2) To analyse the level of alteration of socio-economic landscape of migrants' households in the CDB-I (Motihari) and CDB-II (Tetaria) of East Champaran district, Bihar, India.

Database and Methodology

The collection of primary data was carried out through comprehensive field survey during the year 2017. The structured questionnaires were used to collect information from 20 villages of East Champaran and 25 household from each village were surveyed. Thus, 500 households (20x25 = 500) in total were surveyed. Further, Table-1 shows details of field survey conducted by the scholar during the year 2017. Two Community Development blocks (CDB) have been chosen. One block with higher development while the other with lower development. A comparative study was done to understand the variation in the rural development of the people living in these two CD blocks. The villages in CDB - I (Motihari) were namely Jhit Kahiya, Lakhuara, Barwa, Haraj Tola Lachhmipur, Chhatauni Ramsingh, Ray Singh, Patparia Moran, Bariyarpur, Bankat and Banswara while the villages in CDB -II (Tetaria) were namely Dhobwaliya, Fazilpur, Saraiya, Sonaul, Tajpur, Kadma, Kothia, Pipra, Sobhitapur and Semraha.

Results and Discussion

Occupational Structure of Rural Outmigrants at Place of Destination

Occupational classification of outmigrants can be broadly classified into primary activities, secondary activities and tertiary activities. The specified primary activities include laborer's, waiters, cooks, mining workers, mechanics and drivers. The specified secondary activities include industrial workers, constructional workers, outmigrants engaged in transport, trade and commerce. The specified tertiary activities include government and private services which are confined to eligible and qualified youth having higher education up to either graduation and post-graduation. The above-mentioned economic activities are governed by the education status, economic background and skills possessed by the outmigrants. Occupational structure shows that 47.03% outmigrants worked either as laborer or waiters/cooks, 15.68% worked as mining workers/mechanics/drivers, 10.21% are industrial workers, 7.36% are constructional workers, 6.65% are transport, trade and commerce and 13.06% as engaged in government/private services.

Income level of the rural outmigrants as per the occupational structure at the place of destination

Here, income level has been divided into five categories viz. less than 7000, 7001-10,000, 10,001-15,000, 15001-30,000, more than 30,000. The rural outmigrants have been divided into six broad working classes viz. Laboure's/waiters/cooks, mining workers/mechanics/drivers, industrial workers, constructional workers, transport trade and commerce and government/private services. CDB-I (Motihari) shows that the highest percentage of 41.10% migrants works as laborer's/waiters/cooks followed by mining workers/mechanics/drivers (13.70%), industrial workers (8.68%), constructional workers (5.48%), transport trade and commerce (11.42%) and government/private services (19.63%). The analysis of migrants belonging to different working classes on the basis of their monthly income shows that 5.02% of migrants work under the monthly income of 'less than 7000' followed by 11.42% migrants work for the monthly income between '7001-10,000' and the working class includes laborer's/waiters/cooks with unskilled and illiteracy as their characteristics. Third slab of monthly income is '10,001 – 15,000' in which 31.05% migrants works as laborer's/waiters/cooks, mining workers/mechanics/drivers and industrial worker with increased skills, experience as their major characteristics. Fourth slab of monthly income is between '15001-30,000' in which 37.90% migrants work as laborer's/waiters/cooks, mining workers/mechanics/drivers, industrial worker, constructional worker, transport trade & commerce and government/private service. In this income slab, migrants with higher level of skills are working as constructional workers, migrants with managerial skills and knowledge of market are working as transporter, trader and businessmen while migrants with proper educational qualification are either working in private sector or government sector.

Fourth slab of monthly income is 'more than 30,000' and about 14.61% migrants is working in this income level. CDB-II (Tetaria) shows that the highest percentage of 53.47% migrants works as laborer's/waiters/cooks followed by mining workers/mechanics/drivers (17.82%), industrial workers (11.88%), constructional workers (9.41%), transport trade and commerce (1.49%) and government/private service (5.94%). In CDB-II (Tetaria), the analysis of migrants belonging to different working classes on the basis of their monthly income shows that 7.92% of migrants work under the monthly income of 'less than 7000' followed by 16.33% migrants work for the monthly income between '7001-10,000' and the working class includes laborer/waiter/cook with unskilled and illiteracy as their characteristics.

Third slab of monthly income is '10,001 – 15,000' in which 39.11% migrants works as laborer's/waiters/cooks, mining workers/mechanics/drivers and industrial worker with increased skills, experience as their major characteristics. Fourth slab of monthly income is between '15001-30,000' in which 28.22% migrants work as laborer's/waiters/cooks, mining workers/mechanics/drivers, industrial workers, constructional workers, transport trade & commerce and government/private service. Fifth slab of monthly income is 'more than 30,000' and about 8.42% migrants is working in this income level. In this income slab, migrants with higher level of skills are working as constructional workers, migrants with managerial skills and knowledge of market are working as transporter, trader and businessmen while migrants with proper educational qualification are either working in private sector or government sector. The comparison between CDB-I (Motihari) and CDB-II (Tetaria) shows that migrants with less skills and no experience are migrating to work as laborer's/waiters/cooks and the percentage of migrants under this category is more in CDB-II (Tetaria) that is 53.47% as compared to 41.10% in CDB-I (Motihari). Moreover, 7.92% of migrants from CDB-II (Tetaria) is working under income level '<7000' as compared to 5.02% of migrants of CDB-I (Motihari). Similarly, migrants working in income level '15001-30,000' are more in CDB-I (Motihari) that is 37.90% as compared to 28.22% [CDB-II(Tetaria)]. The improved infrastructure in CDB-I (Motihari) and educational facilities have resulted in enhancement in skills, literacy level and eligibility for various jobs in private and government sectors as compared to CDB-II (Tetaria).

Use of remittances by the outmigrants' household at the place of origin

The remittances earned by migrants are being used for different purposes at the place of origin by the relatives of migrants. The broad categories for which remittances are used include agriculture, housing infrastructure, health care, financial payments and education. In agriculture, remittances increased the purchasing power and consequently, productivity of land increased manifold. Likewise, remittances helped in improving housing structure and made people to afford electrification, LPG gas, water connection, kitchen facility, bathroom facility, toilet facility etc. Further, remittances made people to invest for health care (both treatment of disease/birth of Child) and clearing of financial payments related to debt repayment, savings and investment in land purchasing. Apart from all these, remittances have made people to invest more in education. The use of remittances for agricultural purpose is high in CDB-I (Motihari) that is 14% as compared to

8% [CDB-II (Tetaria)]. The improvement in housing structure and related facilities is taking place rapidly in CDB-II (Tetaria) as compared to CDB-I (Motihari) and this is justified by the high percentage use of remittances in CDB-II (Tetaria) that is 22% as compared to 19% in CDB-I (Motihari). People became more aware for health of their near and dear ones, so they started spending on health care services for treatment of disease and birth of child. People in CDB-I (Motihari) are spending more on health care services that is 17% as compared to CDB-II (Tetaria) that is 13%. The major part of remittances is being used for debt repayment/savings/investment and percentage of use of remittances for these is quite high in CDB-II (Tetaria) that is 24% as compared to CDB-I (Motihari) that is 22%.

Rural Outmigration and Rural Development

The outmigration results in development of rural areas by affecting the aspects viz. Agricultural development, poverty alleviation and inequality, health and education, women empowerment and social remittances.

(a) Agricultural Development: The 'flow of money' through the remittances earned by the migrants has positive impact on agricultural development at the 'place of origin'. Here, agricultural development through the remittances flow have been studied at local, regional and national level. The remittances flow increases the purchasing power of migrant's households that is increases farm investment and thus, making them self-sufficient in buying hybrid seeds to result in high yield per hectare, fertilizers, machines like mini-tractors and harrow. Moreover, migrants hire labour force during sowing season and harvesting season to complete work in minimum possible time1. In this way, the increased remittances result in diversification and development of agricultural activities of the households of migrants. It has been observed (Table-1) that percentage of migrant's household is comparatively high in productivity categories of low (501-1000 kg/hectare) [21.13% (migrants) and 20.83% (non-migrants)], lower medium (1001-1500 kg/hectare) [42.25% (migrants) and 39.81% (non-migrants)] and very high (more than 2500 kg/hectare) [5.28% (migrants) and 4.63% (non-migrants)] due to improved economic conditions of migrants households. On the other hand, percentage of migrant's household is comparatively low in productivity categories of very low (less than 500 kg/hectare) [7.04% (migrants) and 8.80% (non-migrants)], upper medium (1501-2000 kg/hectare) [15.85% (migrants) and 16.67% (non-migrants)] and high (2001-2500 kg/hectare) [8.45% (migrants) and 9.26% (non-migrants)] due to shift of migrant's households from these categories of productivity to higher categories of productivity.

Table-1: Distribution of Households by Productivity

Productivity	CDB I		CDB II		Total	
	Migrants (%)	Non-migrants (%)	Migrants (%)	Non-migrants (%)	Migrants (%)	Non-migrants (%)
Very low (<500kg/Hect.)	5.88	7.22	8.40	10.08	7.04	8.80
Low (501-1000 kg/hect.)	22.22	21.65	19.85	20.17	21.13	20.83
Lower medium (1001-1500 kg/hect.)	43.14	39.18	41.22	40.34	42.25	39.81
Upper medium (1501-2000 kg/hect.)	16.34	18.55	15.27	15.13	15.85	16.67
High (2001-2500 kg/hect.)	7.84	10.31	9.16	8.40	8.45	9.26
Very High (more than 2500 kg/hect.)	4.58	3.09	6.10	5.88	5.28	4.63
Total	100.00	100.00	100.00	100.00	100.00	100.00

Source: Calculated by the author based on the primary data of the field survey, 2017

The flow of remittances made migrants households to invest more in agriculture and thus, resulted in increase in productivity which in turn marked the shift of migrant's households from lower productivity categories to higher productivity categories. Remittances allows the migrant's household to buy livestock and also carry out poultry farming. Remittances enhances the crop productivity, cattle accumulation and technical efficiency etc.

(b) Poverty Alleviation: The poverty alleviation at the place of origin is directly proportional to inflow of remittances earned by the migrant. Thorough study of primary data show that remittances earned by the migrants have 'income stabilizing effect' on the family income and made them to have their basic needs satisfied. Due to the inflow of money through remittances earned by the migrants makes the life of households free from financial crunch and makes them self-sufficient in meeting the economic downturns, financial crisis, and natural disasters. The poverty alleviation is related to the number of migrants per household and independent of differences in remittances earnings or frequency to send remittances. Results shows that percentage of non-migrants (22.69%) was much higher as compared to migrants (15.49%) in the income group of 'less than Rupees 1000'. On the other hand, the non-migrants (21.76%) were comparatively less to migrants (36.62%) in the income group 'more than Rupees 10,000'. Likewise, their percentage share in low-income group (Rupees 2500 - 5500) and medium income group (Rupees 5500 – 10,000) were high 25.93% and 29.63% respectively. Thus, it becomes obvious that migrants were more concentrated in higher income groups confirming an increase in the income level of migrants. This increased income level of migrants has resulted in increased agricultural productivity and less dependency ratio. The second aspect is the 'dependency ratio' which determines the economic scenario of 'place of origin'. Here, the percentage share of migrants in all the categories of 'dependency ratio' was much less as compared to non-migrants. Adams and Page, (2005) carried out study to understand the relationship between remittances and poverty alleviation across the 71 developing countries. The findings of their study show that flow of money through remittances earned by the migrants have led to 3.5 percent decline in the share of people living in poverty. Further, reports from Latin America, Africa, South Asia and other regions suggests that remittances minimize the degree of severity of poverty. Agarwal et.al. (2006) was of the view that remittances increase overall income of household which in turn results more domestic savings and financial stability in family. Remittances play major role in poverty alleviation at origin. Further, remittances are determined by the nature of job and the salary received. Remittances earned from rural-urban migration play major role in poverty alleviation at origin.

(c) Health and Education: Remittances earned through outmigration plays major role in health and education sector at 'place of origin'. But aspects which determines the level of health and education facilities include – firstly, individual awareness regarding the better health and education for family members and secondly, availability of adequate infrastructure of health and education at the 'place of origin'. In the present research study, infrastructure of health is discussed in terms of medical facilities preferred for treatment of disease and birth of child. Results shows that high percentage of migrant's household preferred private hospitals [36.27% (migrants) and 31.02% (non-migrants)] while marginally lower percentage of migrant's households preferred government hospitals [54.58% (migrants) and 54.63% (non-migrants)] for treatment of disease. A very low percentage of migrant's households preferred quack [9.15% (migrants) and 14.35% (non-migrants)] for treatment of disease as compared to non-migrants. The preference to private hospitals among migrant's households is due to improved economic conditions of migrant's households as a result of flow of remittances. Similar scenario has been observed for 'birth of child' where migrants household have preferred private hospitals and non-migrants preferred government hospitals or quack due to variation in their economic conditions. At individual level, returned migrants become aware about the health issues, hygiene factors, type of services provided by the government hospitals and private hospitals, maternal health and related issues, health of newborn, basic knowledge of various diseases and preventive measures. By using the above generalized knowledge outmigrants promote health and hygiene at domestic level along with proper nutrition among the family members5. Remittances earned by migrants increases the 'purchasing power' of the household and thus, making them self-enough in affording various sort of medical facilities. Likewise, returned migrants realizes the importance of education in life and promote their children to attain education, so that they can understand the various issues, government schemes, and express oneself in proper manner. But availability of improper infrastructure of health and education make people to move other places. Here, returned migrants serve as donors and the amount donated by the migrants is used for the development of infrastructure specifically health and education.

In this way, remittances earned result in development of infrastructure at the place of origin. It can be inferred from that flow of remittances and awareness regarding education among the migrants made them to realize the importance of 'being literate and educated' for betterment of their children and to develop them as human resource. Though, non-migrant's due to weak economic conditions and scarce resources limited their capacity to think about their children's literacy and education. Education of children was important to both migrants and non-migrants and consequently, there was marginal difference in expenditure on education of children by migrants and non-migrants. The factor which decides the level of education is the availability of government run primary schools. Further, non-migrant's households do not prefer to educate their children after high school or intermediate level. On the other hand, migrants due to increased overall income of household and knowledge of current scenario prefer higher education for their children. Moreover, children of migrants enjoy the advantage of moving at the place of destination along with migrant.

(d) Women Empowerment: Outmigration made women (housewives) realize their true worth. In the absence of migrants (men as head of family), entire management of domestic chores along with 'decision making' falls in the domain of women (second head of family). Further, women as mothers take proper initiative to develop and educate their children and women take major decisions of family planning on their own. Moreover, societal outlook regarding the women as secondary to men is changing slowly. The flow of remittances has made migrants households more economically secured as compared to non-migrants' households and consequently life of migrants households is characterized by better future of their children, increase in incomes, high social status of women, increase in decision making power of women and more freedom to women. About 79.93% (Fig. 1) women are assured about the better future of their children, 73.24% women are happy with increase in incomes of households, 60.92% are enjoying the respectable position in the society, 55.28% are taking major decisions of the family and 35.92% are feeling free in performing all sorts of tasks. On the other hand, women in non-migrant's households are given secondary status with 'no say' in domestic and financial matters of family and have low self-esteem, low self-respect and no self-confidence. Consequently, low percentage of women (63.43%) thought about the better future of children, 62.96% of women know about the increase in income of household, 54.17% good position in society, 46.70% participated in decision making of family and 29.17% have given more freedom. Women of non-migrant's households are more engaged in domestic chores and characterized by domestic stay.

Moreover, women in migrant's households enjoy high social status and have 'say' in community decision making in the absence of head of the family (migrant) and also have liberal thinking about the education of her girl child. Lastly, women have also started taking decisions on higher age of marriage in order to live happy and healthy married life. The improved economic conditions of migrants' households have resulted in upliftment of overall social status of women in the study area. In case of nuclear households of migrants, women have acquired the sole status of decision making including financial decisions. Though the use of remittance is under the guidance of their husbands but still women are more confident in dealing with problems both at domestic front and agricultural front. Domestic chores (shopping), commercial activities (sale-purchase of agricultural commodities) and supervision in agricultural fields are dealt by women efficiently.

(f) Social Remittances: Social remittances refer to some intangible or invisible virtues gained by the migrants while working at the 'place of destination'.

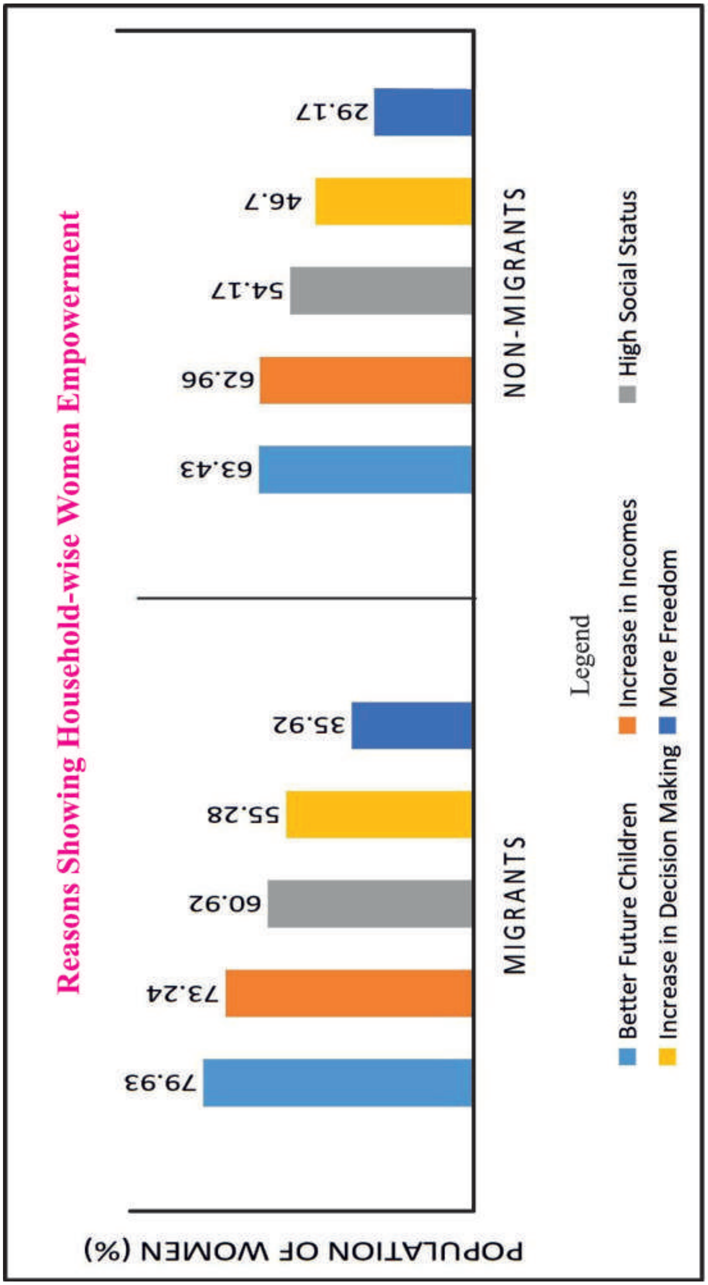
Reasons Showing Household-wise Women Empowerment
POPULATION OF WOMEN (%)
79.93
73.24
60.92
55.28
35.92
63.43
62.96
54.17
46.7
29.17
MIGRANTS
NON-MIGRANTS
Legend
Better Future Children
Increase in Incomes
High Social Status
Increase in Decision Making
More Freedom

Fig. 1

These intangible or invisible virtues includes ideas, practices, identities and social capital. The social remittances help in bringing social transformations at the place of origin. Moreover, migrants bring variety of skills, innovations, knowledge, changes in food habits, perceptions and attitudes. Bhagat (2011) emphasized on the role of social remittances in creating awareness regarding low wages and semi-feudal labour relationships and workers right. Moreover, outmigration makes the rural people to escape caste divisions, restrictive social norms and make them to work with dignity and freedom at the place of destination. Outmigration makes migrants more aware about the basic necessities such as kitchen, LPG gas connections, bath rooms, toilets etc. Returned migrants with the help of remittances and the awareness about various hygienic factors and sanitation make them to construct good kitchens, hygiene bathrooms and toilet etc.

Results shows that migrants households have high percentage of pucca houses (48.94%) and semi-pucca (25.00%) houses as compared to non-migrants [40.74% (pucca houses) and 18.98% (semi-pucca houses)]. While on the other hand, migrants have low percentage of tin shade (16.55%) and kuchcha (9.51%) houses as compared to non-migrants [25.46% (tin shade) and 14.81% (kuchcha)]. The reason behind this is the improved economic conditions due to flow of remittances motivated migrant's household to renovate and modify their traditional houses on the current lines. Results also shows that 78.52% of migrants in comparison to 64.81% non-migrants were preferred houses with kitchen facility and so, got it constructed as a necessary part of house. On the other hand, 21.48% of migrants in comparison to 35.19% of non-migrants are having houses without kitchen facility. The main reason behind this is either their unawareness regarding the separate place for cooking or paucity of funds making them unable to construct kitchens as part of their houses. Household amenities shows that 63.38% of migrants in comparison to 53.70% non-migrants are having LPG gas connections. On the other hand, 36.62% of migrants in comparison to 46.30% of non-migrants are using traditional chulhas with variety of fuels like wood, cow dung, cake, coal etc. It is evident that 68.66% of migrants in comparison to 54.63% non-migrants preferred houses with bathroom and so, got it constructed as a necessary part of house. On the other hand, 31.34% of migrants in comparison to 45.37% of non-migrants are having house without bathroom facility. The main reason behind this is either their unawareness regarding the privacy needed during bathing and sanitation factor or paucity of funds, thus making them unable to construct bathrooms as part of their houses. In case of toilet facilities, results shows that 82.75% of migrants in comparison to 78.70% non-migrants were preferred house with toilet facility and so, got it constructed as a necessary part of house. On the other hand, 17.25% of migrants in comparison to 21.30% of non-migrants have houses without toilet facility. The main reason behind this is either their unawareness regarding the sanitation factor or paucity of funds, thus making them unable to construct toilet as part of their house. The flow of remittances has improved economic conditions of migrants leading to improvement in their living standards and thus, household's development of migrants resulted in overall rural development in terms of social and economic aspects of the East Champaran district, Bihar.

Policy Implications

Before we discuss the policy implications for the rural migrants, we need to discuss the role of rural migrants at the 'place of destination' and contribution at the 'place of origin'. At the place of destination, rural migrants work in 'unorganized sector' which serves as the base of all sorts of infrastructure and urban systems. Rural migrants while working in unorganized sector play a major role in 'nation building' at the place of destination. Simultaneously, flow of remittances by the rural migrants results in the upliftment of local economy and living standards of the migrants' households. Moreover, flow of remittances made the migrants' household less dependent on governmental schemes for rural people and thus, unburdening the ever-increasing economic pressure on the government (both State government and Central government). Recently, the exodus of rural migrants due to 'reverse migration' (back to their native places) as a result of imposition of complete lockdown in our country (India) due to COVID19 Pandemic showcased that rural migrants in such large number work in unorganized sector which were invisble to everyone before the lockdown. Secondly, companies, contractors, owners etc. adopted 'use and throw' attitude and showed apathy towards the plight of rural migrants. Thirdly, rural migrants constitute the 'unorganized sector' which plays major role in industrial sector, manufacture sector, transport sector, agriculture sector and such important 'unorganized sector' faced the 'high degree of negligence' till today. In the light of above discussion, the policy implications can be summed up as under -The politico-administrative set up needs to shift thier focus on the rural migrants. They face the issue of domicile requirement and other legal formalities so, there is urgent need of 'Comprehensive Law' for the proper management and legal security of migrants belonging to unorganized sector. Schemes like 'ONE NATION, ONE RATION CARD' should be launched in comprehensive manner so that rural migrants can take benefits both at the 'place of destination' and 'place of origin'.

The walking rural migrants during the reverse migration due to COVID19 Pandemic showed that they were not having proper savings due to improper wages and therefore, government should impose regular checks and balances to keep an eye on the wages of rural migrants by their respective owners and this will result in 'stable income effect'.

Limitations of Study

Census of India releases the data on migrants with too much delay which results in paucity of data and data gap to study and analyse the past scenarios of rural migrants in India and consequently, it served as major limitation in understanding the background of the rural outmigration and related aspects. And, Census of India do not provide micro-level data of rural migrants. The second limitation was faced during the field survey, when rural folks were not co-operating as they were afraid and not willing to give family and income details.

Conclusion

Outmigration, economic development and social transformation are interrelated to each other and contribute in overall developmental processes of country. They result in socially dynamic, culturally innovative and economically prosperous societies. Outmigration and migrant workers contribute to both regional and national growth by having considerable share in Gross Domestic Product (GDP). Outmigration helps the development of both primary and tertiary sections at the place of origin. Through the remittances, agriculture activities of the migrant families are improved while some people open shops and dairy activity is also seen improving in the place of origin. Besides people at the origin involved in transport and trade. Children in the outmigrant families attain better schooling and health consciousness was also found in such families of migrants.

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The Deccan Geographer
Vol. 62, No. 10 December, 2024, pp. 71-80
(ISSN-0011-7269)
UGC Care Listed Geography Journal

A STUDY OF REGIONAL DISPARITY OF SOCIAL DEVELOPMENT IN RURAL AREAS IN SANGLI DISTRICT, MAHARASHTRA

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Abstract

The area is related with similar characteristics of its qualities and quantities which vary from area to area. These differences along with areas are known as regional disparities. "Regional disparities" mean separation in the values, qualities or quantities of certain items of different regions. In the present research paper, an attempt has been made to study the regional disparities in the levels of social development in Sangli District Social development has been a critical component of the overall development process. Regional disparities in social status are usually the result of a combination of factors, including variations in natural and geographical factors; this phenomenon is inherent and a natural byproduct of the development process itself. The current research study focuses on regional differences in social development levels in rural regions with the help of selected 11 Social indices in the Sangli district. The census handbook, district statistical office, Related Books, Journals and Published Papers etc. and socio-economic abstract of Sangli District were the main sources of extensive data in 2011 and 2021. The spatial distribution of social development and its disparity have been calculated by composite index. The study reveals that, the three regions Palus, Walwa and Tasgaon have the indices value of are above 101 which are more than the district value (100). These tahsils shows high social development due to more percentage of Male and Female literacy rate. Shirala, Khanapur, Kavathe Mahankal, and Miraj are the four tahsils who has the index value of ranges between 98 and 101, indicating that they have a reasonable level of social development that constitutes this region. This is due the high number of primary and secondary schools per 10,000 populations and the high percentage of SC and ST population literacy rate. The study reveals that palus tahsil has highest indices that is 103.98 while Jath tahsil has lowest indices that is 92.12 and the other tahsils have indices ranging between 103.98 to 92.12. This study indicates that Tasgaon, Palus, and Walwa tahasils are highly developed areas in the Sangli district while Jat tahsil is least Developed. The disparity in social development in Sangli district is due its geographical and climatic condition

Introduction

Sangli district in Maharashtra, India, exhibits significant regional disparities in social development in its rural areas. These disparities are evident in various aspects, including education, healthcare, poverty, and infrastructure. While some regions in Sangli district have made notable progress, others lag behind, perpetuating inequality. Rural areas in Sangli district face challenges in accessing basic services, leading to poor social development outcomes. Educationally, rural areas have lower literacy rates and limited access to quality educational institutions. Healthcare facilities are also scarce, leading to poor health outcomes and limited access to medical care. Poverty is prevalent in many rural areas, exacerbating social development challenges. Infrastructure, including roads, sanitation, and electricity, is often inadequate or lacking. Society includes a variety of factors that is education, health, religion, caste, and culture, and every factor plays an essential role in the development of society. Social development has been an important sector in the overall process of development. According to Gosal and Krishan (1984), a society is both a component and a factor in development. Some areas are economically developed but socially lag behind. As a result, an area's social development is critical to the area's future progress (Gaikwad and Mali, 2021). In the Indian scenario, it is always said that the main cause of the social backwardness of India is found in its historical social backwardness, which has negatively affected the standard of living of man. The Sangli district shows comparatively higher social development than overall Indian society because of its rich historical background of saints and reformers, which accelerated good social practices in society. However, tahsil-wise levels of development vary. Social development has been a critical component of the overall development process. Regional disparities in social status are usually the result of a combination of factors, including variations in natural and geographical factors; this phenomenon is inherent and a natural byproduct of the development process itself (Mishra, R. P., 1969). As a result, the current paper aims to assess the spatial disparities in the levels of social development in Sangli district.

Study Region

The study region is Sangli district, located in the south western part of Maharashtra, India. The Sangli district located in west of Deccan plateau of Maharashtra Nearly 75.49 percent in rural and 24.51 percent people live in urban area. It is situated between 16°43’ and 17°38’ north latitude and 73°41’ and 75°41’ east longitude. It has an area of 8,572 sq. Km. and population of 28, 20,575 according to the 2011census. There are 735 villages and 07 urban locations in Sangli district. The district covers an area of approximately 8,578 sq. Km. It is bounded by Satara district to the north, Solapur district to the east, Bijapur district (Karnataka) to the south, and Belgaum district (Karnataka) to the west. The study region comprises 10 tahsil (sub-divisions), namely Sangli, Miraj, Kupwad, Atpadi, Kavathe Mahankal, Jath, Walva, Palus, Kadegaon, and Tasgaon. The region is characterized by diverse geography, including hills, valleys, and plains. The Krishna River and its tributaries, such as the Warna and Panchganga rivers, flow through the district. Sangli district is known for its fertile soil, favorable climate, and abundant water resources. The region has a population of approximately 2.8 million people, with a density of 327 persons per sq. Km. The study region is significant due to its agricultural productivity, social diversity, and economic growth. However, it also faces challenges related to poverty, inequality, and infrastructure development. This study aims to explore the regional disparities in social development in rural areas of Sangli district.

Objectives

(1) To investigate the regional disparity in levels of social Development in the Sangli district.
(2) To assess the level of Economic Development in Sangli district.
(3) To find out the Backward Region of Sangli District.
(4) To study Major Problem of Level of Development in Sangli District.

Database and Methodology

The data and Research materials for this study were collected from a diversity of sources, as well as both published and unpublished reports. The census handbook, district statistical office, Related Books, Journals and Published Papers etc. And socio economic abstract of Sangli District were the main sources of extensive data in 2011 and 2021, respectively. The collected data is processed with the help of various appropriate statistical and cartographic techniques have been applied for analyzing the data has been employed to find out the levels of development. Further the results are shown by Choropleth method. The spatial distribution of social development and its disparity have been calculated by composite index (Shrivastava, 1983). Using appropriate cartographic techniques, the data was classified and presented in the form of tables, charts and maps. The following formula has been adopted for calculating the levels of development.

$$\text{C.I.}=\frac{x_1\dfrac{\overline{x}_1}{\sigma_1}+x_2\dfrac{\overline{x}_2}{\sigma_2}+x_3\dfrac{\overline{x}}{\sigma_3}+x_4\dfrac{\overline{x}_4}{\sigma_4}+\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots}{\dfrac{\overline{x}_1}{\sigma_1}+\dfrac{\overline{x}_2}{\sigma_2}+\dfrac{\overline{x}_3}{\sigma_3}+\dfrac{\overline{x}_4}{\sigma_4}+\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots}$$

Where,

C.I. = Composite Index

X = Particular Indicator

$\overline{X}$ = Mean of the series of one particular indicator

σ = Standard deviation of the series of one particular indicator

Sangli is one of Maharashtra's most developed districts in terms of social progression. However, there are significant tahsil-by-tahsil differences in the social development. Tahsil-level composite indexes and indices were calculated with the help of related data.

Selected Indicators in Social Segment

To determine the levels of social development and disparity in it, researchers have selected 11 indicators as follows,

1. Percentage of literate population to total Population - *x1*
2. Percentage of female literate population to total female population - *x2*
3. Percentage of male literate population to total male Population - *x3*
4. Percentage of SC literate population to total SC Population - *x4*
5. Percentage of ST literate population to total ST Population - *x5*
6. Percentage of female workers engaged in secondary and territory economic activities to total female population - *x6*
7. Number of primary schools per 10000 population - *x7*
8. Number of secondary and higher secondary schools per 10000 population - *x8*
9. Number of senior colleges per 10000 population - *x9*
10. Number of primary health and sub centers per 10000 population - *x10*
11. Number of households having toilets to total households - *x11*

Results and Discussion

Sangli district is Socio-economically, agriculturally glowing developed district in Sothern Maharashtra, India. The Sangli district located in west of Deccan plateau of Maharashtra. It has as well developed in educationally as compare to other districts of state, but within the district there is a disparity in the social development. Therefore, an attempt has been made to study tahsil-wise levels of social development. The position of Agriculture, economy, education, literacy, and health and women status indicates the levels of social development (Masal, 2012). In the district, the social development is not homogeneous, because some geographical reasons behind that the values of composite index of all the tahsils have been given in Table-2. The indices have also been calculated by taking Sangli district as 100. The values of indicators of social development in rural areas of Sangli district are assembled in Table-1. In our study we have used this data to determine the regional disparity of social development. Here composite score of social indicators of each the tahsil of Sangli district is calculated as per mentioned formula in methodology section. All these data is framed in (Table-1 and Fig. 1). This data it reveals that palus tahsil has highest indices that is 103.98 while Jath has lowest indices that is 92.12 and other tahsils have indices ranging between 103.98 to 92.12.

Table-1: Tahsil and Composite Score of Social Indicators in Sangli District

Sr. No.	Name of Tahsil & Composite Score	Indices Score	Ranks
1	Palus (83.31)	103.98	I
2	Walwa (82.46)	102.92	II
3	Tasgaon (81.45)	101.66	III
4	Shirala (80.76)	100.80	IV
5	Khanapur (80.74)	100.77	V
6	Miraj (80.46)	100.42	VI
7	Kavathe mahankal (80.21)	100.11	VII
8	Kadegaon (79.77)	99.56	VIII
9	Atpadi (78.23)	97.64	IX
10	Jat (73.81)	92.12	X

Source: Authors

According to Table-1 the range of indices varies from 92.12 in Jat tahsil to 103.98 in Palus tahsil. In other words, Walwa is the most advanced socially, while Jat is the most backward. To comprehend the true scenario of disparity in economic development in the Sangli district, these tahsils were divided into four groups (Table-2).

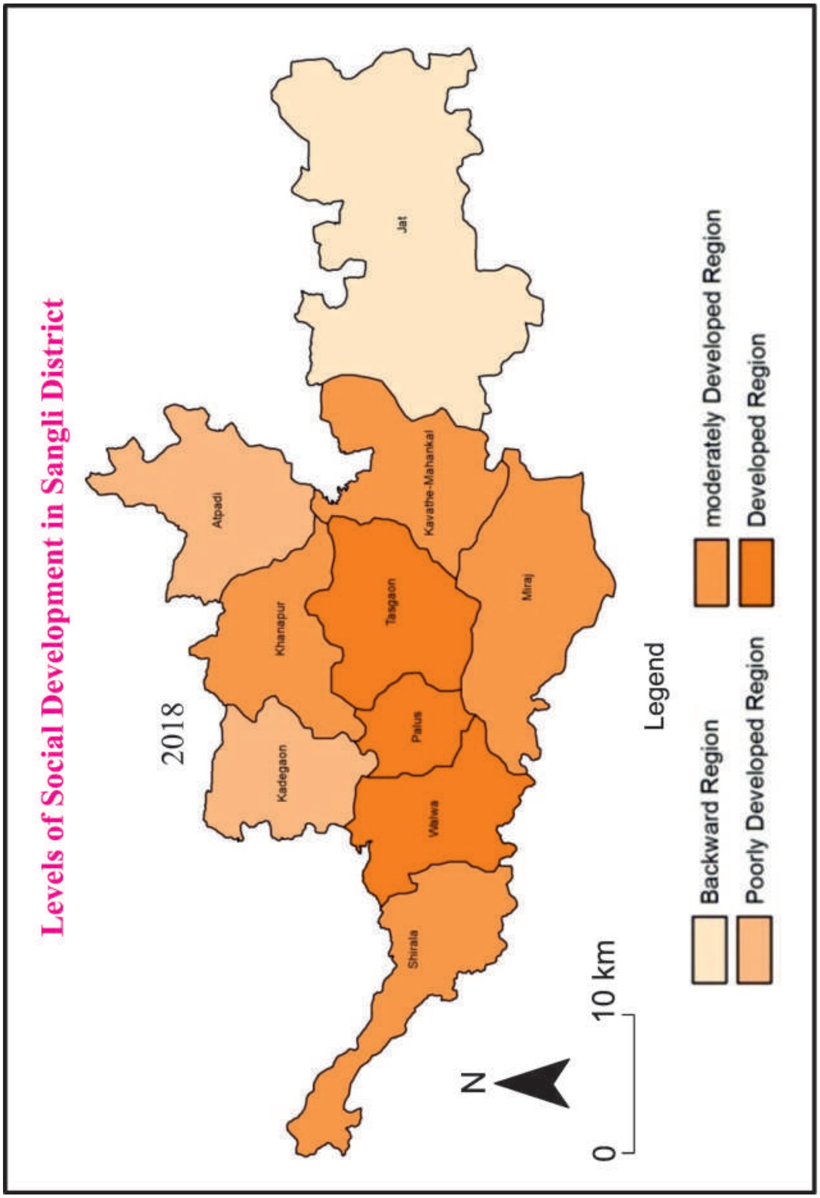
Levels of Social Development in Sangli District
2018
Jat
Atpadi
Kavathe-Mahankal
Khanapur
Tasgaon
Miraj
Kadegaon
Palus
Walwa
Shirala
N
0
10 km
Legend
Backward Region
Poorly Developed Region
moderately Developed Region
Developed Region

Fig. 1

Table-2: Category Levels of Economic Development in Sangli District

Sr. No.	Indices Value	Category Levels of Economic Development	Ranks of tahsils	Indices Score
1	Above 101	Developed region	I. Palus	103.98
			II. Walwa,	102.92
			III. Tasgaon	101.66
2	98 - 101	Moderately developed region	IV. Shirala	100.80
			V. Khanapur	100.77
			VI. Miraj	100.42
			VII. Kavathe Mahankal	100.11
3	95-98	Poorly developed region	VIII. Kadegaon	99.56
			IX. Atpadi	97.64
4	Below 95	Backward Region	X. Jath	92.12

Source: Authors

(a) Developed Region

The developed region of social development includes three tahsils that is Palus, Walwa and Tasgaon of sangli districts. The indices value of these tahsils is above 101 which are more than the district value (100). These three tahsils shows high social development due to more percentage of Male and Female literacy rate. The Palus Walwa and Tasgaon talukas are located in the fertile region of the rivers of Warna, Krishna, Koyna. The availability of abundant water sources, fertile land and favorable climate are responsible for the increased area under cultivation of sugarcane like cash crop result of which agriculture based industries like sugar factories have good presences in this region. Owing to these reasons there is an overall agricultural development in this area and eventually social development. Tasgaon tahsil is also well developed due to the favorable climate and more land under grape cultivation as well as irrigation facility from Takari, Tembhu and Mhaisal water Canals.

(b) Moderately Developed Region

Shirala, Khanapur, Kavathe Mahankal, and Miraj are the four tahsils that constitute this region. Because of the high number of primary and secondary schools per 10,000 populations and the high percentage of SC and ST population literacy rate, the index value of these tahsils ranges between 98 and 101, indicating that they have a reasonable level of social development. The moderate social development in Shirala, Khanapur, Kavathe Mahankal, and Miraj tahsils is due to high percentage of literacy rate population, male-female literacy, SC-ST literacy, No. of Teachers per Hundred Students in Primary Schools, Secondary Schools, available of educational facilities, and well-developed transport route etc.

(c) Poorly developed region

This region is comprised of two tahsils, namely Kadegaon and Atpadi, with index values ranging from 95 to 98. The low level of social development in this region is primarily due to the male and female total population's low literacy rates. The poor social Development in Kadegaon and Atpadi tahsils is due to the low educational units, low male-female literacy rate as well as low teachers at primary and secondary schools behind the levels as compared to other tahsils in the district.

(d) Backward Region

Jat tahsil is the only low in this region whose index value is below 95. In this tahsil, all indicators show very poor values of their indices. In other words, Jat tahsil is a socially backward region in the district. Jat is considered as a backward. The disparity in social development in Sangli district is due its geographical and climatic condition. The eastern part of the district i.e. Jath tahsil is belongs to this category which is socially very low developed in respect of all the indicators of social development. The Geographical condition of this region is hot temperature and very severs. This tahsil is also associated with plain topography, low literacy rate, lacking forest area as well as unfertile soil, lack of water sources, dry river basins, drought prone area and low developed transport facilities are the prime causes of backward social development. These zones are presented on the Fig. 1. The first region has shown high social development, which is located in the western part of the district and spread over the flood plains of the Krishna and Warna rivers. The third zone, which is socially backward, covers the eastern part of the district.

Conclusion

In Conclusion, it is noted that the Sangli district's social development and disparity situation is varied in character. The composite social development indexes have a range of 11 points. The district's greatest levels of social development are found in the tahsils of Walwa, Palus, and Tasgaon. Shirala, Khanapur, Miraj, and Kavathe Mahankal are moderately developed, Kadegaon and Atpadi are poorly developed, and Jat is considered as a backward. The disparity in social development in Sangli district is due its geographical and climatic condition. All these data is framed in Table-2. From this data it reveals that palus tahsil has highest indices that is 103.98 while Jath has lowest indices that is 92.12 and other tahsils have indices ranging between 103.98 to 92.12

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The Deccan Geographer
Vol. 62, No. 10 December, 2024, pp. 81-91
(ISSN-0011-7269)
UGC Care Listed Geography Journal

ASSESSMENT OF ROAD INFRASTRUCTURE DEVELOPMENT AND CONNECTIVITY IN KANNAUJ DISTRICT: A BLOCK WISE AND POPULATION-BASED ANALYSIS

Dr. Juhi Verma

Abstract

Road infrastructure is a key driver of regional development, enabling efficient transportation, enhancing accessibility, and fostering economic growth. This study focuses on the assessment of road infrastructure development and connectivity in Kannauj district, Uttar Pradesh, from 2019 to 2023. The research analyzes road lengths, blockwise distribution, and village connectivity, providing insights into the trends and disparities in road infrastructure across the district. Data were collected from secondary sources, including government reports, PWD records, and Census data, and categorized based on managing authorities: Public Works Department (PWD), Local Bodies, and the National Highway Authority. The findings reveal significant growth in road infrastructure, particularly under PWD, which oversees National and State Highways. National Highways saw a consistent increase in length, from 37 km in 2019-20 to 97 km in 2021-22, while State Highways grew from 8 km to 109 km during the same period. Major District Roads and Rural Roads experienced fluctuations but remained critical components of the network. In contrast, roads managed by Local Bodies exhibited significant variations, with sharp declines in 2020-21 followed by partial recovery in 2021-22. A blockwise analysis highlighted disparities in road distribution, with Umarda and Kannauj blocks having the highest road lengths, while Jalalabad and Gugrapur blocks lagged behind. Village connectivity was analyzed based on population size, showing that larger villages (population >1500) had better access to all-weather roads, while smaller settlements faced notable gaps. Among the blocks, Kannauj, Chhibramau, and Talgram performed well in connecting larger villages, whereas Jalalabad and Gugrapur required targeted interventions. This study underscores the role of road infrastructure in bridging the gap between rural and urban areas, enhancing mobility, and driving economic activity in Kannauj district. It highlights the need for equitable distribution of resources and prioritization of underserved regions to ensure balanced

regional development. This comprehensive assessment provides a foundation for future infrastructure planning and resource allocation in Kannauj district.

Introduction

Road infrastructure plays a pivotal role in regional development, connecting urban and rural areas, enabling the efficient movement of goods and people, and fostering economic growth. In districts like Kannauj, which have a mix of urban centers and vast rural landscapes, the state of road infrastructure is critical for ensuring access to essential services, markets, and social opportunities. This study focuses on assessing the road infrastructure in Kannauj district, analyzing its development and connectivity over time. Kannauj district, located in Uttar Pradesh, is primarily agrarian, with a significant portion of its population residing in villages. For a district with such socio-economic characteristics, well-connected road networks are indispensable for bridging the gap between rural and urban regions. This study categorizes roads based on their managing authorities of Public Works Department (PWD), Local Bodies, and the National Highway Authority—and examines their development trends from 2019 to 2022. It also highlights variations in road lengths across development blocks and assesses connectivity in terms of population-based village accessibility. The Public Works Department (PWD) has played a dominant role in managing road infrastructure in Kannauj district. With a steady increase in road lengths, particularly National and State Highways, the PWD has been instrumental in enhancing the district's transport network. However, the role of Local Bodies and the National Highway Authority also adds an essential layer of complexity, as their contributions and fluctuations reflect different priorities and challenges. This study provides a blockwise analysis of road infrastructure, showcasing the disparities in road development across regions. Blocks such as Umarda and Kannauj exhibit the highest total road lengths, demonstrating a stronger emphasis on infrastructure in these areas. On the other hand, blocks like Jalalabad and Gugrapur highlight the need for further development to ensure equitable connectivity. Village connectivity forms the third critical aspect of this study. By categorizing villages based on population size, the analysis reveals that larger villages, with populations exceeding 1500, enjoy better road connectivity compared to smaller settlements. While this indicates a focus on connecting population-dense areas, it also underscores the need to address the connectivity gaps in smaller villages to ensure holistic regional development.

Study Region

Kannauj district is located in the northern state of Uttar Pradesh, India, and is part of the Kanpur Division. Known for its historical and cultural significance, Kannauj has been a prominent center of trade, culture, and administration since ancient times. The district is situated along the banks of the Ganga River, which plays a vital role in its agriculture and economy. Geographically, Kannauj lies between 26°8' N to 27°1' N latitude and 79°18' E to 80°1' E longitude, covering an area of approximately 2,093 square kilometers. It is bounded by Farrukhabad district to the west, Hardoi district to the north, Kanpur Nagar and Kanpur Dehat districts to the south, and Mainpuri and Etawah districts to the east. The district's topography is predominantly flat, with fertile alluvial plains that support agriculture as its primary economic activity. Administratively, Kannauj is divided into three tehsils: Kannauj, Chhibramau, and Tirwa, further subdivided into eight development blocks: Chhibramau, Talgram, Saurikh, Haseran, Jalalabad, Kannauj, Umarda, and Gugrapur. The district comprises numerous villages and small towns, with a mix of rural and urban settlements. Kannauj town serves as the district headquarters and is famous for its traditional perfume industry, also known as "attar," which has global recognition. The district has a predominantly agrarian economy, with major crops including wheat, rice, sugarcane, and pulses. The fertile soil and availability of water resources contribute to high agricultural productivity. However, connectivity and infrastructure are critical for ensuring access to markets and boosting economic activities. The population of Kannauj district, as per the 2011 Census of India, was approximately 1.66 million, with a literacy rate of around 75%.

The district has a balanced mix of rural and urban populations, with a significant portion relying on agriculture for livelihood. The socio-economic fabric of Kannauj is characterized by its rich heritage and reliance on traditional industries alongside modern agricultural practices. Road infrastructure in Kannauj plays a vital role in linking its villages and towns to major urban centers, ensuring mobility and accessibility. With National Highways, State Highways, and district roads forming the backbone of connectivity, the district's road network is essential for trade, transportation, and overall development. Understanding Kannauj's Road infrastructure is crucial for addressing disparities, enhancing economic growth, and fostering sustainable development in the region.

Objectives

(1) To analyse the trends in road infrastructure development in Kannauj district across different managing authorities (PWD, Local Bodies, and National Highway Authority) from 2019 to 2022.
(2) To examine the distribution of road lengths across development blocks in Kannauj district, highlighting the role of the Public Works Department in maintaining road networks.
(3) To assess the connectivity of villages by all-weather roads in Kannauj district based on population size, focusing on disparities between smaller and larger population centers.
(4) To identify key areas of improvement and prioritize infrastructure development to enhance road connectivity across Kannauj district, particularly in underserved regions.

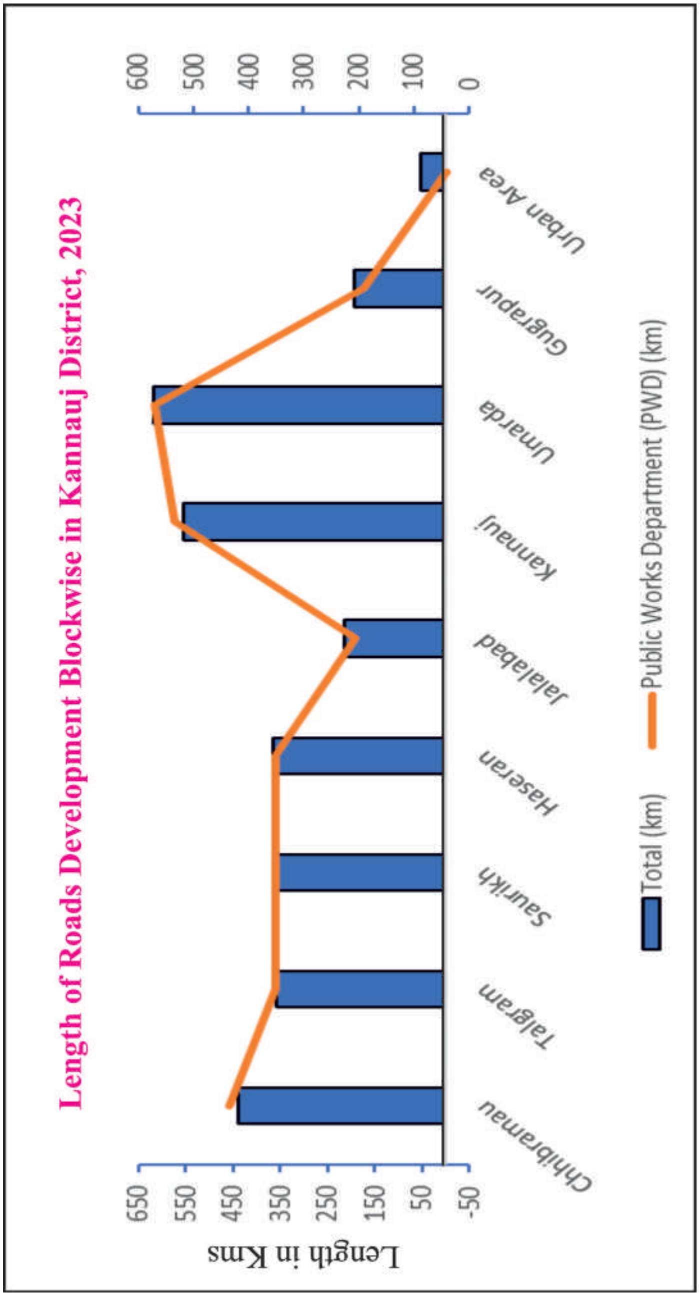
Database and Methodology

The study adopts a quantitative research approach using secondary data to analyze road infrastructure and connectivity trends in Kannauj district from 2019 to 2023. It focuses on road lengths, block wise distribution, and village connectivity patterns. Data was collected from government reports, district infrastructure surveys, PWD records, National Highway Authority updates, Local Body documentation, and Census data to evaluate village populations. Roads were categorized into National Highways, State Highways, Major District Roads, and Other District and Rural Roads to analyze their development, maintenance, and construction trends. Temporal changes were examined across the years 2019-20, 2020-21, and 2021-22 to identify patterns and fluctuations in road lengths. The district was divided into eight blocks—Chhibramau, Talgram, Saurikh, Haseran, Jalalabad, Kannauj, Umarda, and Gugrapur—for a blockwise analysis, focusing on disparities and prioritizing development needs. Villages were categorized based on population size into groups of less than 1000, 1000-1499, and more than 1500 to assess all-weather road connectivity and highlight gaps in access. Statistical tools and visualizations, such as graphs and comparative tables, were used to present data and highlight trends in road development and connectivity. The roles of managing authorities, including PWD, Local Bodies, and the National Highway Authority, were critically evaluated to understand their contributions to road maintenance and development. Regional disparities in road infrastructure and connectivity were identified, pinpointing underserved areas and population groups requiring targeted interventions. This systematic approach ensures a comprehensive evaluation of road infrastructure and its impact on regional development.

Results and Discussion

Length of Roads under Different Departments

The Table-1 provides an overview of the total length of roads in kilometers in Kannauj district for the years 2019-20, 2020-21, and 2021-22, categorized by managing authorities: the Public Works Department (PWD) and Local Bodies, with additional emphasis on roads under the National Highway Authority. Under the PWD, the length of National Highways steadily increased from 37 km in 2019-20 and 2020-21 to 97 km in 2021-22. State Highways experienced a significant rise, jumping from 8 km in 2019-20 to 109 km in 2020-21, maintaining this level in 2021-22. Major District Roads fluctuated, with 80 km in 2019-20, disappearing completely in 2020-21, before climbing to 118 km in 2021-22. Other District and Rural Roads, which constitute the largest share of the network, showed minor variations, increasing slightly from 2794 km in 2019-20 to 2806 km in 2020-21, then reducing to 2754 km in 2021-22. The total road length managed by the PWD consistently grew, reaching 3078 km in 2021-22. Separate from the PWD, the National Highway Authority maintained a gradual increase in road length, rising from 67 km in 2019-20 to 72 km in 2021-22. Roads under Local Bodies, including District Panchayats and Municipal Corporations, exhibited significant fluctuations. The road length managed by District Panchayats fell sharply from 38 km in 2019-20 to 6 km in 2020-21, then surged to 149 km in 2021-22. Similarly, roads under Municipal Corporations or Councils declined drastically from 405 km in 2019-20 to 16 km in 2020-21, recovering slightly to 33 km in 2021-22. Overall, roads under Local Bodies decreased substantially from 443 km in 2019-20 to 22 km in 2020-21, before improving to 182 km in 2021-22. The Table-1 and Fig. 1 reflects growth in road infrastructure, particularly under the PWD, where road lengths increased steadily. However, roads managed by Local Bodies experienced considerable fluctuations, with a notable decline in 2020-21 and a partial recovery in 2021-22. National and State Highways displayed steady progress, signaling a focus on enhancing major transportation routes. This data highlights the trends in road development and the prioritization of infrastructure categories in Kannauj district over these three years.



Length of Roads Development Blockwise in Kannauj District, 2023
Length in Kms
650
550
450
350
250
150
50
-50
600
500
400
300
200
100
0
Chhibramau
Talegram
Saurikh
Haseran
Jalalabad
Kannauj
Umarda
Gugrapur
Urban Area
Total (km)
Public Works Department (PWD) (km)

Fig. 1

Table-1: Length of Roads (km) in Kannauj District, 2019-22

Sr. No.	Items	2019-20	2020-21	2021-22
1	Under Public Works Department			
1.1	National Highways	37	37	97
1.2	State Highways	8	109	109
1.3	Major District Roads	80	0	118
1.4	Other District and Rural Roads	2794	2806	2754
	Total	2919	2952	3078
1(A)	Length of Roads under National Highway Authority	67	71	72
2	Under Local Bodies			
2.1	District Panchayat	38	6	149
2.2	Municipal Corporation / Municipality Council	405	16	33
	Total	443	22	182

Source: https://updes.up.nic.in/

Length of Roads Development

The table presents the length of roads in kilometers across various development blocks in Kannauj district, distinguishing between the total road length and the portion managed by the Public Works Department (PWD). Among the blocks, Umarda has the highest total road length of 619 km, of which 570 km fall under PWD. Kannauj follows with a total road length of 554 km, including 535 km managed by PWD. Chhibramau, Talgram, Saurikh, and Haseran have relatively similar road lengths, ranging between 359 km and 440 km, with PWD managing nearly all of these roads in each block. Jalalabad and Gugrapur have shorter networks, totaling 213 km and 192 km respectively, with PWD managing 207 km and 190 km in these blocks. The urban area has the smallest road network, with a total of 51 km, 40 km of which are under PWD. Collectively, Kannauj district has a total road length of 3159 km, with 3026 km being under the jurisdiction of the PWD (Table-2 and Fig. 2). This data highlights the significant role of PWD in maintaining road infrastructure across the district.

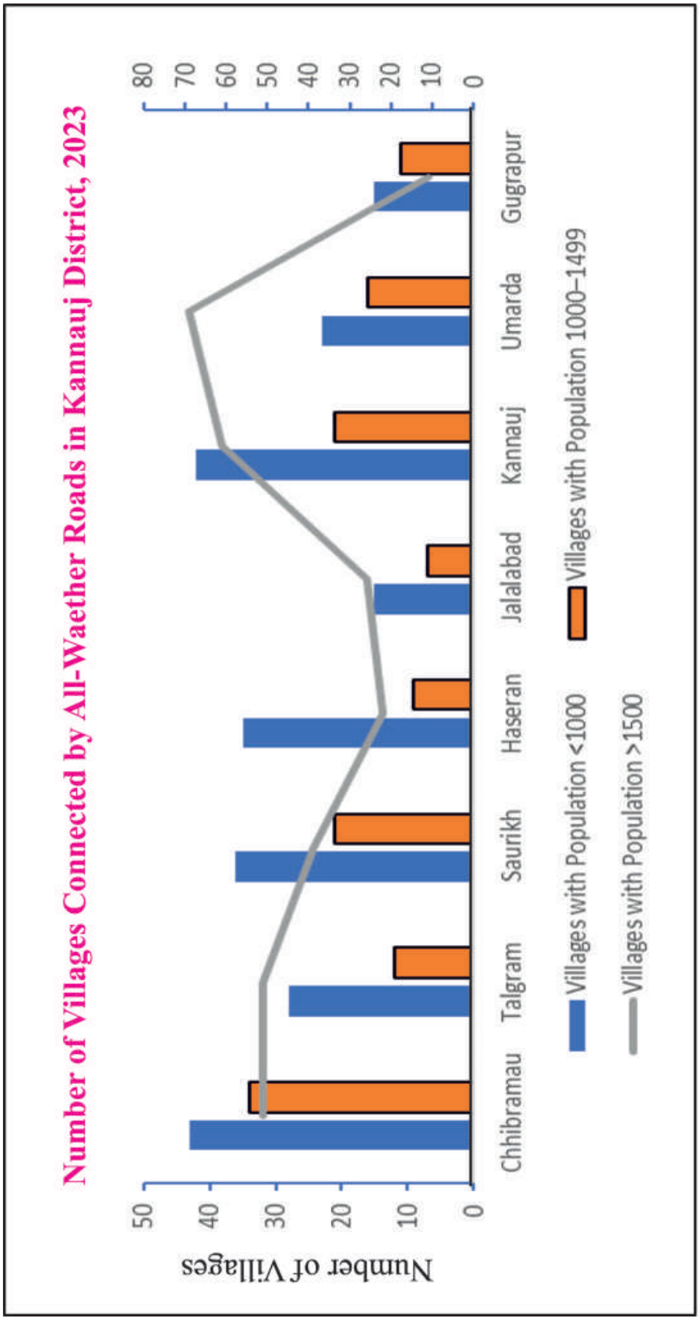

Number of Villages Connected by All-Waether Roads in Kannauj District, 2023
Number of Villages
0
10
20
30
40
50
60
70
80
Chhibramau
Talgram
Saurikh
Haseran
Jalalabad
Kannauj
Umarda
Gugrapur
Villages with Population <1000
Villages with Population 1000–1499
Villages with Population >1500

Fig. 2

Table-2: Length of Roads Development in Kannauj District-2023

Development Block	Total (km)	Public Works Department (PWD) (km)
Chhibramau	440	434
Talgram	359	350
Saurikh	366	350
Haseran	365	350
Jalalabad	213	207
Kannauj	554	535
Umarda	619	570
Gugrapur	192	190
Urban Area	51	40
District Total	3159	3026

Source: https://updes.up.nic.in/

Villages Connected by All-Weather Roads

The table provides data on the number of villages in Kannauj district connected by all-weather roads in 2023, categorized by population size. Among the development blocks, Chhibramau and Talgram each have the highest number of villages with populations over 1500 connected by roads, totaling 51 villages in both blocks. Kannauj stands out with 61 villages connected in this category, the highest across all blocks. For villages with populations between 1000 and 1499, Chhibramau leads with 34 villages, followed by Saurikh and Kannauj with 21 each. In the category of villages with populations below 1000, Chhibramau has the most with 43 villages, while Saurikh and Haseran follow closely with 36 and 35 respectively. Blocks such as Jalalabad and Gugrapur have fewer villages connected across all population categories, with Jalalabad connecting only 26 villages with populations over 1500 and Gugrapur connecting just 11 in this category. In total, Kannauj district connects 237 villages with populations under 1000, 131 villages with populations between 1000 and 1499, and 330 villages with populations exceeding 1500 to all-weather roads (Table-3). This data underscores the focus on infrastructure development in larger villages, while smaller population centers still have substantial connectivity.

Table-3: Villages Connected and All-Weather Roads in Kannauj District

Development Block	Villages with Population <1000	Villages with Population 1000–1499	Villages with Population >1500
Chhibramau	43	34	51
Talgram	28	12	51
Saurikh	36	21	39
Haseran	35	9	22
Jalalabad	15	7	26
Kannauj	42	21	61
Umarda	23	16	69
Gugrapur	15	11	11
District Total	237	131	330

Source: https://updes.up.nic.in/

Conclusion

The assessment of road infrastructure development and connectivity in Kannauj district reveals significant progress in improving road networks, particularly under the management of the Public Works Department (PWD). National and State Highways have seen consistent growth, reflecting a focus on enhancing major transportation routes. However, fluctuations in the management of roads by Local Bodies highlight the need for stable and sustained efforts to address infrastructure gaps. The blockwise analysis underscores disparities in road distribution, with blocks such as Umarda and Kannauj having superior road connectivity, while Jalalabad and Gugrapur lag behind. Village connectivity analysis further indicates a focus on larger villages, with populations exceeding 1500, leaving smaller settlements with limited access to all-weather roads. These findings highlight the critical role of equitable resource allocation and prioritization of underserved regions to ensure balanced regional development. Targeted interventions are needed to bridge the infrastructure gaps in blocks and villages with inadequate connectivity. This study provides actionable insights for policymakers to improve road networks, enhance connectivity for smaller settlements, and promote sustainable development. By addressing disparities, Kannauj district can achieve more inclusive growth, supporting both rural and urban populations in their socio-economic advancement.

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The Deccan Geographer
Vol. 62, No. 10 December, 2024, pp. 92-109
(ISSN-0011-7269)
UGC Care Listed Geography Journal

SPATIAL PATTERN OF GENDER DISPARITY IN UTTAR PRADESH: AN INTER DISTRICT ANALYSIS

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and Mohd. Sajid Rayeen

Abstract

This research paper investigates the spatial patterns of gender disparities in literacy and work participation rates across districts in Uttar Pradesh. The study employs secondary data from various sources, including the District Census Handbooks of Uttar Pradesh districts, 2011 Census data, and various research articles. Sopher's disparity index is utilized to quantify gender disparity. The study indicates that the gender disparity in literacy and work participation rates is more pronounced across all the districts. The highest disparity in male-female work participation is observed in the Saharanpur district, while the lowest is in the Kaushambi district. At the same time, the highest and lowest gender disparities in literacy rates are found in Jaunpur and Kanpur Nagar districts, respectively. The districts in the eastern and Bundelkhand regions of Uttar Pradesh exhibit high levels of gender disparity in literacy rates and low and very low levels of disparity in work participation. Conversely, the districts in western Uttar Pradesh display a low level of disparity in literacy but a high and very high level of disparity in work participation. The districts in central Uttar Pradesh demonstrate a medium level of disparity in literacy and work participation rates. However, certain districts exhibit a high level of gender disparity in work participation. The study highlights the significance of adopting region-specific strategies for reducing the gender disparity and promoting socio-economic development and gender equality in Uttar Pradesh. Moreover, the results of this study may assist planners and policy makers in dealing with the complex issue of gender disparity by highlighting region-specific trends and challenges.

Introduction

Gender disparity in any region is a significant issue that hampers society's social, economic, and overall development. It reduces the principles of equality, equity, and integration by restricting people's potential and opportunities based solely upon their gender (Nanni, 2023). Gender disparity refers to the unequal treatment, opportunities, and access to resources experienced by individuals due to their gender identity, with women being disproportionately affected (Kushwaha & Sharma, 2019). Despite considerable advancements in various spheres of life, gender disparities undermine social and economic progress in many regions (Rai et al., 2019). In last three centuries, India has grappled with a range of economic, political, and social challenges. Amidst these, disparity has consistently remained a defining feature of our society (Jayachandran, 2015). Amidst these, disparity has consistently remained a defining feature of our society. A major area of concern is the gender disparity in educational experiences among adolescents (Wu et al., 2006). Gender-based enrollment differences exist in rural regions (Kington, 2007). Previous studies have shown that socioeconomic and regional development is directly affected by the educational gap between men and women around the world in terms of school access (Anderson & Kohler, 2015; Perrin, 2022; Iqbal et al., 2022), socioeconomic structure, and religious aspects of society (Samir & Lutz, 2017; Deshpanday, 2007). Education is the pivotal element that opens the gateway to modernization (Mohapatra, 1993). Education is an effective tool that can alter society and individuals by empowering people to make well-informed choices about their life and breaking the cycle of poverty (Spiel et al., 2018).

Women play a crucial role in society and enhance their literacy which directly contributes to societal progress (Bayeh, 2016). Therefore, it is imperative to provide education to all women. Historically, women have faced multiple barriers that hinder their access to education and employment opportunities, perpetuating a vicious cycle of poverty and marginalization (Kausar et al., 2024; Frola et al., 2024). In Uttar Pradesh, one of the most populous and diverse states in India, gender disparities are particularly pronounced, impacting critical aspects of human development such as literacy rates and work participation rates (Hebert et al., 2020). Literacy is a fundamental human development and empowerment aspect, and it is closely linked to socioeconomic progress (Pagar, 2018). The socioeconomic advancement of the people living in an area is thought to be strongly influenced by literacy (Svendsen et al., 2020). Literacy is the fundamental cornerstone and a pivotal factor in advancing education within a society (Katiyar, 2016). Literacy has long been considered one of the fundamental demographic indicators of socioeconomic development as it is essential in improving the productivity of an individual and society's productivity (Cockerill, 2014; Svendsen et al., 2020).

Literacy transforms perceptions, attitudes, and behavior as it generates awareness and evolves personality so that the development and welfare of the community and, in turn, the nation may be promoted (Abou Hashish & Alnajjar, 2024). It empowers women in the broader fight against societal inequality and injustice (Patel & Dighe, 1997). Literacy plays a dual role, acting as both a driving force and a consequence of development. In India, the literacy rate significantly increased from 52 percent in 1991 to 74 percent in 2011 (Ghosh, 2011). Over the past few decades, India has experienced varying educational development, with disparities observed across regions, castes, genders, religions, and other factors (Goel & Hussain, 2018). Notably, gender has emerged as a significant determinant in shaping an individual's educational attainment (Agrawal, 2021). Women comprise approximately half the population in India, accounting for 48.45% (Kumarasamy et al., 2023; Goyal & Mohanty, 2024). However, in Uttar Pradesh, gender disparity in literacy rates presents a glaring problem. According to the 2011 Census data, the total literacy rate in the state was 67.68%, with male literacy at 77.28% and female literacy at a significantly lower 57.18% (Sakshi & Bano, 2023). It indicates a considerable gender gap of 20.10 percentage points in literacy rates.

The disparity in literacy rates between genders might be attributed to several factors. Early marriage and prevailing societal norms often lead to girls dropping out of school early (Paul, 2019). Moreover, gender bias and discrimination within educational institutions can deter girls from pursuing education beyond a certain level (Kumar & Pandey, 2021). The lack of safe and accessible schools, particularly in rural areas, also contributes to the disparity (Skinder, 2022). On the other hand, work participation is a crucial indicator of women's economic empowerment and their role in shaping the economy (Devi, 2021). Understanding the factors contributing to gender disparities in these areas is vital for developing effective policies and strategies to address the imbalance. Workforce participation is crucial in gauging women's economic agency and empowerment (Sundström et al., 2017). In Uttar Pradesh, the gender disparity in work participation rates is stark, reflecting the socio-cultural norms that dictate traditional gender roles. As of Census 2011, the overall work participation rate in Uttar Pradesh is 32.9 percent. Male work participation has been estimated at 47.7 percent, and female work participation stands at 16.7 percent. It indicates an alarming gender gap of 31.0 percentage points. Several reasons account for the low work participation rates among women in Uttar Pradesh. Cultural norms dictate that women's primary role is homemaker and caregiver, leading to exclusion from economic activities. Additionally, lack of access to equal job opportunities, unequal pay, and inadequate support for women at work discourages them from seeking employment. Despite growing gender disparity in Uttar Pradesh, only a few researches have been done to examine the variations in gender disparity in terms of literacy and work participation in Uttar Pradesh. Therefore, this study aims to assess the inter-district level variations in literacy and work participation rates in Uttar Pradesh.

Study Region

Uttar Pradesh, the most populous state in the country, covers a geographical area of 240,928 square kilometers, constituting 7.3% of the nation's total area. According to the Census data 2011, Uttar Pradesh boasts a population of 19.98 crores, with 10.45 crores males and 9.53 crores females. The population has grown by 20.23% during this decade. In 2011, Uttar Pradesh's population accounted for 16.50% of India's total population. The state's sex ratio, however, stands at 912 females for every 1000 males, which is below the national average of 940, as indicated by the latest census. On a positive note, the literacy rate in Uttar Pradesh has witnessed an upward trajectory, reaching 67.68%. Among the population, male literacy is 77.28%, while female literacy is 57.18%. Regarding work participation, as of the 2011 Census, Uttar Pradesh's overall work participation rate is 32.9%. Male work participation is estimated at 47.7%, whereas female work participation stands at 16.7%.

Database and Methodology

The current research work relies on secondary data from various sources, such as the District Census Handbook of Districts in Uttar Pradesh, Statistical Abstracts of Uttar Pradesh, and the 2011 Census of India. In addition to these, various other secondary data sources have also been consulted, including books and published research papers. The study employs the Disparity Index method by David V. Sopher in 1974 to assess the disparity between male-female literacy and work participation rates across districts. The data is visually presented using choropleth maps and bar graphs for enhanced comprehension. All the maps have been made using ArcGIS 10.8 software.

Result and Discussion

Disparity Index (Sopher's Method)

The Disparity Index, given by Sopher (1974), is widely used quantitative method to assess the disparities between two groups. It is particularly effective in analyzing gender disparities in literacy, employment, or other socio-economic parameters. If X1 and X2 illustrate the respective percentage of value of variables of group 1 and 2 then the disparity index (Di) can be calculated using equation 1.

$$Di = Log\left(\frac{X2}{X1}\right) + Log\left|\frac{Q-X1}{Q-X2}\right|$$

Where, X2 > or = X1, and Q=100, Di is the disparity index, X1 is the female work participation/literacy rate and X2 is the male work participation/literacy rate.

The value of Di will be Zero in the case of perfect equality, which means there is no disparity at all. The measured value of D is interpreted as – a higher value of D indicates a greater extent of disparity, whereas lower values of D show a low level of disparity.

The 2011 Census data reveals substantial disparities in inter-district Male-Female literacy and work participation rates within Uttar Pradesh. The state's overall literacy rate stood at 67.7 percent in 2011, with the male literacy rate reaching 77.3 percent and the female literacy rate at 57.2 percent. This yields a noticeable gender gap of 20.1 percent between male and female literacy rates within the state. The Gender Disparity Index (GDI) for literacy rate is calculated at 0.406. Regarding work participation, the overall rate in Uttar Pradesh was 32.9 percent, with male work participation at 47.7 percent and female work participation at 16.7 percent. Evidently, a significant gender gap of 31.0 percent exists between male and female work participation rates. The GDI for work participation in Uttar Pradesh is computed to be 0.658. Appendix-1 vividly presents the disparity in literacy and work participation rates across districts in Uttar Pradesh. It becomes evident that a substantial gender gap persists in both literacy and work participation rates across the districts of Uttar Pradesh.

Gender Disparity in Literacy Rates

In Table-1, the data reveals notable disparities in literacy rates across various districts. The district of Gautam Buddha Nagar boasts the highest literacy rate at 80.1%, closely followed by Kanpur Nagar at 79.7%, Auraiya at 78.9%, Etawah at 78.4%, and Ghaziabad at 78.1%, among others (Table-1 and Fig. 1 and 2). Conversely, Bahraich district records the lowest literacy rate at 49.4%, trailed by Balrampur at 49.5%, Budaun at 51.3%, Rampur at 53.3%, and several other districts exhibiting lower literacy rates. The male literacy rate was highest in the district of Gautam Buddha Nagar (88.1%), followed by Auraiya and Etawah (86.1%), Ghaziabad and Jhansi (85.4%),

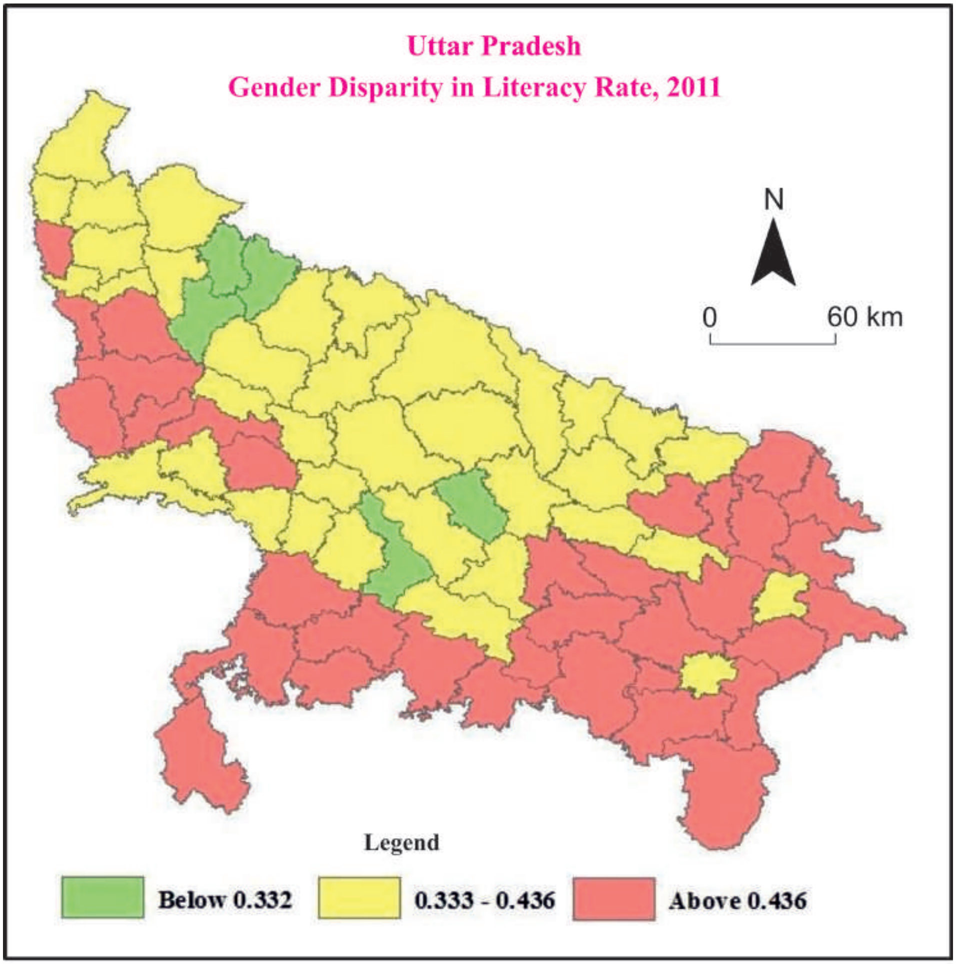
Uttar Pradesh
Gender Disparity in Literacy Rate, 2011
N
0
60 km
Legend
Below 0.332
0.333 - 0.436
Above 0.436

Fig. 1

Mainpuri (84.5%), and others. In contrast, the districts of Bahraich (58.3%), Balrampur (59.7%), Rampur (61.4%), and Moradabad (64.8%) present the lowest male literacy rates. The female literacy rate was highest in the districts of Kanpur Nagar (75.1%), trailed by Lucknow (71.5%) and Gautam Buddha Nagar (70.8%), among others. On the other end, districts like Shrawasti (34.8%), Balrampur (38.4%), and Bahraich (39.2%) report the lowest female literacy rates. A significant gender gap becomes evident, with a substantial 13.0 and 23.5 percentage points difference between the highest and lowest male and female literacy rates, respectively.

Table-1: Gender Disparity in Literacy Rates in Uttar Pradesh

Category	Sopher's Disparity Index	Name of the Districts	% of Districts
Low	<0.332	Kanpur Nagar, Lucknow, Moradabad, Rampur	5.63
Medium	0.333 – 0.436	Agra, Ambedkar Nagar, Auraiya, Badaun, Bahraich, Balrampur, Bara Banki, Bareilly, Bijnor, Etawah, Faizabad, Farrukhabad, Fatehpur, Firozabad, Ghaziabad, Gonda, Hardoi, Jyotiba Phule Nagar, Kannauj, Kanpur Dehat, Kanshiram Nagar (Kasganj), Kheri, Mau, Meerut, Muzaffarnagar, Pilibhit, Rae Bareli, Saharanpur, Shahjahanpur, Shrawast, Siddharthnagar, Sitapur, Unnao, Varanasi	47.88
High	>0.436	Aligarh, Allahabad, Azamgarh, Baghpat, Ballia, Banda, Basti, Bulandshahr, Chandauli, Chitrakoot, Deoria, Etah, Gautam Buddha Nagar, Ghazipur, Gorakhpur, Hamirpur, Jalaun, Jaunpur, Jhansi, Kaushambi, Kushinagar, Lalitpur, Mahamaya Nagar (Hathras), Mahoba, Mahrajganj, Mainpuri, Mathura, Mirzapur, Pratapgarh, SantKabir Nagar, Sant Ravidas Nagar (Bhadohi), Sonbhadra, Sultanpur	46.47

Source: Computed and Compiled by Authors

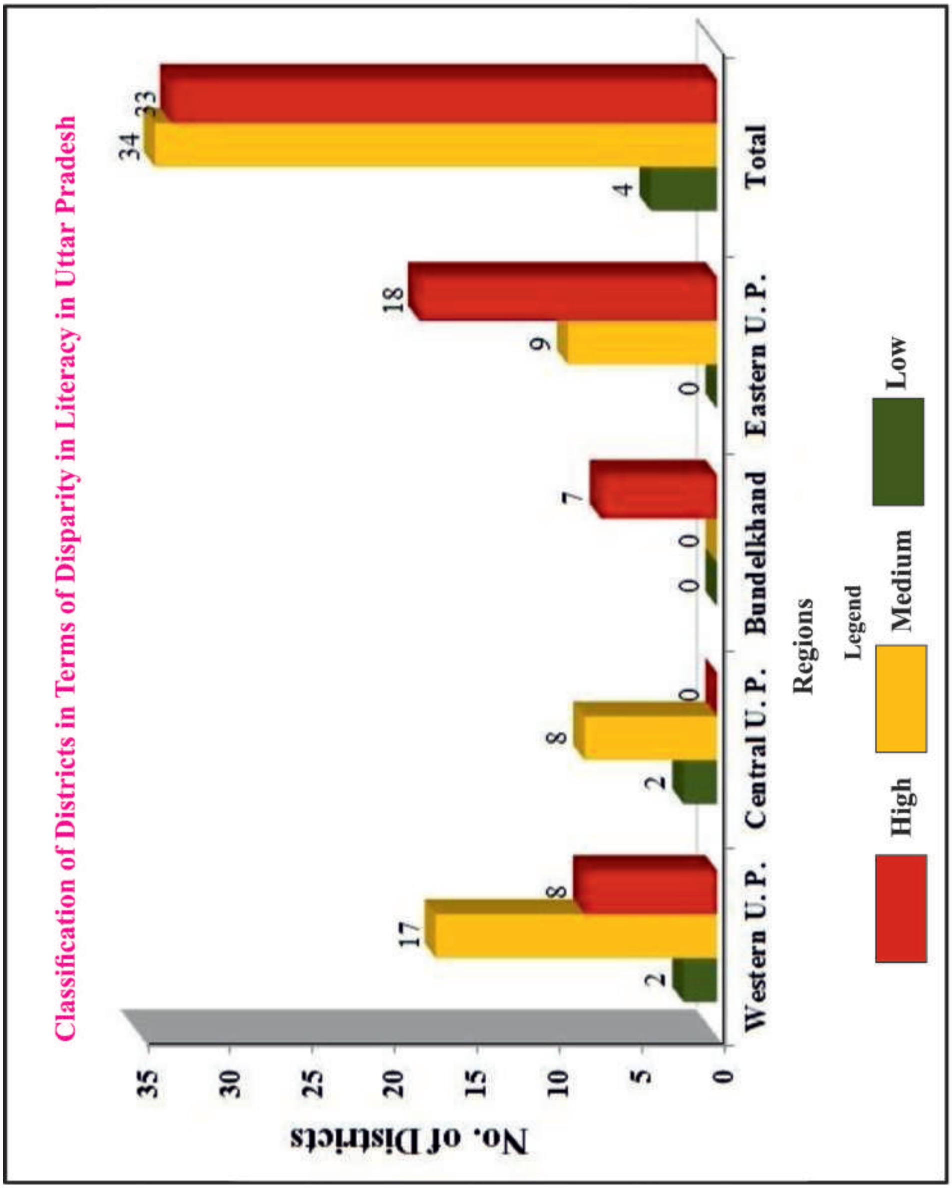
Classification of Districts in Terms of Disparity in Literacy in Uttar Pradesh
No. of Districts
0
5
10
15
20
25
30
35
Western U. P.
Central U. P.
Bundelkhand
Eastern U. P.
Total
2
17
8
2
8
0
0
0
7
0
9
18
4
34
33
Regions
Legend
High
Medium
Low

Fig. 2

Table-1 illustrates the classification of the districts according to gender disparity in literacy rates. The classification is based on Sopher's disparity index values and consists of three categories, (a) The 'Low' category encompasses all districts with a disparity index value below 0.332 (b) The 'Medium' category includes districts with a disparity index value ranging between 0.333 and 0.436 and (c) The 'High' category comprises districts with a disparity index value exceeding 0.436.

Areas of Low disparity

There are only four districts out of 71 districts demonstrate a low level of gender disparity in the male-female literacy rates, with a disparity index value below 0.332. Out of these four, two districts, namely Moradabad (0.302) and Rampur (0.299), belong to the Western Uttar Pradesh. The remaining two, Kanpur Nagar (0.228) and Lucknow (0.277), are in Central Uttar Pradesh.

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Areas of Medium disparity

Out of the 71 districts, 34 districts fall within the medium level of gender disparity in literacy rates, with the disparity index value ranging from 0.333 to 0.436. Among these districts, 17 districts namely Agra (0.421), Auraiya (0.412), Budaun (0.369), Bareilly (0.347), Bijnor (0.344), Etawah (0.432), Farrukhabad (0.369), Firozabad (0.417), Ghaziabad (0.403), JyotibaPhule Nagar (0.429), Kannauj (0.390), Kanshiram Nagar or Kasganj (0.419), Meerut (0.371), Muzaffarnagar (0.407), Pilibhit (0.404), Saharanpur (0.350), and Shahjahanpur (0.338), are in Western Uttar Pradesh. The remaining eight districts, namely Bara Banki (0.334), Fatehpur (0.414), Hardoi (0.408), Kanpur Dehat (0.395), Kheri (0.353), Rae Bareli (0.430), Sitapur (0.362), and Unnao (0.361), belong to Central Uttar Pradesh. The remaining nine districts, including Ambedkar Nagar (0.424), Bahraich (0.336), Balrampur (0.376), Faizabad (0.394), Gonda (0.406), Mau (0.431), Shrawasti (0.399), Siddharth Nagar (0.432), and Varanasi (0.412), are situated in Eastern Uttar Pradesh.

Areas of High disparity

In this category, there are 33 districts characterized by a high level of gender disparity in literacy rates, with a disparity index value exceeding 0.436. Among these districts, only eight, namely Aligarh (0.450), Baghpat (0.494), Bulandshahr (0.529), Etah (0.484), Gautam Buddha Nagar (0.485), Hathras (0.509), Mainpuri (0.443), and Mathura (0.538), belong to the Western Uttar Pradesh region. Seven districts, including Banda (0.480), Chitrakoot (0.449), Hamirpur (0.494), Jalaun (0.482), Jhansi (0.527), Lalitpur (0.463), and Mahoba (0.440), are part of the Bundelkhand region. The remaining 18 districts are situated in the Eastern Uttar Pradesh region. These districts are Allahabad (0.482), Azamgarh (0.446), Ballia (0.472), Basti (0.439), Chandauli (0.466), Deoria (0.533), Ghazipur (0.501), Gorakhpur (0.487), Jaunpur (0.541), Kaushambi (0.452), Kushinagar (0.500), Mahrajganj (0.515), Mirzapur (0.455), Pratapgarh (0.508), Sant Kabir Nagar (0.476), Sant Ravidas Nagar or Bhadohi (0.539), Sonbhadra (0.438), and Sultanpur (0.462).

Gender Disparity in Work Participation

According to the 2011 Census, the overall work participation rate in Uttar Pradesh was 32.9 percent, with male work participation at 47.7 percent and female work participation at 16.7 percent. A significant gender gap of 31.0 percent existed between male and female work participation rates. The work participation rates also exhibited substantial variations at the district level. The districts with the highest rates of work participation included Lalitpur (41.8%), Jhansi (40.8%) (Fig. 3 and 4), Fatehpur (40.4%), Hamirpur (40.2%), Kaushambi (40.0%), and others. On the other hand, the lowest work participation rates were observed in districts such as Deoria (28.3%), Bijnor (29.5%), Azamgarh, Moradabad, and Shahjahanpur (29.7%), Sant Ravidas Nagar (29.8%), and Saharanpur (29.9%), among others. Female work participation rates varied across the districts, with the lowest rate recorded in Saharanpur district (7.7%) and the highest in Kaushambi (31.1%), while the highest and lowest male work participation rates were reported in Jhansi at 53.5% and Azamgarh at 41.2%, respectively. Notably, a wide gender gap was present between male and female work participation rates in Uttar Pradesh's districts. Saharanpur district exhibited the largest gap of 42.0%, while the lowest gender gap in work participation rate was found in Kaushambi district, at 16.9%.

Table-2 illustrates the categorization of districts in Uttar Pradesh based on Sopher's disparity index of work participation rates. The categorization is divided into five distinct groups: Very Low, Low, Medium, High, and Very High.

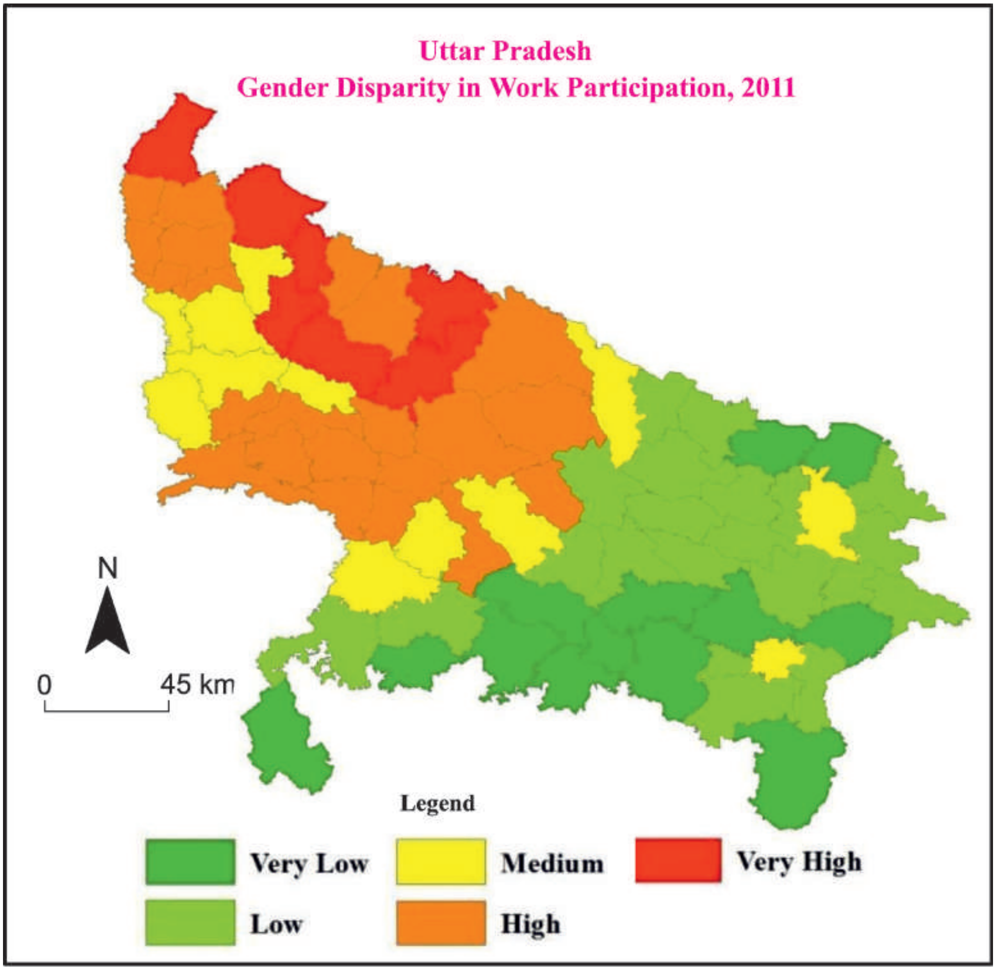
Uttar Pradesh
Gender Disparity in Work Participation, 2011
N
0
45 km
Legend
Very Low
Medium
Very High
Low
High

Fig. 3

These categories correspond to gender disparity index (GDI) values as follows: Below 0.463 for Very Low, 0.464 - 0.615 for Low, 0.616 - 0.767 for Medium, 0.768 - 0.919 for High, and above 0.919 for Very High (Fig. 3).

Table-2: Gender Disparity in Work Participation Rates in Uttar Pradesh, 2011

Category	Sopher's Disparity Index	Name of Districts	% of districts
Very low	<0.463	Allahabad, Banda, Chitrakoot, Fatehpur, Ghazipur, Jaunpur, Kaushambi, Lalitpur, Mahoba, Mahrajganj, Pratapgarh, Siddharthnagar, Sonbhadra	18.30
Low	0.464 – 0.615	Ambedkar Nagar, Azamgarh, Ballia, Balrampur, Bara Banki, Basti, Chandauli, Deoria, Faizabad, Gonda, Hamirpur, Jhansi, Kushinagar, Mau, Mirzapur, Rae Bareli, Sant Kabir Nagar, Sant Ravidas Nagar (Bhadohi), Shrawasti, Sultanpur	28.17
Medium	0.616 – 0.767	Aligarh, Bahraich, Bulandshahr, Gautam Buddha Nagar, Gorakhpur, Jalaun, JyotibaPhule Nagar, Kanpur Dehat, Kanshiram Nagar (Kasganj), Mathura, Unnao, Varanasi	16.90
High	0.768 – 0.919	Agra, Auraiya, Badaun, Baghpat, Bareilly, Etah, Etawah, Farrukhabad, Firozabad, Ghaziabad, Hardoi, Kannauj, Kanpur Nagar, Kheri, Lucknow, Mahamaya Nagar (Hathras), Mainpuri, Meerut Moradabad, Muzaffarnagar, Rampur, Sitapur	30.98
Very high	>0.919	Bijnor, Pilibhit, Saharanpur, Shahjahanpur	5.63

Source: Authors

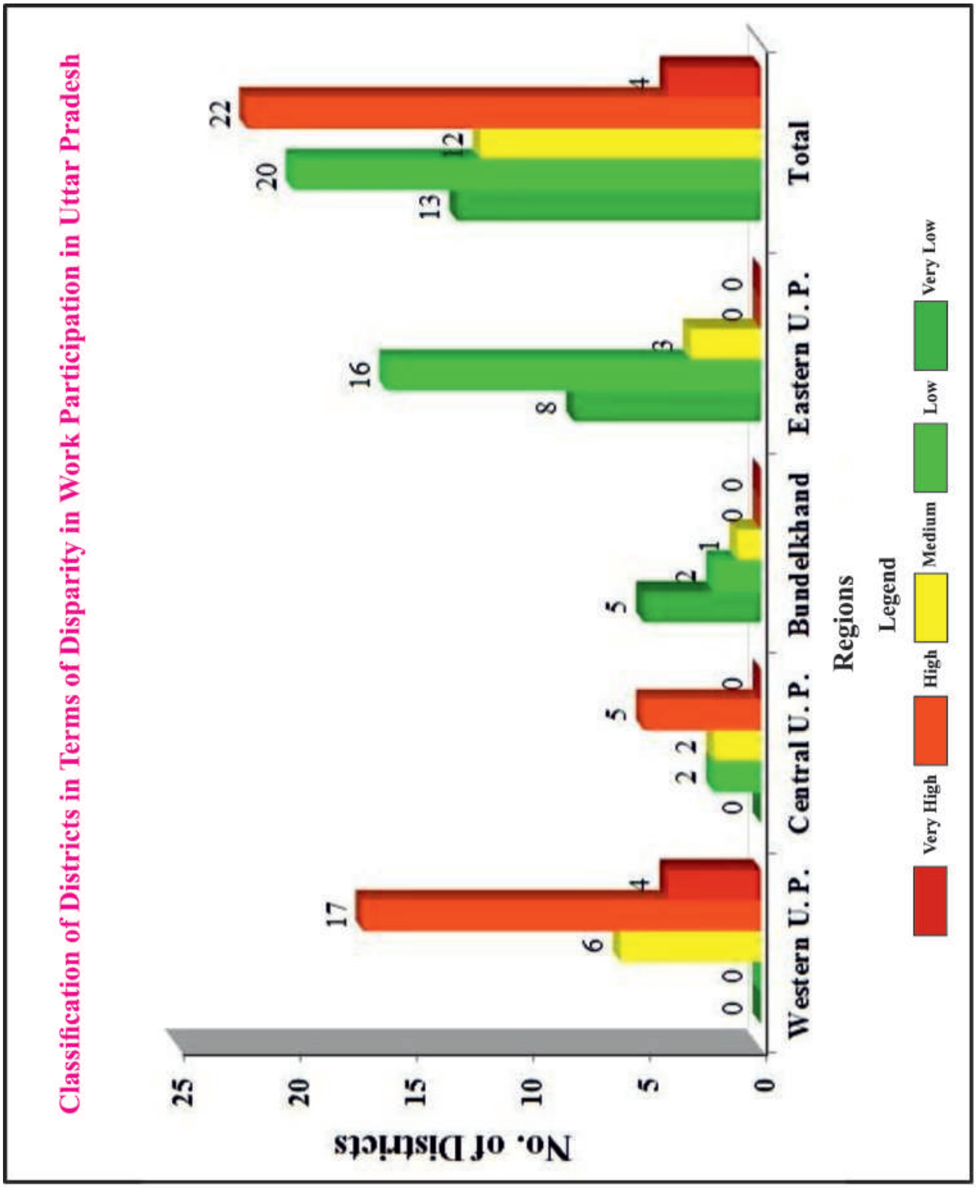
Classification of Districts in Terms of Disparity in Work Participation in Uttar Pradesh
No. of Districts
0
5
10
15
20
25
Western U. P.
Central U. P.
Bundelkhand
Eastern U. P.
Total
Regions
0 0 6 17 4
0 2 2 5 0
5 2 1 0 0
8 16 3 0 0
13 20 12 22 4
Legend
Very High
High
Medium
Low
Very Low

Fig. 4

Very Low Disparity

Among the total of 71 districts, 13 are identified as having low disparity in work participation, characterized by disparity index values below 0.463. Among these districts, five, namely Banda (0.458), Chitrakoot (0.338), Fatehpur (0.434), Lalitpur (0.377), and Mahoba (0.437), are situated in the Bundelkhand region of the state. The remaining eight districts, including Allahabad (0.415), Ghazipur (0.428), Jaunpur (0.409), Kaushambi (0.311), Mahrajganj (0.421), Pratapgarh (0.428), Siddharth Nagar (0.430), and Sonbhadra (0.330), lie in Eastern Uttar Pradesh. This category does not include any districts from the western and central parts of the state.

Low Disparity

Districts exhibiting a disparity index value between 0.464 and 0.615 fall into the category of low disparity. A total of 20 districts falls within this category. Among them, Bara Banki (0.601) and Rae Bareli (0.583) are in the Central region, and Hamirpur (0.478) and Jhansi (0.504) are in the Bundelkhand region. The remaining 16 districts, including Ambedkar Nagar (0.513), Azamgarh (0.490), Ballia (0.514), Balrampur (0.516), Basti (0.545), Chandauli (0.516), Deoria (0.590), Kushinagar (0.562), Mau (0.464), Mirzapur (0.475), Sant Kabir Nagar (0.544), Sant Ravidas Nagar (0.573), Shrawasti (0.567), and Sultanpur (0.527), are in Eastern Uttar Pradesh. No districts from western Uttar Pradesh are present in this category.

Medium Disparity

Twelve districts are identified as having a medium level of gender disparity in work participation, with index values ranging from 0.616 to 0.767. Out of these, six districts, including Aligarh (0.739), Bulandshahr (0.675), Gautam Buddha Nagar (0.698), Jyotiba Phule Nagar (0.678), Kanshiram Nagar (0.755), and Mathura (0.616), are in Western Uttar Pradesh. Kanpur Dehat (0.736) and Unnao (0.682) are in the Central region, while Jalaun (0.662) is in the Bundelkhand region. The remaining three districts, Bahraich (0.709), Gorakhpur (0.642), and Varanasi (0.649), belong to Eastern Uttar Pradesh.

High Disparity

The 'High Disparity' category encompasses districts with a high level of gender disparity, characterized by a disparity index value ranging from 0.768 to 0.919. A total of 22 districts falls into this category. Among them, 17 districts, including Agra (0.771), Auraiya (0.849), Budaun (0.926), Baghpat (0.834), Bareilly (0.850), Etah (0.772), Etawah (0.826), Farrukhabad (0.888), Firozabad (0.808), Ghaziabad (0.809), Kannauj (0.842), Hathras (0.832), Mainpuri (0.863), Meerut (0.856), Moradabad (0.919), Muzaffarnagar (0.905), and Rampur (0.883), are in Western Uttar Pradesh. The remaining five districts, namely Hardoi (0.866), Kanpur Nagar (0.882), Kheri (0.911), Lucknow (0.795), and Sitapur (0.857), are situated in the Central Uttar Pradesh.

Very High Disparity

There are only four districts in Uttar Pradesh showing a very high level of disparity in work participation, with disparity index values above 0.919. These districts are Bijnor (0.944), Pilibhit (1.019), Saharanpur (1.073), and Shahjahanpur (1.052). All of these districts are located in Western Uttar Pradesh."

Conclusion

The current study highlights spatial patterns in gender disparity in literacy and work participation across Uttar Pradesh's districts. The study underscores the significant disparities in work participation rates at the state and district levels. The spatial variation of literacy in Uttar Pradesh shows a wide gap of 20.1 percent literacy from male to female. Among the districts, Saharanpur exhibited the highest gender disparity in work participation, while Kaushambi displayed the lowest, with disparity index values of 1.073 and 0.311, respectively. Concerning literacy rates, Jaunpur district recorded the highest disparity, while Kanpur Nagar district reported the lowest, with disparity index values of 0.541 and 0.228, respectively. A noteworthy finding of this study is that most districts in eastern Uttar Pradesh display a high level of disparity in literacy rates. However, conversely, these same districts exhibit a lower level of disparity in work participation rates. This disparity might be attributed to the region's need for more educational and socio-economic development. The low disparity in male-female work participation in these districts is mainly because a large female population is engaged in primary economic activities. The main drivers of the extremely wide gender literacy gap are practice of early marriage, lack of parental support for school, detrimental economic conditions, domestic work for females, inadequate quality of life, and backwardness of region (Pagar, 2018). On the other hand, the districts in western Uttar Pradesh display a low level of disparity in literacy but a high and very high level of disparity in work participation, characterized by a lower female work participation rate than males. When the economy shifts from agriculture to manufacturing and service sector, women's work participation starts to decline due to a lack of work opportunities and training for females (Devi, 2021). The districts in central Uttar Pradesh demonstrate a medium level of disparity in literacy and work participation rates (Devi & Towari, 2022). However, certain districts exhibit a high level of gender disparity in work participation. Female literacy and work participation are lower in all the districts than male literacy and work participation rates. The male-female disparity in work participation was high in the districts of developed regions like western Uttar Pradesh. Conversely, it was low in the districts of less developed regions such as eastern Uttar Pradesh and Bundelkhand regions. It demonstrates that females of eastern Uttar Pradesh and Bundelkhand regions are comparatively more employed than western Uttar Pradesh females. It is because western Uttar Pradesh experiences comparatively more industrialization, urbanization, and agricultural development, which caused more disparities in male-female work participation rate than the eastern part of the state.

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The Deccan Geographer
Vol. 62, No. 10 December, 2024, pp. 110-118
(ISSN-0011-7269)
UGC Care Listed Geography Journal

ANALYZING WATER STATUS AND LANDUSE AND LANDCOVER IN THE GARAKOT AND GOHSARI VILLAGES OF DISTRICT TEHRI GARHWAL, UTTARAKHAND

Veer Singh, Roosen Raiz Ahmed and Anita Rudola

Abstract

landuse landcover pattern of mountainous region is different from plains and plateaus regions, availability of water in mountainous regions for agriculture is very limited and depends mainly on Gad, Gaders, Streams, Springs and monsoon, availability of soil in mountainous regions is less comparatively from plains and plateaus, the research examines how much water needs for the agriculture, researcher prepared water stress maps for identifying the water stress, this study categorized water stress into high water stress, medium water stress, low water stress and no water stress area, landuse landcover and water stress maps gives us scenario regarding impacts of water scarcity and the dependency of people on the water for agriculture, research studies aims to find out relationship of water and landuse and landcover in the Garakot and Gohsari village of district Tehri Garhwal Uttarakhand, livelihood of people depends mainly on agriculture and associated work, research studies also tries to understand impact of landuse landcover pattern on the livelihoods of the people, in the study area, Landuse Landcover patterns and its impacts on the livelihoods of people, despite having mountainous regions agricultural practices in the small patches also seen during research studies, research also tries to considers crops grown, cropping combination, land holding size and others attributes which are directly or indirectly related to agriculture and water scarcity.

Introduction

Natural and socioeconomic factors, as well as how humans interact with them throughout time and place, determine how an area's landuse and landcover change (Tewabe & Fentahun, 2020), in order to properly plan, utilize, and effectively handle resources from nature, it is crucial to analyze changes in landuse and landcover (Mallupattu & Reddy, 2013), A complex interplay between institutional, economical, and environmental factors leads to LULC alterations (Abebe et al., 2021) A significant rise in population is the primary driver of the unchecked growth of built-up regions, which eventually results in changes to landuse and landcover (Mehra & Swain, 2024) Agriculture practiced all over the world, Agriculture is practiced with different forms and different types and almost every types of agriculture needs water (Aryal et al., 2024), some crops needs high quantity of water and some needs less amount of water, here researcher tried to analyzing relationship of agriculture and water in the mountainous region of Uttarakhand, there is less availability of land resource for agriculture in the mountainous region, water is essential for agriculture, in the mountainous region there is less resources of water for agriculture, some sources are springs, Gad, Gaderas, small streams (Sati & Kumar, 2023) the Indian Himalaya Region is particularly susceptible to these changes due to its primarily rural population and low capacity for adaptation. Conditions for the communities are made worse by poverty and inequality, a lack of infrastructure, and a heavy reliance on rainfed agriculture (Biella et al., 2022), outcropping and the loss of important agricultural land are common outcomes of rapid expansion brought on by immigration and natural population growth (Hassan et al., 2016) since the majority of agricultural operations rely on water supplies, crop productivity is heavily reliant on timely and adequate precipitation as well as water resources (Risal et al., 2022) understanding the existing adjustments in order to predict future variations requires analyzing the factors that are driving LULC change, Garakot and Gohsari village landuse and landcover and situation of water tells about the future prospects of villages (Lindholm, 2019) without planning, it is clear that the tendency of turning agricultural and forest land into built-up areas would continue, negatively affecting the local ecosystem, It is crucial for understanding the proportion of land usage and how it has changed over time in order to plan and create control measures (Mirkatouli et al., 2015).

Study Region

Garakot and Gohsari is two small villages in Tehri Garhwal District of Uttarakhand, Garakot and Gohsari located on the latitude of 30.20 N and 78.61 E longitude Garakot, nestled away in the picturesque slopes of Tehri Garhwal, provides a charming perspective of the surrounding Himalayan landscape, both the villages lie in the Jakhnidhar Block, the primary occupation in this little village is agriculture, villagers rely on local resources and engage in subsistence farming to make a living, the customs of Garhwali society are reflected in Garakot village, where festivals, folk music, and dance are essential components of everyday existence. people celebrate holidays like Diwali, Harela, and local fairs with considerable fervour, both village is surrounded by lush forests, terraced fields, and small streams, village economy mainly based on agriculture, traditional crops like wheat, Mandua barley, and seasonal vegetables are grown by villagers, Rich biodiversity surrounds the village, providing a home for a variety of plant and animal species. It's a great place to observe birds and take in the pure splendor of nature.

Objectives

(1) To analyze Landuse Landcover of 2023 by using Sentinel 2 satellite series data.
(2) To find relationship between Landuse and Landcover and Water stress.

Database and Methodology

The research will be based on primary data and secondary sources. This research will be focused on Primary data collected from field survey and secondary data will be collected from Esri earth explorer using Sentinel-2 series satellites data. Primary data will be collected from the study area based on structured questionnaire, focused group discussion, and various stakeholders' interviews, Landuse Landcover map of 2023 prepared by using high resolution 10-meter data collected from Esri earth explorer using sentinel-2 series data, water stress maps prepared by collecting information from field survey, researcher categorized four category of the water stress on the availability of water, high water stress, medium water stress, low water stress and no water stress, researcher analyzed impact of agricultural landuse and cropping pattern on the livelihood from collecting data from field survey in the study area using structured questionnaire, methods of Data Collection: A comprehensive questionnaire was prepared and used for the primary data collection, observation method and indirect oral investigation methods were also be utilized for the study.

Result and Discussion

The villages of Garakot and Gohsari in Tehri Garhwal, Uttarakhand, have landuse and landcover (LULC) data that shows a thorough geographical distribution of land types throughout a 25.1 square kilometer region, Rangeland makes up the majority of the land, making up 15.08 square kilometers (60.07%), demonstrating its importance in the area, this implies that the local landuse pattern is significantly influenced by natural grasslands or livestock grazing, At 6.91 square kilometers (27.52%), agricultural land makes up the second-largest class, underscoring the significance of farming to the local economy, About 1.60 square kilometers (6.37%) of the total land is covered with vegetation, which includes forests and other natural greens (Table-1), This refers to either little forest cover or extensive landuse for farming or other uses. The degree of human utilization and development in these communities is reflected in the 1.51 square kilometers (6.01%) of built-up areas, which include settlements and infrastructure (Fig. 1).

Table-1: Landuse and Landcover in Tehri Garhwal District

Landuse/Landcover	Area in Sq. Km.	Percentage
Vegetation	1.60	6.37%
Agricultural Land	6.91	27.52%
Built Up Area	1.51	6.01%
Rangeland	15.08	60.07%
Total	25.1	100%

Source: Authors

Landuse landcover in four different categories: rangeland, built-up area, agricultural land, and vegetation. It's critical to consider how these classifications fit with local requirements, terrain, and socioeconomic circumstances in order to manage the utilization of land in Garakot and Gohsari effectively, Vegetation occupies a modest proportion, A substantial portion of land is used for agriculture, which reflects the rural nature and reliance on farming, The area can improve livelihoods and food security by utilizing its agricultural basis, A minor portion of the total is made up of built-up regions, suggesting little urbanization or infrastructure development, There is opportunity for planned growth in sparsely populated areas to make room for homes, schools, health facilities, and small businesses, employ environmentally friendly construction techniques and encourage the usage of regional resources, because the area is prone to earthquakes and landslides, concentrate on developing infrastructure that is resilient to disasters, the majority of the terrain is rangeland, which is probably used for grazing or left as open, uncultivated land, rangelands serve as buffer zones for ecological conservation and can be used to raise cattle, Explore options to convert some rangeland into multi-use landscapes, integrating agroforestry or community farming.

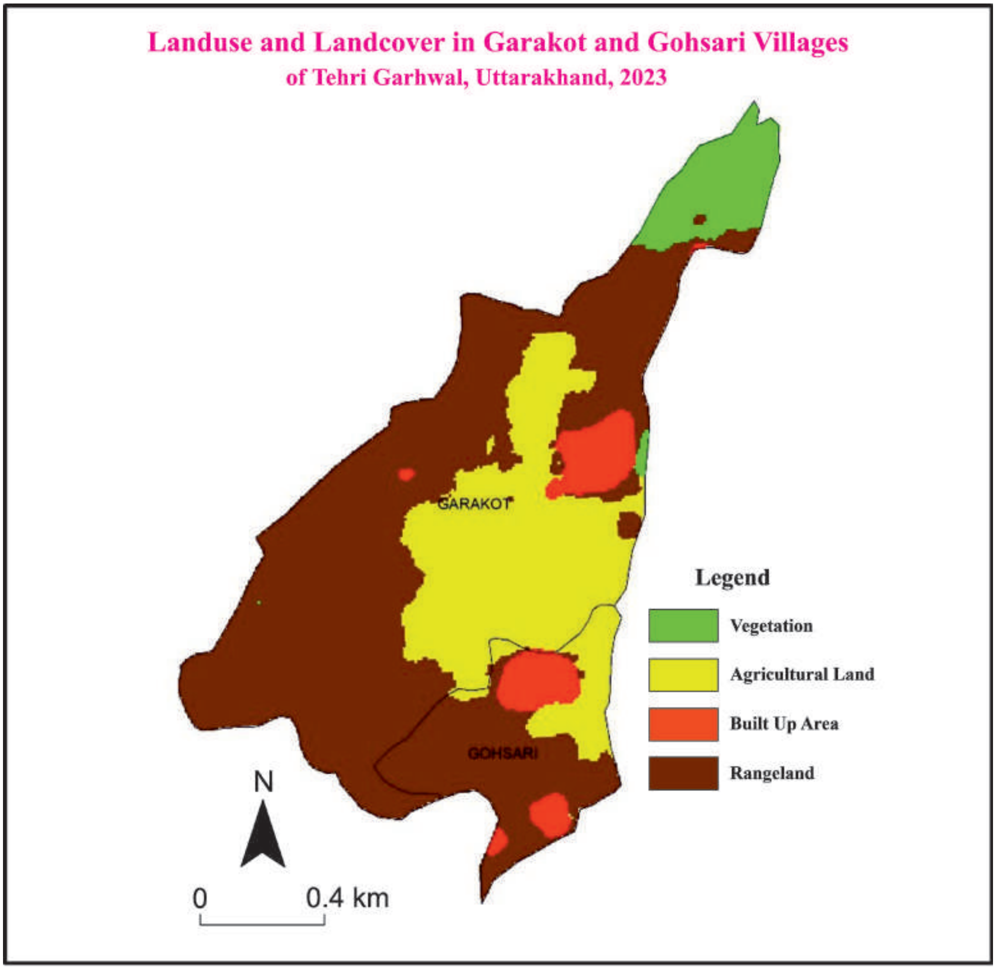
Landuse and Landcover in Garakot and Gohsari Villages
of Tehri Garhwal, Uttarakhand, 2023
GARAKOT
GOHSARI
Legend
Vegetation
Agricultural Land
Built Up Area
Rangeland
N
0
0.4 km

Fig. 1

Water Status and Landuse

A scenario referred to as "water stress" occurs when there is a brief scarcity of water. This may have an effect on human and natural systems. This sign of water resource strain can be caused by a number of factors (Zingaretti S.M.) Agriculture and water have a direct relationship (Gleick). Both Garakot and Gohsari villages have sloping landscape, limited resources, and dependence on conventional water sources like streams and natural springs (referred to as naulas or dharas in the area, Garakot experiences minimal water stress, suggesting comparatively simpler access of water for agricultural and household requirements (Table-2). This points to either constant rainfall, springs close by, or effective water management techniques, Gohsari faces moderate water stress, indicating greater difficulties obtaining water for everyday usage, either as a result of a longer commute to the water source or higher demand in comparison to availability.

Table-2: Status of Water

Name of Village	Water Stress	Distance from source of water	Average Land Holding Size (Hectare)
Garakot	Low Water stress	Less than 1 km	0.7
Gohsari	Medium Water Stress	Between 1 to 2 Km	0.9

Source: Authors

Garakot its main water source is less than a kilometer away, villagers can more easily develop small-scale irrigation systems or physically retrieve water because of this close proximity, Gohsari the village may have to spend extra time and effort obtaining water because it is located 1-2 kilometers from its water source, particularly in the lack of piped water systems. The distances to water sources are important since the mountainous terrain frequently makes even short treks arduous, and steep slopes make gathering water more difficult (Fig. 2). Garakot the typical landholding size is less than one hectare, at 0.7 hectares. This is typical in mountainous regions like Tehri Garhwal, where geography and inheritance patterns result in small and dispersed land parcels. Rain-fed agriculture or mixed crops are two options available to farmers, with an average landholding of 0.9 hectares, Gohsari may offer additional agricultural prospects, but it also raises the need for irrigation water, smaller landholding sizes are a result of the area's topography and scarcity of arable land.

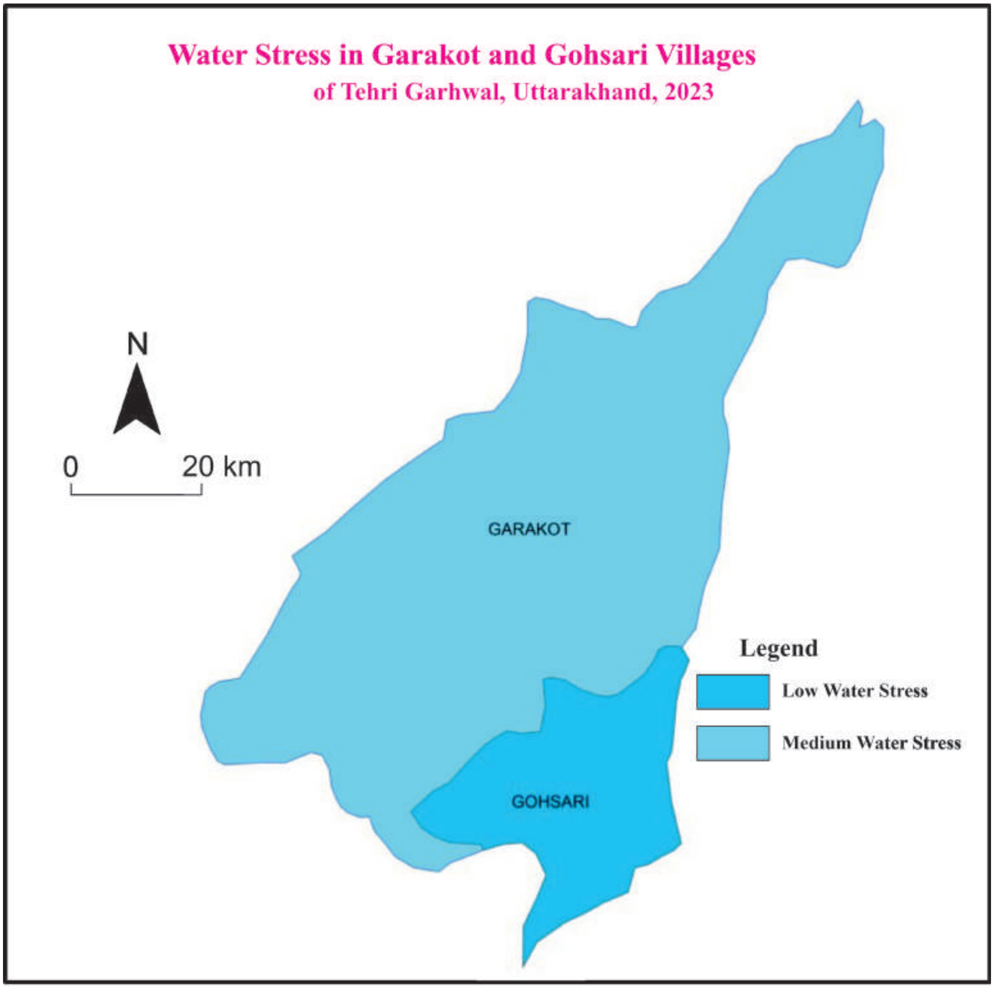
Water Stress in Garakot and Gohsari Villages
of Tehri Garhwal, Uttarakhand, 2023
N
0
20 km
GARAKOT
GOHSARI
Legend
Low Water Stress
Medium Water Stress

Fig. 2

Conclusion

Landuse landcover analysis of Garakot and Gohsari village of Tehri Garhwal district tells about dependence on agriculture for livelihood, Villages depends on water supplies for agriculture, nearer water sources in villages typically experience less water stress, but those farther away, experience moderate to high levels of stress, effective water utilization for agriculture is necessary due to the tiny landholding sizes, especially in villages with mild water stress, The impact of water source distance is further magnified by difficult terrain. making even slight variations in kilometres noteworthy in terms of the infrastructure and effort needed to obtain water, developing water pipeline distribution networks will reduce the strain of transporting water over great distances, government needs to pursue proper water conservative policies and sustainable livelihood practice adopted by people for future landuse and landcover management, promote organic farming and crop diversity to increase sustainability and production.

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The Deccan Geographer
Vol. 62, No. 10 December, 2024, pp. 119-127
(ISSN-0011-7269)
UGC Care Listed Geography Journal

UTTARAKHAND DISASTERS AND CLIMATE CHANGE: RISKS, CONSEQUENCES AND MITIGATION

Vaseem Ahmad, Poonam Shah Gangola and Puran C. Joshi

Abstract

This paper examines the increasing frequency and intensity of Climate change related natural disasters in Uttarakhand, a Himalayan state in northern India, attributed to climate change and human intervention. Known for its religious significance and natural beauty, Uttarakhand is highly vulnerable to disasters such as landslides, floods, glacial melting, cloudbursts, and forest fires. These events have caused significant loss of life, property, and environmental degradation, adversely affecting the region's resources and economy. Using a combination of primary and secondary data, this study analyzes the causes and consequences of these disasters, with a particular focus on changes in atmospheric conditions, rainfall patterns, and temperature. The findings underscore the urgent need for sustainable development, effective disaster management strategies, and climate adaptation measures to mitigate risks. Concrete recommendations are provided to address the challenges posed by climate change, ensuring a safer and more resilient future for Uttarakhand.

Introduction

Over the last century, human activities have accelerated climate change, resulting in an alarming increase in natural disasters worldwide. Urbanization, industrialization, deforestation, and unsustainable practices have significantly contributed to this crisis, with mountain regions like Uttarakhand being particularly vulnerable. Himalaya is experiencing rapid and sweeping changes in the pattern of rainfall which is increasing the frequency and severity of extreme weather events (Tiwari and Joshi, 2015). According to the IPCC (2014), the global temperature has already risen by approximately 0.85°C, intensifying extreme weather events and ecological disruptions. Ashok k. Sharma and others in their study (2014) said that Uttarakhand is a part of Himalaya, which is the world's youngest folded mountain ranges, most of it is formed of uplifted sedimentary and metamorphic rocks and region is tectonically is alive, and extremely vulnerable to natural disaster.

As per global climate risk index (CRI) 2020, India is among the 10 most affected countries in 2018, and National Institute of Disaster Management (NIDM), declared that Uttarakhand is one of the most disaster prone states in the country due to its geo-climate , ecology and socio- economic conditions. NIDM in its report on Uttarakhand flood incident 2013 has attributed both human interventions as well as climatic change for the flood disaster. Uttarakhand, located in the foothills of the Himalayas, is geologically fragile and ecologically sensitive. It's unique topographical features make it prone to a range of natural disasters, including landslides, floods, cloud burst and forest fires. Additionally, climate change has led to the melting of glaciers, altered rainfall patterns, and increased temperatures, further exacerbating the state's vulnerability. However, the dual impact of climate change and human interference is jeopardizing these assets. Disasters not only cause extensive loss of life and property but also disrupt livelihoods and hinder development. This paper is focusing on the causes, consequences, and solutions to mitigate the challenges posed by natural disasters. By analyzing data from various sources, this study emphasizes the importance of sustainable practices and effective management strategies to ensure the safety and stability of the region.

Study Region

Uttarakhand, a prominent northern state of India, lies in the Himalayan range and shares international borders with China and Nepal. Formed on November 9, 2000, it is geographically located between latitudes 28°43' N and 31°27' N and longitudes 77°34' E and 81°01' E. Spanning an area of 53,483 square kilometers, Uttarakhand is the 18th largest state in India, with a population of approximately 10 million as per the 2011 census. Renowned as Devbhoomi or the "Land of Gods," Uttarakhand holds immense cultural and spiritual significance. It is a hub for tourism and rich in natural resources such as forests and water. The state's diverse topography includes subtropical lowlands and alpine highlands. Nearly 86% of Uttarakhand's land area is mountainous, encompassing districts such as Uttarkashi, Chamoli, and Rudraprayag. The remaining 14% comprises plains and semi-plains, primarily in districts like Dehradun and Haridwar. Uttarakhand's population density is 189 persons per square kilometer. Key geological features, such as the Main Central Thrust (MCT) and Main Boundary Thrust (MBT), run through the state, making it tectonically unstable and prone to seismic activities. The region is also the origin of two major rivers, the Ganga and Yamuna, which are vital for India's water resources. Additionally, the state is known for its extensive forest cover, comprising 53.48 lakh hectares, and its rich biodiversity.

Uttarakhand is also a significant spiritual destination, housing the revered Char Dham— Gangotri, Yamunotri, Kedarnath, and Badrinath. These features contribute to the state's religious, cultural, and ecological importance. However, its fragile environment and proximity to tectonic fault lines make it highly susceptible to climate-induced disasters.

Objectives

Present paper tarces out the scenario of climate change related disasters in Uttarakhand. Paper also dissuces the climate change and its impacts and provides recommendations for the problems.

Database and Methodology

This study adopts a mixed-method approach, utilizing both primary and secondary data to examine the impacts of climate change and related disasters in Uttarakhand. Data was collected through field surveys and interviews with affected communities in disaster-prone areas. Supplementary information was obtained from government reports, academic research papers, and official statistics from institutions such as the meteorological sation of Indian Meteorological Department (IMD) and the Forest Department of Uttarakhand. Quantitative data on rainfall, temperature changes, and disaster incidents were analyzed to identify trends and correlations. The study also draws on qualitative data to understand the socio-economic impacts of these events.

Results and Discussion

Impact of Climate Change

Uttarakhand's Himalayan geography makes it highly susceptible to the adverse effects of climate change. In recent years, there has been a noticeable increase in extreme weather events, leading to significant environmental, economic, and social challenges.

- **(a) Atmospheric Changes:** The accelerated melting of glaciers in Uttarakhand has been a major concern. According to the Center for Ecology and Development (CED, 2019), nearly 1% of the state's glaciers are melting annually. This trend poses a significant risk of glacial outburst floods, altering river water levels and increasing the likelihood of floods downstream.
- **(b) Changes in Rainfall Patterns:** Data from the Indian Meteorological Department (IMD) highlights a 10% decrease in average annual rainfall between 1901 and 2013. However, high-intensity rainfall events have

increased significantly, often causing flash floods and landslides (Table-1). Such erratic rainfall patterns are a clear manifestation of climate change.

Table-1: Rainfall Variability and High-Intensity Events

S. No.	Year	Total Annual Rainfall (mm)	High-Intensity Rainfall Days
1	2001	2400	04
2	2002	2125	04
3	2003	2010	03
4	2004	2200	07
5	2005	1915	09
6	2006	1870	11
7	2007	1700	14
8	2008	2970	15
9	2009	1635	14
10	2010	3570	17
11	2011	1610	21
12	2012	1605	25
13	2013	1155	07

Source: Tiwari and Joshi, 2015

(c) Rise in Temperature: According to the Intergovernmental Panel on Climate Change (IPCC), the average temperature in Uttarakhand rose by 1.2°C between 1901 and 2018. This increase has accelerated glacier melt and prolonged summer seasons, further destabilizing the region's ecological balance.

Disasters and Their Impacts

Uttarakhand faces a range of natural disasters, exacerbated by both natural and human-induced factors.

(a) Landslides: Landslides are among the most frequent and devastating disasters in the region. Between 2010 and 2020, over 1,100 landslides were reported, causing the deaths of more than 300 people (NDMA). The causes include deforestation, unregulated construction, and road development, which destabilize the region's fragile slopes (Table-2).

Table-2: Prominent Landslide Events in Uttarakhand

Date/Year	Location and Major Impact
20 July 1970	Velakuchi landslide damaged Alaknanda River; 55 people and 142 livestock killed, 101 villages affected.
1977–1979	Pak Khela landslide in Dharachula, Pithoragarh devastated Tabaghat.
1978	Landslide at Bhagirathi River destroyed 2 motor bridges, 3 pedestrian bridges, and 5 km of road.
1979	Kaul (Ukhimath) landslide claimed 39 lives.
1983	Kurmi village, Bageshwar destroyed by a landslide.
1986	Jakhuli, Tehri Garhwal landslide resulted in 32 deaths.
19 September 1988	Landslide in Kaliasaur, Alaknanda Valley caused significant damage.
1991	Landslides around Gopeshwar, Chamoli affected 6 villages and 36 people.
July 1998	Landslide in the southern hills of Nainital caused destruction.
11–12 August 1998	Landslide near the Madhmaheshwar River, Ukhimath caused 101 deaths, impacted 29 villages, damaged 820 houses, and killed 422 livestock.
18 August 1998	Malpa landslide killed 207 people, including 60 Kailash Mansarovar pilgrims.
28–29 March 1999	Earthquake-induced landslides in Chamoli district caused extensive destruction.
20 October 1999	Earthquake-triggered 47 new landslides and worsened 6 old ones in Uttarkashi, causing significant fatalities and property loss.
August 2003	Landslide in Uttarkashi affected critical infrastructure.
3 August 2003	Landslide linked to Tehri Dam Project claimed 9 lives.
8 August 2009	Landslide in Lachhanchana village, Pithoragarh, killed 38 people.

Source: Rautela & Pande

The table demonstrates that landslides have been recurring catastrophes in Uttarakhand, with significant loss of life, property, and infrastructure. The Malpa landslide of 1998 alone caused 350 deaths, highlighting the devastating consequences of such events. These disasters disrupt local livelihoods, transportation, and ecosystems, further emphasizing the region's vulnerability.

(b) Floods: Flooding is another severe issue, often triggered by intense rainfall and glacial bursts. The Kedarnath flood disaster of 2013, caused by a combination of glacial avalanches and cloudbursts, claimed over 4,000 lives and devastated villages and infrastructure. The estimated loss was INR 13,000 crore, with Rudraprayag district suffering the most damage.

Analysis of Damage and Loss

Assessment of Damages from Landslides and Floods: Landslides and floods in Uttarakhand have caused significant losses to life, property, and infrastructure. A 2022–2023 survey revealed the following:

(1) 20 incidents damaged agricultural fields, leading to an estimated loss of INR 10 lakh.
(2) Five fully damaged houses incurred losses amounting to INR 1 crore.
(3) Livestock losses totaled INR 80,000, and furniture losses were valued at INR 1 crore.
(4) Hotels and schools also suffered damage, with combined losses exceeding INR 2 crore. These figures highlight the economic strain disasters impose on local communities, requiring urgent interventions to mitigate risks and enhance resilience.

(a) Forest Fires: Forest fire has become a major disaster in the study area in recent past. Some years ago, forest fire incidents were less as compare to present. In 2002, there were 1,401 such incidents. In 2016, the figure went up to 12,958, and then fell to 2,158 in 2019. As of June 2022, there have been 2,131 forest fires, affecting more than 3,348 hectares and causing a loss of Rs87.31 lakh. Uttarakhand has a forest cover of 53.48 lakh hectares12. (The Week Magazine) according to forest fire department of uttarakhand Between 2005 and 2017, the district Almora recorded total 1161 forest fire incidents,

Forest fires have become increasingly common due to rising temperatures and dry conditions, namely, In 2002, there were 1,401 incidents, escalating to 12,958 in 2016 By June 2022, 2,131 incidents had occurred, burning over 3,348 hectares of forest and causing losses amounting to INR 87.31 lakh. The spread of chir pine forests, which are highly flammable due to resin-rich leaf litter, has worsened the situation. These fires threaten biodiversity, disrupt ecosystems, and cause air quality deterioration. In the Himalayan state of uttarakhand, incidents of forest fire are a serious threat to human population, ecosystem, biodiversity and water sources, for which man-made causes are particularly responsible and global warming, and increasing pine forest cover have increased the chances of forest fire. In the year 2023, till August, 761 incidents of forest fire occurred, resulting in extensive damage to 914.4 hectares of forest, life and property (Ahmad and Gangola, 2023).

(a) Glacier Bursts: The Chamoli glacier burst of February 2021 highlighted the devastating potential of climate change in Uttarakhand. Over 200 lives were lost in the sudden flood, which also caused extensive damage to infrastructure. Such events are likely to increase as glacier melt accelerates.

(b) Impact on Wildlife: Rising temperatures and increased forest fires have led to habitat loss for many species. Reports from the Forest Department indicate over 1,500 forest fires in 2020, which burned 3,500 hectares of forest. The loss of biodiversity has far-reaching consequences for the region's ecological stability.

Recommendations

(1) Comprehensive Risk Assessment: Initiate in-depth scientific assessments using advanced geospatial and remote sensing technologies to identify disaster-prone zones, ensuring precise risk management strategies.

(2) Sustainable Infrastructure Development: Focus on constructing eco-friendly, disaster-resilient infrastructure in vulnerable regions, adhering to strict environmental guidelines to minimize risks.

(3) Enhanced Forest and Ecosystem Management: Implement large-scale afforestation programs in degraded areas and promote community-led forest conservation initiatives to mitigate soil erosion and stabilize ecosystems. Develop robust systems for preventing and managing forest fires, especially in chir pine-dominated areas.

(4) Adaptation in Agriculture: Introduce climate-resilient agricultural techniques and sustainable practices, empowering farmers to reduce environmental impacts and enhance productivity.

(5) Early Warning and Disaster Preparedness: Strengthen and expand early warning systems for disasters like cloudbursts, floods, and landslides. Conduct regular community awareness and capacity-building programs to improve disaster preparedness and response mechanisms.

(6) Integrated Urban and Rural Development: Implement regulated urbanization policies, prioritizing planned construction in hill areas to balance development with ecological preservation. Promote rural development initiatives to reduce over-dependence on fragile urban ecosystems.

(7) Policy Enhancement and Governance: Formulate and enforce comprehensive policies focusing on disaster management, climate adaptation, and sustainable development with participatory governance frameworks.

(8) Monitoring Climate Change Impacts: Establish dedicated research facilities for real-time monitoring of glaciers, water resources, and climate patterns, enabling timely mitigation measures.

(9) Community Empowerment: Actively involve local communities in disaster risk reduction planning and policy implementation to ensure practical, ground-level solutions.

Conclusion

It is concluded that disaster caused by climate change in the Himalayan region poses a serious threat to the security, stability, natural resources, livelihood and socio- economic development of Uttarakhand. The dynamic and fragile ecosystems of hilly regions demand a fine balance between development and environmental conservation. While the challenges posed by natural disasters, climate change, and human-induced pressures are significant, a multi-pronged approach involving scientific assessments, sustainable planning, and community participation can address these issues effectively. Strengthening institutional frameworks, fostering local resilience, and adopting eco-friendly practices will ensure the long-term safety and sustainability of these regions. Together, collaborative efforts between stakeholders can pave the way for a resilient and harmonious coexistence with nature.

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The Deccan Geographer
Vol. 62, No. 10 December, 2024, pp. 128-136
(ISSN-0011-7269)
UGC Care Listed Geography Journal

COMPARATIVE STUDY OF MIGRATION IN DEVELOPMENT BLOCKS OF CHAMOLI DISTRICT UTTARAKHAND

Aadarsh Pant and Dr. B.P. Naithani

Abstract

Migration is the movement of individuals across national and regional borders. This movement, whether involuntary or voluntarily undertaken, might be motivated by financial, political, social, or environmental considerations. Migration can take various forms, such as either temporary or permanent, domestic or international, forced or voluntary, and commercial or refugee migration. This study article examines migration in Uttarakhand's Chamoli district, including its origins and implications. This research article aims to examine the current state of migration in the Chamoli district, identify its causes and implications, and propose solutions to reduce it. The research paper is entirely based on secondary data. The secondary information was collected from the Uttarakhand Government's Rural Development and Migration Commission report 2022-23 and the District Census Handbook 2011. Data collecting was followed by analysis using graphical representations. Data was analysed using Microsoft Excel for analysis and mapped using QGIS (Lima 3.32) software.

Introduction

Migration is an interconnected and constantly evolving phenomenon that has influenced the human race throughout history. People move across borders for several reasons, including financial possibilities, instability in politics, changes in the environment, and social goals, and has far-reaching implications for people, neighborhoods, and nations. As mankind becomes more interconnected, the analysis of migration has grown in significance, spanning an extensive variety of disciplines and strategies. The most obvious component of population change is migration, with the other two being the rates of fertility and mortality. Migration is the most challenging aspect of population change. It is essential for understanding the continuously shifting space content and space relationship of an area as individuals move as an instrument of cultural propagation and social integration, which leads to a more meaningful population distribution. Movement, in addition to birth and death, is one underlying the three most important factors of demographic shift in any country. Demographic change is triggered by the fundamental characteristics of relocation. Population fertility and death rates are determined by a variety of social, economic, political, and cultural parameters, and these components have been shown to operate essentially within the biological framework.

Study Region

District Chamoli was established in 1960. Chamoli is located in Central Himalayas, Chamoli district is bounded bhai Uttarkashi in the north west, Pithoragarh in the North East Almora in the south and Rudraprayag district in the west. The geographical area of the district is approximately 7520 square kilometres. Latitudinal extension of district Chamoli is between 290 55’ north latitude to 310 03’ 45” North latitude and 790 2’ 39” East longitude to 800 55’ 29” East longitude. This area total 9 development block in Chamoli district. The altitude of Chamoli district ranges from 800m to 80000 metres above sea level. Winter season is from November to March. Maximum rainfall oaccurs here from June to September. Till now the highest temperate in the district was 34 degree and minimum was 0 degree Celsius. The main river Alaknanda and its tributaries Mandakini and pinder flow in Chamoli district. The total population of this district is 391605 and decadel growth rate is 5.74%.

Objectives

(1) To study the current situation of migration in the study area.
(2) To Study the causes and consequences of migration and suggest appropriate measure to reduce migration.

Database and Methodology

In the last few years, migration of beople from villages to cities has emerged as a main problem of Uttarakhand. paper, the causes in Therefore, chamoli district in thich research Thande effects of migration in chamoli district have been studied in depth, so that to this problem an appropriate salution can be found. This research pp is based on secondary data. This data has been obtained from the Rural Development and migration prevention Commission of the Government of Uttarakhand (February 2023). The data was analyzed using Microsoft excel, data OGIS 3.32.

Results and Discussion

Migration in Chamoli District Present Status of Migration

In Uttarakhand according to the rural development and migration report (Uttarakhand 20-20) 502707 people migrated in Uttarakhand in the last 10 years. 3837263 full migrated temporarily and 118981 people migrated permanently. A total of 46309 people migrated in Chamoli district in the last 10 years in which three two zero two zero people from 556 panchayats migrated temporarily and 14289 people from 373 panchayats migrated permanently. Ine Chamoli district maximum 8649 people have migrated from gairsan block and minimum 2772 people have migrated from the deval. A part from this 4649 people have migrated from the dasoli block. 4857 from Ghat block 3205 from joshimath 5323 from karanprayag 5093 from narayangarh 5327 from pokhari and 6434 from tharali. Block wise maximum 5837 people have temporarily migrated from gairsan and block and minimum 1869 people from the deval block. Along with these 3871 people from the dasoli 399 from Ghat 2756 from joshimath 3207 from karanprayag 3559 from narayangarh 3296 from pokhari and 3626 from tharali block have temporally migrated.

Favorite Destinations of Migrants

Uttrakhand most of people migrate from one district to another district 35.69% migrants migrated from one district to another 28.72% people migrate to other state 90.46% to the recent towns 15.18% to the district headquarters and 0.96% out of the country. In the Chamoli district 50.48% people migrate from one district to another 15.88 percent people migrate to other state 19.79% people my grands town 13.35 percent to the district headquarters and 0.51% out of the country in the Chamoli district maximum migration towards nearby town is 53.98% in joshimath block and maximum 10.21% in tharali block. Maximum migration towards district headquarters is 31.46 in the Dasoli block and minimum 3.03% in tharali. The maximum migration from one district to another is 74.15% in tharali block and minimum 20.24% in ghat block. Maximum migration from district to out of states is 23.33% in gairsan block and minimum 6.41% in joshimath block. Maximum migration from district to out of the country is 2.45% in the wall block and minimum. In Uttrakhand maximum population that migrated in the last 10 years has been done by youth East 26 to 35 years which is 42.25% of the total migration. The migration percentage of people above 35 years of age is 29.09% and 28.66% of people below 25 years of age. In the last 10 years the maximum migration in Chamoli district has been done by youth is 26 to 35 years which is 43.49% of the total population migration 29.79% people are above 35 years of age and 26.71% people are below 25 years of age (Fig. 1).

Table-1: Age wise Migration in Chamoli District

Name Block	Age Group Below 25 Years	26 to 35 Age group	Age group Above 35 tears	Total
Dasoli	28.25	45.12	26.63	100
Deval	36.31	40.87	22.82	100
Gairsan	24.66	46.64	28.70	100
Ghat	36.35	32.47	31.18	100
Joshimath	34.84	42.70	22.46	100
Karnpryag	21.52	50.11	28.38	100
Narayanbagad	27.64	40.36	32.00	100
Pokhri	14.82	35.31	49.87	100
Tharali	23.00	55.37	31.63	100
Total Chamoli District	26.71	43.49	29.79	100
Uttarakhand	28.66	42.25	29.09	100

Source: Prevention Commission Report, Pauri Garhwal, 2023.

In the age group of 25 years maximum 36.35 percent people have migrated from Ghat block and maximum 14.82% people have migrated from pokhari block. In the age group of 26 to 35 years maximum 55.37% people have migrated from tharali block and maximum 32.47% people have migrated from Ghat block in the age group above 35 years maximum of 49.87% people have migrated from pokhari block and maximum 21.63% people have migrated from tharali block.

Reduction in Rural Population

Ine Uttrakhand off 2011 the population of 565 villages has reduced by 50%, similarly there are 18 villages in Chamoli district from where 50% people have migrated, block wise maximum 8 blazers are in pokhari block from where 50% population has migrated. There are 1 village in Dasoli, 1 village in the deval two village in joshimath, 2 village in karanprayag and 4 village in tharali from where 50% people have migrated. The main reason of migration is lack of employment and infrastructural facilities.

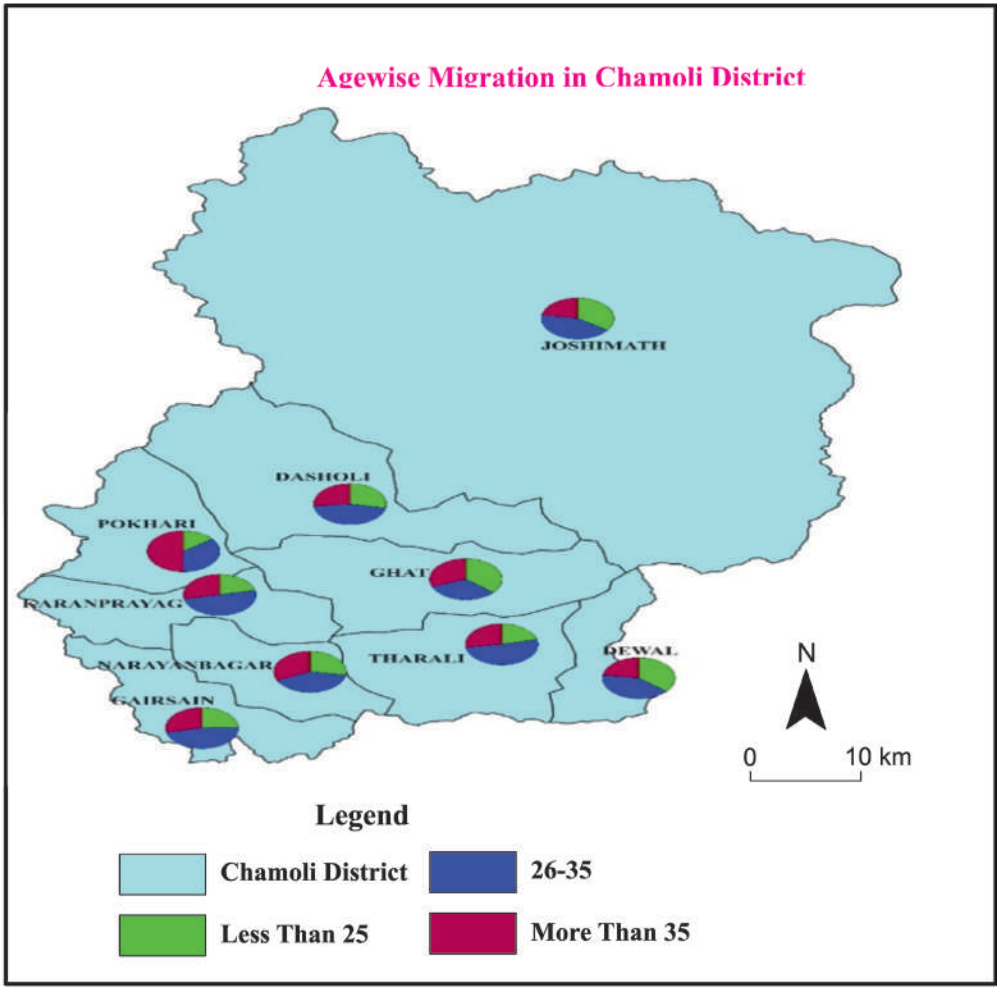
Agewise Migration in Chamoli District
JOSHIMATH
DASHOLI
POKHARI
GHAT
KARANPRAYAG
THARALI
DEWAL
NARAYANBAGAR
GAIRSAIN
N
0
10 km
Legend
Chamoli District
26-35
Less Than 25
More Than 35

Fig. 1

Reasons of Migration in Chamoli District

In Uttrakhand 50.16 % migration due to lack of employment, 15.21% due to lack of education facilities, 3.74% lack of infrastructure, 8.83% lack of medical facilities, 5.4% low agriculture productivity, 2.52% people influenced by family members and relatives, 5.61% due to damage of agriculture by wild animals and 8.48% people have migrated due to other reasons, the highest migration in Chamoli district is due to lack of employment at 49.30% apart from this, 10.83% due to lack of medical facilities 19.73% due to lack of education facilities 4.93% due to lack of infrastructure, 4.7 3% due to low agriculture productivity 2.51% due to influenced by family members and relatives, 3.09% due to destruction of agriculture by wildlife animals and 4.87% people have migrated due to other reason.

Unemployment and Lack of Medical Facilities

Most of the migration in Chamoli district is due to lack of employment which is 49.30% of the total migration. Block wise due to Lack of employment in Chamoli district the maximum migration is 70.62% in tharali block and the minimum is 36.13% in joshimath block. 66.03% people from the dasoli, 37.1 0% from diwal 47.41% people from gairsan and 38.38% from Ghat 55.41% karanprayag 37.05% narayanabhagarh and 53.92% from pokhari have migrated to other areas in search of employment. Due to lack of health facilities 10.83% of the total migrants have migrated from Chamoli district. The maximum migration is 19.04% in gairsan block and the minimum is 2.41% in tharali block. A part from these, 7.05% people from the dasoli 15.36% people from diwal, 10.12 people from Ghat, 14.67% people from joshimath, 7.56% people from Karan Prayag 10.49% people from narayangarh and 12.45% people pokiri have migrated other place in search of better medical facilities.

Damage of Agriculture Crops by Wild Animals

3.09% people migrated from chamodi district to other areas due to damage of Agriculture crops bya wild animals. Block wise, maximum migration has been done from karnprayag block at 5.62%, and minimum from Pokhri, block at 0.92%. Apart from these, 3.49%% From Rasali, 4.69% Deval, 1.87% from Gairsan, 1.59% from Ghat, 2.96% from Joushimath, 2.04% From Narayanbagad and 2.53% from Tharali block have migrated due to the damage. Of their agriculture bya wild animals. (Table-2). 4.87% people have migrated from chamodi district to other areas due to natural disaster, marriage etc. Que to these reasons maximum migration in chamoli district has happened from Ghat block 16.12% and minimum from Gairisan block 0.52%. Apart from these, 4.15% from Desli block, 4.05% from Reval, 4.75 % from Joushimath, 2.59% from Karnprayag, 6.58% from Narayanbagad, From Pokhri and 2.59 %% from Therali migrated to other areas 3.12% have due to marriage and Natural disaster.

Low Agriculture Productivity and Influenced by Family Members and Relatives

Due to low agriculture productivity, 4.73% of the total migrants have migrated from Chamoli district. Block wise due to low agriculture productivity in Chamoli district maximum migration has been done from karanprayag block at 8.57% and maximum from joshimath, block at 2.31% apart from these, 2.72% from Dasoli, 5.9% from deval 2.67% from gairsan, 5.08% from Ghat 2.96% from karanprayag 6.71% from pokhari and 3.34% from tharali have migrated to other areas due to low agriculture productivity. 2.51% pipal migrated from Chamoli district to other reason under the influence off Diya relatives and family members. Block wise due to the influence of their relatives and family members in Chamoli district maximum migration has been done from pokhari block at 5.24% and minimum from the Dasoli, block 80.77%. Apart from this 2.67% from diwal 1.28% from gairsan, 3.30% from Ghat 2.1% from joshimath 3.78% from Karnal Prayag 1.64% from narayanbagh and 0.97% from tharali block have migrated to other area the influence from their relatives and family members.

Positive Impact of Migration

Migration is dorce bhai a person so that he can fulfill has needs. When a person migrates from Chamoli district that person provides money to his family, due to which the economic condition of that family improves and their standard of living improves. Chamoli district has limited amount of water land and natural resources, external migration reduce the pressure on these resources. When person goes to a foreign area, he learns new skill and accuracy new knowledge and when he returns home he use those skill in his home area.

Negative Impacts of Migration

The population of 18 villages in Chamoli district has been reduced bya 50% due to population relocation. Villages are getting increasingly a desolate. And because metropolitan areas are receiving more people, there is a high population pressure on these locations. It increases economic opportunities and the availability a of basic necessities. The demographic imbalance may a be evident here due to the transfer of young people to cities. The elderly a population is higher in this region, and the workforce will continue to decline, but the dependency a rate will rise. Economic operations will be disrupted as a result of migration. When people relocate, they a bring along their assets, knowledge, and skill. The primary a motivation for individuals moving to cities is economic opportunities. Agriculture, education, and health all play a important roles in moving individuals to another place. Social relations are also distress, and relationships based on trust are dwindling. Because of the large-scale movement of the Chamoli district's educated population, the skill of the person will travel to different regions, abandoning rural areas with few or no trained individuals. Agriculture sectors have also suffered greatly, and as a result, fertile and cultivable areas are converting to barren and unproductive lands.

Suggestions to Reduce the Problem of Migration

To provide quality education health facilities. To encourage and better and support the development of small-scale enterprises, which will create more employment opportunities and encourage people. Chamali district is known for agriculture, tourism, adventure sports, these sectors be further strengthened, technological innovation should be promoted in these seators should and better marketing relations be created that people get Employment at home and migration is reduced. There is immense potential for tourism in the district, the district is known for its natural beauty, culture, and adventure sports activities, promoting tourism can generate employment.

Conclusion

In this study various reasons have been identify which are forcing people to migrated from Chamoli district, the main reason of which lack like of employment. Lack of health facility educational facilities natural disasters reduction in agriculture activities etc. The study also revealed that the man factors that motivated people to migrate to another place are employment, health and education facilities. A total of 46309 people migrated in Chamoli district in the last 10 years. In which three two zero two zero people from 556% migrated temporarily and 14289 people from 373 panchayats migrated permanently. The highest migration in the Chamoli district is due to lack of employments at 49.30% aparts from his 19.73% due to the lack of education, 10.83% due to lack of health facilities 4.73% due to low agriculture productivity 3.09% due to destruction of agriculture by animals 49.3% due to lack of infrastructure facilities and 2.51% people have migrated due to influence of family members and 4.8% people have migrated other reason in the last 10 years.

Maximum migration in the district has been done by people of aged between 26 to 35 years which is 43.49%.

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The Deccan Geographer
Vol. 62, No. 10 December, 2024, pp. 137-153
(ISSN-0011-7269)
UGC Care Listed Geography Journal

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PROTECTING THE POOR: STRATEGIES FOR SOCIOECONOMIC DEVELOPMENT OF MONABARIE TEA ESTATE WORKERS OF BISWANATH, ASSAM

Shahid Jamal and Khusro Moin

Abstract

Monabarie tea estate is the largest not only in India but also in Asia. Tea plantations in the region are one of the first in the country, and nurture a unique type of tea saturated with intricate flowery aromas. However, the condition of tea garden workers is not good, despite rich and quality tea gardens. They faced several kinds of exploitation like low wages, long working hours, unhygienic working environments, no holidays, and human trafficking. The main objective of this study is to identify, and analyse strategies for socioeconomic development of Monabarie tea garden workers. After the discussion, it was concluded that approximately 70% of tea workers are women as their spry fingers, and soft hands are appropriate for tea plucking. The natural ecosystem of Monabarie tea gardens has been endangered over the years due to anthropogenic disturbances. Tea plantation still governs the lives of tea garden workers, but the role of state government is important.

Introduction

Tea is renowned as the sovereign drink for health and pleasure. India is the second largest producer of tea, and the largest black tea producer after China in the world. India is the fourth largest exporter of tea, and the largest consumer of black tea (18%) worldwide (Hannan, 2020). Approximately 10 million tons of tea were consumed in India in 2020, and this number is expected to increase in the future (McLeod Russel India Limited, 2022). Tea estates are one of the largest, and formal private sectors of India. The first geographical indications (GI) tag product in India was Darjeeling tea, which is also called as Champagne of teas (Jamal et al., 2024). Around 20% of people in Assam are engaged in tea gardens, and plantations either directly or indirectly (Dipshikha, 2018). It contributes significantly to the state's economic growth. A high percentage of tea garden workers are women because of their sincerity, discipline, and hard work (Ahmed et al., 2010). Several heavy metals like mercury, arsenic, cadmium, and lead are common in Biswanath district, Assam (Purkayastha and Kalita, 2016). The situation gets out of control during monsoons that start in June and continue until September (Dutta and Misra, 2010). The living standard of tea workers is extremely miserable and their lives suffer from the lack of several basic amenities (Hazarika and Jamal, 2020). Changes in the ownership of tea estate are problematic for tea garden workers because they need to migrate in search for their livelihood. The workers do not have any say to refuse any exploitation hence they continue working in the tea garden. The right to work and right to life with dignity has no place in the tea estate scenario (Barua, 2015). Is Biswanath tea industry is growing at a rapid pace, but no or very minor improvement has been seen in worker's standard of living over the past decades. The outbreak of COVID-19 made their lives more difficult as the production, and sale of tea declined drastically (Sen, 2020). During the lockdown, consumers focused solely on basic goods, while tea fell under the discrete category (Katakee, 2020). During lockdown, the government focused on work from home, but this was not possible for tea garden workers. They must go outside and pluck tea leaves to sustain their livelihood (Jamal et al., 2022). The government must interfere and make suitable provisions for the upliftment of Monabarie tea garden workers and prepare sustainable strategies for their socioeconomic development. The aroma of Monabarie tea should be improved so that the tea industry can become more profitable and sustainable.

Study Region

The geographical location of Biswanath district is highly favourable to the tea plantation, and the region is blessed with the largest tea estate of Asia. McLeod Russel India Limited owns Monabarie tea estate of Biswanath district, McLeod Russel India Limited is the largest tea growing company in the world. Monabarie tea estate is an eminent tea tourism destination in India, covering an area of 1,160 ha. The bumper production of reddish bright colour tea contributed to the popularity of Monabarie (The Sentinel, 2021). Kaliambhumora bridge is a lifeline for the district, which is the 2nd ever bridge constructed on Brahmaputra River (District Census Handbook-Sonitpur, 2011). This connects Biswanath with Nagaon district, and is a point of attraction in the district (District Profile, 2019). It covers a large alluvial tract between foothills of Eastern Himalayas and Brahmaputra

River (Census of India, 2011). The distance of Monabarie tea estate from the main town is 10-12 km. Biswanath district has a total assessed number of 10,767 small tea growers in total assessed tea area of 10914.84 ha. Government should take initiative to promote organic tea through promotion and brand marketing. Strengthen demand and supply networks to make tea producers self-sufficient (Tea Board of India, 2022).

Objective

This paper is an attempt to identify, and analyse strategies for socioeconomic development of Monabarie tea garden workers.

Database and Methodology

Both secondary and primary data were used for data collection. Personal observation is the best way to gather primary data, and purposive stratified random sampling technique was used. Further, a field survey was conducted in Monabarie tea estate, which has a high concentration of tea workers, whether permanent or contractual/non-permanent. A qualitative descriptive study was conducted in Biswanath Chariali of Assam for critical analyses. Permission was obtained from each respondent prior to their interviews. The names of all the participants have been changed and not been used anywhere in the study to maintain secrecy, integrity, and to protect the privacy of respondents. Participants were selected for the focused group discussion based on age, working conditions, family structure, and income. In another case, respondents were interviewed on the basis of religion, origin, educational qualification, type of household, savings account, and duration of residence. Secondary data were collected from different sources, this includes Tea Board of India, District Census Handbook, Statistical Handbook, District Profile-Government of Assam, Census of India, McLeod Russel India Limited Company, and others were used to achieve the desired outcome. Research findings, international reports, instrumental readings, newspapers, magazines, journals, research articles, blogs, and books were referred for critical analyses. Historical and analytical methods were used for further analysis. Quantum GIS software was used to prepare several maps, and statistical tools were applied to represent data through bar graphs, pie diagrams, and tables for the inclusive understanding of the study. Each unit is standardised as the difference from unit with minimum value divided by the difference between maximum value, and minimum value is described below.

Standardised

$$I^s = \frac{I - min*(I)}{max(I) - min*(I)}$$

Whereas:

S = Standardized value of I and satisfy 0<1S ≤1

I = Indicator of unit

max (*I*) = Maximum value of *I*

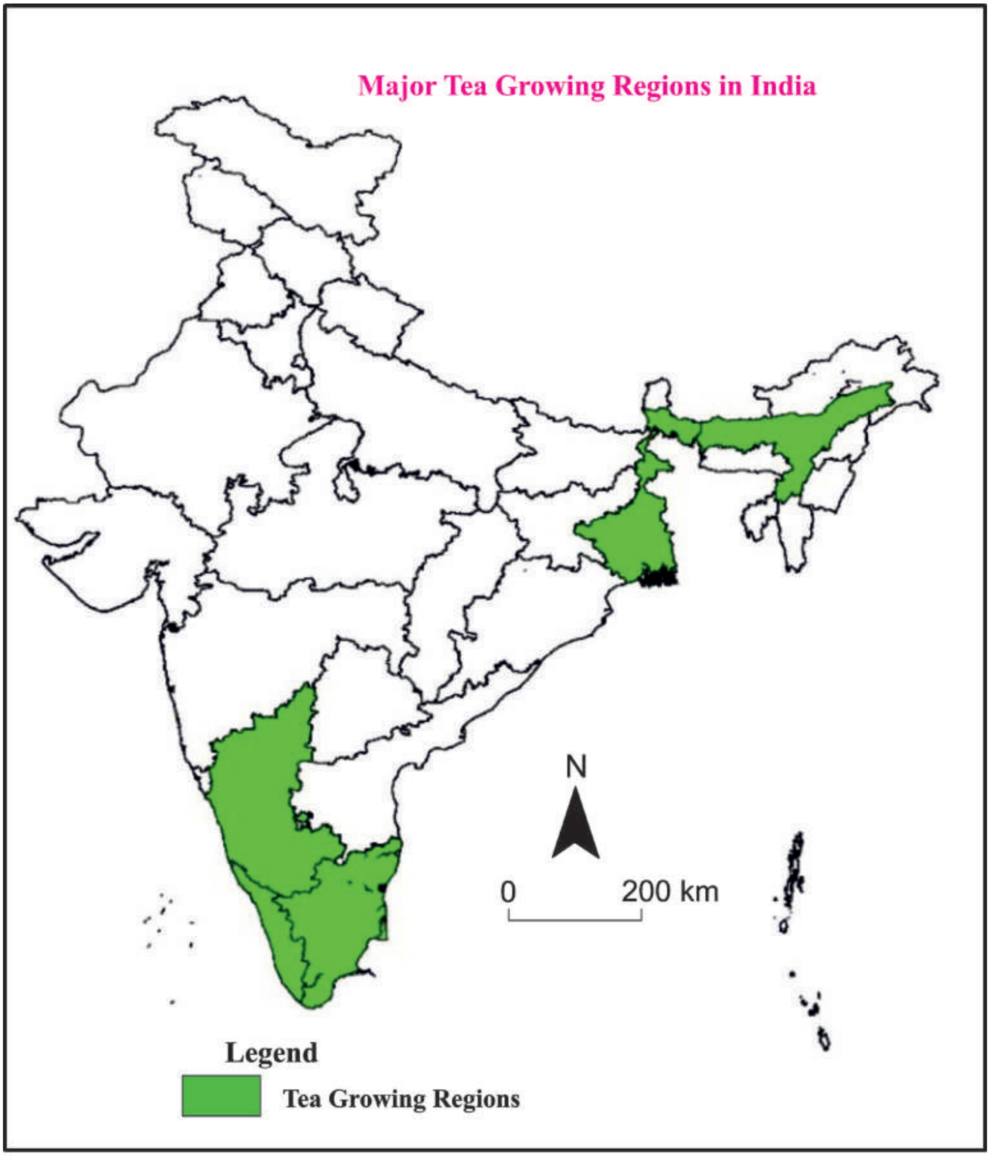
min (*I*) = minimum value of *I*

Result and Discussion

The Tea Board of India develops and promotes tea industry throughout India. The major tea growing regions in India include Northeast (Assam, Sikkim), South India (Nilgiris), and North Bengal (Doors and Darjeeling District) (Fig. 1). Monabarie tea is facing stiff competition from within the country, such as Darjeeling tea, and from outside the country, like tea from Kenya. The quality of Monabarie tea has been compromised over the years due to some malpractices and counterfeit tea which is represented as organic. These practices compromise the quality of Monabarie. There is a need of risk proof ecosystem that focuses on the need for sustainable strategies to tackle the socio-economic challenges of Monabarie tea workers.

Harvest Seasons

In Monabarie, the tea harvest season starts from March and continues until November. The first flush, second flush, rain Flush, and autumn flush are the four harvest seasons, while tea gardens are closed in winter from December to February for maintenance and pruning (Table-1). The first flush is a short season, that begins with a few showers in early March. The first flush tea is bolder, contains more plant parts, but lacks the required quality. The second flush is spring harvest that occurs before the arrival of the monsoon. The briskness, seasonal flowering, maltiness, fruity and syrupy flavours are the traits of the second flush. Dormancy permits bushes to offer better quality of tea leaves at harvest. Tea prepared during the second flush often has the best market price. Rain flush is the most productive and the longest as the tea bushes thrive under humidity and heat. The average quality of tea is extracted as water enters into shoots. Autumn flush starts with the retreat of rain and as the temperature dips to 10-15 °C, the harvest is short and ends in the last


Major Tea Growing Regions in India
N
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200 km
Legend
Tea Growing Regions

Fig. 1

week of November. After the end of autumn harvest, full dormancy sets in where the growth of tea shoots stagnates for the remaining winter.

Table-1: Physical Features of Monabarie Tea Gardens

Features	Description
Elevation	45-60 metre above the mean sea level
Annual rainfall	250-380 cm
Slope gradient	Northern
Soil	Fertile loamy
Humidity	High humidity >80% with snow, and fog
Sunshine	2-3 hours per day
Temperature	25-38 °C (summer), 10-15 °C (Winter)
Harvest Season	March to November
Maintenance and pruning	December to February
Economic life	40-45 years

Source: Tea Board of India, 2022

Challenges

Land available for tea cultivation in Monabarie is divided into three categories such as forest land, grazing land, and agricultural land. Tea growers clear forest and grazing land in several areas due to rising scarcity of agricultural land. Most of these lands belong to the government, and tea growers have nothing to claim as these lands are taken on lease from the government. At present, the condition of tea growers is pathetic because they depend on contractors for their livelihood. There is an urgent need to make more provisions as they have lost their livelihood, and rarely compensation is given that was promised for any loss. However, the government made several arrangements for them in the past, but these were not enough.

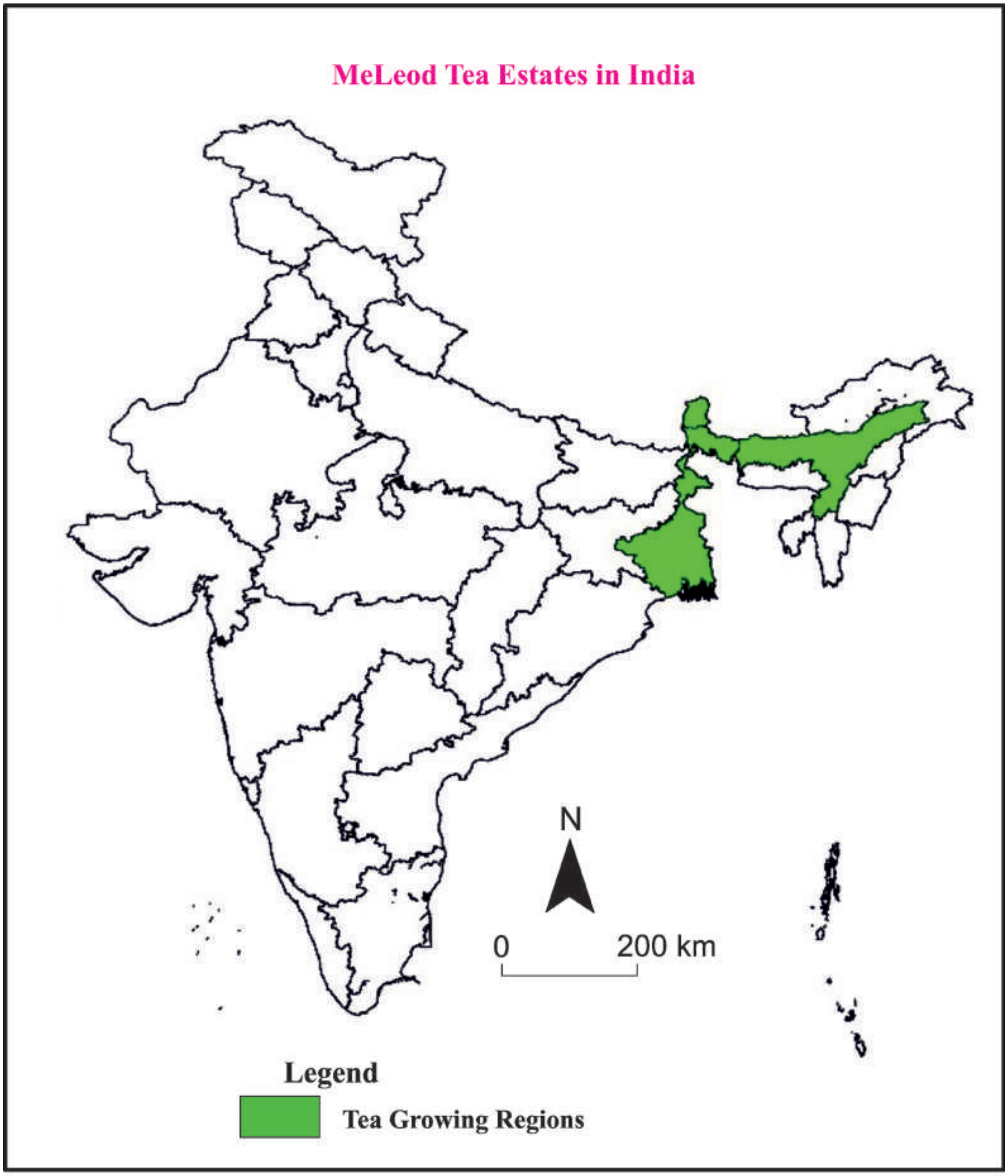
Human Trafficking

Women are key workers in the tea gardens because they constitute 70% of the total labour force. Most of them have migrated from Odisha, Jharkhand, and West Bengal, while some are locals. Odisha constitutes the largest proportion of migrated tea garden workers. Language and culture are the main barriers that they have encountered which result in less bargaining capacity for wages, and remuneration over the years. They have been working in the tea garden since their forefathers came to Assam during the British India for the economic development.

Women workers and their children are victims of several evils such as human trafficking for the sake of good employment opportunities in urban or metropolitan areas. Most of them are less educated, and easily trapped by human trafficking syndicates because they easily trust people and lured by minor financial help and a little emotional attachment. Traffickers target young girls because they are in high demand in domestic and global markets. These traffickers take advantage of innocent tea workers, play with their emotions and push them into the darkest phase of their lives, and from there, it would be impossible for them to return. They sell them to large traffickers at a high price. Trafficked workers and children live without safety and dignity. They are often beaten up by their owners and forced to live in inhuman conditions. They are unaware of the location where they are located; if they try to escape, they are given life-threatening warnings. These incidents depict the dark reality of one of the richest, and the oldest living civilizations, where they are treated as slaves of the modern world.

Change in Source of Livelihood

Monabarie tea workers have been doing tea plucking work for generations. Absence of good opportunities in tea estates has forced them to adopt other occupations as alternative sources of livelihood. There are two types of workers; non-permanent and permanent. In case of non-permanent, the number of participants with less than 2 years of work experience is more than any other category of workers. In case of permanent, the number of participants with 2-10 years of work experience is greater than in all categories. Permanent workers are provided housing facilities, whereas non-permanent workers are not. Non-permanent workers cannot afford costly houses and hence live far from tea gardens. Permanent workers are given several facilities like minimal pay, healthcare, ration, education, allowances, and holidays, while non-permanent workers are temporary workers and are not provided these facilities. Many households face shortfall in electricity and water supply. However, all permanent workers are not given housing facilities due to housing shortage. Monabarie tea estate workers are not given wages that are equivalent to their work, despite working in the tea garden for 16 hours a day, they are often underpaid and unpaid for months. They begin their work early at 4 am in the morning and finish around 9 pm. This duration keeps changing according to weather conditions. After working the whole day, their entire body parts are in pain. However, many of them are used to such harsh work, and they cannot sit idle because this is their main source of livelihood (Table-1 and Fig. 2). However, many of them have migrated to the surrounding cities to work in agricultural fields and construction, opened small businesses to sustain their livelihood. Young tea workers


MeLeod Tea Estates in India
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Tea Growing Regions

Fig. 2

have migrated to Gujarat and South India for better economic opportunities. This step has brought a significant transition and awareness among the youth that several new employment opportunities would be impossible if they remained in the tea gardens. This opens a new field for them, where they can explore something new, and innovative, interesting, and dignified employment for a better future.

Table-2: Socio-economic Profile

Features	Description	Number of Workers	Percentage of Workers	Standardisation
Religion	Christian	18	9%	0
	Hindu	182	91%	1
Origin	Odisha	162	81%	1
	Jharkhand	22	11%	0.041095
	West Bengal	16	8%	0
Educational Qualification	Illiterate	80	40%	1
	Primary	70	35%	0.837837
	High school	44	22%	0.513513
	Above high school	6	3%	0
Duration of Residence	By birth	150	75%	1
	20 years	24	12%	0.136986
	40 years	16	8%	0.082191
	60 years	6	3%	0.013698
	Above 60 years	4	2%	0
Type of Household	Pacca	76	38%	0
	Kuccha	124	62%	1
Monthly Income (₹)	Below 3000	108	54%	1
	3001-5000	72	36%	0.673267
	5001-7000	16	8%	0.118811
	Above 7000	4	2%	0
Saving Account	Yes	4	2%	0
	No	196	98%	1

Source: Field Survey, 2024

Decline in Productivity

Deforestation, monoculture, and land grabbing result in decline in soil fertility. Earlier, most of the small farmers who cultivated rice, pulses, and other food crops, now replaced it with tea cultivation only. This increases food insecurity in the future as once the food surplus region, became food deficit due to the tea monoculture. The transport facility in the region is not good as most of the time, some problems occur due to political or social reasons. Tea gardens in Assam have undergone several changes since their establishment in 1823. Initially, tea gardens of Assam registered a huge growth and used to produce more than 10% of global tea production. Tea production has declined due to global competition from countries like as Kenya, China, Sri Lanka, and Vietnam. Tea production depends on demand in the export markets such as Europe and domestic consumption. Currently tea gardens are facing tough times to maintain their previous key position as tea prices in the markets are also on decline. The tea bushes should be replanted at intervals of every five years, but many of them are older than thirty years. The replanting process requires significant investment, and labour costs. They depend on favourable climate to have good production, but erratic rainfall due to climate change impacts the tea productivity and quality leading to lower prices. It is important to maintain a continuous high quality to retain the export demand for the premium tea in international markets. The demand for organic tea has been rising over the years due to rising health consciousness among rich consumers. Huge capital investments and modern training are needed to meet the rising demand for organic tea, but these investments is beyond the capacity of small tea growers.

Miserable Condition of Tea Garden Workers

Tea garden women workers lag behind on social and economic parameters. Most of them are less educated and work on lower wages with minimum facilities lacking basic hygiene and sanitation to earn livelihood for their family. The small tea growers in Monabarie are not getting optimum price for their green leaves. In addition, tea workers are not getting the right price for their labour due to incapability of small tea growers to capitalise, advertise and market their finished products. Tea plantation is an unorganised sector and is not directly governed by the government. Apart from domestic factors, several global factors such as Russian-Ukraine war, Iran-Israel war have compounded the challenges of tea gardens. Price fluctuations have raised several questions about the sustainability of tea garden workers. Poverty is the worst form of violence and is associated with asymmetry in social position. Poverty affects lives of tea garden workers including health, purchasing power, food, shelter and education. Most of the women workers are poor, and have no social security. Facilities such as maternity and childcare leave during pregnancy and delivery is also not provided to them. They must take unpaid leave from their tea garden manager during these periods. Tea garden workers are struggling for their livelihoods because they are victims of the darker side of life. Women are more victimised than their male counterparts because they are comparatively more vulnerable in our society. However, the government has decided ₹350/day minimum wage for them, but the contractors pay ₹250/day or even less. The reason is that they are unaware of their rights because they are socially and educationally backward. Tea garden workers work throughout the year as the tea plucking process does not stop during monsoons. Tea plucking is extremely problematic during monsoons because they do not have proper sheds to protect themselves from the rain. In some instances, they fall on slippery roads and injure themselves while carrying plucked leaves on their shoulders. They are desperate and frustrated because they live and work in highly stressed environment without any rest. They live pathetic lives because they fear losing their daily wages as they have no other option to feed their family members.

Lack of Basic Amenities

Tea garden workers rarely get any chance to lead a better life and ensure a bright future for their children and themselves. They are counted amongst the most depressed and backward classes in the country. They mostly dwell within the surroundings of the tea estate as it is convenient for them to reach their place of work on time. They reside in rural areas, which is an indicator of remoteness where absence of basic amenities is obvious. Approximately 30% of the tea garden workers are below 30 years of age. About 40% of workers fall in the age group of 30-40 years, while remaining 30% belong to 40-50, 50-60 and above 60 years of age group combined together. This is because tea industry requires young workers to have maximum output with minimum input. Forget the advanced healthcare facilities, tea gardens lack even basic amenities. There are no specialised doctors around the tea estate, which often creates problems in various emergencies. Lack of adequate primary and secondary healthcare facilities puts the precious lives of the country in danger that can be easily saved with a minor allocation of budget in the health sector. Tea workers are dying from minor diseases due to the absence of specialised healthcare centres. Grim poverty, alcoholism, hunger, lack of education, gender abuse, among others have become an immutable part of their lives. Alcohol consumption is frequent in plantation during and after working hours.

They are aware that alcohol is injurious to their health yet both men and women consume alcohol. However, the proportion consumption in male is higher than female. Many families are involved in the preparation and sale of alcohol, that is an alternative source of income. They sell alcohol to compensate for their low wages.

Opportunities

Monabarie tea garden, apart from tea is well-known for its scenic beauty. Unrestrained and constant rise in the number of tourists over the years and unscientifically planned urbanisation are threatening its fragile ecosystem. Extensive plantations were built in the hills, and tea workers developed several hybrids of tea like green tea and black tea to meet the rising demand. Therefore, people from neighbouring states, and countries, mainly West Bengal, Arunachal, Sikkim, Nepal, and Bhutan migrated to tea estates and were employed as cheap tea workers.

Medicinal Value

Monabarie tea acts as an antioxidant that neutralises unwanted radicals in the body. Antioxidants slow aging process, reduce body inflammation, improve skin health, and enhance glow. Adding tea to our diet can provide natural protection against cellular damages. Reddish bright colour flavour keeps our heart healthy as it contains bioactive compounds to remove bad cholesterol and improve good cholesterol. The tea is linked to blood circulation, maintains better blood pressure, reduces strokes, and heart attacks. Tannins in the tea reduces the gut inflammation by promoting the growth of good bacteria in the gut, reduces gastrointestinal disorders, and improves digestion. Sipping warm tea after half an hour of the meal aids digestion and eases discomfort. The tea contributes a key role in managing stress and relaxation. Presence of L-theanine reduces the release of cortisol responsible for stress and increases the production of serotonin to boost mood. This lessens anxiety and strengthens emotional balance. Caffeine stimulates chemical composition and promotes relaxation without drowsiness. Caffeine burns body fats, boosts metabolism more efficiently, regulates sugar levels and curbs appetite to avoid fast foods, cravings, and overeating. This is an excellent product to support weight loss and maintain a perfect body mass index (BMI). Permissible limit of caffeine stimulates positive effects on brain as the tea enhances mental alertness, making it an unavoidable choice throughout the day and night. This provides a sustained release of energy due to the presence of amino acids that synergise with caffeine to improve mood, cognitive performance and reduce the risk of cognitive decline. The antioxidants present in the tea support a healthy immune system, fight pathogens and protect against flu, common cold, and infections. The antimicrobial properties protect against virus, and harmful bacteria. Reddish bright colour tea is a good source of minerals (potassium, magnesium) and vitamins that play a key role in maintaining a healthy immune system.

Tourism

Assam is blessed with several tea gardens that remind us of the colonial past, where tourists from different regions visit to enjoy different flavours of tea, and Monabarie is one of them. Tea tourism contributes a significant portion in the economy of Biswanath district. The panoramic view of tea gardens depicts an unmatched scenic beauty of the estate. Tourists around the globe visit Monabarie tea estate to refresh themselves. The enticing greenery of Monabarie tea estate on either side of the highway makes the journey of tourists pleasurable and peaceful. Local transport to the tea estate is feasible and affordable that further contributes to clean and calm environment. Reddish bright colour is the most famous flavour of Monabarie tea estate that has significantly contributed to large-scale growth and popularity. The tea estate is divided into several sections: Behu Pukri, Lahori Jan, Old Line, and New Line. October to April are the best months to visit Monabarie tea estate as the weather remains calm and pleasant for walking through the gardens. One can admire the spectacular landscape of tea gardens, beautiful aroma of tea leaves that refreshes the soul of everyone. The entire area is mixed with the unique tea flavour that spreads everywhere like the air we breathe. This is a good symbol for the invaluable treasures of incredible India.

Contributions of Women

Women work to uplift their families and incomes. They play a noteworthy role in the development of society because they are the better half of the globe. If we Increase 1% share of women in the economy, then the Gross Domestic Product (GDP) of that region will register an increase of 4-5%. The entire human civilization could never be developed without their economic, social, political, and cultural participation. Tea plantation is a labour-intensive industry where dedicated large number of workers are in high demand. A large percentage of women are employed in the tea cultivation from the start of the tea plantation. Women account for approximately 70% of the total workforce in Monabarie tea estate. Women workers mostly belong to other backward caste (OBC). 80% of the workers have nuclear families while remaining 20% have joint families. Nuclear families dominate the tea estate, but they have minimum 6-8 family members.

Majority of tea garden workers are adopting nuclear family, which is different from the modern urban family system. Both nuclear, and joint families have some challenges and benefits. 75% of women tea workers were married, 15% were unmarried, 8% were widows, and 2% were separated. It was observed that early marriages were prevalent in tea estates; hence, most of them were married. A significant number of children support their parents, and they constitute 15%. The average life expectancy of women is naturally higher than men, which is applicable to tea garden workers. 8% of the women were widows, they were alcohol addict and could not take care of their health. Remaining 2% were separated from their husbands either voluntarily or involuntarily due to several reasons.

Role of Government

After 1947, the government announced several welfare schemes to raise living standards of tea garden workers, but many of them were deprived of these benefits. Most of the tea garden workers are unaware of the government programmes going on for their welfare. This may have been due to the negligence of workers, tea garden owners, or government officials. The government made several provisions for their social, educational, and economic upliftment, but they are still living a miserable life. The state government has failed on several fronts to implement sustainable strategies for socioeconomic development of tea estate workers in Assam including Monabarie tea estate. State government's recognition of tea garden workers under the Panchayati Raj Institution (PRI) is mandatory. Extension of union and state government welfare schemes to vulnerable sections is very slow and time-consuming. The workers have been waiting for their numbers for years to come, and several strikes, processions, and rallies have been organised in the past to hasten the process. Other agendas of these movements were to listen, understand, and propose sustainable strategies to solve their grievances that they have been facing for several decades.

Significance of Tea Garden Labour Society

The tea tribes are denoted as the tea garden labour society. They belong to a rich and prosperous working-class in a capitalist society. In the tribal community, girls are treated as assets because they take the responsibility and accountability with full integrity to look after their siblings since childhood. Hence, they make daily wage earnings convenient and easy for their mother. Among tea tribes, females not only handle their household tasks but are also equally competent in managing their livelihoods. In this society, females are more competent than their male counterparts in crop harvesting in tea estates. This society protects tea garden workers from any exploitation, but their role is quite limited.

Contribution of Social Groups

The tea labour society is represented by several organisations, but the most important and front-runner is Assam Cha Mazdoor Sangha (ACMS). ACMS has represented the tea estate workers for more than 65 years since 1958 and is the largest recognised trade union in the Northeast. The union acts as a bridge between tea garden workers and the state government to address genuine and rational grievances of workers. The growing disagreement between tea garden workers and the trade union led to the emergence of a new and energetic organisation. Students are leading the new organisation, which is doing well to address the immediate challenges faced by tea garden workers, and sanction several government welfare schemes for them. Accredited Social Health Activist (ASHA), Auxiliary Nurse-Midwife (ANM), and Anganwadi centre (AWC) maintain official records of all tea garden workers and perform fair enough work. They provide enough resources to tea garden children, pregnant and lactating women who suffer from malnutrition. These groups act as bridge between tea garden workers and the government as they collect data from the workers and inform the government about the need of infrastructure in their locality. Some primary schools and primary health centres are built with the help of these groups as they put pressure on the government to provide essential requirements for tea workers.

Conclusion

Most Indians start their day with tea as its taste is distinct, energetic, and refreshing with unique aroma and pigment but we often overlook the condition of the workers who make it possible to bring it to our table. The condition of women can be understood by examining their status because they are the ones who manage the entire family apart from work. They represent half of the population, but they are struggling for their rights in every aspect of their lives, and Monabarie tea garden is one of them. The tea estate is full of aesthetic beauty for those who look from outside, but its soil is mixed with the sweat and blood of tea workers' struggle and exploitation. This represents the dark phase of tea plantation, and for that reason everyone is responsible as we rarely stand for their rights. Those who stand up for their concerns are seen with suspicion and is often victimised.

We should raise their concerns so that they will lead a respectable and dignified life not for themselves but for everyone. Otherwise, the tea called red gold, soon turns into red blood. It is said that injustice anywhere is a threat to justice everywhere.

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The Deccan Geographer
Vol. 62, No. 10 December, 2024, pp. 154-165
(ISSN-0011-7269)
UGC Care Listed Geography Journal

TEMPORAL PATTERNS OF EMPLOYMENT GENERATION AND DELAYED PAYMENTS UNDER MGNREGA IN NUH DISTRICT, HARYANA

Deepak Moda and Dr. Mehtab Singh

Abstract

Located in close spatial proximity to the national Capital New Delhi, Nuh is the most backward district in the country characterised by semi-arid climatic conditions, resource scarcity, minimal per capita income, and sky-high multi-dimensional poverty. Since its implementation, the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) has generated significant employment in rural India. Therefore, the present study analysed the temporal change in employment generation and delayed payments under MGNREGA from FY 2014-15 to FY 2021-22 employing secondary data sources. The present study probed to answer three research questions viz., a) whether there is a shift in employment demand and employment generation under MGNREGA over the years? b) Whether the employment generation capacity of the MGNREGA has improved over the years? and c) whether the efficiency of the MGNREGA with respect to timely disbursement of wages has improved over the years?

Outcomes revealed that the proportion of households that demanded employment increased 812.50 per cent from FY 2014-15 to FY 2021-22, which clearly indicated that households are willing to undertake unskilled manual work under MGNREGA. Further, the data analysis revealed a widening gap between employment demand and supply over the years, indicating that MGNREGA failed to fulfill increasing employment demand. Additionally, the study found that the amount of unskilled wages paid to labourers recorded a stupendous increase of 943.47 per cent during the study years, indicating the government's commitment to ensuring the welfare of rural households. Finally, the study revealed that the proportion of delayed transactions has consistently declined over the years, indicating an increase in the efficiency of the MGNREGA with respect to the timely disbursement of wages. This study is an opportunity for the concerned stakeholders

to help them to analyse the trends in employment generation and delayed payment that would, ultimately, guide them to undertake more relevant and constructive steps towards meeting the aims of this scheme and ensuring pro-poor development of the rural masses.

Introduction

Passed by the Indian Parliament on 23 August 2005, Mahatma Gandhi National Rural Employment Act (MGNREGA) is the world's most popular rural employment generation scheme. It guarantees every member of a rural household at least 100 days of employment in a financial year. Thus, the Act's most important goal is to enhance the household's livelihood security. It also aims at building long-lasting rural assets, promoting social inclusion and democracy at the local level, among others. Any member of the households who have attained the age of 18 or above can apply for job/employment with a daily working duration of at least nine hours at the prevailing wage rate (Rs. 315/- a day, FY 2021-22).

A large number of research studies have been carried out on the performance analysis of the MGNREGA. Some studies highlighted that MGNREGA improved rural households' livelihood security through wage employment and raised their standard of life (Yasmin and Srinivas, 2020) while some other studies highlighted that the Act failed to extend its potential benefits to rural masses (Meenu, 2022; Aomatsung, 2021; Ahmad et al., 2017; and Narang and Meenia, 2015). Many studies highlighted that the Act's provision of guaranteed wage employment on demand proved beneficial in lowering the beneficiary households' poverty levels (Vattriselvan et al., 2018 and Negi et al., 2015). Many studies have highlighted that MGNREGA, to some extent, proved beneficial in curbing the problem of out-migration to urban areas (Patra, 2021; Choudhary, 2020; Mishra and Singh, 2018; Sharma et al., 2017 and Prasad, 2012) while other studies highlighted that rural households still migrate to urban areas in search of better employment opportunities (Peter and Maruthi; 2020 and Kumar and Deogharia, 2017). Various research studies also highlighted that the provision of employment within a radius of 5 kms, 33% job reservation, no wage discrimination, the provision of basic facilities such as creche and child-care at the work-site, a complete ban on contractors, direct disbursement of wages in Bank/Post-Office Account, engagement in decision-making and many others have empowered women economically, socially as well as politically (Negi et al., 2015). A sizeable literature is available on the various issues and challenges in MGNREGA implementation, specifically in terms of lack of awareness about the Act's minimum provisions and worker's entitlements (Ahmad et al., 2017), non-availability of employment on demand (Narang, 2014), non-payment of unemployment allowance and transportation allowance (Ahmad et al., 2017), lack of worksite facilities (Gnyaneswar, 2016; and Narang, 2014), use of machinery at the work-site (Narang, 2014), slow rate of completion of projects undertaken (Aomatsung, 2021), and delay in wage payments (Kumar and Deogharia, 2017; Narang and Meenai, 2015; and Narang, 2014), among many others.

Study Region

Earlier known as Mewat, Nuh is one of the 22 districts in the Indian State of Haryana. The district comprises four tehsils, two sub-tehsils, seven community development blocks, and 441 villages, and Nuh town is the district's headquarters. Geographically, the district spreads over a total area of 1,507 sq kms. As per the Census of India, 2011, Nuh is home to 10,89,263 persons of which 52.44 per cent comprises males and 47.56 per cent comprises females. There are 907 females per thousand males (Census, 2011). People are mainly dependent on agriculture and agro-based industries for their survival earnings which are quite low.

Nuh is one of the most under-developed districts in the country characterised by adverse climatic conditions, resource deficiency, lack of employment opportunities, and rampant poverty conditions. In fact, 63.18 per cent of the district's population is categorised as multidimensionally poor measured in terms of education, health, and standard of living (NITI Aayog, 2021). The district is placed at the bottom in Haryana in terms of performance on Sustainable Development Goals (Haryana SDG District Index, 2022) and it is the only district selected from the State under the Central government's 'Transformation of Aspirational Districts' initiative which was launched in January 2018. Additionally, the district has the lowest per capita income (Rs. 1,04,518, FY 2019-20, Haryana SDG District Index, 2022) in the State with the highest share of the State's MGNREGA job card holders (12.14%, FY 2021-22) and employment seekers (15.46%, FY 2021-22), which depicts that there is a dearth of employment opportunities in the local job market. Thus, we see that the district needs special attention from the policymakers, researchers, and implementing agencies so that the benefits of the social security measures reach even the last person equally. In this view of the district, MGNREGA seems to be a 'silver bullet'. MGNREGA bears the potential to change poor socio-economic conditions on the ground. MGNREGA was implemented in the Nuh district on 01 April, 2007. The provision of guaranteed employment opportunities for up to 100 days in a financial year at a minimum declared daily wage, and its payment goes straight into beneficiaries' bank/post-office account within 7-15 days.

This directly touches the lives of the rural poor households. Therefore, the present study made a humble attempt to analyse the temporal patterns of employment generation and delayed payments under MGNREGA in the Nuh district.

Objectives

(1) To examine the temporal patterns of employment demand and employment generation under MGNREGA in Nuh district during the FY 2014-15 to 2021-22; and

(2) To examine the temporal patterns of unskilled wages paid to labourers and delayed payments.

Database and Methodology

This paper relies on the analysis of secondary data for the period FY 2014-15 to FY 2021-22 (eight continuous financial years). Data related to households demanded employment, households provided employment, households completed 100 days of employment (Table-1), the amount (Fig. 1) and the period of payment of unskilled wages paid to beneficiaries (Table-2) were collected from the official website of the MGNREGA, Ministry of Rural Development, Government of India. The data were analysed using the statistical method using MS Excel. Further, to infer the conclusions, descriptive and judgemental analyses were applied.

Two significant limitations of the study need to be mentioned. One, the proportion of employment demand and employment generation have been calculated against the total number of rural households in the district. The data pertaining to the number of households demanding employment and provided employment have been taken for each reference financial year while data related to the total number of rural households in the district, the 2011 Census data have been utilised. Year-wise data on the number of rural households in the district is not used. Henceforth, it can be inferred that whenever new Census data are published, a sharp fall in the proportion of households demanding employment and provided employment is expected due to the methodology adopted for calculation. Secondly, we wanted to analyse the trends since the implementation of the MGNREGA in the district (i.e., April 1, 2007) but due to the lack of data, the present study analysed the data from FY 2014-15 to FY 2021-22 only.

Results and Discussion

The results of the present study have been discussed and analysed under the ensuing two heads:

(1) Temporal patterns of employment generation and households completed 100 days employment: and
(2) Temporal patterns of unskilled wages paid to labourers and delayed payments

Patterns of Employment Generation and Households Completed in 100 Days

MGNREGA aims at securing livelihood of the rural households by way of providing unskilled wage employment on demand for up to 100 days in a financial year. Table-1 lists the households that demanded employment, provided employment and completed 100 days of employment under MGNREGA in the Nuh district of Haryana from FY 2014-15 to FY 2021-22 (Table-1).

Table-1: Number of Households, Demanding and Provided Employment

Financial Year	Number of Households		
	Demanded Employment	Provided Employment	Completed 100 Days Employment
2014-15	8,014	6,144	569
2015-16	8,443	7,079	764
2016-17	10,294	8,647	401
2017-18	14,258	12,578	1,100
2018-19	19,141	16,619	650
2019-20	33,692	29,009	992
2020-21	87,675	75,829	3,480
2021-22	73,128	55,735	891

Source: https://mnregaweb2.nic.in

Fig. 1 reveals that both employment demand and employment supply witnessed an upward trend over the study period. Of the total rural households (1,39,975, Census-2011), a small proportion (i.e., 5.73 per cent) demanded employment during the initial study year and it crossed half mark (52.24 per cent) during the FY 2021-22 which appears to be due more to a decline in employment opportunities in rural job markets and returning of rural workers to the villages amid Covid-19 pandemic. On the contrary, the proportion of households provided employment increased from 4.39 per cent to 39.82 per cent during the reference period which could be attributed to demand-driven nature of the MGNREGA.

The trends in gap between employment demand and employment supply need careful analysis. A close analysis of Fig. 1 also reveals a gap between the

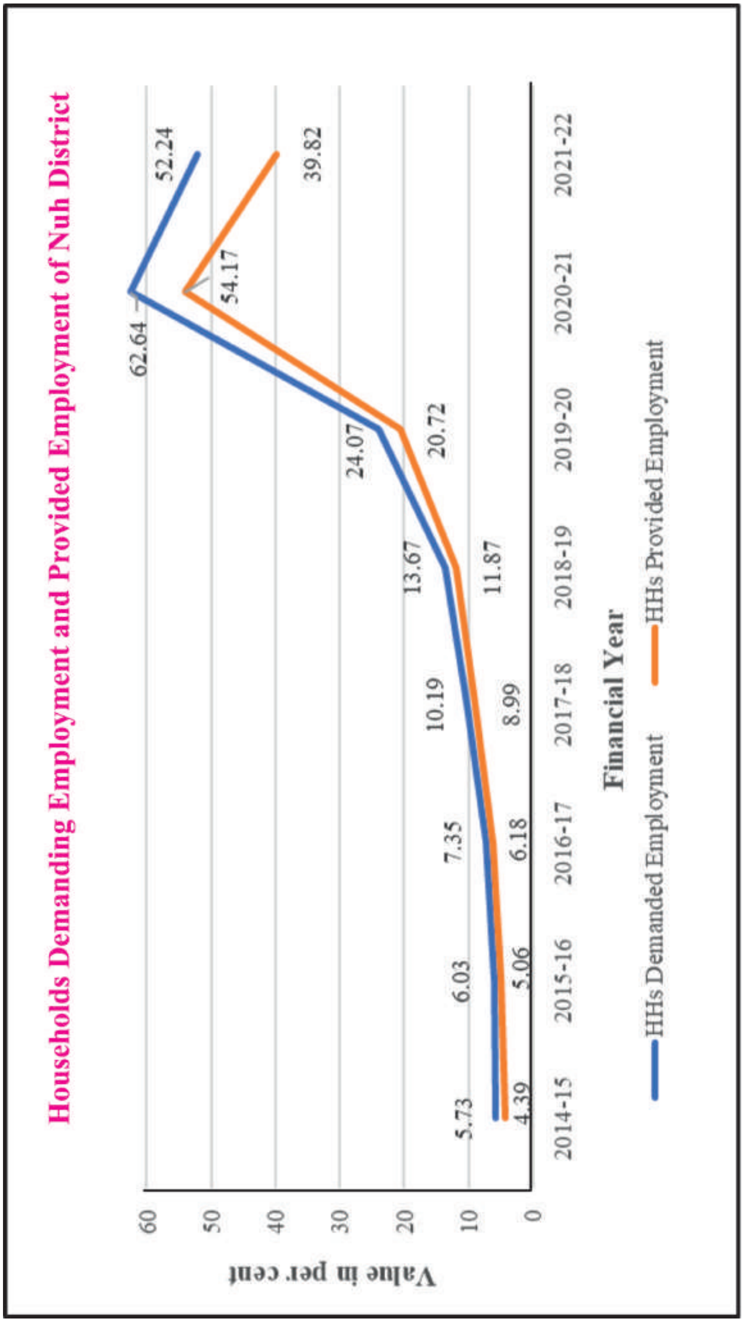
Households Demanding Employment and Provided Employment of Nuh District
Value in per cent
60
50
40
30
20
10
0
5.73
4.39
6.03
5.06
7.35
6.18
10.19
8.99
13.67
11.87
24.07
20.72
62.64
54.17
52.24
39.82
2014-15
2015-16
2016-17
2017-18
2018-19
2019-20
2020-21
2021-22
Financial Year
HHs Demanded Employment
HHs Provided Employment

Fig. 1

proportion of households demanding employment and provided employment and it is worsening over the study years. For example, the gap was 0.97 per cent during the FY 2015-16 and widened to a double digit (12.43 per cent) during the FY 2021-22. The consistent increasing gap strengthens the fact that MGNREGA failed to fulfil employment demand, thereby, depriving the rural households of exercising their Right to Employment.

MGNREGA promises at least 100 days of unskilled manual work to willing rural households, hence, analysing the trends in the proportion of households completed 100 days employment merits serious attention. Table-1 reveals that, the overall percentage of beneficiary households who completed 100 days of employment is minimal and is further declining over the years. For example, during the FY 2014-15, merely 9.26 per cent households completed 100 days employment which came down to just 1.6 per cent during the FY 2021-22. Thus, it could be said that MGNREGA failed to deliver its promise/guarantee of providing at least 100 days of employment in the Nuh district.

Patterns of Unskilled Wages Paid to Labourers and Delayed Payments

Unskilled wages paid to labourers constitute an important component of the act as this is what directly goes to labourers. Beneficiary households in the district were paid a total of Rs. 6.74 crore as unskilled wages during the FY 2014-15, 7.28 crore during the FY 2015-16, 10.75 crore during the FY 2016-17, 19.68 crore during the FY 2017-18, 26.82 crore during the FY 2018-19, 44.42 crore during the FY 2019-20 and rose stupendously to Rs. 143.26 crore during the FY 2020-21 which can be attributed to an increase in the funding allocated to MGNREGA amid Covid-19. However, it again slipped to 70.33 crore during the FY 2021-22 (Table-2 and Fig. 1).

It is also worthy to mention here that employment demand recorded 812.50 per cent increase while the amount of wages paid to labourers increased 943.47 per cent over the study years, indicating that the government is committed to ensuring the welfare of the rural households through wage employment. The Act expressly states that daily wages must be paid weekly, or no later than a fortnight after the date on which the work was completed, straight into the beneficiary's Bank Account. Therefore, any payment made after 15 days would be counted as a delayed transaction (wage payment).

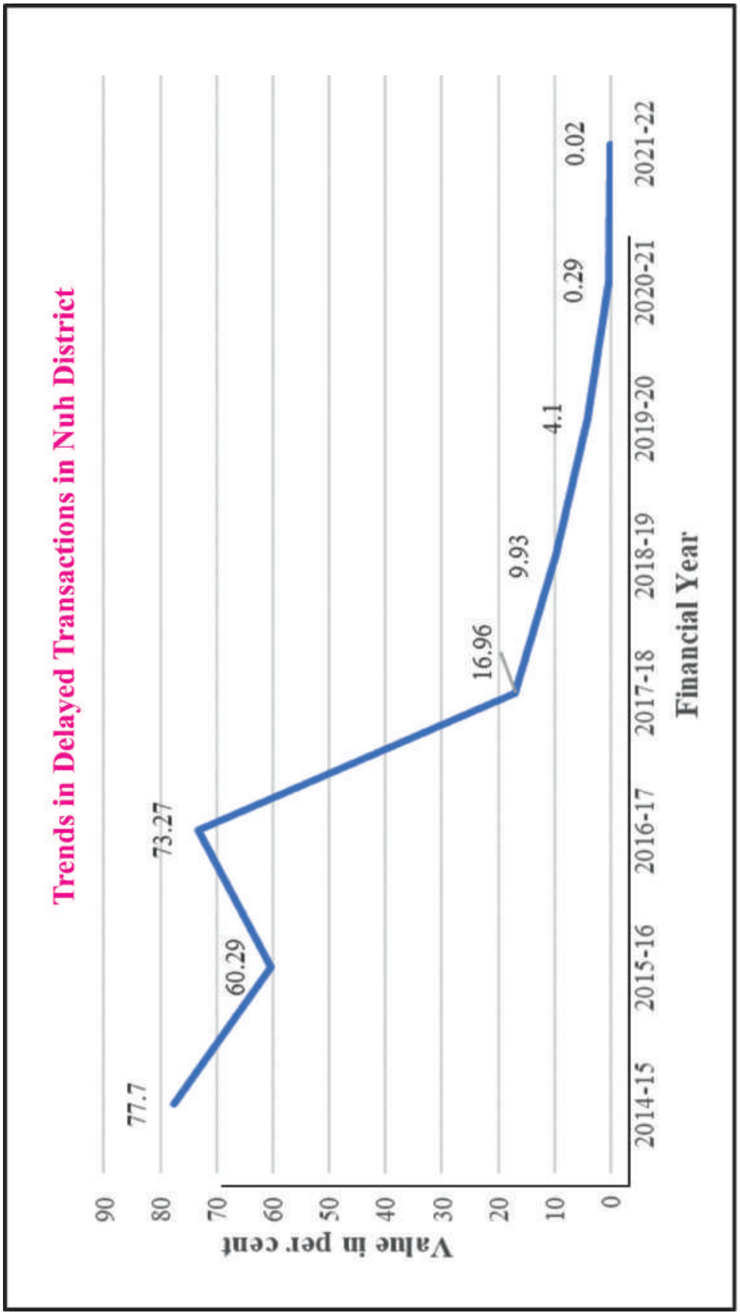
Trends in Delayed Transactions in Nuh District
Value in per cent
90
80
70
60
50
40
30
20
10
0
77.7
60.29
73.27
16.96
9.93
4.1
0.29
0.02
2014-15
2015-16
2016-17
2017-18
2018-19
2019-20
2020-21
2021-22
Financial Year

Fig. 2

Table-2: Nuh District: Period of Payment of Unskilled Wages Paid to Labourers

Financial Year	Transactions (Period between days)						Total Transactions	Total Delayed Transactions
	No Delay		Delayed					
	0-8	9-15	16-30	31-60	61-90	>90		
2014-15	0	0	5,752	10,308	4,264	7,893	36,313	28,217
2015-16	0	0	8,396	10,569	3,853	2,768	42,439	25,586
2016-17	5,168	6,198	11,177	12,896	4,479	2,618	42,536	31,170
2017-18	29,266	15,446	8,147	959	4	19	53,841	9,129
2018-19	38,362	21,703	5,801	763	0	57	66,686	6,621
2019-20	82,342	25,265	4,140	430	28	0	1,12,205	4,598
2020-21	3,20,214	23,014	973	38	0	0	3,44,239	1,011
2021-22	1,69,356	2,803	27	14	0	1	1,72,201	42

Source: https://mnregaweb2.nic.in

During the FY 2014-15, out of a total of 36,313 transactions, a total of 28,217 transactions (77.7 per cent) were labeled as delayed of which 20.38 per cent were delayed by 16-30 days, 36.53 per cent were delayed by 31-60 days, 15.11 per cent were delayed by 61-90 days, and 27.97 per cent were delayed by more than 90 days. However, the situation improved during the subsequent years. During the FY 2021-22, out of a total of 1,72,201 transactions, only 42 transactions (0.02 per cent) were delayed which is quite encouraging and laudable.

Trends in delayed transactions merit serious academic analysis. Fig. 2 clearly revealed that the percentage of delayed transactions were consistently declining over the years. For example, during the FY 2014-15, 77.7 per cent of transactions were delayed which came down to 4.1 per cent during the FY 2019-20, and further, came down to 0.02 per cent during the FY 2021-22, which is an extremely positive sign. This depicts that implementing agencies were deeply concerned with the welfare of rural poor households. This also contributed to an increase in employment demand under MGNREGA.

Conclusions

MGNREGA is widely considered the world's largest employment generation scheme and a 'magical pill' to alleviate household poverty in rural geographies like Nuh district, the most backward district in the country. An eight-year trend analysis revealed that Nuh district on the one hand experienced a significant increase in MGNREGA beneficiaries and on the other hand it saw a widening gap between proportion of households demanded employment and provided employment, thereby depriving many needy households of their right to employment. Considering the backwardness of the district, these trends are not welcome. However, the trends in the period of wage payment to beneficiaries are laudable and encouraging. At this juncture, it is suggested that employment should be provided to households on demand at the earliest possible time. Keeping in view extreme backwardness and poverty levels in the district, the media, the public and private organisations, the opinion leaders, and the Panchayats should all be used extensively to bring more fruitful results.

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The Deccan Geographer
Vol. 62, No. 10 December, 2024, pp. 166-181
(ISSN-0011-7269)
UGC Care Listed Geography Journal

ETHNIC MOBILIZATION AND STATE RESPONSES: ANALYSING TRIBAL DYNAMICS IN MANIPUR'S CONFLICT

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Abstract

Ethnic conflicts in multi-ethnic regions like Manipur arise from issues of identity, power, and resource distribution. These conflicts cause violence, displacement, and instability, which disrupt social and economic development. This study aims to explore the factors behind ethnic tensions in Manipur, assess existing academic perspectives on ethnic conflict, and examine peacebuilding strategies for sustainable resolution. Using secondary data and a thorough literature review, the study looks at the causes and socio-economic effects of ethnic conflict in Manipur, focusing on historical, theoretical, and policy-based insights. The findings show that the conflict has led to significant socio-economic setbacks, including displacement, destroyed infrastructure, and economic stagnation. It has also deepened inter-ethnic tensions, disrupted local economies, and hindered governance, creating instability and undermining efforts for peace and development. The study identifies historical grievances, socio-economic inequalities, and political neglect as critical drivers of the conflict. It suggests dialogue, governance reforms, community empowerment, and international cooperation as pathways to lasting peace.

Introduction

Ethnic conflict generally refers to disputes or acts of violence committed against a group on account of the group's ethnicity (Miedema, 2010). It has affected human life since time immemorial. One of the most severe issues of concern for many nations worldwide is the rise of movements based on socio-cultural, ethnic and identity issues (Casellie & Collemen, 2013). There is hardly any country in the world that does not struggle with ethnic conflict; best-known examples are Rwanda, Somalia, Seira Leone, Iraq, Sri Lanka and the Gaza Strip. Thus, the problem of ethnic conflict is extremely global (Taras & Ganguly, 2015). Ethnic conflict usually takes place in securing the emerging interest of a specific ethnic group by protecting the ethnic and cultural identity of a particular group. Ethnic conflict also occurs due to rapid socio-economic changes in society, resulting in unequal access to available resources, particularly land (Gilley, 2004). In a multi-ethnic society, unequal power distribution sometimes results in ethnic tension and conflicts. Sometimes, migration also contributes towards ethnic conflicts (Mohammadzadeh, 2016). India is an ethnically diverse region, and a series of significant problems faced by the country are due to differences in ethnicity. Numerous insurgent scenarios, separatist demands articulated in terms of autonomy, and controversies over linguistic and religious issues are rooted in the failure of the state to fulfil the ethnic aspirations of the competing ethnic groups (Goswami, 2001). The North Eastern part of India is a multi-ethnic, multi-cultural and multilingual region, making it very distinct from other regions of India. For this diverse ethnicity, the region has always been susceptible to ethnic violence, extremism and insurgency (Haokip, 2012; Brahmachari, 2019). These conflicts have shattered the peace and tranquillity in the region and violated all norms of humanity, killing and torturing innocent people. Numerous lives have been lost as a result of this violence and countless destruction of properties in the region (Nityananda, 2011). These problems have recently made headlines in Manipur, one of India's northeastern states. The state is home to many small communities in northeast India, each of which cherishes its distinct identity and is often deeply rooted in historical narratives and cultural practices (Meitei, 2016). However, this cultural pluralism has also led to the emergence of competing territorial claims and political aspirations, occasionally giving rise to ethnic tensions and conflicts (Piang, 2015).

Armed conflict has occurred in Manipur between the government and various insurgent groups, along with inter-ethnic conflict arising over the demands for the formation of new states within India's federal system or complete independence from India (Singh, 2016; Brahmachari, 2019). These conflicts have given rise to several flashpoints that have gained domestic and global attention (Sharma, 2017). As a consequence of ethnic violence, thousands of people were subject to internal displacement and were forced to abandon their homes and livelihoods for several months (Meitei, 2016). Inter-ethnic rivalries and hostility have caused Manipur's instability and peace. Both human life and property have been lost as a result of these violent conflicts among the various communities. Time and again, basic human security and dignity were severely compromised. People's civil and political rights were violated, and critical developmental infrastructures were destroyed. Thus, violent ethnic conflicts have a crippling effect on overall social and economic development in North-East India, particularly in Manipur (Hussain, 2000). In this paper, an attempt has been made to understand the causes of conflicts between different tribes of Manipur and to examine the impact of ethnic conflict on Manipur's social and economic development.

Study Region

Manipur, located on the extreme north-eastern border, is one of the eight states in the north-eastern region of India. It shares national borders with Nagaland, Assam, and Mizoram states and an international border with Myanmar. The latitudes of Manipur lie between 23.500 N and 25.410 N, and longitudes are between 93.030 E and 94.470 E. The state is known for its distinct geography and diverse culture, fondly referred to as the 'little paradise' and the 'maid of the mountain' (Constantine, 1981); at the centre lies a small low-lying fertile valley which the Meitei dearly called, "Sanaleibak" meaning land of the jewels. The state's overall geographical land area is 22,327 square kilometres, of which the valley makes up around 10%, and the remaining 90% is surrounded by blue hills and mountains (Singh, 2005). Under British colonial rule, Manipur was once a princely state where the Meitei kings had significant autonomy as long as they respected the colonial interests (Bhattacharyya, 2019). However, after merging with India in 1949, Manipur lost its autonomy and became a state of the country in 1972. Manipur is a multi-ethnic, multi-linguistic and multi-religious state with more than 33 recognised tribes.

Objectives

(1) To identify factors contributing to ethnic tension and conflict between cultural groups.
(2) To assess academic perspectives on ethnic conflict and explore effective peacebuilding strategies.

Database and Methodology

This research will rely on a secondary data approach and an extensive literature review to understand the causes and socio-economic impacts of ethnic conflict in Manipur. The literature review will focus on theoretical frameworks and key concepts related to ethnic conflict, such as the relationship between ethnicity and violence, socio-economic inequalities, and territorial disputes. It will explore how power imbalances, cultural identity, and historical narratives contribute to ethnic tensions and conflicts. Additionally, the review will examine how rapid socio-economic changes and unequal access to resources can fuel tensions, particularly in multi-ethnic societies. The research will analyse literature that discusses the role of state policies in addressing or exacerbating ethnic aspirations and grievances, especially in regions marked by diverse ethnic groups. The review will also highlight studies on the socio-economic consequences of ethnic violence, including human displacement, infrastructure destruction, and the disruption of local economies and development. Sources such as academic journal articles, government reports, and NGO publications will be utilised to gather insights into the impact of ethnic conflict on human security, civil rights, and overall development. The thematic analysis of this literature will provide a comprehensive understanding of the causes and consequences of ethnic conflict in Manipur, contributing to potential policy recommendations and peace-building strategies.

Results and Discussion

Historical Background of Ethnic Conflicts

The historical background of Manipur is marked by its rich and complex past, which has been shaped by various political and cultural influences over the centuries. Before British colonial rule, Manipur was a sovereign kingdom with a distinct Meitei identity featuring its language, religion, and social structure. However, its strategic location made it vulnerable to foreign powers, notably the Burmese and the British, who sought control over trade routes and resources. In the 18th century, the British East India Company asserted its influence, imposing a dual administrative system: direct rule over the Meitei in the valley and indirect rule over the hill tribes, such as the Nagas and Kukis. This division fostered ethnic distinctions and tensions, setting the stage for future conflicts (Singh, 2005). The controversial integration of Manipur into the Indian Union in 1949 marked another turning point in the region's history. Maharaja Bodh Chandra Singh was forced to sign the "Merger Agreement," leading to the elected government's dismissal and Manipur's designation as a Part C state. This event, coupled with concerns over the preservation of Manipur's autonomy, ignited ethnic tensions and gave rise to insurgent groups demanding greater self-determination.

These conflicts, compounded by the state's ethnic diversity, have significantly impacted its socio-political stability, mainly through competition for resources and political power among Meitei, Kuki, and Naga communities (Baruah, 2005). Manipur's geopolitical significance, sharing borders with Myanmar and Bangladesh, has further complicated its security and development challenges, fuelling regional tensions. The conflict in Manipur between the Meitei and Kuki communities has resulted in over 250 deaths and displaced approximately 70,000 people as of November 2024. The violence has led to significant destruction of property, including homes and places of worship. The United Nations has raised alarms about serious human rights violations, including acts of sexual violence, extrajudicial killings, and forced displacement. The Indian government has deployed over 10,000 central forces to contain the violence, but the situation remains unresolved, with ongoing unrest and a digital blackout hindering communication.

Major Ethnic Tensions in Manipur

Manipur is home to a diverse population, including Meiteis, Meitei Pangals (Manipuri Muslims), Kukis, Nagas, and various smaller tribes. Ethnic conflicts often arise due to competition for recognition, resources, autonomy, and self-determination. The roots of these tensions trace back to the colonial era when the British divided Manipur into two parts—the valley and the hills—creating administrative divisions that intensified ethnic alienation and territorial disputes (McDuie-Ra, 2014). The major ethnic rivalries involve the Meitei, Nagas, and Kuki-Zomi/Mizo groups. The Meitei-Naga conflict, often described as a "cold war," stems from competing territorial and political claims. The Nagas, seeking greater autonomy and creating Nagalim, a separate region, clashed with the Meitei, who feared the inclusion of their lands in the proposed Naga region (Maring, 2008). Disputes over land ownership and ancestral territories continue to fuel tensions. Similarly, the Naga-Kuki conflict in the early 1990s revolves around land ownership disputes between the Thadou-speaking Kukis and Nagas. The conflict, marked by armed clashes, was exacerbated by territorial claims over districts like Senapati, Ukhrul, and Tamenglong. Despite a decline in violence after 1998, deep-seated animosities and human rights violations persist (Haokip, 2012). The Meitei-Meitei Pangal conflict erupted in 1993, sparked by a monetary dispute in Thoubal district. The violence, resulting in over 100 deaths and extensive property damage, was rooted in growing intergroup and religious tensions, with the Meitei Pangals targeted due to fears of being "overrun" by Muslim settlers (Siamkhum, 2014). The ongoing Meitei-Kuki conflict, ignited by protests over the Meitei's inclusion in the Scheduled Tribe list, has deep historical roots. Tensions over land ownership, identity, and resource allocation continue to fuel violence, complicating efforts for lasting peace in the state.

Cause of Ethnic Conflict

Ethnic conflict has been a major problem in many countries around the world. The root causes of ethnic conflict usually arise from a complex combination of ethnic forces, social class, inequality, political opportunity, resource mobilisation, interdependence and international intervention (Williams, 1994). The impact of ethnic conflicts, particularly in the form of riots, has immensely affected lives and livelihoods in conflict-affected regions. These conflicts threaten the internal peace and stability of the regions and have broader implications for the countries involved in the conflict itself. Conflict distracts the parties involved from more important and productive tasks, diverting their attention, effort, materials, and resources. They create an environment conducive to increasing the number of crimes within states, fostering extremism, even terrorism, leading to violations of political and socio-economic rights, etc. Ultimately, these conflicts undermine the foundations of the most important vitality of the affected countries and sometimes even result in the loss of entire states themselves (Jourek, 1999). Numerous research studies have explored the causes of ethnic conflict and its impact on the socio-economic and demographic structure of different regions worldwide. The composition of an ethnic group inside a nation is a social fact and a product of history. Understanding the ethnic landscape is crucial because the patterns of ethnic competition and conflict are not only influenced by the mere existence of ethnic groups but also by their relative size and geographical distribution. It has been observed that countries with one or two major ethnic groups of comparable proportion are found to be more vulnerable to violence compared to those with a more diverse ethnic makeup. Furthermore, nations with a high concentration of small ethnic groups tend to experience slower economic growth than those with a higher ethnic homogeneity (Posner, 2003). Conflict arises when there is competition between ethnic groups and when one group is unfairly treated or is disadvantaged in terms of economic opportunities, socio-economic status, political rights or cultural expressions (Blouin & Mukand, 2019). In these circumstances, complaints are stimulated by moral indignation, leading to ethnic conflict. Many ethno-regional conflicts are directed against countries in an attempt to gain or restore control over a particular region. Several unresolved ethnic conflicts in the past have involved land claims or territorial disputes (Esman, 2019; Casellie & Collemen, 2013). The conflicts also target ethnic groups, often immigrants in the region, which are perceived as a threat and can eventually diminish the original ethnic groups into minorities in the region over the years.

The apprehension of losing control over the state and the economy often results in ethnic conflicts. Separatist movements also arise due to fear of being permanently subjugated by a dominant ethnic group or coalition (Fearon, 2006; Esman, 2019; Melikishvili & Janiashvili, 2019). Conflicts can arise among groups in an area with historical disputes due to uneven developments within a state, leading to tensions between ethnic groups, especially when one of the groups is perceived to be favoured by the state. Ethnic conflict may also be instigated by the leader of particular ethnic communities, who exploit ethnic sentiments for their political interests and ambitions; often, elites take advantage of the situation. Therefore, in a hostile political environment, the policy ambitions of these leaders are often disguised as ethnic struggles to achieve success (Esteban & Ray, 2008; Ray, 2019). The North-East region of India has been becoming largely vulnerable to ethnic conflict primarily due to its rich diversity in ethnicity, culture, religion and language. Various ethnic groups in this region have resorted to mobilisation and violent agitation to preserve their unique identity. They have called for political recognition from the government and advocated the reorganisation of territorial boundaries in their favour (Kolas, 2017; Gogoi, 2018; Dutta, 2021). Historical analysis reveals that the root cause of ethnic conflict in North-East India has social and cultural roots. The turmoil has more to do with ethnic political aspirations and efforts to protect local territories and resources (Baruah, 2005; Borah & Chakraborty, 2018; Chhetri, 2019; Sarbahi, 2020). Historical injustices and colonial legacies have exacerbated the ethnic conflicts in Manipur. The integration of Manipur into the Indian Union in 1949 and subsequent governance issues have intensified the feelings of marginalisation among certain ethnic communities (Singh, 2001). This perceived infringement on Manipuri's right to self-rule has served as a justification for taking up arms against India, making the region a hotbed of conflict and instability (Mukherjee, 2017; Dangmei & Maharajan, 2022). Perceptions of political marginalisation and lack of representation among certain ethnic communities have also been a driving force behind insurgency movements in Manipur. Some groups feel excluded from the political process and have resorted to armed struggle to demand greater autonomy or political rights (Shimray, 2002).

The complexity of identity formation, demographic configurations, and historical background of the communities offers insightful information about the fundamental causes of intergroup conflict in Manipur. Since each ethnic group in Manipur has come to understand and accept that land is the only reliable, long-term capital for growth, ethnic conflict has gotten worse (Oinam, 2003). Manipur is home to various ethnic groupings, each with different political aspirations that, unfortunately, do not converge but are confined to their respective groups. The Meiteis desire a unified state, whereas the Nagas and Kukis favour territorial division. These conflicts are motivated by diverse ethnic identities and are rooted in land control disputes. Manipur's politics and society are sharply divided along ethnic lines, and the local populace controls the government (Sharma, 2016; Singh, 2014). Socio-economic disparities between different ethnic communities, including unequal access to education, healthcare, and economic opportunities, have contributed to feelings of marginalisation and alienation. Economic deprivation and lack of development in certain areas have also fueled support for insurgency movements (Haksar, 2017). Focusing solely on law and order problems without addressing the core issues would be detrimental (Tennyson, 2015). Despite significant development funds from New Delhi intended for peace and development, these resources often end up in the hands of militant groups, perpetuating conflict rather than progress. As a result, the ethnic conflict continues, making Manipur unsafe, and government efforts to manage it have not been successful (Singh, 2010).

Impact of Ethnic Conflict

Ethnic conflicts are among the most complex and impactful social issues in the modern world, profoundly affecting the countries and communities involved. The persistent and unabated ethnic conflicts have significantly affected human life and economic resources, undermined the traditional way of life and broken up communities in several countries. Ethnic conflicts are often accompanied by gross human rights violations, such as genocide and crimes against humanity, as well as economic decline, state failure, environmental problems, and refugee flows. Violent ethnic conflict leads to tremendous human suffering, often leading to forced relocation of people from their settlements. Conflicts and violence have traumatised people's lives and have paralysed socio-economic activities. Therefore, understanding the multifaceted impacts of ethnic conflicts is crucial for formulating effective interventions and policies to foster peace and reconciliation. Ethnic conflicts can potentially disrupt economic development in a region and destroy its resources and development initiatives. They also hinder economic growth by damaging farms and products and prohibiting land cultivation (Jonsson, 2009). Conflict-affected areas disrupt economic activity and discourage investment, labour flows and tourism (Easterly & Levine, 1997; Khalimovna, 2021). High-risk environments due to unrest discourage domestic and foreign investments, further stunting economic growth. Insecurity poses significant challenges to infrastructure development, obstructing the construction of any region's roads, schools, hospitals, and other essential infrastructure, hindering overall development. Several studies have shown that ethnic conflicts negatively impact a region's socioeconomic development (Goswami, 2001; Handique et al., 2018).

Furthermore, repeated ethnic conflicts have been identified as the most important contributor to the region's economic stagnation (Bhattacharjee & Nayak, 2013). Violent conflicts often led to the displacement of the population from their villages. This kind of displacement causes more distress to the population than the displacement induced by developmental activities. The victims have suffered severe forms of financial and personal losses due to the destruction of property and death of near relations during violent outrage and many a time caused forced displacement leading to refugee crises and internal migration. In the aftermath of conflict, there were many instances of out-migration from conflict-affected areas, which have led to changes in the demographic pattern of society, at least in the short run. Although some individuals return to their original homes once peace is restored, the fear of recurring violence lingers, leading to a gradual breakdown of social cohesion and trust among different community groups, ultimately resulting in divided societies. Conflicts thus segregate people in different areas based on ethnicity (Hussain, 2000; Corvalan & Vargas, 2015). Ethnic conflicts often lead to political instability as different ethnic groups may have conflicting demands and aspirations in the region, making governance challenging and hindering the implementation of effective policies. Violence during these conflicts leads to death, arson, looting, shootings, robberies and destruction of homes, property, assets, and livestock, thus negatively affecting the livelihood of conflict-affected households (Sinha & Liang, 2021). Furthermore, conflicts lead to the breakdown of law and order, which increases the crime rate and impunity (Green, 2018; Ito, 2020). The high expenditures required to maintain security in these regions mean the government cannot allocate sufficient resources for adequate infrastructure facilities. Moreover, it is also difficult for the government to provide the resources required for development activities if it has to spend many resources on security purposes in conflict-affected areas (Khan et al., 2021).

The occurrence of ethnic conflicts has the potential to disrupt both local and international trade, which affects the economies of the involved areas as well as their trade partners. During the conflict, "bandhs" and blockades are often prevalent in affected regions, severely hindering commercial activities, particularly in Manipur. Moreover, violent conflicts impact existing businesses and deter potential investors from entering the region, leading to significant out-migration of many business people. The consequences of conflict include restricted movement, disruptions in business activities, loss of capital due to the burning of houses and business establishments and limited business transactions. These adverse effects of violence serve as disincentives to business activities, resulting in decreased demand for goods and services and the shutdown of several business establishments in conflict-affected areas (Olzak & West, 1991; Majaro, 2011; Pamei, 2017; Njeri, 2020). Amid the conflict, the innocent villagers were forced to evacuate their village and take shelter in government relief camps. Sadly, the harsh reality is that children are now hesitant to attend schools, hospitals and clinics for fear of exposing themselves to violence. The loss of property and the inability to use public facilities affect the quality of life of families in conflict-affected areas. Studies have found that people whose properties are looted or destroyed and are forcibly removed from their homes suffer trauma from pain and shock. This can have serious health consequences that may eventually lead to the death of the victim (Pedersen, 2002; Singhal, 2019; Njeri, 2020). The loss of economic power with the collapse of complex livelihood systems leads to a decline in their overall standard of living, which leads to the marginalisation of the victims of the conflict (Trueba, 2002; Bhugra, 2004; Yamauchi et al., 2010; Wang et al., 2010).

Strategies to Mitigate the Challenges

The ongoing ethnic conflict in Manipur is a result of deep-rooted historical grievances, social divisions, and political neglect. A comprehensive strategy involving dialogue, governance reforms, community empowerment, and external cooperation is needed to address these challenges and foster peace. Below are key recommendations and strategies to help mitigate the challenges and promote lasting peace in the region. One of the most critical steps in resolving the conflict is bringing the primary parties involved especially the Meitei and Kuki communities—into a structured dialogue. However, this task is challenging due to the involvement of insurgent groups and underground elements. Impartial and authoritative mediators should supervise the negotiations to ensure that the concerns of all communities are heard and addressed. Effective dialogue is essential to overcoming distrust and finding common ground.

Community Involvement and Empowerment

The local population should be actively involved in decision-making to foster a sense of ownership and belonging. Empowering communities to participate in governance and collective responsibility will help address grievances, build trust, and promote societal rebuilding. Local governments should listen to civil society representatives before making significant decisions. Inclusive governance can pave the way for sustainable peace and cooperation between ethnic groups.

(a) Strengthening Border Surveillance and Preventing External Influences

External actors, including insurgent groups and the smuggling of arms, have exacerbated the ongoing conflict. More robust border surveillance, particularly along the Indo-Myanmar border, is essential to reduce these external influences. Areas like Moreh, known for being a hotbed of insurgent activities, require heightened security measures. Preventing the flow of arms and militants into the region can significantly curtail the violence and destabilising forces at play in the conflict.

(b) Government Intervention: Relief and Restoring Order

For peace to be established, the government must intervene decisively by providing relief to all victims and ensuring their safety, regardless of ethnic identity. Relief measures should include financial support, psychological counselling for trauma victims, and aid for rebuilding destroyed homes and infrastructure. The government should prioritise restoring law and order, using an impartial approach to prevent bias in its security response. Further, efforts should be made to promote social justice by addressing issues such as the trauma experienced by displaced populations. Financial assistance to those affected would help rebuild trust between communities, contributing to the reconciliation process.

(c) Addressing Socio-economic Issues: Poverty, Unemployment, and Corruption

Economic disparities are a significant driver of the conflict. Addressing poverty, unemployment, and corruption will help alleviate some of the root causes of ethnic tensions. Creating job opportunities, improving infrastructure, and reducing corruption through better governance and accountability can mitigate long-term grievances. The government should focus on equal distribution of resources and investments across all state regions to foster economic stability and harmony.

(d) Revisiting the MLR & LR Act of 1960: Land Reforms for Equitable Resource Distribution

The Manipur Land Revenue and Land Reforms (MLR & LR) Act, 1960, which restricts non-tribal Meitei communities from owning land in the hill regions, has contributed to growing resentment. Modernising land policies and ensuring a more equitable distribution of land resources is crucial. The reform process should focus on transparency, protecting tribal land rights, and ensuring social justice for all communities. Such reforms would help prevent conflicts over land ownership and encourage greater social cohesion.

(e) Policy Formulation: Emotional and Territorial Integration

The state government should focus on policy formulation that integrates all communities' emotional and territorial aspirations. Many of the problems in Manipur arise from a failure to address these sentiments. Policymakers should create initiatives that promote cultural understanding and equality, reduce discrimination in resource allocation, and ensure that development is distributed fairly across all regions. The government should also build a shared identity encompassing the state's diverse communities.

(f) Consideration of Autonomy: The Manipur (Hill Areas) ADC Bill, 2021

One potential solution for addressing ethnic demands is the proposed increased autonomy for the hill areas through the Manipur (Hill Areas) Autonomous District Council (ADC) Bill, 2021. This proposal seeks to meet the socio-political, cultural, and economic aspirations of the tribal people without compromising the territorial integrity of the state. Giving tribal communities more political power and control over local governance could help alleviate tensions, fostering a sense of ownership and self-determination.

(g) Suspension of Operations (SoO) and Disarmament

The Suspension of Operations (SoO) agreement between the state government and several insurgent groups, including the Kuki National Organisation (KNO) and United People Front (UPF), was a positive step toward peace in 2008. However, the breakdown of this agreement due to escalating violence underscores the need for renewed efforts toward disarmament. The government should prioritise the disarmament of insurgents and the destruction of illegal arms in the region to prevent further violence.

(h) International Support and Cooperation

The role of external factors, such as the influence of Myanmar and China on insurgent activities, must be considered. Diplomatic efforts to limit the flow of arms and insurgents into the region should be pursued. Engaging in regional cooperation on security issues with neighbouring countries could help stabilise the situation. The international community's support for addressing human rights abuses and promoting peace is vital for the long-term resolution of the conflict.

Conclusion

Manipur, despite being rich in minerals and natural resources, remains economically backwards due to factors such as poor infrastructure, persistent militancy, and ongoing ethnic conflicts. Since the 1960s, the state has experienced large-scale violence, displacement, destruction of villages, and loss of lives, particularly between the Meitei (majority) and Kuki (minority) communities. These tensions hinder development and contribute to Manipur being one of the most violence-prone regions in India, with over 50% of violence in Northeast India occurring here. Issues like the demand for a greater Nagalim and separate Kukiland further exacerbate the ethnic divide, with the state government historically neglecting the hill areas, resulting in their economic underdevelopment. In 2021, Manipur ranked poorly in the Good Governance Index. For sustainable peace, all communities must compromise, with the Meitei-dominated government offering greater autonomy to hill tribes and the Kuki community reconsidering its demand for a separate state. Economic development, especially in industry and services, could reduce dependency on land and inter-group conflicts. Promoting economic interdependence among communities and adopting a holistic approach to governance is essential for lasting peace. A transparent, inclusive governance system is needed to address the region's challenges effectively.

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The Deccan Geographer
Vol. 62, No. 10 December, 2024, pp. 182-191
(ISSN-0011-7269)
UGC Care Listed Geography Journal

EXPLORING THE RELATIONSHIP BETWEEN SOCIO-ECONOMIC STATUS AND FERTILITY TRENDS: A CASE STUDY OF ALWAR CITY

Monika Kannan and Divya Chauhan

Abstract

This study explores the intricate relationship between socio-economic status and fertility trends, focusing on Alwar City as a case study. Understanding the Complex dynamics between socioeconomic status and fertility is pivotal for policy-making, peculiarly in developing countries where demographic changes can significantly impact economic development and social stability. The research aims to examine how various socio-economic factors, encompassing income levels, education, employment status, and access to healthcare, determine reproductive behaviours and fertility trends in Alwar City. A comprehensive Sample survey was carried out across diverse socio-economic strata within Alwar City, collecting data on family size, preferred number of children, and socio-economic indicators. Initial findings indicate a prominent inverse relationship between socioeconomic status and fertility rates in Alwar City. Better levels of educational attainment and income are associated with lower fertility rates, resulting in families with better socio-economic standing tend to have fewer children. This trend supports existing literature that determines that higher educational attainment, exclusively among women, leads to delayed childbearing and small family size. Cultural determinates also play a crucial role in shaping fertility behaviors in Alwar city. Traditional norms regarding family size and the status of children within families persist, particularly in lower socio-economic groups. These norms can lead to increased fertility rates in spite of improved access to education and healthcare. In conclusion, the relationship between socio-economic status and fertility trends in Alwar City is examined by a range of interrelated determinants. The findings of this study highlighted the significance of integrating socioeconomic determinants into fertility-related policies and programs. The future research vision should continue to examine these dynamics, focusing on longitudinal studies that can track changes over time and the impact of evolving socio-economic conditions on fertility parameters. Policymakers and practitioners must prioritize educational and health interventions that consider

the socio-economic realities of communities to effectively address the challenges associated with fertility in Alwar and similar urban settings.

Introduction

Fertility trends, which are significant in understanding demographic changes, have been impacted by a variety of determinants, among which socio-economic status plays an exclusive role. This research paper delves into the intricate relationship between socio-economic status and fertility trends in Alwar City, located in Rajasthan, India. As one of the key urban centres in the region, Alwar serves as an interesting case study for evaluating how variations in income, education, occupation, and social class affect reproductive behaviour and family size due to its situation exactly between the two major capitals i.e., Delhi and Jaipur. Smith et al. (2001) - Environmental Factors and Reproductive Health have contributed to study how environmental pollutants, specifically heavy metals and endocrine disruptors, impact reproductive health. The research highlights the global concern over environmental toxins and their correlation with reproductive issues, providing a foundational understanding for assessing similar factors in Jaipur. Jones and Brown (2004) determined the Socioeconomic Status and Women's Reproductive Health as they tried to explore the link between socioeconomic status and reproductive health outcomes in various countries. It underscores the impact of poverty and education on reproductive health, offering a comparative perspective relevant to Jaipur. Nguyen et al. (2007) emphasised the Urbanization and Reproductive Health and examined the effects of rapid urbanization on reproductive health in developing cities. It provides insights into how urban environments, like Jaipur, might influence reproductive health through environmental and socioeconomic changes. The historical analysis of women's status in medieval India Kannan, M. (2018). Helps in understanding long-standing cultural patterns that may influence fertility. Fertility patterns in modern-day India may be linked to historical gender roles, societal expectations, and economic structures. Such historical analysis offers a contextual backdrop for current fertility trends and can identify regions or communities where these patterns are still influential.

Study Area

Study Alwar City, strategically located about 150 kilometres south of the national capital, New Delhi, is identified by both its historical significance and rapid urbanization. Over the recent years, the city has experienced substantial demographic shifts, with rural-urban migration contributing to its growth.

The city's geographical landscape is marked by a blend of urban and semi-urban areas, including several well-developed colonies such as Apna Ghar Shalimar, Malviya Nagar, Panchwati, etc alongside traditional residential neighbourhoods. These colonies are identified with diverse socio-economic strata within the city. The socio-economic diversity within Alwar's population offers a unique opportunity to explore the impact of economic and social factors on fertility trends. The paper examines key parameters such as household income, education levels, employment status, and access to healthcare services across different localities of Alwar, considering both formal and informal sectors of employment. By focusing on these socio-economic determinants, this study aims to provide a deeper understanding of how demographic changes in Alwar City align with broader fertility trends observed in urban India. In analysing this relationship, the paper will explore whether the more educated working women living in furnished Colonies tend to have fewer children compared to street Women with lower income, and how other socio-economic variables like housing conditions and access to family planning services play a role in shaping fertility choices. Through this case study, we aim to draw attention to the broader implications for policy interventions and family planning programs, with the goal of maintaining sustainable demographic development in rapidly urbanizing regions.

Objectives

(1) To examine fertility trends in Alwar City, focusing on birth rates, family size, and age at marriage.
(2) To investigate the intricate relationship between various socio-economic factors (education, income, occupation) and fertility rates in Alwar City.
(3) To explore the impact of socio-economic status on reproductive decision-making and family planning behaviours in Alwar City.

Data base and Methodology

His study employs a combination of both quantitative and qualitative research methods. The sample consists of 200 women from Alwar City: 100 street women and 100 working women. The data collection process is divided into two parts: a structured questionnaire for quantitative analysis and in-depth interviews for qualitative insights. Random sampling was used to select the participants. The sample of street women was drawn from women living in urban slums and street-based communities in Alwar, while the working women were selected from various formal sectors such as healthcare, education, and retail businesses. Ethical considerations were adhered to, with informed consent obtained from all participants.

A structured questionnaire was designed to gather demographic information, socio-economic data, and fertility-related factors such as: Age, education level and employment status, Number of children, age at first birth, and desired family size, Access to healthcare and reproductive health services. In-depth interviews were carried out with a subset of 20 women (10 from each group) to understand the socio-cultural influences on fertility behaviour.

Result and Discussion

The data collection for this research was carried out in various residential areas across Alwar City, Rajasthan, India, with the aim to vide a broad picture of perspectives from both working women and street women. The specific locations for Woking women data included Hasan Khan Mewati Nagar, Scheme 10A, Manu Marg, Scheme 8, Malviya Nagar, Surya Nagar, Ansal Town, and Budh Vihar and for Street women data sample survey was carried out at places like Dhobi Gatta, Sahaab Joda, Akahpura Moholla, Kabir Colony, Khadana Mohalla, Choori Market, and Lohiya Ka Tibara. These areas were pointed out to viewpoint a range of socioeconomic backgrounds and urban development patterns within the city given. The data evaluated reveals significant trends regarding the relationship between socio-economic factors and fertility rates in Alwar City, with particular emphasis on education, income, and employment status.

Inverse Relationship Between Socio-economic Status and Fertility Rates

The study that there is a significant inverse relationship between socio-economic status and fertility rates in Alwar City is well-supported by the data. The fertility trends pointed out that women with lower socio-economic status resulted to have higher fertility rates. For instance, women from lower income groups (below the poverty line and low income) displays higher fertility rates. 63% of women from the "below poverty line" category and 30% of women from the "low income" category have higher fertility, with larger family sizes (3-4 children or more). In contrast, higher income women (middle- and high-income groups) show significantly lower fertility trends, with only 7% from the middle-income group and 0% from the high-income group having large families. The relationship is also evident when looking at education levels. Women with low education levels (no education and primary education) have much higher fertility rates. For example, 45% of women with no education have larger families (3 or more children), compared to just 20% of women with higher secondary education and 80% of women with higher secondary education having fewer children.

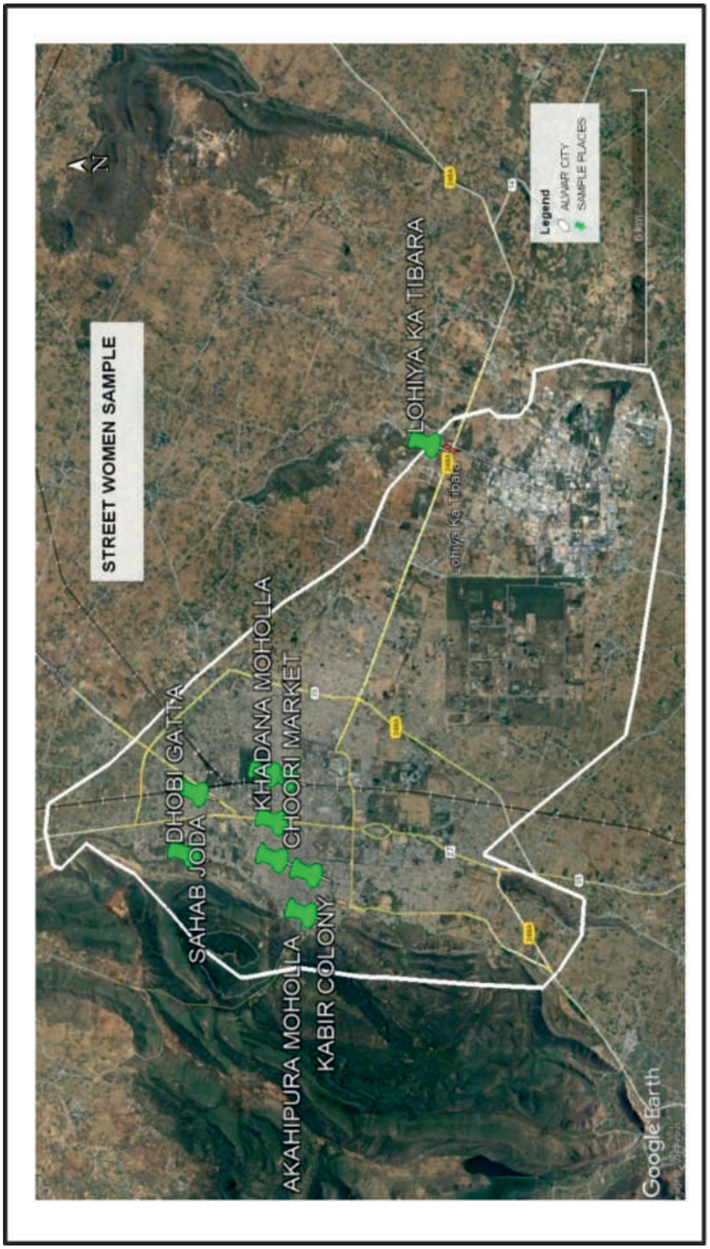

Photo-1: Location Map of Street Women Samples

Socio-Economic Parameter	Street Women (%)	Working Women (%)
Age (25-30 years)	44%	32%
Age (31-35 years)	32%	25%
Age (36-40 years)	19%	22%
Age (41+ years)	5%	21%
Age at First Child (Below 20)	33%	8%
Age at First Child (21-25)	52%	42%
Age at First Child (26-30)	10%	35%
Age at First Child (Above 30)	5%	15%
Number of Children (1-2)	28%	74%
Number of Children (3-4)	52%	26%
Number of Children (5+)	20%	0
Educational Level - No Education	45%	0
Educational Level - Primary	37%	0
Educational Level - Secondary	13%	20%
Educational Level - Higher Sec.	5%	80%
Housewife/Unemployed	17%	0
Street Vendor/Small Business (Unorganised Sector)	83%	15%
Full-Time Employment (Organised Sector)	0%	85%
Income Level - Below Poverty Line	63%	0
Income Level - Low	30%	0
Income Level - Middle	7%	45%
Income Level - High	0	55%
Health Access (Regular)	20%	50%
Health Access (Occasional)	60%	40%
Health Access (Rare)	20%	10%
Decision-Making Power	25%	75%
Plan to Stop Having Children	45%	70%

Contd...

Contraceptive Use (Yes)	17%	80%
Preferred Number of Children (2)	42%	30%
Preferred Number of Children (3+)	53%	7%
Preferred Number of Children (1)	5%	63%

Source: Questionnaire

This demonstrates that education acts as a key factor in reducing fertility, with women with better educational attainment generally opting for less children, likely due to bent towards career aspirations and better access to family planning resources.

Impact of Employment Status on Fertility Trends

Employment status, particularly full-time employment in private or government sectors, also plays a determining role in shaping fertility patterns. The data explicit a remarking contrast between women who are employed and those who are not. For instance, 83% of street vendors and women in small businesses particularly in unorganised sector have 3 or more children, which suggests that they are likely to have higher fertility rates due to socio-economic constraints. On the other hand, 85% of full-time employed women (in organised Sector) have smaller families, with most having 1 or 2 children. This is consistent with global trends, where employed women often delay childbearing, prioritize career advancement, and have fewer children, owing to economic independence and better access to healthcare and family planning services.

Age at First Child and its Relationship with Socio-Economic Factors

Age at first child is another critical determinant compiled to socio-economic status. The data demonstrates a clear difference in the age at which women have their first child, with lower socio-economic status women tending to have children at younger ages. For example, 33% of women from lower socio-economic strata (below 20) have their first child before age 20, in contrast to only 8% of working women who delay childbirth until their 30s. On another dimension, women with higher educational attainment and employment tends to have their first child later. For instance, 35% of working women have their first child between the ages of 26-30, reflecting the trend that educated, employed women are more likely to delay childbearing as they on career development and financial stability.

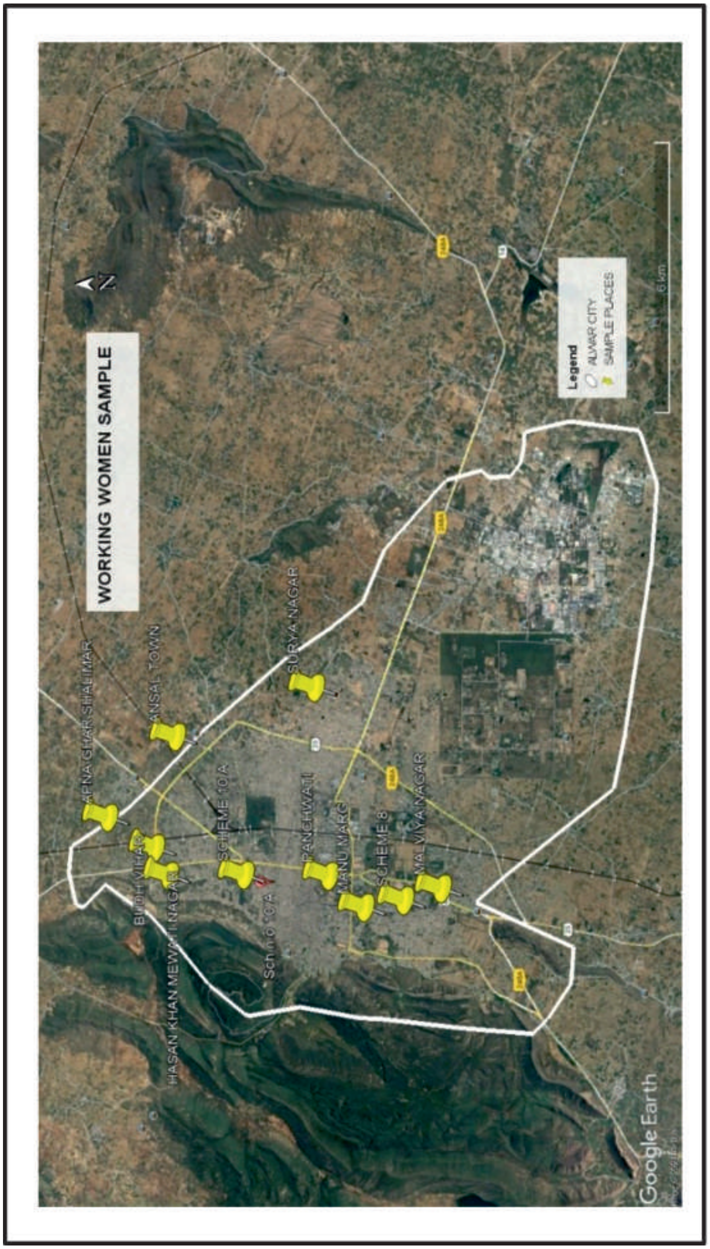

Photo-2: Location Map of Working Women Samples

Fertility and Family Size Patterns

The other notable examination is that the number of children a woman has correlates strongly with her socio-economic status. Street women and women in small businesses more likely to have larger families (3-4 children), whereas working women (especially those in government or private employment) have fewer children. This can be examined to the higher economic and social costs of raising children in formal employment and the prioritization of career over family size. Additionally, working women (exclusively those in the high-income category) likely have access to better healthcare, contraceptive methods, and family planning, which resulting in balancing fertility.

Health Access and Fertility Control

Access to healthcare plays a crucial role in fertility rates, as it directly impacts a woman's ability to plan and space her children. The data shows that only 20% of women in street vendor or small business occupations have regular access to health services which is remarkable, while 50% of working women have access to health care services, reflecting the better healthcare access attainment that comes with formal employment. Women with regular healthcare access are more likely to use family planning methods, further supporting the inverse relationship between socio-economic status and fertility rates.

Conclusion

In conclusion, the study that socio-economic status significantly influences fertility trends in Alwar City supported by filed survey. The data supports the theory that women with lower socio-economic status tend to have higher fertility rates, while those with higher education, better employment opportunities, and higher income generally have fewer children. This is due to a combination of variety of factors, including better access to healthcare, financial resources, career prioritization, and family planning services. The inverse relationship between socio-economic status and fertility rates evaluated in this study introduced the significance of education, income, and employment in shaping fertility choices and trends. The data reveals that education, income, and employment status are key indicators of fertility trends. Therefore, targeted interventions and Policies should be come in light focusing on improving education, healthcare access for lower socio-economic groups and economic opportunities could contribute to lowering fertility rates and enhancing overall socio-economic development in the region.

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The Deccan Geographer
Vol. 62, No. 10 December, 2024, pp. 192-204
(ISSN-0011-7269)
UGC Care Listed Geography Journal

URBAN GOVERNANCE FOR SUSTAINABLE DEVELOPMENT: A CASE STUDY OF CBD OF DELHI

Dr. Karuna Shree, Dr. Isha Kaushik and Rohit Kumar Yadav

Abstract

This study investigates the relationship between government performance and electoral behaviour in Regarpura, focusing on key development indicators such as electricity supply, drinking water, infrastructure, and the average prices of essential commodities. Primary data was collected through a structured questionnaire distributed to 300 households, representing approximately 12.6% of the total electorate in Regarpura (2,385 families). Quota sampling was employed to ensure proportional representation from different sectors within the study area. Respondents were asked to evaluate the government's performance in their area regarding electricity supply, drinking water, roads, transportation, and metro services, with options to grade these aspects as 'Good', 'Average', or 'Poor'. Additionally, questions regarding the average prices of essential commodities like rice, wheat, pulses, and vegetables were included to assess household economic strain. The study examines how satisfaction with these indicators might influence voters' preferences and their likelihood of supporting or rejecting the current ruling government. Preliminary findings suggest that sectors with better infrastructure and more affordable prices show higher satisfaction, potentially leading to more excellent electoral support for the incumbent government. Conversely, dissatisfaction with critical services may drive voters to consider alternative political parties.

Introduction

Global urbanisation trends indicate a significant shift, with projections suggesting that nearly 70% of the world's population will reside in urban areas by 2050, increasing pressures on infrastructure, resources, and governance systems (Onyango, 2018; Singh et al., 2024). The level of urbanisation in a nation always reflects the country's level of development. Almost half of the world's humanity lives in urban areas like cities, and their number is continuously growing.

Cities are drivers of economic activities and essential economic and social development engines, offering significant economies of scale in providing shelter, employment and services and critical productivity centres (Di Clemente et al., 2021). Urbanisation is particularly pronounced in India, with the urban population expected to reach 600 million by 2031, driven by rural-urban migration and economic opportunities (Punyamurthy & Bheenaveni, 2023; Nayak & Rajan, 2021). India is experiencing rapid urbanisation with significant economic shifts to cities (Roy, 2022). Usually, metropolitan areas are the hub of ideas, commerce, culture, science and social development. The quality of life being offered in cities is of some concern. Common urban challenges are deterioration of the physical environment, congestion, lack of essential services like drinking water quality, sanitation and electricity, declining infrastructure facilities like roads and transportation, shortage of housing and lack of opportunity for socio, cultural and educational development (Ezadin mohammed & Faraj Mustafa, 2022). The country's capital, Delhi, experiences rapid growth that impacts the ecosystem and resources. Also, it exemplifies these challenges, as its Central Business District (CBD) plays a crucial role in the city's economic and social fabric yet faces issues such as rapid population growth, environmental degradation, and traffic congestion, exacerbating socio-economic inequalities (Bansal et al., 2022; Punyamurthy & Bheenaveni, 2023; Meng, 2024) and also Delhi's Central Business District (CBD) faces significant governance challenges that hinder sustainable urban development, including inadequate urban planning, inefficient public services, and severe air pollution (Garima, 2018; Ghertner, 2020; Gupta et al., 2019). The fragmented governance structure complicates air quality management, as evidenced by the need for coordination among agencies, which diminishes the effectiveness of pollution control measures (Khera & Irshad, 2023; Yadav & Saxena, 2023). Waste management issues further exacerbate these challenges, with privatisation efforts leading to conflicts between informal recyclers and residents concerned about environmental impacts (Demaria, 2023). Additionally, social inequalities manifest in the uneven distribution of pollution burdens, highlighting the need for inclusive decision-making processes that recognise diverse stakeholder perspectives (Joshi & Swarnakar, 2023). For instance, urbanisation has led to economic growth and issues like slum expansion and pollution, necessitating comprehensive urban policies that balance growth with sustainability (Punyamurthy & Bheenaveni, 2023; Kureshi, 2023). Effective management strategies, such as integrated urban planning and investment in green infrastructure, are essential to mitigate these challenges and promote resilient urban environments (Meng, 2024; Salimova, 2022). Thus, understanding urbanisation's dynamics is vital for fostering sustainable development and improving the quality of life in cities. Sustainable urban development, aligned with frameworks like the UN Sustainable Development Goals (SDGs), particularly SDG 11, emphasises sustainable governance's need to address these urban challenges effectively (Battisti & Baiani, 2022; Singh et al., 2024).

Despite existing literature on urban sustainability, there is a notable gap regarding governance models specific to rapidly growing cities like Delhi, indicating a need for research that addresses these unique urban governance dynamics (Kathambi & Obiero, 2022). This study explores how urban governance in Delhi’s CBD affects sustainable development, examines critical challenges, and evaluates stakeholder roles, contributing to governance models, policy recommendations, and broader urban sustainability implications.

Objective

The present paper has examined how good governance is vital to the city's development and to analyses how the government has performed in different decision-making spheres and their subsequent acceptance by the resident citizens.

Study Area

The study area for this research is Regarpura, located within the Central Business District (CBD) of Delhi. Regarpura is a lower to middle-income area with densely packed residential buildings and a mix of commercial establishments, such as small shops, markets, and local businesses. The locality is situated near major transportation hubs, enhancing its connectivity with other parts of the city. The area faces challenges typical of urban neighbourhoods, including traffic congestion, waste management issues, and limited green spaces.

Regarpura has been divided into fourteen sectors for data collection and analysis, each bordered by roads on all sides. These ten roads intersect the CBD, outlining the fourteen industries as follows: Sector A (streets 1-5), Sector B (streets 6-17), Sector C (streets 17-22), Sector D (streets 23-31), Sector E (streets 31-39), Sector F (Sant Nagar, streets 1-5), Sector G (streets 40-46), Sector H (streets 47-52), Sector I (streets 53-58), Sector J (streets 59-66), Sector K (Krishan Nagar, streets 1-5), Sector L (streets 67-70), Sector M (streets 71-74), and Sector N (streets 75-81) (Fig. 1). The demographic characteristics are that Regarpura is home to a diverse population with a high density of residents living in compact housing units.

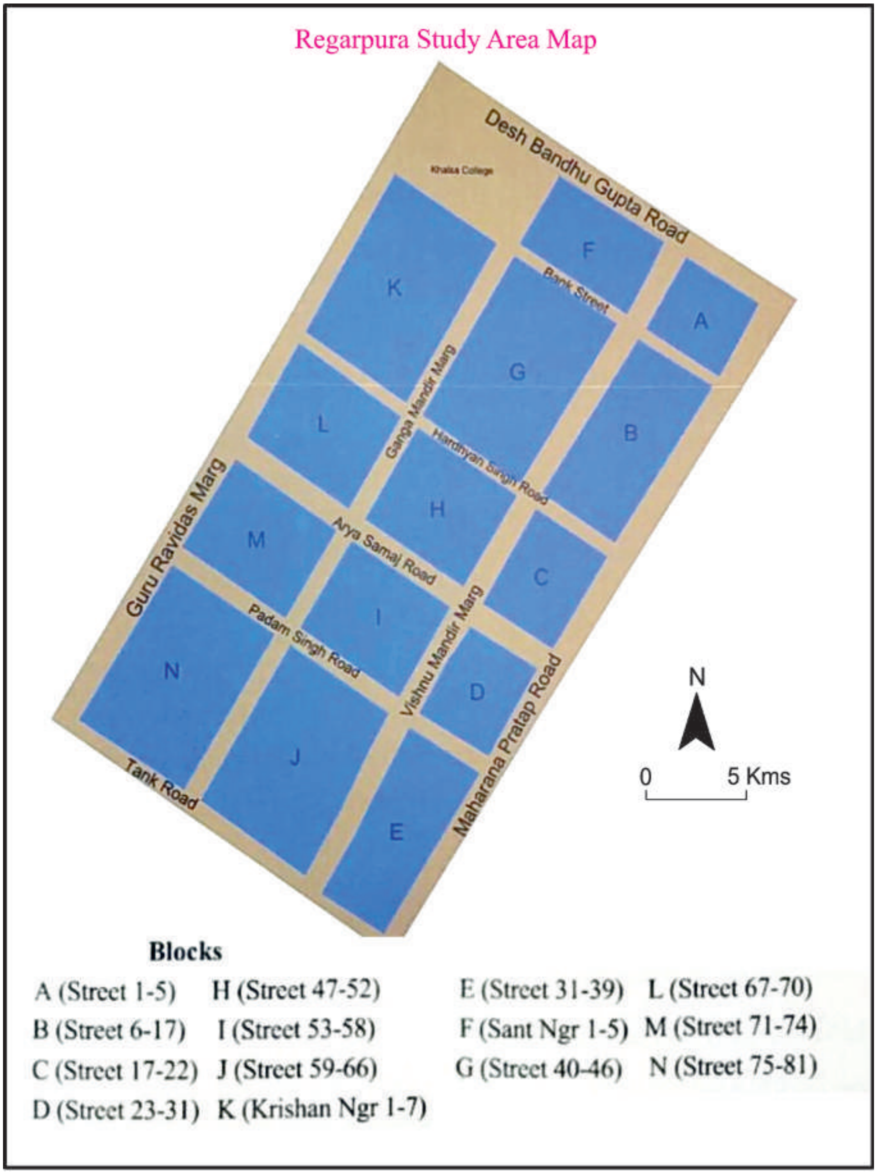
Regarpura Study Area Map
Desh Bandhu Gupta Road
Khalsa College
Bank Street
Ganga Mandir Marg
Hardhyan Singh Road
Guru Ravidas Marg
Arya Samaj Road
Padam Singh Road
Vishnu Mandir Marg
Maharana Pratap Road
Tank Road
A
B
C
D
E
F
G
H
I
J
K
L
M
N
N
0
5 Kms
Blocks
A (Street 1-5)
B (Street 6-17)
C (Street 17-22)
D (Street 23-31)
H (Street 47-52)
I (Street 53-58)
J (Street 59-66)
K (Krishan Ngr 1-7)
E (Street 31-39)
F (Sant Ngr 1-5)
G (Street 40-46)
L (Street 67-70)
M (Street 71-74)
N (Street 75-81)

Fig. 1

The area is predominantly populated by families from lower and middle-income groups, with a mix of workers from the informal sector, small business owners, and service providers. The population exhibits a range of socio-economic backgrounds, with many households depending on daily wages or small-scale employment. Educational attainment in the area is varied, with many children attending local schools, while adult literacy rates are moderate, reflecting the socio-economic conditions of the locality. The population is predominantly young to middle-aged, with a significant proportion of residents engaged in local commerce and small industries.

Database and Methodology

The study is based on primary sources of data. Primary data is collected through a questionnaire. Elector respondents from about 300 households were asked questions regarding the government's performance in their area. Quota sampling was done for each sector within the study area. 300 represent the total elector's Regarpura household, about 2,385 households. A proportional quota for respondent households was calculated for each industry. Grading the electricity supply and drinking water, infrastructure like roads, transportation, and metro were categorised as 'Good', 'Average', and 'Poor'. Apart from that, the government should also perform in the assembly. Average prices of the essential commodities were also asked. Suppose the government meets the indicators mentioned above of development in an area. In that case, there is more possibility that the electors would vote back the ruling government, but if unsatisfied, they may want to test other political parties. In the Regarpura study area, respondents were also questioned about the government's performance on the above indicators, and the following results emerged.

Result and Discussion

Electricity Supply

Even though Delhi is India's capital and a metropolitan city, many of its CBD regions still lack electricity. An uninterrupted electricity supply is necessary, with a maximum number of people doing business in this CBD region (like small traders or shopkeepers). The grading of the electricity supply in Regarpua had mixed responses. The highest, 92.86% of respondents in sector F rated it as 'Good', whereas the highest, 70.83%, in sector N, rated it as 'Average', and the highest, 22.22% of respondents in sector L rated it as 'Poor'.

Drinking Water

When asked questions regarding the availability of clean drinking water, which is the bare minimum need of a household, the responses were very alarming. The highest, 35.71% of sector F respondents rated it as ‘Good’. The highest, 37.50% of respondents in sector C, rated it as ‘Average’, whereas, as the highest, 93.75% of respondents in sector D rated it as poor.

Infrastructure

Infrastructure plays a role in improving the economic standard of any region. It helps flourishing business and employment. Regarpura is a dominant business region, so the infrastructure must be improved here. Respondents were asked to rate the infrastructure facilities within the study area.

Transport

The highest 57% of respondents rated Transport as ‘Good’ in sector F, north of Regarpura, between the Deshbandhu Gupta Road on the northern side and Bank Street on the southern side. None of the respondents rated transport as ‘Good’ in sectors G, K and L, mainly the interior sectors of Regarpura. The highest 75% of respondents in sector D rated Transport as ‘Average’, and the lowest, 42.86%, rated it as ‘average in sector F. The highest percentage of respondents rated transport as ‘Poor’ in sector G, with 55.56%. Only sectors such as F, which lie on the border of the study area adjacent to a major road, consider transport reasonable. Sector F had the highest percentage of 57.14% of respondents rating ‘Roads’ as ‘Good’, whereas in sectors A, C, D, G, H, L and N, none rated it as ‘Good’. In sector F, only the highest % of respondents (28.57%) rated it as ‘average’. In at least two sectors, H and L, 100% of respondents rated it as ‘Poor’. Almost all strata of people are using metro service in this region. It is considered economical and safe, especially for women. Most of the respondents liked the Metro facility. In sectors C, H, K, L and N, 100% of respondents rated it as ‘Good’. The highest 18.18% of respondents in sector A consider it as ‘Average’. Very few respondents rated it as ‘Poor’; the highest percentage was in sector D, where 6.25% regarded it as ‘poor’.

Impact Assessment of Price Rise

Price rise is an essential indicator on which the elector’s behaviour depends. If a ruling government can control the price rise, it has more chances of returning to power. The impact of the constant price rise was putting the residents of the study area under much pressure. They were paying high prices for essential food items and fuel.

Constant rises in fuel prices have also been a matter of concern for the residents of the CBD. Respondents were asked to mention the average amount they spend per month on fuel like petrol, diesel or CNG. On average, respondents in Regarpura spend Rs 2041.51 per month on fuel. Respondents in sector A spent the most significant amount of Rs 3312.50 on fuel, whereas respondents spent the least amount of Rs 1166.67 in sector G. The table highlights significant variations in food prices across sectors in Regarpura, with some areas experiencing higher costs than others. "Sector F" consistently has the highest prices for multiple items, including rice (Rs. 43.21/kg), wheat (Rs. 23.21/kg), onions (Rs. 34.29/kg), mangoes (Rs. 35.50/kg), and oranges (Rs. 31.36/kg), suggesting higher demand or better access to markets. "Sector A" has the highest prices for pulses (Rs. 68.33/kg) and apples (Rs. 47.00/kg), reflecting potentially higher living costs or supply constraints. Conversely, "Sector C" offers the lowest prices for rice (Rs. 29.38/kg), wheat (Rs. 16.88/kg), potatoes (Rs. 13.13/kg), and tomatoes (Rs. 17.50/kg), which may indicate lower demand or less developed market access (Table-1). "Sector G" and "Sector L" also provide lower prices for several items, including onions, mangoes, and bananas, suggesting differences in local supply and demand dynamics. The price disparity across sectors indicates that residents in higher-priced areas, like F and A, may face more financial strain. In contrast, lower-priced sectors like C, G, and L could experience lower living costs, though potentially with challenges in supply and infrastructure. It should be noted that for food items and fuel, the most significant amount spent was by sectors mainly lying on the northernmost side of the Regarpura study area. These sectors are also the ones with the highest percentage of people with the castes considered high under social structure and are considered economically better. They can, therefore, afford high prices of food items and fuel.

Impact on Human and Urban Governance

The challenges faced by Regarpura reveal significant issues related to infrastructure, essential services, and economic pressures, all of which have direct implications for the well-being of residents, urban governance, and development. The inconsistent supply of essential services like electricity, clean drinking water, and transport facilities negatively impacts the quality of life. For example, the electricity supply in Regarpura CBD could be more reliable, particularly for small traders and shopkeepers. Uninterrupted electricity is critical for business operations, and its absence creates economic insecurity and disruptions. Similarly, the clean drinking water situation could be better, particularly in sectors like D, where 93.75% of respondents rated it inadequate. This lack of access to clean water poses serious health risks, Table-1: Impact of price rise (Average price of food items) Rs. Per Kg.

Sectors	Rice	Wheat	Pulses	Potatoes	Tomatoes	Onions	Mangoes	Oranges	Bananas	Apples
A	35.50	20.20	68.33	18.60	26.50	38.50	33.57	30.00	32.50	47.00
B	31.77	20.00	61.36	18.05	29.29	23.56	36.82	28.57	29.71	65.00
C	29.38	16.88	40.63	13.13	17.50	21.88	20.00	28.75	30.00	52.50
D	35.00	17.50	49.69	18.44	19.69	28.88	31.82	27.92	27.81	38.08
E	31.43	17.14	46.07	18.21	22.50	22.50	30.00	29.44	26.54	33.46
F	43.21	23.21	58.21	18.93	26.07	34.29	35.50	31.36	28.93	37.50
G	30.88	16.76	48.24	15.31	16.56	21.88	25.00	23.33	24.33	34.23
H	36.13	19.38	50.63	18.83	21.42	23.75	26.90	23.53	28.33	34.09
I	34.44	18.15	41.41	16.67	19.81	29.44	27.94	26.18	28.20	32.61
J	30.54	17.03	45.00	18.51	22.16	47.43	26.07	27.78	28.09	35.44
K	34.62	16.92	43.27	16.15	19.62	28.85	29.74	26.43	30.00	36.40
L	30.00	15.56	35.56	14.44	20.00	28.13	28.57	23.33	20.63	31.25
M	36.05	16.84	44.21	20.00	25.26	27.37	25.53	23.53	29.72	36.25
N	34.09	21.82	46.59	22.95	32.50	45.91	40.38	28.61	30.45	37.14
Regarpura	33.7887	18.38	48.514	17.7307	22.7771	30.1673	29.846	27.055	28.232	39.3538

leading to waterborne diseases and other public health challenges. Furthermore, uneven transport and road conditions across sectors complicate daily life for residents. Sectors like G, K, and L suffer from poor infrastructure, which limits mobility and access to essential services. In contrast, sector F, located at the border, has better transport infrastructure due to its proximity to major roads. The rising food and fuel costs exacerbate household economic pressures, particularly in sectors like A and F, where residents face higher prices for necessities. This financial strain leaves families with less disposable income for other essential needs like healthcare and education. These disparities in service delivery and infrastructure point to areas for improvement in urban governance. Effective urban governance requires equitable distribution of resources and efficient service provision to all residents. The significant differences in the quality of electricity, water, and transport services across sectors indicate poor urban management and planning. For example, the high percentage of poor ratings for roads and water supply in some sectors reflects a need for more investment and maintenance. Urban governance must address these issues to ensure all residents can access essential services regardless of socioeconomic background or location. Additionally, urban policies must prioritise underdeveloped sectors to bridge the gap between economically privileged and disadvantaged areas. Without comprehensive policies targeting these underserved areas, inequalities persist, further exacerbating social divisions. Urban governance must also address price rises for food and fuel, as these economic challenges directly affect residents' daily lives and influence their political behaviour. In terms of urban development, Regarpura's infrastructure needs significant improvement. The disparity in infrastructure quality directly impacts economic growth and social equity. With better transport and road access, sectors like F benefit from more business opportunities and economic activity. In contrast, sectors like G and L, with inadequate infrastructure, need help with economic growth and access to services. Urban development policies should improve infrastructure in underdeveloped areas by enhancing roads, transport, and reliable access to clean water and electricity to foster economic development. Investments in these areas would improve residents' quality of life and attract business investment, contributing to economic growth. Sustainability is another critical aspect of urban development in Regarpura. The rising fuel cost highlights the need for more sustainable transportation options, such as expanding the metro system. The metro service in Regarpura has received positive feedback for being economical and safe, especially for women. Expanding and improving such sustainable public transport options would help reduce fuel dependence and alleviate the financial burden on households.

Additionally, integrating renewable energy sources into the city's infrastructure would reduce reliance on fossil fuels, making the urban environment more sustainable. Lastly, urban development must address social equity. There is a marked disparity between economically privileged sectors (like A and F) and underdeveloped sectors (like G and L). Sustainable urban development must ensure that all residents, regardless of socioeconomic status, have equal access to economic participation, education, and social mobility opportunities. Regarpura can create a more equitable, resilient, and prosperous community by prioritising inclusivity in urban planning.

Strategies for Mitigation of the Challenges

Regarpura faces significant challenges related to infrastructure, essential services, and economic pressures, which directly impact the well-being of its residents, urban governance, and development. Key issues include inconsistent electricity supply, poor water quality, inadequate transportation infrastructure, and rising food and fuel costs. Several strategies can be adopted from an urban geography perspective to mitigate these challenges. First, improving infrastructure in underserved sectors is crucial. This could involve upgrading roads, water facilities, and electricity supply, focusing on bridging the gap between economically privileged sectors (like A and F) and underdeveloped areas (such as G, K, and L). This strategy aligns with **Central Place Theory**, which emphasises the need for well-connected regions to improve accessibility and promote equitable economic activity. Another key mitigation strategy involves expanding and improving public transport, particularly the metro system, to ensure better connectivity between sectors. This could follow the **Transit-Oriented Development (TOD)** model, which promotes high-density, mixed-use development around public transport hubs. This strategy would reduce dependency on private vehicles, decrease fuel costs, and improve overall mobility, benefiting businesses and residents. Focusing on renewable energy solutions, such as solar power and energy-efficient buildings, would help reduce energy costs and contribute to long-term environmental sustainability, aligning with the "Sustainable Development Model". Addressing social inequalities through affordable housing policies is another essential strategy. The growing disparity between sectors with varying levels of development underscores the need for urban policies that prioritise inclusive growth. "Urban Political Economy Theory" highlights the influence of political and economic forces, often benefitting wealthier sectors. To counter this, targeted investments in affordable housing and equitable access to public services in underdeveloped sectors would help reduce social inequities. Furthermore, ensuring community participation in urban planning, particularly in marginalised areas, is vital for more inclusive governance. The “Advocacy Planning Model” suggests that urban planning should involve the active participation of local communities, especially those in economically disadvantaged sectors, to address their needs. This would lead to more tailored and effective solutions for industries like G, K, and L, needing more infrastructure and services. Finally, addressing the public health and sanitation challenges, especially in sectors with poor water quality, is essential. Implementing a comprehensive public health infrastructure program to ensure access to clean drinking water and proper sanitation would mitigate health risks, reduce disease, and improve residents' quality of life. This approach aligns with “Environmental Justice Theory”, ensuring that vulnerable communities do not bear disproportionate environmental burdens and promote sustainable and equitable development.

Conclusion

The sustainable development of any city region largely depends on effective governance and residents' satisfaction with government policies. In the case of Regarpura, a locality in Delhi’s CBD, government performance in areas like infrastructure, electricity, and drinking water has been mixed. While residents were generally satisfied with the electricity supply, transportation, and roads near Deshbandhu Gupta Road, interior roads were rated poorly. Drinking water supply, however, was a significant concern due to uneven distribution and cleanliness issues. Regarpura's population is primarily middle-income, with 50.91% of respondents engaged in their businesses. Residents are increasingly frustrated by rising prices of essential goods and higher fuel costs, affecting their monthly expenses. Most of the population belongs to socially disadvantaged groups, with 56.57% of respondents from Scheduled Castes. Most families are nuclear (59.64%), and women comprise 48.25% of the population. Educational attainment is low, with only 51.48% of respondents having studied beyond the fifth grade, and the area needs significant higher education institutions. The government's efforts to improve infrastructure are evident. Still, issues like rising costs and awareness of local political matters suggest that the area needs more governance. Greater local participation in policy-making and addressing economic concerns are essential for sustainable development in Regarpura.

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The Deccan Geographer
Vol. 62, No. 10 December, 2024, pp. 205-218
(ISSN-0011-7269)
UGC Care Listed Geography Journal

ENHANCING OPERATIONAL EFFICIENCY AND SCALABILITY OF START-UPS UNDER THE START-UP INDIA INITIATIVE: AN ANALYSIS HOW FAR WE HAVE REACHED

Dr. Richa Sharma and Himalya Sharma

Abstract

Promoting entrepreneurship has grown to be a key component of global economic policies in recent years. Governments everywhere have recognized the importance of startups in fostering innovation, economic expansion, and job creation. Countries such as Singapore, Germany, Israel, and the United States have successfully put structures and regulations in place to build strong start-up ecosystems. Notwithstanding these advancements, growing start-ups, guaranteeing fair access to capital, and resolving regional inequities remain difficulties for many nations, including India. India's flagship program to solve these issues is called Startup India. However, there are still a lot of gaps in funding channels, infrastructure assistance, and operational efficiency, particularly for start-ups in rural and non-tech sectors. This study aims to critically assess the initiative's progress in accomplishing its objectives and tackling these worldwide concerns. In order to examine the operational effectiveness and scalability of start-ups under the Startup India initiative, the study uses a qualitative and descriptive research technique.

Background

Startup India is an initiative launched by our Hon'ble Prime Minister Shri Narendra Modi in January 2016 to foster entrepreneurship and promote startup culture in the country. The primary objective of the Startup India campaign is to create a favourable environment for startups to grow and thrive, thereby driving economic growth and job creation. The idea for the Startup India initiative originated from the vision of the Indian government to promote entrepreneurship and innovation as key drivers of economic growth. The government recognized the potential of startups to spur job creation, attract investment, and contribute to overall economic development. In his Independence Day speech on August 15, 2015, the Prime Minister of India, Shri Narendra Modi, highlighted the importance of entrepreneurship and the need to create a conducive ecosystem for startups. He emphasized the role of startups in transforming India into a global hub for innovation and technology. Building upon this vision, the government launched the Startup India campaign on January 16, 2016. The initiative was aimed at addressing the challenges faced by startups in India and providing them with the necessary support, resources, and incentives to thrive. The government sought to streamline regulations, ease the process of starting and operating a business, and foster a culture of entrepreneurship in the country. The Startup India initiative was designed to create an enabling environment where startups could flourish by removing barriers, encouraging investment, providing funding support, and promoting collaboration between stakeholders. The government engaged with various stakeholders, including entrepreneurs, investors, industry associations, and experts, to shape the policies and programs under the Startup India campaign. The initiative was formulated through consultations, feedback, and discussions with the startup community, with the aim of addressing their specific needs and aspirations. Since its launch, the Startup India initiative has evolved and expanded, incorporating feedback from the startup ecosystem and adapting to the changing needs of entrepreneurs. It has become a comprehensive program that encompasses various measures to support and nurture startups, making India a more attractive destination for entrepreneurship and innovation.

Objectives

The main objectives of the Startup India initiative are Simplified regulations, Startup India Hub, Startup India Learning Program, Funding support and incentives, Intellectual Property Rights (IPR) protection, Collaboration with academia, Incubation and innovation centres etc. The government aims to reduce the regulatory burden on startups by introducing simplified procedures, such as a single-page startup registration form and fast-track patent examination at lower costs.

Database and Methodology

Secondary Data have collected from existing literature on the Startup India initiative, government publications, policies, and research journals. We have examined reports from the Ministry of Commerce, NITI Aayog, and scholarly research. Comparative Analysis; to find gaps and best practices, policies and results from international start-up ecosystems—such as those in the US, Israel, and Singapore are contrasted with the Indian one. SWOT study; to assess the performance, constraints, and potential of the Start-up India project, a thorough SWOT (Strengths, Weaknesses, Opportunities, and Threats) study has been carried out. Case Studies; to offer practical insights into the difficulties and possibilities in India's startup ecosystem, case studies of both successful and unsuccessful start-ups are included. Thematic Analysis; to determine how they affect start- up growth, themes such as funding assistance, geographical disparities, grassroots entrepreneurship, and policy execution are examined.

Results and Discussion

A dedicated online platform, the Startup India Hub and BHASKAR (Bharat Startup Knowledge Access Registry) serves as a one-stop solution for startups, providing access to information, resources, and mentorship programs. The initiative offers online learning and capacity-building programs to equip entrepreneurs with the necessary skills and knowledge to run their startups effectively. The government has introduced various measures to facilitate access to funding, including the creation of a Rs 10,000 crore (approximately \$1.4 billion) Fund of Funds for startups. Additionally, tax benefits, such as a three-year income tax exemption for eligible startups, have been provided. The initiative emphasizes the importance of intellectual property and provides fast-track examination and a reduced fee structure for filing patents, encouraging startups to protect their innovations. The government has established incubation centers and research parks to provide startups with infrastructure facilities, mentoring, networking opportunities, and access to investors. Startup India aims to foster collaboration between startups and academic institutions, encouraging research and development, and promoting innovation. The Startup India initiative has played a significant role in fostering entrepreneurship and promoting the growth of startups in India. It has helped in creating a vibrant ecosystem for startups, attracting investment, encouraging innovation, and generating employment opportunities. As Startup India focuses specifically on promoting start-ups and entrepreneurship, Vishwaguru Bharat represents a broader vision for India's overall development and global leadership across various domains. One cannot deny the fact that Startup India plays important role in a roadmap of India to become Vishwaguru Bharat. It is also important to note that both initiatives are part of the government's larger agenda to drive economic growth, innovation, and social progress in the country. Corporates can help these incubators by providing support in the form of CSR funds, which the incubators can utilize to address a number of economic, social, and environmental issues.

Corporate involvement would also improve innovation and the quantity of opportunities for entrepreneurs. Aside from that, working with start-ups based on fresh ideas and market research can result in being business ready and can also help corporates respond to the market's constantly changing expectations. Many prominent business experts have cautioned that "corporates would die if they did not innovate," so businesses are now cooperating with startups to obtain access to new ideas, technology, and methodologies. As a result, engaging with start-ups would benefit corporates not just financially, but also in terms of industry research and development undertaken by startups to generate innovative concepts. Finally, corporate support via CSR money can be mutually beneficial for both firms and entrepreneurs, resulting in the growth of the country's economy. Several countries across the world are actively working on developing and implementing startup policies to foster entrepreneurship and innovation within their borders. Some countries like United States, Israel, United Kingdom, Singapore, Germany, France, South Korea etc. are known for their focus on startup policies and initiatives. The United States has been a leader in promoting startup culture, with various policies and initiatives at the federal, state, and local levels. The Small Business Administration (SBA) and organizations like the National Science Foundation (NSF) support startup development through funding, grants, and mentorship programs. Israel has a thriving startup ecosystem and has implemented several policies to support entrepreneurship and innovation. Programs like the Israel Innovation Authority (IIA) provide funding, grants, and support to startups, while technology transfer offices at universities promote commercialization of research. United Kingdom: The United Kingdom has established initiatives such as Tech Nation and Innovate UK to support startups. The British Business Bank provides funding and support, and the Enterprise Investment Scheme (EIS) offers tax incentives for investors in startups. Singapore: Singapore has actively fostered a startup-friendly environment through policies such as Startup SG, which includes funding schemes, tax incentives, and mentorship programs. Organizations like Enterprise Singapore and Infocomm Media Development Authority (IMDA) provide support to startups. Germany: Germany has implemented policies to support startups, including the High-Tech Startup Fund and the EXIST program, which provides funding, coaching, and infrastructure support. The German government also promotes collaboration between startups and established companies. France: France has launched the French Tech Initiative, which aims to position the country as a global hub for startups. Initiatives like La French Tech Visa and French Tech Ticket facilitate the entry and support of foreign entrepreneurs, while Bpifrance provides funding and support to startups.

South Korea: South Korea has focused on promoting startup ecosystems through initiatives such as the Korea Creative Content Agency (KOCCA) and the Korea Startup Forum. The government has also introduced policies to encourage investment in startups and support innovation. These are just a few examples, and many other countries across the globe have recognized the importance of startups and have been working on policies and initiatives to foster entrepreneurial growth and innovation within their respective borders.

Benefits

The Startup India initiative has several benefits for entrepreneurs, startups, and the overall economy of India. Some of its advantages includes the entrepreneurial ecosystem, job creation, access to funding, simplified regulations etc. The Startup India has played a crucial role in fostering a vibrant entrepreneurial ecosystem in India. It has encouraged the spirit of innovation, risk-taking, and entrepreneurship among aspiring entrepreneurs, leading to a surge in startup activity across various sectors. Startups are significant contributors to job creation, and Startup India has been instrumental in generating employment opportunities. By supporting startups and enabling their growth, the initiative has facilitated the creation of new jobs, addressing the employment challenges in the country.

Startup India provides startups with access to funding and investment opportunities. The Fund of Funds for startups, with a corpus of Rs 10,000 crore, has encouraged investment in startups by supporting registered Alternative Investment Funds (AIFs). This funding support helps startups secure the necessary capital for their growth and expansion.

The initiative aims to simplify regulatory compliance for startups. The introduction of a single-page registration form, self-certification of compliances for labor and environmental laws, and fast-track patent examination reduces administrative burdens and compliance costs for startups, making it easier for them to operate and grow. Eligible startups under Startup India enjoy various tax benefits. These include a three-year income tax exemption, exemption from capital gains tax, and exemption from tax on investments above fair market value. These incentives reduce the financial burden on startups during their initial years of operation. Startup India emphasizes the importance of intellectual property rights (IPR) and provides support to startups in protecting their innovations. Fast-track examination and reduced fee structure for patent filing, along with facilitation of legal support, encourage startups to safeguard their intellectual property.

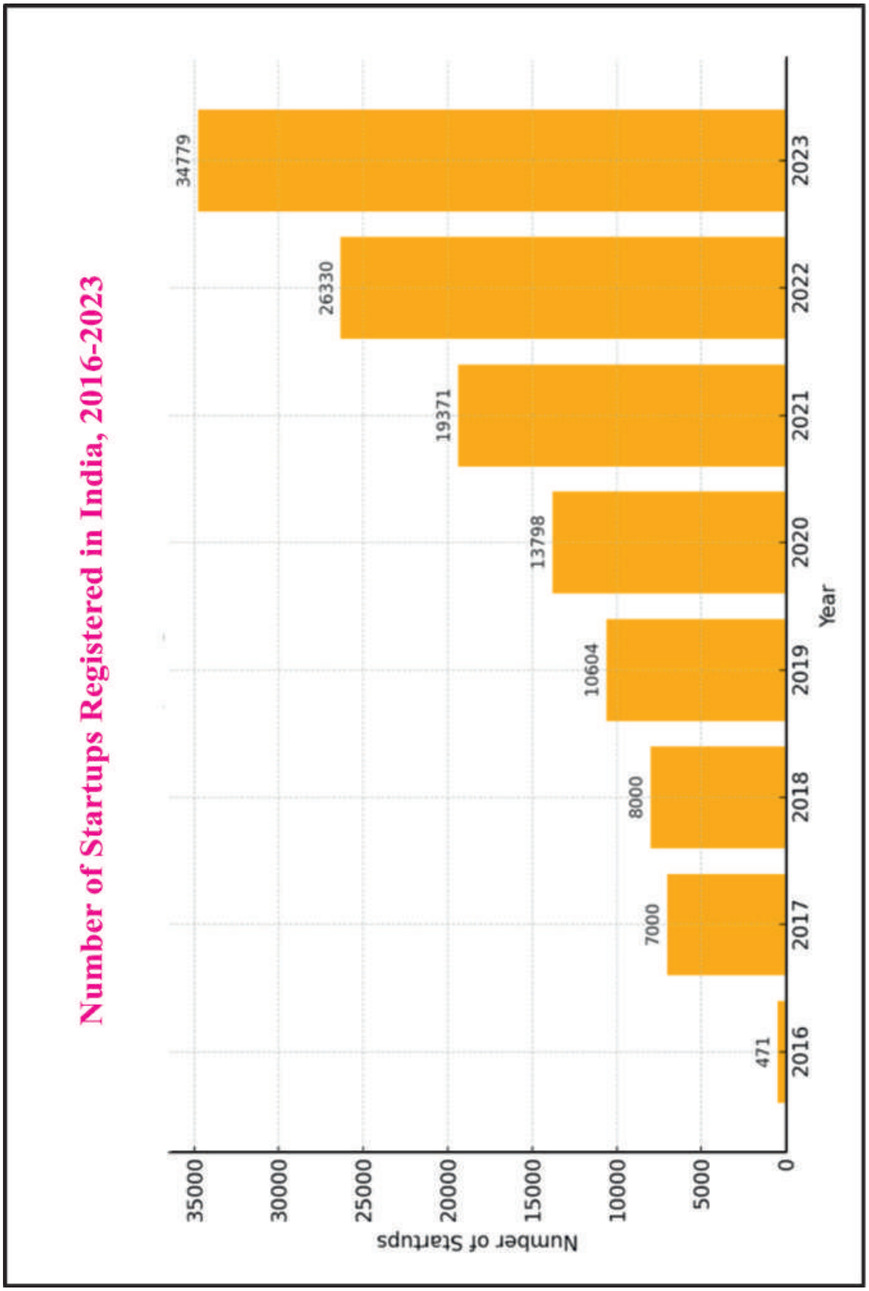
Number of Startups Registered in India, 2016-2023
Number of Startups
Year
35000
30000
25000
20000
15000
10000
5000
0
471
7000
8000
10604
13798
19371
26330
34779
2016
2017
2018
2019
2020
2021
2022
2023

Fig. 1

Startup India facilitates networking and mentorship opportunities for startups through incubation centers, research parks, and innovation hubs. These platforms connect startups with experienced mentors, industry experts, and investors who provide guidance, support, and valuable networks. The Startup India initiative has gained international recognition, making India a more attractive destination for global investors and startups. The initiative has helped showcase the innovation and potential of Indian startups on a global stage, attracting foreign investment and fostering international collaborations.

Limitations

Startup India has been beneficial in nurturing a thriving startup ecosystem, driving economic growth, promoting innovation, creating employment opportunities, and positioning India as a favourable destination for startups and entrepreneurship. While the Startup India initiative has been instrumental in promoting entrepreneurship and supporting startups in India, there are certain limitations and challenges associated with it. Some of the limitations include.

Implementation Challenges

Despite the positive intent and policy framework, the implementation of Startup India has faced challenges. Timely and effective implementation of policies and programs at various levels of government is crucial for startups to reap the full benefits of the initiative. While Startup India has introduced the Fund of Funds to support startups, there is still a significant funding gap in the ecosystem. Yadav and Goyal (2022) highlight that despite initiatives like the Fund of Funds, Indian start-ups continue to face challenges in securing early-stage funding, particularly in sectors requiring significant capital investment, which hampers their scalability and innovation potential. Access to early-stage and risk capital remains a challenge for many startups, especially those operating in sectors that require substantial capital investments. The presence of bureaucratic hurdles are also a major concern. Despite efforts to simplify regulations and compliance processes, some startups still face bureaucratic hurdles and red tape. Navigating through complex administrative procedures can be time-consuming and cumbersome, particularly for early-stage startups with limited resources. Limited Impact on Startup India has primarily focused on tech-enabled startups and high-growth sectors. The initiative's impact on grassroots entrepreneurship and startups in traditional sectors, such as agriculture and manufacturing, has been relatively limited.

Regional Disparity

The startup ecosystem in India is concentrated in major cities like Bengaluru, Mumbai, and Delhi-NCR, while startups in smaller cities and rural areas face challenges in terms of access to infrastructure, funding, and mentorship. Bridging the regional disparity and creating a more inclusive ecosystem remains a challenge. Skill Gap: While Startup India offers various learning programs, there is a need to bridge the skill gap in areas like technology, business management, and market access. Building a skilled workforce that can effectively contribute to startup growth and innovation is essential for the long-term success of the initiative. Exit Opportunities: Startups require a conducive ecosystem for exit opportunities, such as mergers, acquisitions, or public listings, which can provide returns to investors and facilitate further investments in the ecosystem. Improving exit opportunities and fostering a robust secondary market for startups is an area that needs attention. Addressing these limitations would require continuous evaluation and refinement of policies, targeted interventions to support diverse sectors and regions, and strengthening the overall startup ecosystem. By recognizing and addressing these challenges, Startup India can further enhance its impact and create a more inclusive and supportive environment for startups in the country.

SWOT Analysis of Startup India

SWOT analysis is a framework used to assess the strengths, weaknesses, opportunities, and threats associated with a particular entity or initiative. Here's a SWOT analysis of Startup India:

Strengths

Startup India benefits from strong government backing and support, which helps create a favourable environment for startups to thrive. It was mentioned in Anitha (2017) that the government's excellent policy choice of "Startup India" to encourage and enhance youth potential will benefit not only their entrepreneurial firms but also the country's economy. Furthermore, for someone who aspires to pursue their entrepreneurial goals, there are several opportunities in the clothing, textile, forms of entertainment, medical care, event structuring, the tourism sector, and automobile industries and so on. On the other side, there are numerous hurdles that inhibit the growth of a start-up, such as a lack of infrastructure, reservations about embarking on one's professional endeavor, and with a lack of skills as a result of a failure to hire the right persons. According to the study's conclusions, strong relationships between the government and start-ups can assist overcome such barriers.

Funding Initiatives

The establishment of the Fund of Funds and tax incentives provides startups with access to funding and encourages investment in the ecosystem. Startup India has introduced simplified registration processes, reduced compliance burdens, and fast-track patent examination, making it easier for startups to navigate regulatory requirements. In the study "A Study on start- ups in India and the role of government in empowering start-ups through various schemes and policies" of Dr. Abdul Razak, & Dr. K. Mallikarjuna Reddy (2019) state's hegemony over the economy is progressively eroding, and there are some indications that the country is transitioning towards a market-oriented structure. India has also established a clear policy and goal of becoming a premier business-friendly economy. The initiative has fostered the creation of incubation centres and mentoring programs, providing startups with infrastructure, resources, and guidance for growth. Startup India offers platforms for startups to connect with industry experts, mentors, investors, and other stakeholders, enabling networking and collaboration.

Table-1: Analysis of Startup Growth in India

Year	Number of Startups	Yearly Growth
2016	471	0
2017	7000	6529
2018	8000	1000
2019	10604	2604
2020	13798	3194
2021	19371	5573
2022	26330	6959
2023	34779	8449

The average growth in the number of startups per year (from 2017 onwards) is approximately 4,901 startups. The maximum growth occurred in 2023, with an increase of 8,449 startups compared to the previous year. Government policies, economic trends, and demographic considerations all contributed to the notable increase in the number of startups registered under the Startup India initiative, especially the notable spike in 2023. The Startup India Action Plan (2016) established a framework of 19 key initiatives to streamline regulations, offer financial assistance, and promote collaborations between industry and academia.

Additionally, the Fund of Funds for Startups (FFS), possessing a corpus of ₹10,000 crore, along with the Credit Guarantee Scheme for Startups (CGSS), introduced in 2023, markedly improved access to capital for early-stage and growth-stage enterprises. Moreover, more than 50 regulatory improvements have facilitated compliance, simplifying the initiation and operation of firms in India.

India's ascent as the third-largest startup ecosystem worldwide signifies an increase in both local and international investment, propelled by improvements in digital infrastructure and the expansion of technology-driven sectors such as fintech, edtech, and healthtech. The nation's demographic dividend, characterized by a youthful and entrepreneurial populace, propels innovation and startup endeavors. Finally, the post-pandemic economic recovery and alterations in global market dynamics have created new chances for entrepreneurs, facilitating exponential growth. The amalgamation of these efforts and advantageous conditions has fostered a vigorous environment for entrepreneurs, driving the significant growth observed in 2023.

Weaknesses

The implementation of policies and programs under Startup India has faced challenges, leading to delays and gaps in delivering the intended benefits to startups. While the Fund of Funds has provided some funding support, there is still a considerable funding gap for startups, especially in early-stage and high-risk ventures. Regional Disparity: The startup ecosystem is primarily concentrated in major cities, leading to a disparity in opportunities and support for startups in smaller towns and rural areas. Startup India has primarily focused on tech-enabled startups and high-growth sectors, which may limit its impact on grassroots entrepreneurship and traditional sectors.

In the Study of Jain (2020) the research on the effects of a health crisis such as COVID-19 on work opportunities. In the study, uncertainties about job development and employment levels were proven to be persistent in the approaching year. Aside from that, the author argued that the pandemic will result in increased employment losses. The present pandemic issue, on the other hand, may drive more start-ups since people may see them as a realistic alternative. While the post-covid situation may be difficult in terms of employment creation, it was finally determined that the entrepreneurial ecosystem will grow significantly.

Opportunities

Startup India can drive innovation and job creation by nurturing a vibrant startup ecosystem and encouraging entrepreneurship across various sectors. It was found in Mishra (2017) that the financial life cycles of the Start-ups, effective operational management of start-ups. In the study, it was identified that the rate of start-ups is increasing like never before. Male and female entrepreneurs are both participating. Females are also contributing more ideas as compared with males and taking risks in order to maintain their credibility.

A startup initiative allows an entrepreneur to educate and inspire others as they ponder what to do and how to achieve it. Although entrepreneurs face challenges, they are being addressed concurrently. They are committed to establish and redirect their energies in order to plan, support, and carry out their dreams while also contributing to economic prosperity. This new start-up initiative offers faster business approvals, easier exits, tax benefits, and faster patent registration. This initiative has the ability to create jobs at a time when the industrial sector is declining. Stakeholders, the government, and the society must all provide enough support, coordination, and mentoring for every new concept. Also it was reported by Shamini N & Dr. Shanimon (2023) in their study "Start Up Boom During Covid 19-An Analysis in India" opined that this effort has the potential to create jobs at a time when the industrial industry is in decline. Any innovative idea requires adequate support, coordination, and mentoring from stakeholders, the government, and the community. During or after the covid pandemic, e-commerce and delivery-based services, ott platform and online gaming, pharmaceutical, and other related startups had a major surge. This report also contains the fact that, despite the fact that several industries, such as tourism, entertainment, and others, suffered losses as a result of the epidemic. This study also discusses the reasons behind the increase in start-ups in Covid 19. Adhana & Kumar, (2020) initiated research focused on legal challenges, corporate degrees of sustainability and awareness, among other things. Apparatus can be quite beneficial in helping entrepreneurs in this situation. The report also chronicled the complete ecosystem that encourages entrepreneurship through government schemes, rules, and relaxations, among other things. Various Government Schemes like Pradhan Mantri Mudra Yojana, Stand up India loan scheme, etc. are some of the policies. Several other concessions include tax breaks, eased bidding through government tenders, an easier departure plan under a 90-day term, and so forth.

The researcher come to an end that, despite the fact that such beneficial activities have been highlighted, according to an IBM Institute report the initiative can facilitate international collaborations, attracting foreign investment and promoting cross-border partnerships to enhance the growth and reach of Indian startups. There is an opportunity to enhance skill development initiatives to address the skill gap and equip entrepreneurs with the necessary knowledge and capabilities for startup success. Startup India can explore opportunities to support startups in diverse sectors, such as agriculture, healthcare, renewable energy, and manufacturing, to foster innovation and address critical challenges. It was reported by Kshetri, Nir (2016) that the state's hegemony over the economy is progressively eroding, and there are some indications that the country is transitioning towards a market-oriented structure. India has also established a clear policy and goal of becoming a premier business-friendly economy.

Threats

Economic volatility and changes in regulatory policies can pose challenges for startups in terms of business sustainability and compliance. Indian startups face competition from international startups and established companies, necessitating continuous innovation and scaling to stay competitive. Insufficient physical and digital infrastructure in certain regions can hinder the growth and scalability of startups, limiting their potential. The availability of exit opportunities, such as acquisitions and IPOs, is vital for startups and investors. Challenges in this area can impact investor confidence and future funding prospects. It was reported by Omid Sharifi, Bentolhoda Karbalaei Hossain (2015) in their study “Understanding the financing challenges faced by startups in India” that the Startups in India confront a variety of financial issues. The report depicts the problems that startups experience during the innovation and early stages. The big discoveries in technology have driven investors to increase the bar in terms of how much handwork entrepreneurs are expected to perform before pitching their companies for funding and investments.

Conclusion

India's start-up ecosystem has experienced significant growth; nonetheless, the path is still laden with hurdles. Although initiatives such as Start-up India have ignited a crucial transformation by tackling significant challenges including legislative impediments and resource accessibility, deficiencies in funding, creativity, and collaborative networks remain. A collaborative effort from all stakeholders is essential for long-term sustainability and scalability. The government has established a robust framework by providing financial incentives, expedited approvals, and optimized procedures, enabling young innovators to convert ideas into significant solutions. Nonetheless, the responsibility now rests with citizens, corporations, and society as a whole to cultivate a culture of innovation and entrepreneurship. Corporations must enhance their contributions through substantial investments, mentorship, and infrastructural support to nurture these enterprises. For India to establish itself as a worldwide start-up hub, young innovators must persist in their vision, developing solutions that stimulate economic growth while also tackling societal concerns. Through active collaboration among the government, corporate sector, and entrepreneurial community, Startup India may effectively act as a catalyst for job creation, industrial revitalization, and the achievement of a New India. The success of this movement depends on communal accountability and a mutual dedication to invention, collaboration, and nation-building—transforming India into a prosperous economy propelled by its entrepreneurial spirit.

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The Deccan Geographer
Vol. 62, No. 10 December, 2024, pp. 219-226
(ISSN-0011-7269)
UGC Care Listed Geography Journal

NAVIGATING MARITIME LANDSCAPE GEOGRAPHIES: THE RISE AND FALL OF CAMBAY IN THE 16TH AND 17TH CENTURIES

Dr. Isha Kaushik and Dr. Karuna Shree

Abstract

The Gulf of Cambay situated on the western coast of India in Gujarat, was an eminent maritime centre during the 16thand 17th centuries, with the town of Cambay (Khambat) at the core of its commercial activity. This research explores into the geographical features of the Gulf of Cambay and its port towns mainly Khambat with a definite focus on the factors that led to the rise and fall of this town. By looking at the historical records, traveller's accounts and other secondary sources, this study calls attention to how Cambay, formerly a cynosure of maritime trade, fell into decline-on account of its changing Geography and the drifting dynamics of international trade. The changeover of trade from Cambay to Surat is analysed in depth, determining the critical geographical, infrastructural, and political factors that manifested this transition.

Introduction

On the western coast of India, nestles Cambay which has been a region of prominent geographical and commercial significance for centuries. During the 16th and 17th centuries one of the core port towns was Cambay, located at the head of the Gulf, was a prosperous fulcrum of international trade, linking the Indian Subcontinent with the Middle East, Europe and East Africa. This paper delves into the geographical location of Cambay and tries to unveil the role of its Geographies in carving out its ebb and flow as an economic center. Incipiently Cambay became successful in becoming a pivotal port town mainly due to its beneficial location: a natural harbour created by the confluence of the Mahi River and the Gulf of Cambay. Owing to this geographical feature Cambay emerged as an ideal site for maritime trade and for a time it was one of the leading commercial centres of Gujarat. Nonetheless, eventually, Cambay's geography which was at one point in time was its exceptional asset became its utmost liability. The altering physical landscape, along with changing political and economic dynamics under the

Mughal Empire, contributed to Cambay's creeping deterioration and the inevitable ascent of Surat as the commanding port of the region.

Objectives

(1) To delve into the geographical features of the Gulf of Cambay and its port town in the 16th and the 17th centuries.
(2) To apprise how Cambay's geographical advantages at the start led to its popularity as a port town and how shifting geographical factors contributed to its contingent decline.
(3) To spell out the fundamental factors that led to the transition of trade from Cambay to Surat during the 17th century, centring on geographical, infrastructural hand political influences.

Database and Methodology

This study engages a qualitative research approach, essentially based on historical records, travellers account and scholarly secondary sources. Primary sources in terms of archival data. Secondary sources encompassing books and articles that further furnish the context on geography, economic conditions and political transformations of Gujarat in the Mughal period. The methodology emphasises on historical and geographical analysis as it is critical for comprehending the evolution of any urban centre and it bestows acumen regarding the rise, growth and occasionally their decline with time. In a nutshell historical and geographical analysis furnish a potent framework for grasping the trajectories of rise and fall of an urban center. Geography put forwards the environmental context in which a city comes in to being, while history outlines the changing processes- political, economic and social that have an effect on their growth and transformation progressively. By exploring both, the rise and fall of urban centres is better understood, also, by analysing their spatial leverages and historical mosaic, their future trajectories would be predicted. The mesh between geography and history weaves the tapestry of the city in terms of its identity, resilience and possibilities for the future.

Results and Discussion

Geographical Context of Gulf of Cambay

Along the western coast of India, the Gulf of Cambay is situated has a shallow inlet. Cambay or modern day Kambat is located at the head of this gulf, owing to its key location at the junction of the mahi river and the Gulf of Cambay grew into a thriving port town during the Medieval era. The geography of this region offered Cambay with natural harbours With the Mahi River providing a protected anchorage for ships and it's juxtaposition with Arabian Sea promoted trade with far of regions, including Europe, Africa, Middle East.

Geography and Climate of Cambay

Cambay is located at the head of the gulf, where the Mahi River confluences with the Sea. The land is largely flat with some agricultural zones enclosed by groves of Tamarind, Neem and Mango trees. Due to the tidal influx the soil in the region is majorly saline making it unqualified for traditional agriculture but suitable for some crops. The region experiences high temperature in summer 108-degree Fahrenheit and milder conditions in winter around 46-degree Fahrenheit, with an annual rainfall of 31 inches. Its strategic location at the head of the gulf has made it or natural harbour, sheltered from the rough seas of Arabian Sea by the neighbouring land mass. This formed an ideal location for the anchorage of ships and the development of port facilities, nonetheless Cambay's geography also posed certain threats such as the risk of silting and the narrowing of the gulf which eventually hindered the access of large ships to the towns port (Fig. 1).

Cambay's Commercial Rise: The Cynosure of Maritime Trade

Cambay's Importance as a port town reached its zenith in the 16th century, when it emerged has one of the most significant centres of trade in India and the wider Indian Ocean world. The towns' key location furthered direct maritime trade routes with the Red Sea the Persian Gulf, East Africa and Europe. According to Jahangir, the Mughal emperor, Cambay was "a place of great trade and commerce, and a resort of merchants from all parts of the world." The port's proximity to the Arabian Sea allowed it to connect with key international markets, where it became a center for the exchange of goods such as cotton textiles, indigo, spices, precious stones, and bullion.

Cambay also benefitted from its industrial activities. The cutting and shaping of beautiful agates into prized objects, alongside the production of indigo, made the town a key exporter of luxury goods. By the early 17th century, Cambay was one of the most frequented ports in India, with bustling bazaars that sold aromatic perfumes, silken fabrics, ivory, agate cups, rings, and chaplets. Thevenot, a French traveler, remarked on the vibrancy of Cambay's commercial activities, describing it as "a very considerable town, and one of the most frequented by merchants in all India." The town's global trade links were further supported by the presence of large merchant communities, including Gujarati Banias and Muslim Bohras, who

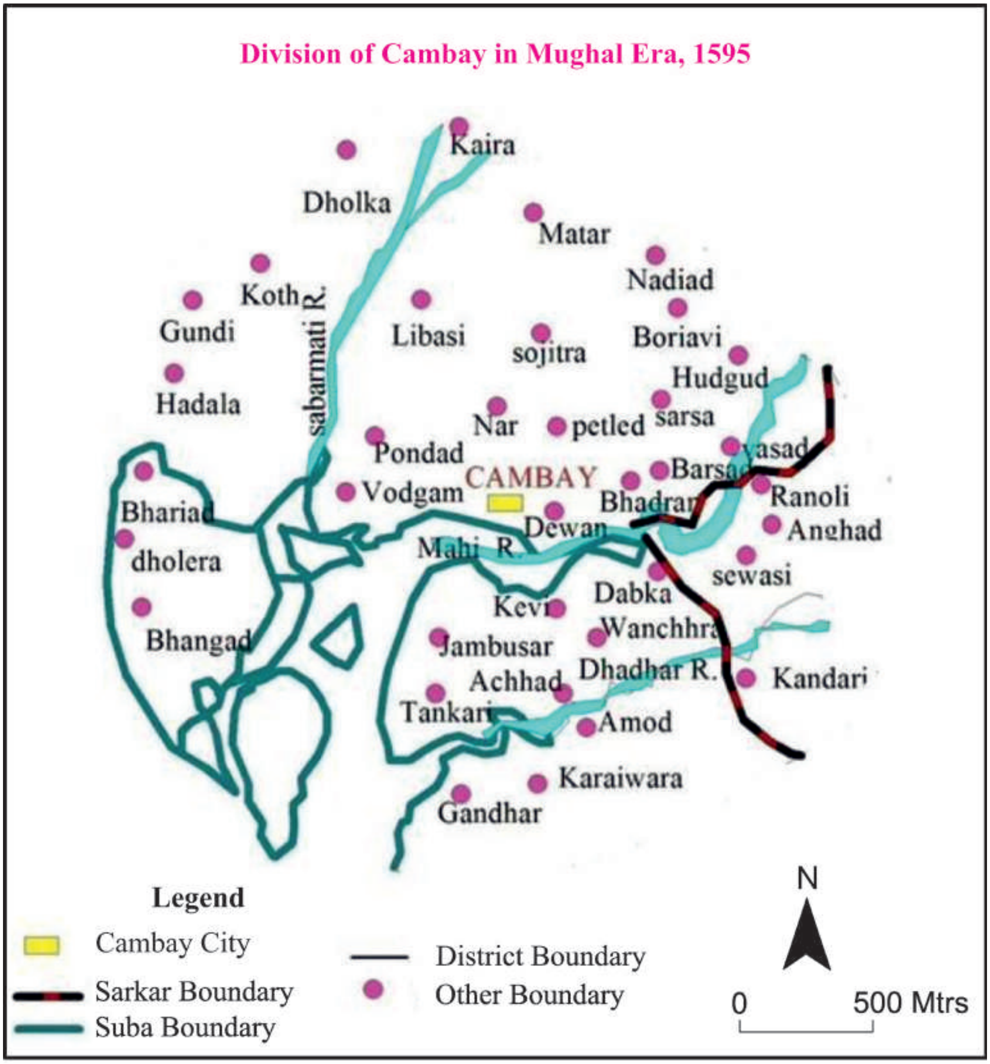
Division of Cambay in Mughal Era, 1595
Kaira
Dholka
Matar
Nadiad
Koth
sabarmati R.
Gundi
Libasi
sojitra
Boriavi
Hudgud
Hadala
Nar
petled
sarsa
Pondad
yasad
CAMBAY
Barsad
Vodgam
Bhadran
Ranoli
Bhariad
Dewan
Anghad
Mahi R.
dholera
sewasi
Dabka
Kevi
Wanchhra
Bhangad
Jambusar
Achhad
Dhadhar R.
Kandari
Tankari
Amod
Karaiwara
Gandhar
Legend
Cambay City
Sarkar Boundary
Suba Boundary
District Boundary
Other Boundary
N
0
500 Mtrs

Fig. 1

acted as intermediaries between Cambay and the wider world. Cambay's extensive trade network facilitated the exchange of goods such as horses from Hormuz, spices from Aden and the Red Sea, and pearls from the southern tip of India.

Decline of Cambay

Cambay's Decline as a significant port was not instantaneous rather it occurred gradually over the period of g 16th hand 17th centuries. Multitude of factors let to this shift:

(a) Geographical Changes: Silting and Sedimentation

The location of Cambay at the head of the gulf which was which was once natural advantage, turned in to a drawback as the region began to experience increased silting and sedimentation. The Mahi River silted and it stopped providing a deep-water channel for ships, also this decreased navigability. Earlier the ships used to dock directly at Cambay but now it was very difficult for them to access the port, larger ships were forced to anchor at outer ports like Gogha, across the gulf on the Kathiawar coast. Although efforts were made to maintain accessibility, the narrowing of the gulf and the likelihood of tidal bores further restrained Cambay's Status as a maritime pivot.

(b) Shifting Trade Routes under Mughal Rule

One event which had profound economic consequences was the political integration of Gujarat into the Mughal Empire in 1572. During the Mughal rule, Gujarat's Ports began to meet the needs of the Mughal Empire, which had its heartland in the Agra -Delhi region. The Annexation of Khandesh In 1601 paved the way for shift in trade routes and saw the growth of Surat as a more beneficial port as it had easy access to the Mughal heartland and it's deeper more navigable harbour. Surat's Closeness to the important administrative centres of the Mughal empire made it much conducive location for trade and commerce. Cambay, once the central nucleus, started to lose its trade significance as Surat's growth quickened, partly because it was better connected by land to the Mughal heartland and had a port that would land a hand to longer ships. Additionally, Surat benefited from its location near the river Tapti, which provided a direct water way to the central part of the empire (Fig. 2).

Decline in Commercial and Infrastructural Activity

As trade shifted to Surat, Cambay's economic landscape began to disintegrate. The town's merchant population moved to Surat, where competent commercial

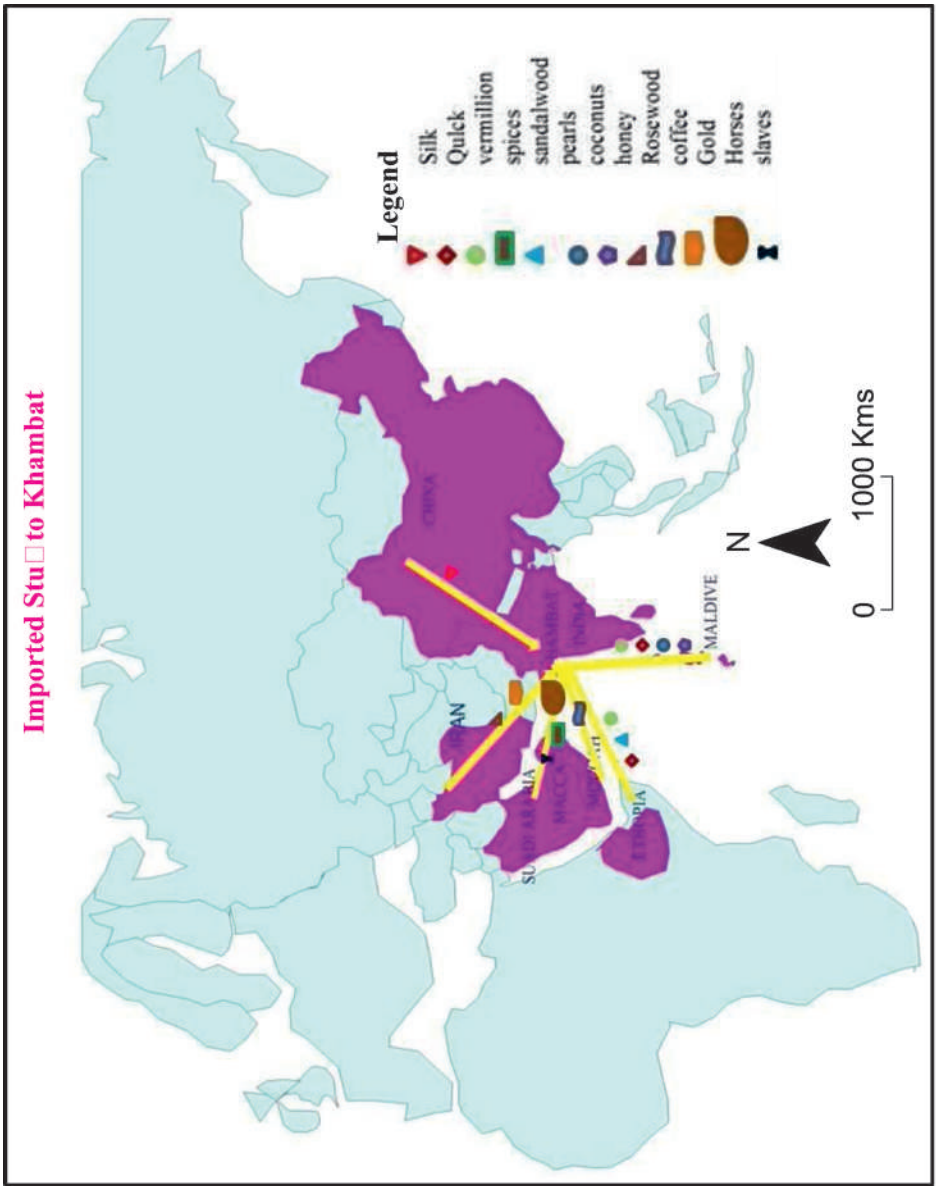
Imported Stu□ to Khambat
Legend
Silk
Quick
vermillion
spices
sandalwood
pearls
coconuts
honey
Rosewood
coffee
Gold
Horses
slaves
CHINA
INDIA
IRAN
MALDIVE
N
0
1000 Kms

Fig. 2

opportunities existed. The loss of trade had a ripple effect, affecting Cambay's industries and infrastructure. The town's once-overflowing markets fell silent, and its port facilities, once swarming with activity, fell into dilapidation. Infrastructural deterioration further compounded Cambay's crisis. Roads and bridges, which had once been well-maintained, deteriorated as fewer resources were allocated for their upkeep. The town's economic and political power withered, leading to a substantial reduction in population and a shift in the social structure of Cambay.

The Rise of Surat

Surat's rise in the 17th century as the incomparable port of Gujarat can be attributed to several key factors are, namely, improved Harbor: Surat had a deep-water harbor, unlike Cambay, which permitted larger ships to dock and load goods directly and political Support: Surat's proximity to the Mughal Empire's core areas. By the early 17th century, Surat's prompt growth as a port town had outpaced Cambay. Surat's improved access to trade routes, associated with better harbour conditions and the support of the Mughal Empire, led to the decline of Cambay. Surat became the center of Gujarat's overseas trade, attracting merchants from across the world, while Cambay's commercial activities ebbed. Consequently, Cambay lost its status as a major port, and much of its merchant population migrated to Surat. The decline was further exacerbated by the lack of investment in infrastructure and the deterioration of the town's once-thriving port facilities.

Conclusion

Cambay's geographical location, once a strategic advantage, became a liability by the 17th century. The town's silting harbor, combined with the shift in trade routes and political changes under the Mughal Empire, led to its decline as a major port town. Surat, with its deeper harbor and better connectivity to the Mughal Empire's heartland, appeared as the new maritime epicenter. This case study underlines the critical role that geography, infrastructure, and political changes play in the rise and fall of port towns.

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The Deccan Geographer
Vol. 62, No. 10 December, 2024, pp. 227-239
(ISSN-0011-7269)
UGC Care Listed Geography Journal

IMPACT EVALUATION OF MGNREGA DERIVED DROUGHT MANAGEMENT PROGRAMME IN MEWAT REGION, HARYANA, INDIA

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Abstract

The Mahatama Gandhi National Rural Employment Guarantee Act 2005 has a vital significance in ensure at least 100 days rural employment for the villagers; belonged to the BPL households. Apart from generating the rural employment, the MGNREGA has a vital significant in generating rural assets and applications of several structural measures to combat the frequent drought like conditions in the rural areas. The present paper examines the vital role of MGNREGA in drought management programme in the 12 sample villages of six blocks of the Mewat region of Haryana. It is an empirical study; where there were numerous of MGNREGA derived drought management structural measures which have been implemented in the study areas of the Mewat region. The study is aimed at evaluation of executed drought management structural measures; and worked out with the help of composite measures of some of the qualitative measures; taken for the study. The study is based on the respondents of the 300 households; belonged to BPL facilities of the 12 sample villages of the six blocks of the Mewat region; comprised Nuh and Palwal districts. The study shows a significant regional disparity of the impact of MGNREGA derived drought management programme; excited in the selected study areas.

Introduction

The Mahatama Gandhi National Rural Employment Guarantee Act 2005 has a very significance to ensure at least 100 days rural employment for the villages; belonged to the BPL households. Apart from generating the rural employment, the MGNREGA has a vital significant in generating rural assets and its applications in terms of taking structural measures to combat the frequent drought like conditions across the country (Report of Comptroller & Auditor General of India, on performance audit of MGNREGA, 2021). The MGNREGA programme primarily aimed at generating the rural employment in the rural areas of the country;

but the programme has a significant importance in the drought management in the rural areas too. However, the guidelines of MGNREGA shows that there are 60 % of the total allocated budget which is allowed on to develop earth relating works like soil conservation, groundwater recharging, water harvesting techniques (Pandey, 2017). There are over 60 % of the villages; across the country; usually face the drought like conditions in every alternative year. It is due to uneven distribution of rainfall and surface and groundwater resources; across the country; as a result, farmers usually trapped in to the crop debt (Dutt & Sundaram, 2020).The role of MGNREGA is highly appreciated and very much significant in reducing the drought vulnerability in frequent drought prone areas. With the limited available resources in the rural society, particularly in the arid and the semi-arid areas; it becomes imperative to evaluate the climate related risk and the uncertainties; before address the droughts. in the rural areas. The options of the least diversified sources of the livelihood during the drought conditions in the non-farm sector and the lack of skill-based jobs becomes vulnerable to the drought. In this grim situation, the households to take up the low-income generating livelihood to survive themselves by taking jobs within their village itself (Jatav & Chararbortys, 2019). Further, the study was supported by Akhtar (2014), Das (2019) and Seedari (2021) in terms of MGNREGA derived drought management programmes in the frequent drought prone areas.

Study Area

The study is confined to Mewat region of Haryana which includes the two districts; Nuh and Palwal. There were total 12 sample villages, belonged to six blocks, taken for the study. .Earlier this region was the part of the Gurugram district and subsequently, it has become an independent district and the Hathin block was shifted to Palwal district. The entire study area is characterized with almost leveled topography with some of continuous and isolated Aravalli hills, located from north to south in a longitudinal extent. (Handbook of Mewat, 2020).The climate of the Mewat region is semi-arid type of climatic condition with low seasonal rainfall. The summers are hot and dry; as a result, the people of Mewat often face the drought like conditions. On the other hand, the situation of the groundwater is far from satisfactory; as there is 78 % of the groundwater is extremely saline and not suit for drinking and agricultural purposes. It is because of these dual reasons, the farmers of the Mewat region often practice the dry land farming, as a result, there are few crops of the Rabi and Kharif which are practiced by the farmers. Whole Mewat region is characterized with the fragile ecosystem with a chronic population pressure on the agricultural resources with low carrying capacity of the land in almost every village of the Mewat region (Narag, 2014). The demographic profile of the Mewat region indicates that population numbers are 1089406 numbers of population. Out of this figure, there are 52.43 % are male and 47.57 % are female population; which indicate a considerable gender inequality. The density of population of the Mewat region is 727 persons per square KM. The literacy rate of this region is 54.08 %; whereas 69.94 % are male and 36.36 % are female which again shows a considerable inequality in the literacy rates between men and women; but the sex ratio is much higher than that of the others districts of Haryana. The ecological aspects of the region are too fragile with poor 'carrying capacity' to support the growing population of the Mewat region. It is therefore it becomes imperative to formulate an effective regional plan in accordance with prevailing socio-economic and physiographic conditions of Mewat region to ensure a long-term sustainability of man-environment relationships. The ecosystem of Mewat is fragile and severely affects the physiographic and the socio-economic conditions of the whole region. The natural factors of production which include the soil and the water of this region; and gradually degrading and retarding the growth and development of agriculture. The health of the soil is deteriorating and ground water is extremely saline; and led to secondary Stalinization / sodification of soils. The poor availability of the soil nutrients is have a direct bearing ons crop growth and the quality of produces as grains, vegetables, fruits, cattle fodders crops etc. The major affacts are slower yields of the crops which are poor and uncertainity for availability of water for the irrigation, poor status of the soil nutrients, low carbon contents in the soil, brackish ground water, growing the soil salinity and environment relating stresses during the growth period of crops etc. The problem of the depleting soil fertility, declining water table; particularly in the Firozpur Jhirka and Tauru blocks, are some of another pressing problems. The fragile eco-system with high chronic population pressure on the agricultural resources; and it has also have a least probability of diversifying the cropping pattern in the near fure which require a right strategical approach to overcome this fragile eco-system in the Mewat regions (Mehra & Singh, 2018). The physiographic region of Mewat region is shown in Fig. 1.

Objectives

(1) To examine the role of MGNREGA in drought management through execution of structural measures;
(2) To evaluate the impact of MGNREGA derived drought management programmers across the Mewat region of Haryana.

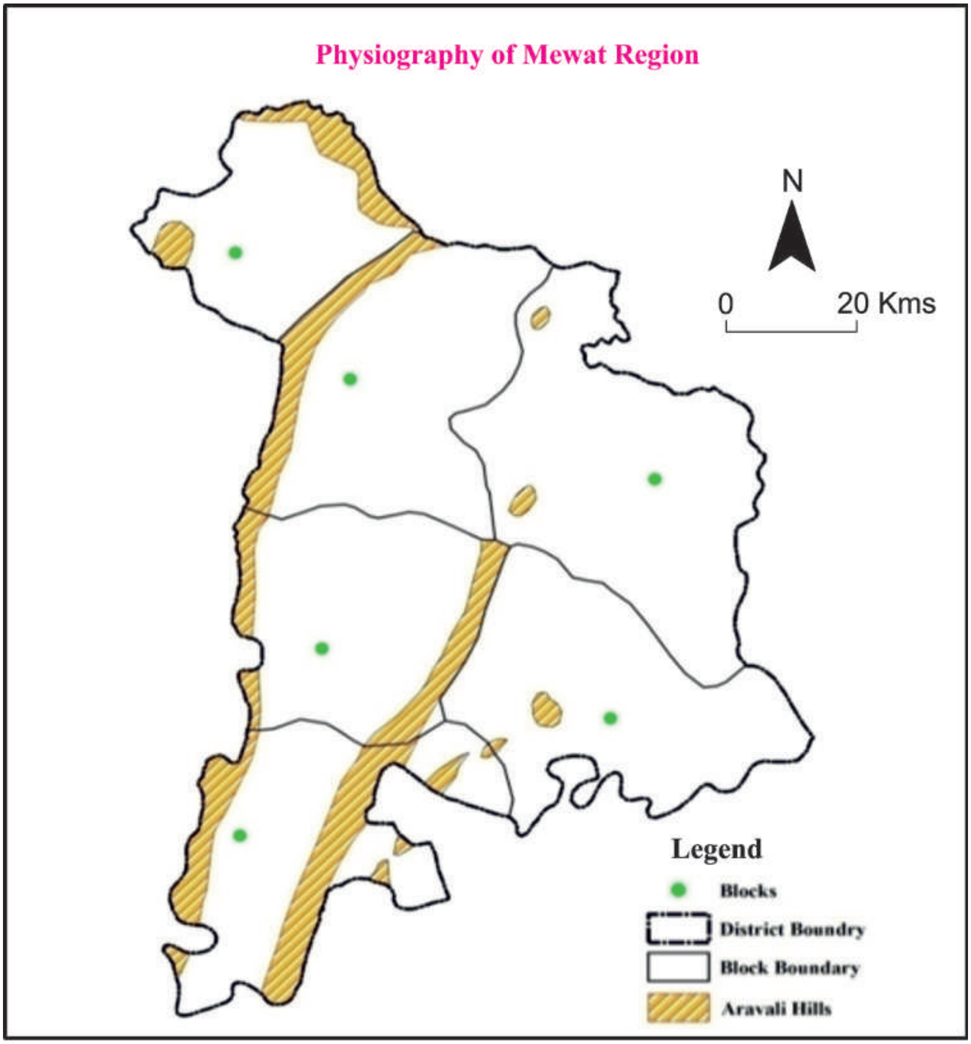

Physiography of Mewat Region
N
0
20 Kms
Legend
Blocks
District Boundry
Block Boundary
Aravali Hills

Fig. 1

Database and Methodology

The LIKERT SCALE based parameters have been applied to find the varied levels of impact level of MGNREGA derived drought management programmes as 1. Very low, 2. Low 3. Medium, 4. High and 5. Very high and weightage has been given in accordance with different degree of response to this ‘Likert scale’ with ‘Weightage Mean Index’ (Benidiktus & Prahmana, 2023). The ranges of the ‘Likert scale’ have given the weightage as, 1. Strongly disagree (Index value below 1.5), Disagree (Index value between 1.5 to 2.5). Undecided (Index value greater than 3.5 confirm the significant impact of MGNREGA and confirm the degree of the participation of the villagers in the drought management program; derived by MGNREGA. The formula is given follows:

$$(W1f1 + W2\ f2 + W2\ f3 + \text{---------} + Wn\ fn)$$

$$\sum W1mi$$

$$WMI = \underline{\hspace{4cm}} = \underline{\hspace{4cm}}$$

$$(f1 + f\ 2 + f\ 3 + \text{---------------------------} + f\ n)$$

Whereas, W1 is the assigned the weightage for a particular class under the ‘Likert scale’ which shows varied degree of ‘very low’ or ‘very high’ scale and f 1 is the corresponding frequency of that particular class; as shown in this study, i.e. under the degree of the community participation in the drought management program; undertaken under MGNREGA in the five different classes, like ‘Very High’, ‘High’ ‘Medium’ ‘Low’ and ‘Very low’. The correspondingly weightage has given as 5, 4, 3, 2 and 1 respectively. The ‘WMI’ Weightage Mean Index’ is lie within the range of the numerical values 1 to 5 which has allotted to get the desired results (Kothari, 2016). There are total 300 respondents; selecting 25 respondents, from each district from the Nuh and Palwal district of Haryana. Hasanpur Tauru and Chharora villages (Tauru block), Kotla and Ghasera (Nuh, block), Ghaghas and Marora (Nagina block), Agoan and Rigarh (Firozpur Jharka block), Jamalgarh and Akbarpur (Punhana blocks) and Paharpur and Mandkola village (Hathin block).

Results and Discussion

This study has worked out by applying LIKERT SCALE, as a result, the varied values of impact of MGNREGA derived drought management programs have been worked out and is shown in Table-1.

Further, this varied level of the impact in terms of the block wise distribution of the MGNREGA derived drought management program in the Mewat region (Fig. 2).

Table-1: Impact of MGNREGA Derived Drought Management Program Villages (2020-21)

The overall impact of MGNREGA on drought management	Sample Villages	Very low Impact W=1 (f1)	Low Impact W=2 (f2)	Medium Impact W=3 (f3)	High Impact W=4 (f4)	Very High Impact W=5 (f5)	Total Frequency	WWI	Remarks on impact of MGNREGA
Tauru Block	1. Hasanpur Tauru	1	1	3	8	12	25	2.52	Very High
		(4)	(4)	(12)	(32)	(48)			
	2. Chharura	2	2	15	4	2	25	2.38	Medium
		(8)	(8)	(60)	(16)	(8)			
	Total	3	3	18	12	14	50	2.45	Very High
Nuh Block	1. Kotla	1	2	4	2	16	25	2.66	Very High
		(4)	(8)	(16)	(8)	(64)			
	2. Ghasera	2	2	4	2	15	25	2.49	Very High
		(8)	(8)	(16)	(8)	(60)			
	Total	3	4	8	4	31	50	2.58	Very High
Nagina Block	1. Ghaghas	1	2	4	13	3	25	2.44	High
		(4)	(8)	(16)	(52)	(12)			
	2. Marora	4	7	12	2	0	25	2.25	Low
		(16)	(28)	(48)	(8)	(0)			
	Total	5	9	16	15	3	50	2.35	Medium
Firozpur Jhirka Block	1. Agoan	1	1	3	8	12	25	2.52	Very High
		(4)	(4)	(12)	(32)	(48)			
	2. Righa	2	3	5	13	2	25	2.31	Medium
		(4)	(12)	(20)	(52)	(8)			
	Total	3	4	8	21	14	50	2.42	High

Contd...

The overall impact of MGNREGA on drought management	Sample Villages	Very low Impact W=1 (f1)	Low Impact W=2 (f2)	Medium Impact W=3 (f3)	High Impact W=4 (f4)	Very High Impact W=5 (f5)	Total Frequency	WWI	Remarks on impact of MGNREGA
Punhana Block	1. Jamalgarh	17	3	2	2	1	25	2.01	Very Low
		(68)	(12)	(4)	(8)	(4)			
	2. Akbarpur	5	15	2	2	1	25	2.11	Low
		(20)	(60)	(8)	(8)	(4)			
	Total	22	18	4	4	2	50	2.06	Very Low
Hathin Block	1. Paharpur	2	3	12	4	4	25	2.38	Medium
		(8)	(12)	(48)	(16)	(16)		2.45	
	2. Mandkola	1	2	3	4	15	25	2.42	Very High
		(4)	(8)	(12)	(16)	(60)			
	Total	3	5	15	8	19	50		High

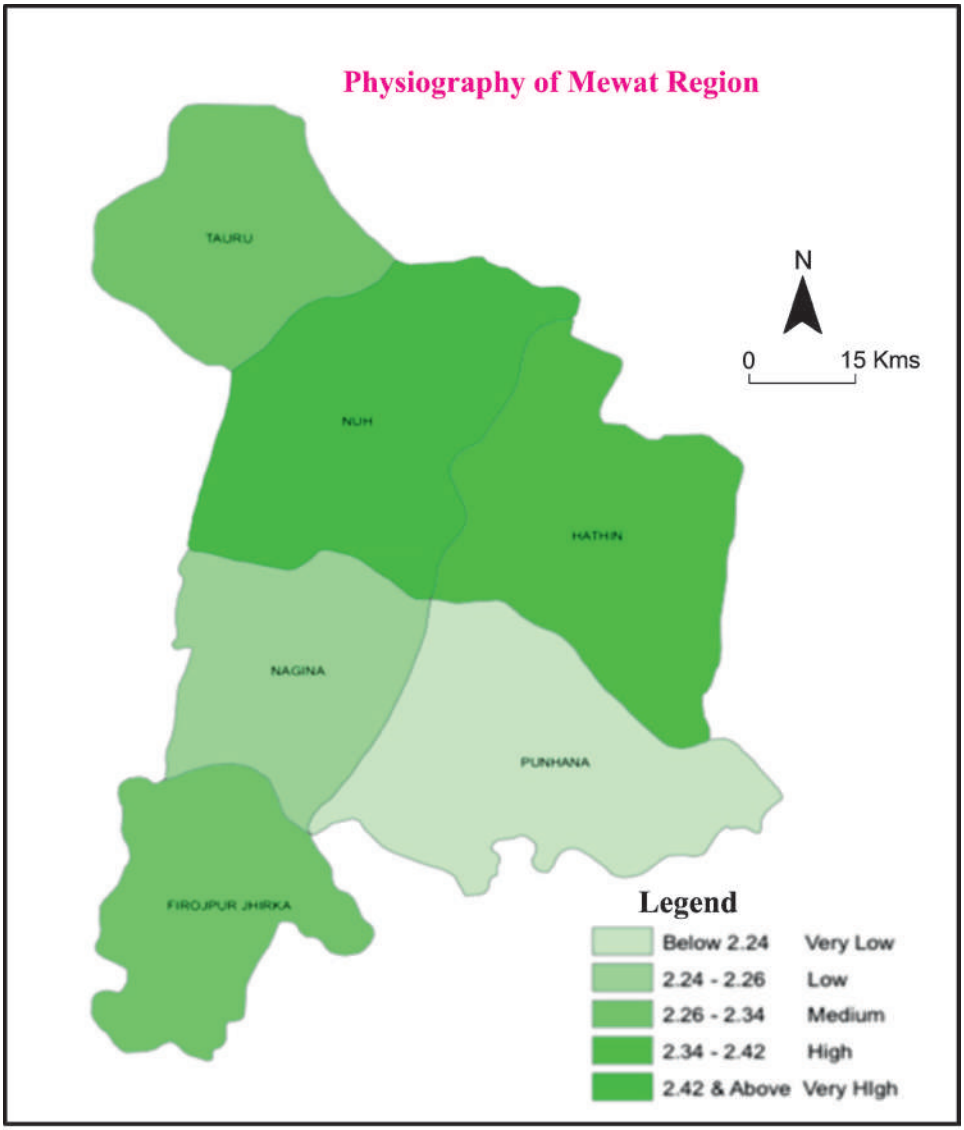
Source: Field Survey

Note: (1) Percentages are given in brackets.

(2) Very low: <2. 24, 2.24 to 2.26 Low Impact, 2.26 to 2.34 Medium Impact, 2.34 to 2.42, High, Very High Impact > 2.42 & above.

The worked out and the tabulated figures show a block wise impact of various quantitative and qualitative parameters of the drought management micro projects; undertaken by MGNREGA scheme in the entire Mewat region, reveal a mixed picture of its results in all the six blocks. Based on the various drought management strategies; have undertaken under MGNREGA; in all the six blocks. Indicate a considerable block wise regional disparity in accordance with the worked-out figures of each strategy, taken for two sample villages of a block, taken under the MGNREGA scheme. In order to know the regional disparity of the impact of drought management programme, undertaken under the MGNREGA scheme, there were two villages were selected from each block of the Mewat region which indicate a varied impacts on the outcome of the drought management. On the contrary, there are villages are those villages which have unsafe ground water; which is not suitable for drinking and the irrigation purposes.

It is because of excessive concentration of salinity and fluoride, total hardness, EC and other salts and minerals, dissolved in the ground water. In the 'advantageous villages' due to their location under the foothills of the Aravalli hills; as a result, in the rainy season, the rainy water usually tends to flow to downwardly from hills to village premises and its vicinal areas, which led to naturally recharge the ground water during different successive periods; as a result of this natural process, the level of salinity with its hardness water property percolate in to groundwater which tends to turn as quality underground water. However, similar good results of MGNREGA derived drought management works reveal a 'success story' in the Vijaypur Tehsil Talukas in Maharashtra (Bholana. 2022). Subsequently; an extensive afforestation program was taken place in the Panchayat lands in some of northern states India (Yadav; Jha; Jain, 2024) This topographical regional character of the sample villages; show a considerable difference on varied level of the drought management strategies, taken under MGNREGA by the Gram Panchayats. However, it is quite obvious from the regional study which show that the villages which are located under the foothills of Aravalli; had a better impact of the MGNREGA derived strategies; as compared with the villages which are located at the far distant or interior part of the block headquarters area. In case of the recharging the ground water either from 'recharging the old wells' or 'recharging the ground water through sock pits' were the drought management programme, executed under MGNREGA, found more fruitful; as compared with the far located villages. The other drought management strategies; which were undertaken by MGNREGA, showed a significant difference in terms of their implementation and the impacts as compared with far located villages.



Physiography of Mewat Region
TAURU
NUH
HATHIN
NAGINA
PUNHANA
FIROJPUR JHIRKA
N
0
15 Kms
Legend
Below 2.24 Very Low
2.24 - 2.26 Low
2.26 - 2.34 Medium
2.34 - 2.42 High
2.42 & Above Very High

Fig. 2

In order to show the overall impact in all the six blocks, the worked out in accordance with the average figures of the composite index; for each sample villages of the Mewat region. Thus, the impact of MGNREGA derived drought management structured measures is classified in to various categories as follows:

(a) Villages with Very High Impact

There are two villages which include Kotla and Ghasera sample villages; belonged to Nuh block of Nuh (Mewat) District with very high impact index with 2.42 indexes. The study shows that the sample village Kotla, is located near the Kotla Lake; where the cultivated area of the village is irrigated well the continuously recharged groundwater; as a result, it tend to make available the groundwater for the drinking and the irrigation purposes. The availability of fresh groundwater has led to make available for increasing the capacity of the micro-check under the water shed water management programme in this sample village of Nuh block. Another sample village is Ghasera, which enjoy a nodal location with high accessibility to block and district headquarters. Apart from recharging of the groundwater, other MGNREGA derived drought management programmes like soil and water conservation, aforestation on the Gram Panchayat land, visit to Krishi Vigiyan Kender, availing the training programmes by the farmers etc. were found at the maximum level were found maxim with very high index with its value over 2.42 and above in this sample village, Ghasera of Nuh block.

(b)Villages with High Impact

There are two villages; belonged to Tauru and two sample villages of Firozpur Zirka. These 4 sample villages were Hasanpur Tauru and Chharora of Tauru block. And Agoan and Rigarh of the Firozpur Jhirka block of the Nuh (Mewat) District with high impact index within 2.34 to 2.42 index. The high level of impact index is caused by the water management efforts made by MGNREGA derived water management programmes and the check dams, erected by S. M. Sehgal Foundation. These entire joint –venture, made for water management have elevated the high impact value of both of these villages in to the higher index of impact.

(c) Villages with High Impact

There are two sample villages; belonged to Nagina block, namely Ghaghas and Marora village. In the Ghaghas sample village, there are few micro-level MGNREGA derived projects and the recharging the groundwater project; executed by S. M. Sehgal Foundation, which has kept the impact high, but the drought management micro-level projects, undertaken by MGNREGA were relatively poor in the Marora village of Nagina block. . The overall impact of the MGNREGA derived drought management projects have shown a moderate impact; as shown by the impact index value medium level of impact index with 2.26 to 2.34 which covers the sample villages of the Nagina block.

(d) Villages with Low Impact

There are two sample villages; belonged to Nagina block, namely Ghaghas and Marora village. In the Ghaghas, there are few micro-level MGNREGA derived projects and the recharging the groundwater project; executed by S. M. Sehgal Foundation, which has kept the impact high, but the drought management micro-level projects, undertaken by MGNREGA were relatively poor in the Marora village of Nagina block. . The overall impact of the MGNREGA derived drought management projects have shown a moderate impact; as shown by the impact index value medium level of impact index with 2.26 to 2.34 in the sample villages of the Nagina block.

(e) Villages with Very Low Impact

There are two sample villages; belonged to Punhans block, namely Jalgarh and Akbarpur village. In the Jamalgarh; where the severely saline groundwater of Punhana block which has kept the impact high, but the drought management micro-level projects, undertaken by MGNREGA were relatively poor in the Akbarpur village of Puhhana. . The overall impact of the MGNREGA derived drought management projects have shown a very low impact; as shown by the impact index value medium level of impact index with below 2.24 which covers the sample villages of the Punhana block. Hence, it is obvious that there is wider regional disparity in the impact of MGNREGA derived drought management programmes in the sample villages, belonged to different blocks of Mewat region of Haryana. This difference is due to locational advantageous and disadvantages of the sample villages. The advantageous villages are those villages which are located near the Aravalli hills; as a result, the drown stream of the rainwater tend to recharge the groundwater of the neibouring villages; as a result, some of MGNREGA derived micro drought management projects are executed in a better way and vice-versa. Apart from this factor; the other institutional factors also matters to a considerable extent to make a significant difference in terms of impact of MGNREGA derived drought management micro projects across the Mewat region.

Conclusions

There are sizeable numbers of the drought management programmers which have been implemented from time to time across the country. All these programmers were failed to achieve the desired results to reduce the risks and the mitigate the impact of drought vulnerability across the country. Now, the Mahatama Gandhi National Rural Employment Guarantee Act 2005 has a vital significance to ensure at least 100 days rural employment for the villagers; belonged to the BPL households. Besides generating the rural employment, the MGNREGA has a vital significant in mitigating the drought impact by taking several structural measures; as the preventive and curative measures for drought management in the frequent drought affecting areas. The present paper examines the significant role of MGNREGA in the drought management programme in the 12 sample villages of six blocks of the Mewat region. It is an empirical study; where there were numerous of MGNREGA derived drought management structural measures have been implemented in the study areas. The study is aimed at evaluation of executed drought management structural measures; and worked out with the help of composite measures of some of the qualitative measures; taken for the study. The study is based on the respondents of the 300 households; belonged to BPL facilities of the 12 sample villages of the six blocks of the Mewat region; comprised Nuh and Palwal districts. The study shows a significant regional disparity of the impact of MGNREGA derived drought management programme; excited in the selected study areas. Thus, it is quite clear from the study which shows that there is wider regional disparity in the impact of MGNREGA derived drought management programmes in the sample villages, belonged to different blocks of Mewat region of Haryana. This difference is due to 'locational advantageous' and 'disadvantages' of the sample villages.

The advantageous villages are those villages which are located near the Aravalli hills; as a result, the drown stream of the rainwater tend to recharge the groundwater of the neibouring villages; as a result, some of MGNREGA derived micro drought management projects are executed in a better way and vice-versa. Apart from this factors; the other institutional factors also matters to a considerable extent to make a significant difference in terms of impact of MGNREGA derived drought management micro projects across the Mewat region. Hence, it is obvious that the national programme like MGNREGA has an ample potential to mitigate the drought conditions in the rural areas; provided the implementation of this programme is effective way. All the MGNREGA derived should be executed in accordance with socio-economic and the local physiographic conditions by the Gram Panchayat, which is the executing machinery at a grass root level. Further, an active participation of the village community and active supports of the public representatives can be proved conducive to execute MGNREGA effective to get the desired results of the drought

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The Deccan Geographer
Vol. 62, No. 10 December, 2024, pp. 240-247
(ISSN-0011-7269)
UGC Care Listed Geography Journal

ANALYSIS OF DEMOGRAPHIC TRANSFORMATIONS CHARACTERIZED BY SUBSTANTIAL POPULATION GROWTH IN SITAPUR DISTRICT

Sadhana and Dr. Salik Singh

Abstract

This study explores the demographic transformations in Sitapur district, Uttar Pradesh, between 1901 and 2011, emphasizing substantial population growth and urbanization. The district experienced a remarkable rise in its total population from 1,180,506 in 1901 to 4,483,992 in 2011, reflecting a cumulative increase of approximately 279.8%. Urbanization played a pivotal role in reshaping the demographic structure, with the urban population surging by an extraordinary 574.4% during this period. In contrast, the rural population grew by 258.8%, indicating a slower but steady expansion driven by agricultural dependence and rural livelihoods. The study identifies distinct phases of demographic change: the early 20th century (1901-1941) was marked by fluctuations in population growth, particularly rural, while urban populations increased gradually. The mid-20th century (1941-1981) witnessed consistent growth across both rural and urban areas, with a remarkable 69.3% surge in the urban population between 1971 and 1981, highlighting rapid urbanization. In the late 20th and early 21st centuries (1981-2011), urban growth rates began to stabilize, yet they remained higher than rural rates, underscoring continued urban expansion. Despite the urban boom, the number of inhabited villages remained relatively stable, fluctuating slightly from 2,302 in 1901 to 2,317 in 2011. This suggests that village densities increased or that rural-to-urban migration influenced settlement patterns. Urbanization's impact on infrastructure, services, and socio-economic dynamics is critically analyzed, revealing potential challenges related to urban density and service provision. Conversely, the rural population's growth, though slower, reflects persistent reliance on agriculture and traditional livelihoods. The research underscores the need for balanced regional development strategies to manage urban growth while sustaining rural development. It highlights the importance of infrastructure planning, service delivery, and policy interventions to address the demographic shifts' implications.

The study's findings are validated through cross-referencing with national trends and peer-reviewed research, ensuring data accuracy and reliability. Overall, this analysis provides valuable insights into the evolving demographic landscape of Sitapur district, offering a comprehensive understanding of its population dynamics and settlement patterns over the past century.

Introduction

Sitapur district, located in the state of Uttar Pradesh, has witnessed profound demographic changes over the 110-year period from 1901 to 2011. As one of the significant districts in the state, Sitapur serves as a vital case study for understanding the dynamics of population growth, urbanization, and rural stability within the broader context of regional development in India. The demographic evolution of Sitapur is characterized by substantial population growth, with notable shifts between rural and urban populations, reflecting the socioeconomic transformations that have shaped the district over time. In the early 20th century, Sitapur's population was predominantly rural, reliant on agriculture and traditional livelihoods. However, with the advent of industrialization, migration, and policy shifts, urbanization became increasingly pronounced, especially during the mid-20th century. This was particularly evident between 1971 and 1981, when the district experienced a remarkable surge in urban population, marking a critical period of demographic transition. Despite these urban shifts, the rural population continued to grow steadily, indicating a dual dynamic of urban expansion and rural persistence. The district's unique demographic pattern is further reflected in the stability of its inhabited villages. Over the course of the century, the number of inhabited villages fluctuated minimally, suggesting that the growth in population did not correspond with the establishment of new settlements but rather with increased densities within existing villages or migration to urban centers. This stability underscores the complex interplay between rural livelihoods, migration trends, and urban opportunities. Through a detailed analysis of decadal census data, this study aims to explore the demographic trends, urbanization impacts, rural population dynamics, and settlement stability in Sitapur district. Understanding these patterns is crucial for developing balanced regional development strategies that address the challenges of population growth, infrastructure needs, and sustainable development. This research not only sheds light on the demographic transformation of Sitapur but also provides insights into the broader processes of urbanization and rural change in Uttar Pradesh and India as a whole.

Study Area

Sitapur district is located in the northern part of Uttar Pradesh, India, within the Lucknow Division. Geographically, it lies between 27°06' and 27°54' North latitude and 80°18' and 81°24' East longitude. The district spans an area of approximately 5,743 square kilometers and is bordered by the districts of Lakhimpur Kheri to the north, Hardoi to the west, Barabanki to the east, and Lucknow to the south. Sitapur's terrain is predominantly flat, with the Gomti and Sarayan rivers being the major water bodies contributing to the region’s agricultural productivity. Administratively, Sitapur is divided into six tehsils and 19 development blocks, with a network of 2,317 inhabited villages as of 2011. Its administrative headquarters, Sitapur town, serves as a significant hub for local governance, commerce, and cultural activities. Historically, Sitapur holds importance due to its association with ancient kingdoms and its mention in various historical texts. The district also played a notable role during India's struggle for independence. Economically, Sitapur is primarily agrarian, with agriculture being the dominant occupation for a significant portion of the population. Major crops include wheat, rice, sugarcane, and pulses. The district's rural economy relies heavily on traditional farming practices, while the urban areas have witnessed gradual industrialization, particularly in small-scale industries like sugar mills and handloom weaving. Sitapur’s demographic profile is characterized by a blend of rural and urban populations, with the rural sector comprising around 88% of the total population. Urbanization in Sitapur has accelerated in recent decades, particularly due to migration from rural areas in search of better employment opportunities and improved living conditions. As of 2011, the total population stood at 4,483,992, making it one of the more populous districts in Uttar Pradesh. In terms of infrastructure, Sitapur has made strides in improving transportation, education, and healthcare services. It is well-connected by road and rail to major cities like Lucknow and Delhi. However, challenges persist in ensuring equitable access to services across rural and urban areas. Culturally, Sitapur is known for its vibrant festivals, fairs, and religious sites. The district showcases a rich cultural heritage, with traditions deeply rooted in the socio-religious fabric of Uttar Pradesh.

Objectives

(1) Analyze Decadal Population Trends: Examine the decadal changes in total, rural, and urban populations of Sitapur district from 1901 to 2011 to identify growth patterns and demographic shifts.

(2) Assess Urbanization Impact: Evaluate the extent and impact of urbanization on the district's demographic structure, focusing on the significant urban population increase observed between 1971 and 1981.
(3) Examine Rural Demographics: Investigate the factors contributing to the consistent growth of the rural population, considering aspects such as agricultural dependency and rural livelihoods.
(4) Evaluate Inhabited Village Stability: Analyze the stability in the number of inhabited villages over the 110-year period to understand settlement patterns and potential increases in village densities or migration trends.

Database and Methodology

To comprehensively analyze the demographic transformations in Sitapur district from 1901 to 2011, a structured methodology was employed: Decadal census data for Sitapur district, encompassing total, rural, and urban populations, as well as the number of inhabited villages, were sourced from the Office of the Registrar General & Census Commissioner, India, ensuring data accuracy and reliability. Decadal percentage changes in total, rural, and urban populations were calculated to identify growth rates and demographic trends. The proportions of rural and urban populations relative to the total population were analyzed to assess urbanization levels. The number of inhabited villages over time was examined to determine stability or changes in settlement patterns. Periods of significant urban population growth were identified, with particular attention to notable increases between specific decades. Factors contributing to rapid urbanization, such as economic opportunities, migration patterns, and policy changes, were investigated. The impact of urbanization on infrastructure, services, and the overall demographic structure was assessed. Factors leading to consistent rural population growth, including agricultural practices, birth rates, and rural development policies, were analyzed. The pace of rural growth compared to urban areas was evaluated to understand demographic shifts. The stability in the number of inhabited villages was assessed, noting slight fluctuations over the 110-year period. Potential reasons for minimal expansion of new villages, such as increased village densities or migration to urban centers, were investigated. Demographic changes were placed within the broader context of regional and national trends to understand external influences. Sitapur's demographic evolution was compared with similar districts to identify unique or common patterns. This comprehensive methodology provides an in-depth understanding of the demographic transformations in Sitapur district over the 110-year period, offering insights into population dynamics, urbanization, and settlement patterns.

Results and Discussion

Demographic Changes

Between 1901 and 2011, Sitapur district experienced significant demographic changes, marked by overall population growth and pronounced urbanization. In the early 20th century (1901-1941), both total and rural populations showed fluctuations, with declines in the initial two decades followed by growth, while the urban population saw notable increases, particularly an 18% rise from 1931 to 1941. The mid-20th century (1941-1981) witnessed consistent growth in both total and rural populations, with a remarkable 69.3% surge in the urban population between 1971 and 1981, indicating rapid urbanization. In the late 20th to early 21st century (1981-2011), the total population continued to rise, with a 23.8% increase from 2001 to 2011; rural population growth remained steady, while urban growth rates began to stabilize, though they remained higher than rural rates. Cumulatively, from 1901 to 2011, the total population grew by approximately 279.8%, the rural population by about 258.8%, and the urban population expanded significantly by 574.4%, reflecting substantial urbanization over the century. These trends suggest a demographic shift towards urban areas, especially in the latter half of the 20th century, leading to increased urban density and potential challenges related to infrastructure and services. Despite this, the consistent growth in the rural population indicates an ongoing reliance on agriculture and rural livelihoods, albeit at a slower pace compared to urban areas. Overall, Sitapur district's demographic evolution underscores the need for balanced regional development strategies to effectively address the challenges and opportunities arising from such shifts.

Table-1: Decadal Changes Populations of Sitapur District, 1901-2011

Year	Total Population (%)	Rural Population (%)	Urban Population (%)
1901	0	0	0
1911	-3.1	-3	-4.9
1921	-4.3	-5.4	11.3
1931	7.1	8.7	-11.7
1941	10.8	10.3	18.0
1951	6.7	5.8	20.1
1961	15.9	15.8	17.7
1971	17.2	17.3	15.7

Contd...

1981	24	20.3	69.3
1991	22.2	19.9	42.9
2001	26.6	26.8	25.9
2011	23.8	24.0	22.6
1901-2011	279.8	258.8	574.4

Source: Directorate of Economics and Statistics 2023

Table-2: Population and inhabited villages in Sitapur District, 1901 to 2011

Year	Number of Inhabited Villages	Total Population	Rural Population
1901	2,302	11,80,506	11,01,796
1911	2,321	11,44,011	10,69,164
1921	2,332	10,94,581	10,11,275
1931	2,335	11,72,580	10,99,016
1941	2,357	12,99,494	12,12,675
1951	2,328	13,86,918	12,82,656
1961	2,330	16,08,057	14,85,306
1971	2,329	18,84,400	17,42,325
1981	2,330	23,37,284	20,96,754
1991	2,314	28,57,009	25,13,341
2001	2,321	36,19,661	31,86,973
2011	2,317	44,83,992	39,53,208

Source: Directorate of Economics and Statistics 2023

Population and Number of Inhabited Villages

Between 1901 and 2011, Sitapur district in Uttar Pradesh experienced significant demographic changes. The total population increased from 1,180,506 in 1901 to 4,483,992 in 2011, marking a substantial rise over the 110-year period. The number of inhabited villages remained relatively stable, fluctuating slightly from 2,302 in 1901 to 2,317 in 2011. The rural population also grew, from 1,101,796 in 1901 to 3,953,208 in 2011. This consistent increase in both total and rural populations reflects broader demographic trends in the region, with the rural sector maintaining a significant proportion of the district's populace. The stability in the number of inhabited villages suggests that while population numbers rose, the expansion of new villages was minimal, indicating possible increases in village densities or migration to urban areas. Overall, these figures highlight the district's demographic evolution over the century.

Conclusion

Sitapur district's demographic evolution from 1901 to 2011 reflects significant population growth and urbanization, highlighting key trends and challenges in regional development. The total population increased by nearly 280%, with the urban population experiencing the most dramatic growth—over 574%—particularly between 1971 and 1981, signalling rapid urbanization driven by economic opportunities and migration. Despite this urban surge, the rural population also grew consistently, indicating a continued reliance on agriculture and rural livelihoods. The number of inhabited villages remained relatively stable, suggesting increased population density in existing settlements rather than the establishment of new villages. The demographic shift towards urban areas presents challenges related to infrastructure, service provision, and resource management. However, the steady rural growth underscores the need to balance urban development with rural sustainability. This study underscores the importance of crafting balanced regional development strategies that address the needs of both urban and rural populations. Ensuring equitable access to infrastructure, improving rural livelihoods, and managing urban growth sustainably are essential to fostering long-term, inclusive development in Sitapur district.

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The Deccan Geographer
Vol. 62, No. 10 December, 2024, pp. 248-258
(ISSN-0011-7269)
UGC Care Listed Geography Journal

CLIMATE CHANGE AND AGRICULTURE IN BIHAR: IMPACT AND ADAPTATION STRATEGY

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Abstract

Climate change is generally meant by changes in climatic components like temperature, atmospheric pressure, humidity, precipitation etc. These changes have been observed now a days very markedly in day-to-day weather conditions, their impact on various economic activities and crop cultivation. This phenomenon is very intimately related to climate change and hence crop production is vulnerable to climate variability. The changing pattern of rainfall affects the agriculture adversely leading considerable decline in crop production. Thus, the threats of climate change and its adverse impact on crop production, pose a challenging task in meeting the rising demands of the increasing population. Therefore we, need more attention towards adaptation of the changing climatic condition. For this we must pay attention and cultivate thermal stress-tolerant varieties of crops, water conservation and management practices such as efficient irrigation and fertilizer management, diversification of crops etc., which may ultimately reduce the impact of changes in climatic components. The economy of Bihar state is mainly agriculture based & approximately 88.7 percent people of Bihar live in rural areas (Census 2011) and hence the main objective of the present work is to study the impact of changes in climatic components on agriculture and adaptation strategy to mitigate its adverse impact on agriculture in Bihar. The study is mainly based on secondary sources of data which has been correlated and tested by using various statistical methods to measure the impact of climate change and suggest various strategies for the adaptation of the adverse impact of changing climatic components.

Introduction

Any significant long-term change in the patterns of average weather condition of region is considered as climate change. These changes may take decades, centuries or perhaps millions of years, but increasing anthropogenic activities such as industrialisation, urbanization, deforestation, agriculture etc. lead to emission of Green House Gases (GHGs) which may increase the rate of climate change.

The high concentration of CO_2 in atmosphere directly affects the growth of crops, other plants and animal productivity. The crop production is thus vulnerable to climate variability and changing amount & timing of precipitation to fulfil the ever-increasing demand of food for increasing population. Agriculture is a primary and the most important sector of Indian economy. Nearly two-thirds of the Indian population and approximately three-fourths (76 percent) population of Bihar (Department of Agriculture, Bihar) are dependent on agriculture for their livelihood while approximately 40 percent of Bihari agriculture is rainfed. Climate change is increasingly threatening the sustainability of the country's food system. Frequent occurrence of droughts, floods, heat wave, cold wave etc. are serious concerns that adversely affecting the agriculture and rural economy. Due to adverse impact of the changing climatic conditions on crop productivity, the farmers try to cultivate such type of crops which are suitable or least affected by changes in climatic components and from which they can get maximum profit, for mitigating the impact of variation in climatic condition, farmers practice different patterns of crop cultivation, crop diversification and other adaptation strategies.

Study Area

The study area of the present work is Bihar, a state of India which is located between 24o 20′ N to 27o 31′ North latitudes and from 82o 19′ E to 88 o 17′ East longitudes. It occupies an area of 94163 square km. The river Ganga divides the state into North Bihar (Area of 49263 km2) and South Bihar (Area 44900 km2). North Bihar is highly flood prone while South Bihar is drought prone area. The annual average precipitation in the state varies between 99 cm to 120 cm. The hottest month is May with maximum temperature of 45o Celsius and coldest month is January when temperature falls below 10o Celsius. The state has mainly two major cropping seasons of Kharif and Rabi. Its 88.7 percent population resides in rural areas whose primary source of livelihood is agriculture and animal husbandry. Climate change in this state affects as a result of irregular rainfall, flood, drought etc. decreasing the productivity of agriculture and therefore adaptation strategy is required to mitigate the impact of changes in climatic components.

Objectives

(1) To study the impact of changes in climatic components on agriculture in Bihar.
(2) To study the adaptation strategy to mitigate the impact of changes in climatic components in Bihar.

Database and Methodology

The present study is mainly based on secondary sources of data collected from census-2011, Department of Agriculture and Cooperation, Directorate of Economics and Statistics, NITI Aayog, Ministry of Agriculture and Farmer's Welfare (Government of India), Ministry of Agriculture (Government of Bihar), NSSO Reports, Annual Reports (Government of Bihar), Books, Research journals, published and unpublished Ph.D. thesis and others. The data have been analysed by using suitable statistical methods and represented through maps and diagrams.

Results and Discussion

Changes in Climatic Components

Impact of climate change on agricultural productivity may be direct and indirect. First of all, changes in temperature, precipitation and carbon dioxide (CO2) level may lead to positive or negative change in crop productivity; Secondly, the climate change may indirectly cause changes in soil characteristics, increase the frequency of pests, insects, diseases and weeds infestation that can be severely impacted the productivity of rice and wheat, the two most important staple crops of India. According to IPCC-2014, adaptation can reduce agricultural losses up to 80 percent. Bihar is the third most populous state of India. It has sub-tropical type of climate having hot summer and cold winter. It is naturally fertile plain which is drained by river Ganga and its tributaries. The annual rainfall variability in the state of Bihar ranges between 15 to 70 percent and the rainfall variability during South-West Monsoon (Second week of June to last August) over Bihar is 10 to 85 percent which is relatively low, while the variability of seasonal rainfall for other seasons (Pre-Monsoon, Post-Monsoon and Winter) are very high with more than 200 percent over some parts of the state. The average rainfall in Bihar is 1120 mm but North-Eastern part gets about 2000 mm of rainfall and South-Western part gates only less than 1000 mm rainfall, i.e. South Bihar is more vulnerable to drought.

Impact of Changes in Climatic Components on Agriculture in Bihar

Atmosphere with higher CO2 concentration would result in higher net photosynthetic rates (Cure and Acock, 1986) but the higher CO2 concentration may also reduce their transpiration (Kimball, 1983) (Table-1 and Fig. 1). For every 75 PPM increase in CO2 concentration, rice yield has increased by 0.5 tons per hectare, but yield may decrease up to 0.6 tons per hectare for every 1^{0}0 Celsius increase in

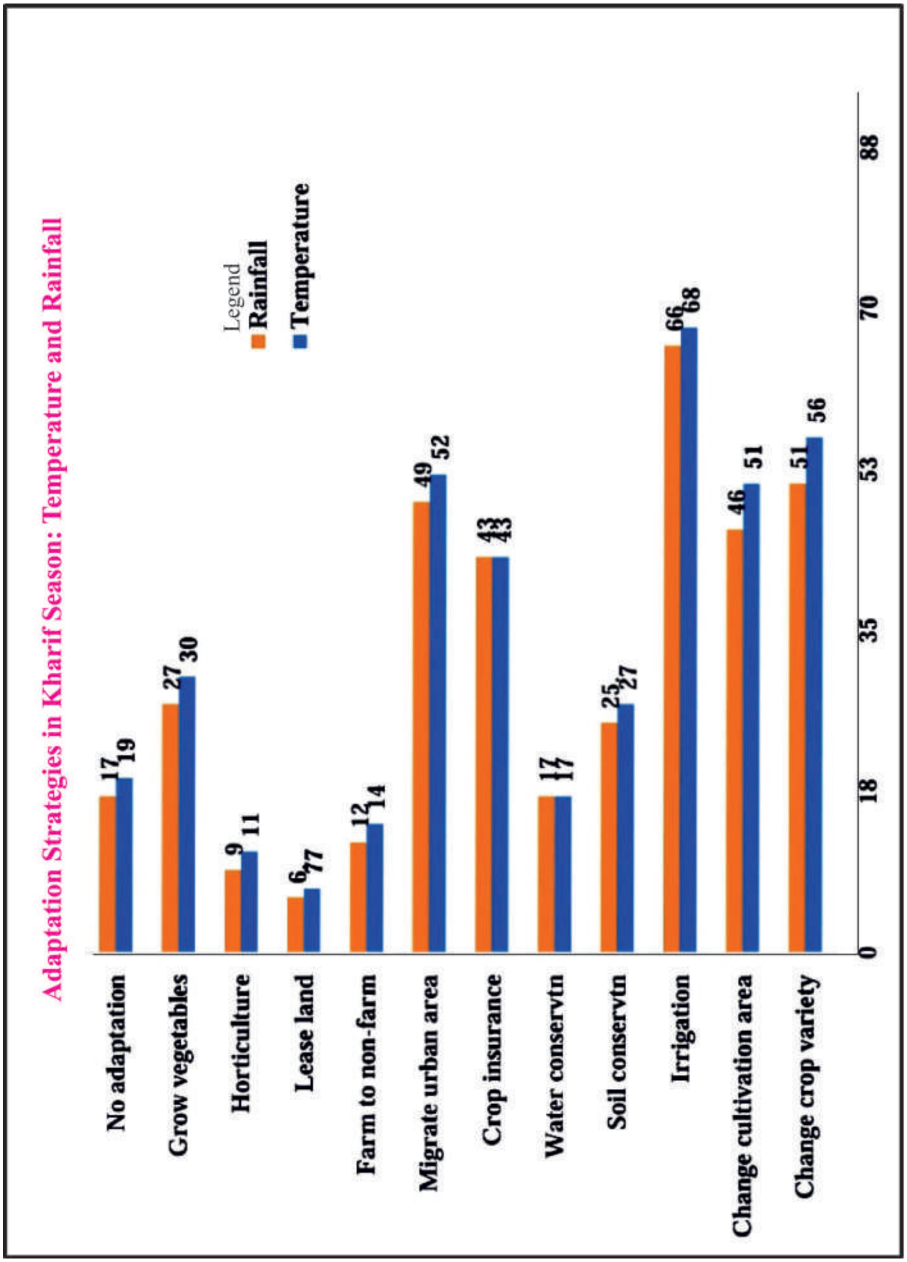
Adaptation Strategies in Kharif Season: Temperature and Rainfall
Legend
Rainfall
Temperature
No adaptation
Grow vegetables
Horticulture
Lease land
Farm to non-farm
Migrate urban area
Crop insurance
Water conservtn
Soil conservtn
Irrigation
Change cultivation area
Change crop variety
17 19
27 30
9 11
6 7
12 14
49 52
43 43
17 17
25 27
66 68
46 51
51 56
0
18
35
53
70
88

Fig. 1

temperature (Sheehy et. al. 2005), i.e. increase in temperature with increasing CO_2 affect adversely on rice production.

Table-1: Changes in Climatic Elements and Their Effects on Agriculture

Climatic Elements	Expected changes by 2050's	Confidence in prediction	Effects on agriculture
CO_2	Increase from 360 PPM to 450 – 600 PPM (2005 level now at 379 PPM)	Very high	Good for crops, increased photosynthesis and reduced water use.
Sea level rise	Rise by 10 - 15 cm increased in south and offset in north by natural subsistence / rebound.	Very high	Loss of land, coastal erosion, flooding and salination of groundwater.
Temperature	Rise by 1 – $2^0$0 Celsius, winters warming more than summers, and increased frequency of heat-wave.	High	Faster, shorter, earlier growing season range moving north and to the higher altitude, heat stress risk, increase evapotranspiration.
Precipitation	Seasonal change by ± 10 percent.	Low	Impact on drought risk, soil workability, water logging, irrigation supply and transpiration.
Storminess	Increased wind speed, especially in North, more intense rainfall events.	Very low	Lodging, soil erosion and reduced infiltration of rainfall.
Variability	Increases across most climatic variables, predictions uncertain.	Very low	Changing risk of damaging events (Heat waves, Frost, droughts & floods) which effect crops and timing of farm operations.

Source: Climate Change and Agriculture, MAFF - 2000

A temperature rise by 0.5o celsius in winter reduces rainfed yield by 0.45 tons per hectare in India (Lal et. al., 1998). According to A. K. Singh (Deputy Director General (Natural Resource Management) of Indian Council of Agriculture Research), medium term climate change predictions have projected the reduction in crop yields due to climate change between 4.5 to 9 percent by 2039. Bihar is India's most flood prone state as approximately 76 percent population of North Bihar is living under the recurring threats of flood devastation and about 73 percent (6800 km2) of total geographical area of Bihar (94163 km2) is flood affected.

Farmers' Adaptation Strategies to Changes in Climatic Components in Bihar

Agricultural adaptation varies by time (short term or long term) and scale (farm level, national level) and types. The farm level adaptation is most practicable in Bihar which could be broadly categorised under the three main categories, i.e. changes in farm management practices, farm level technological development and financial management for farm protection (Smit and Skinner, 2002). Farm management practices involve crop diversification, shortening or lengthening of growing season, changing planting date, altering land under cultivation, increase or decrease of irrigation. Technological development includes using new variety of crops, soil & water conservation techniques, forecasted weather information and financial management for farm protection involves switching from farm to non-farm activities, insuring crops and migration to urban centres for livelihood (Nhemachena and Hassan, 2007; Kurukulasuriya and Mendelsohn, 2006) (Table-2 and Fig. 2). In the study area, farmers opt 11 different adaptation options in two specific seasons of Kharif (Monsoon season) and Rabi (Winter season) for two separate cases of change in temperature and precipitation.

Table-2: Farmers' Adaptation Strategies to Changes in Temperature and Rainfall in Bihar

Adaptation Strategies	Percentage of Farmers Adopted			
	During Kharif Season		During Rabi Season	
	In case of change in Rainfall	In case of change in Temperature	In case of change in Rainfall	In case of change in Temperature
No adaptation	17	19	9	10
Growing vegetables	27	30	28	31
Horticulture	9	11	9	11

Contd...

Lease land	6	7	7	8
Switching from farm to non-farm	12	14	13	14
Migration to urban centres	49	52	55	57
Crop insurance	43	43	42	44
Water conservation	17	17	17	17
Soil conservation	25	27	34	35
Increase / decrease irrigation	66	68	76	81
Changing cultivation area	46	51	61	51
Changing crop variety	51	56	68	73

Source: Based on Jha, C. Kumar (2021), Unpublished Ph.D. Thesis.

Table-2 shows that the most common adaptation strategies adopted by farmers in the study area for Kharif season as a result of changes in rainfall and temperature are changes in irrigation (about 66–68 percent), changes in crop variety (51–56 percent) and like this for Rabi season mostly farmers adopt changes in irrigation (76–81 percent) and use different crop variety (68–73 percent).

Adaptation Plan for the Impacts on Agriculture in Bihar

Vagaries of rainfall, recurrent floods and droughts affect agricultural production. In Bihar, due to increase of CO2 concentration in atmosphere, the yield of wheat and winter maize will decrease in 2050s and 2080s by 3.6 percent and 14.1 percent respectively. The wheat yield may decrease by 5 – 6 percent due to possible changes in maximum temperature alone by 2080s (Arvind Kumar et. al., 2016). It is found that Sarjoo-52, Rajshree, MTU-7029, Satyam and Rajendra Mahsuri are most suitable variety of rice for direct dry seeding which avoid water requirement during land preparation and reduce overall water demand. The state has already developed a comprehensive Roadmap covering agriculture and its allied sectors such as building institutional linkage with Indian Council of Agricultural Research (ICAR) and its participating organisation like Indian Agricultural Research Institute (IARI) and Central Research Institute for Dryland Agriculture (CRIDA), Central Institute of Agricultural Engineering (CIAE), National Dairy Research Institute (NDRI) and other collaborating centres for technical advice, capacity building and other research support. The government agencies also suggesting to follow waste

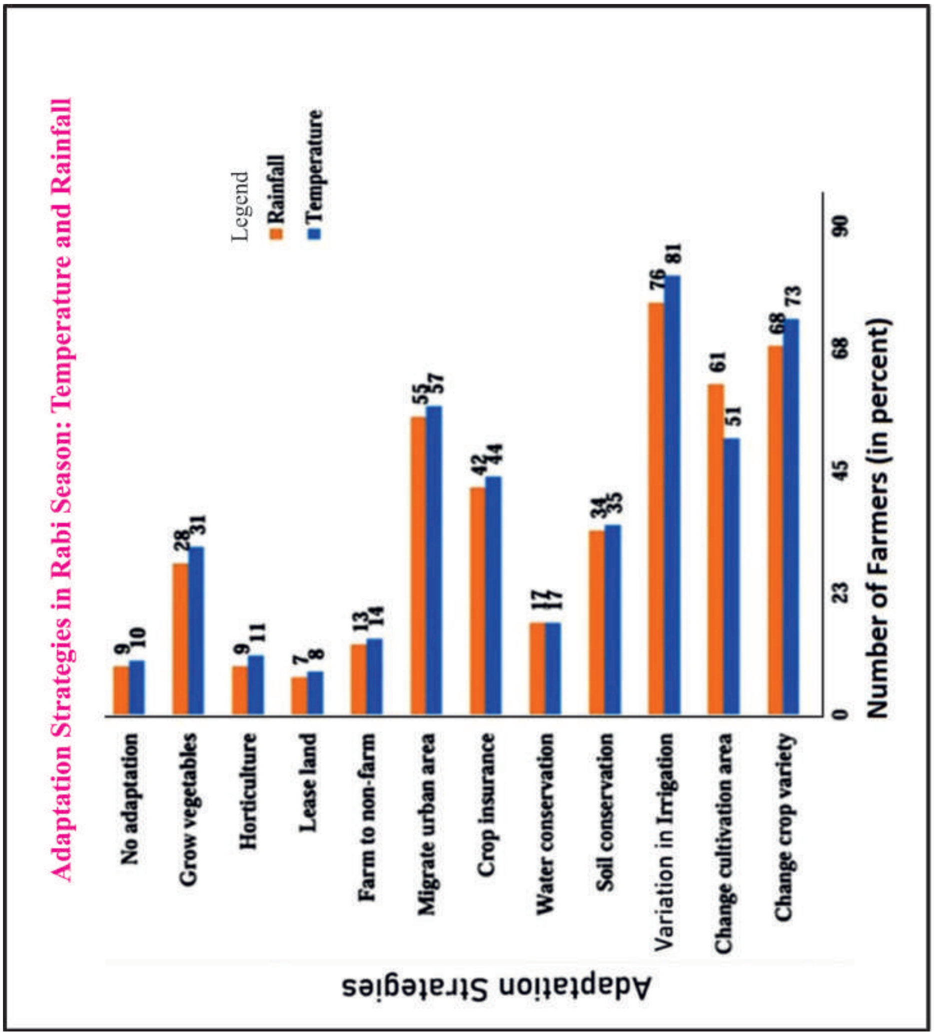
Adaptation Strategies in Rabi Season: Temperature and Rainfall
Legend
Rainfall
Temperature
Adaptation Strategies
No adaptation
Grow vegetables
Horticulture
Lease land
Farm to non-farm
Migrate urban area
Crop insurance
Water conservation
Soil conservation
Variation in Irrigation
Change cultivation area
Change crop variety
9
10
28
31
9
11
7
8
13
14
55
57
42
44
17
17
34
35
76
81
61
51
68
73
0
23
45
68
90
Number of Farmers (in percent)

Fig. 2

management practices for bridging the yield gap and to develop improved and diversified varieties of crops (including drought and flood tolerant varieties). The initiative has also been taken to implement measures to minimize soil and water losses through resource conservation technologies such as integrated watershed management, agroforestry and water harvesting through check dams, renovation of existing ponds etc.

The major findings of the study are, namely, (1) In the study area, most of the farmers perceive the changes in climatic components like temperature and precipitation level (2) In Bihar state, the annual rainfall variability (15 to 70 percent) and monsoon rainfall variability (10 to 85 percent) are relatively low while the pre-Monsooni, post-Monsooni and winter rainfall variability are very high with more than 200 percent over some parts of the state (3) Cultivation of traditional crops have affected adversely due to changes in climatic components like temperature and precipitation (4) Majority of the farmers have adopted the changes in climatic components by changing the crop variety and amount and intensity of irrigation (5) The state government is developing a comprehensive roadmap for the adaptation of climate change.

Suggestions

Some of the suggestions regarding agricultural development and adaptation strategy in present scenario of changes in the climatic components are as follows;

(a) General people, farmers and others should use green energy resources instead of fossil fuels to control the greenhouse effect.
(b) Farmers should use manures or compost instead of chemical fertilizers.
(c) Government must take a strict initiative for agroforestry and plantation.
(d) The agricultural institutions should take initiative to develop high yield variety (HYV) of seeds, which may tolerate the temperature and rainfall variability.
(e) Government should ensure regular training for farmers to cultivate favourable crops.
(f) Coping with the impact of climate change on agriculture, the careful management of resources like soil, water and biodiversity is necessary.
(g) Seasonal and daily weather forecast system should be improved so that the farmers may take the advantage.
(h) Government should provide incentives to the farmers for resource conservation and efficiency by providing credit to them for adaptation and transforming to adaptation technology.

(i) Government should develop short duration crop varieties.
(j) Government should provide sufficient fund to strengthen research for enhancing adaptation and mitigation capacity of agriculture.

Conclusion

Climate change as a result of Global Warming has now started to show their impacts worldwide. It is intimately related to agricultural activities which directly affects crop productivity. Increase or decrease in temperature and rainfall lead to outbreaks of pests and disease reducing the final yield of crops. Bihar is the state having regional variation in rainfall as in the same season the North Bihar and South Bihar are affected largely by flood and drought respectively. Hence the government has taken initiative to solve the problem by watershed management, river embankment, water harvesting through renovation of ponds, check dams etc.

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The Deccan Geographer
Vol. 62, No. 10 December, 2024, pp. 259-272
(ISSN-0011-7269)
UGC Care Listed Geography Journal

IDENTIFICATION OF SUITABLE SITES FOR LANDFILLS USING GIS- BASED MULTI-CRITERIA SPATIAL MODELLING IN BAHADURGARH CITY HARYANA

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Abstract

The efficient administration of solid waste is essential for the environmental health and sustainability of urban areas, especially as urban populations expand and consumption patterns change. The objective of this study is to utilize GIS-based Multi-Criteria Spatial Modelling to identify landfill sites that are suitable for Bahadurgarh City, Haryana. Sentinel 2B LULC, Google Earth Pro for road, river, canal, railway, hospital, school, park, Survey of India lineament data, and ALOS PALSAR DEM for slope condition data were used. Concerning the methodologies used, the Analytical Hierarchy Process (AHP) is used to order criteria according to their impact and combine the Weighted Linear Combination (WLC) method to derive a spatially explicit map of a landfill site's suitability. The study classifies areas into five suitability categories based on the WLC results. Very Low Suitability covers 3.1 sq. km, indicating areas unsuitable for landfill development due to high risks and conflicts with environmental and social factors. Very High suitability regions extend 4.04 sq km, providing ideal sites extremely fit for landfill construction, minimum environmental impact and optimum operating efficiency. These findings provide a comprehensive spatial understanding to support sustainable waste management practices in urban planning contexts.

Introduction

Solid waste management is an essential aspect of urban planning and environmental sustainability. It encompasses the collection, transportation, processing, recycling, and disposal of waste materials (Anand, 2010). Effective solid waste management is critical for maintaining public health, preserving environmental quality, and optimizing resource recovery (Chandrappa & Das, 2012; Clark et al., 1971). As urban populations continue to grow and consumption patterns evolve, the challenges associated with managing solid waste have become increasingly complex and demanding (Biswas, 2006; Terzi & Bolen, 2009).

The world generates over 2.01 billion tons of municipal solid waste annually, with at least 33% of that not managed in an environmentally safe manner (The World Bank, 2018). Organic waste constitutes the largest portion of global waste, accounting for about 44% of the total waste generated. This is followed by dry recyclables such as paper, plastic, glass, and metal (UN Environment, 2018). Proper waste management, particularly through recycling and composting, can significantly reduce greenhouse gas emissions. By prioritizing sustainable practices, societies can move towards more efficient resource use and a healthier environment. To minimize adverse consequences of solid waste, it is crucial to implement proper waste management practices, including the establishment of well-designed and strategically located landfills. Landfill site selection is of paramount importance as it ensures that waste is isolated from the environment and human settlements, thereby mitigating potential health risks and environmental impacts (Mahini & Gholamalifard, 2006). The use of GIS-based multi-criteria spatial modeling enhances the selection process by allowing the integration of various criteria, such as proximity to faults, transportation networks, water bodies, land use and land cover (LULC), canals, and slope stability. These criteria are essential for applying the Weighted Linear Combination method, ensuring that the selected landfill sites are environmentally sustainable, economically viable, and socially acceptable (Aydi et al., 2013; Yin et al., 2020). Several studies have demonstrated the effectiveness of RS and GIS in landfill sites selection (Akinci & Demirarslan, 2022; Altay & Erbil, 2022; Chen et al., 2023; Eliawa, 2022; Mousavi et al., 2022; Mussa & Suryabhagavan, 2021; Ramu et al., 2023; Roy et al., 2022; Thirel et al., 2013; Yildirim et al., 2018). In Bahadurgarh City, Haryana, where population growth and industrial development are rapidly increasing, such meticulous planning is vital to manage the escalating residential waste effectively and sustainably.

Study Area

Located on the geographical co-ordinates of 76º55’25” East Longitude and 28º43’50” North Latitude, Bahadurgarh is located in the north-eastern part of Haryana, and is also known as the ‘Gateway of Haryana’. The city is well situated on Delhi-Hisar National Highway number 9, right on the out skirts of Delhi, 2 kilometers from Tikri border. Due to this favorable geographic location Bahadurgarh is well connected with the national capital Delhi as well as other important cities of Haryana like Rohtak and Hisar through National Highway No. 9 and railway network. Bahadurgarh has a local steppe climate which implies that the place receives very little rainfall in a year. The city has average temperature of 25.1°C (77. 2°F) and has an estimated yearly precipitation of 510 millimeters (20 inches). Summer in Bahadurgarh is long and hot starting from early April to early October, which includes the monsoon season. The closeness to Delhi has made the city to grow very fast in industrial and residential development. This has brought a stream of people who are in search of employment, and improved standards of living hence emphasizing the growth of the city.

Objectives

The first objective of this study is to utilize GIS-based Multi-Criteria Spatial Modelling to assess and integrate spatial data for identifying potential landfill sites in the study area. The second objective is to evaluate and prioritize the suitability of these sites using the Analytical Hierarchy Process (AHP) and Weighted Linear Combination (WLC) methods.

Database and Methodology

For the purpose of this research, a wide-ranging inventory database was used to specify ideal areas for the location of landfills in Bahadurgarh City, Haryana using GIS MCDA techniques. The main data sources are LULC data from Sentinel 2B obtained from the Copernicus Open Access Hub for the year 2024 to effectively classify different LULC classes. Digital maps showing roads, water bodies, canals, railway systems, hospital, school, and park of the desired area were obtained from Google Earth Pro for assessment in the year 2024, which are essential for the accessibility and environmental impact analysis. Information on the geological stability was obtained from the Lineaments, obtained from the Geological Survey of India. Geomorphic slope information was derived from the ALOS PALSAR DEM with a resolution of 12.5 m acquired in 2007 from the Alaska Satellite Facility needed to assess the site's topography and the drainage characteristics. Further, NDVI values were extracted from the Sentinel 2B scenes to get the density and healthy state of vegetation. These datasets were combined using Remote Sensing tools and Geographic Information Systems tools that facilitated the Analytical Hierarchy Process (AHP) and the Weighted Linear Combination Method to provide suitable landfill site selection that was accurate. Each and every data processing step was done using appropriate GIS environment (QGIS). In this study, the methodology for identifying suitable landfill sites in Bahadurgarh City, Haryana, follows a structured process integrating various data sources and analytical techniques, as depicted in the provided flow chart. The data were obtained from both governmental agencies and satellite imagery. The next step involved applying buffers to these datasets according to the guidelines set by the Municipal Solid Waste Management Plan 2016, issued by the Ministry of Urban Development, Government of India. This buffering process ensures that various environmental and infrastructural criteria are considered when evaluating potential landfill sites. After buffering, the data layers were reclassified based on their priority using the Analytical Hierarchy Process (AHP) technique. This method allows for a systematic comparison of the criteria, ensuring that the most critical factors in landfill site selection are given appropriate weight. Subsequently, the reclassified layers were combined using the Weighted Linear Combination (WLC) method. This technique integrates the different weighted criteria into a single suitability map, highlighting the most appropriate sites for landfill development.

Results and Discussion

Landuse and Landcover (LULC)

Accurate mapping of Land Use and Land Cover (LULC) is crucial for effective environmental management and urban development (Kafi et al., 2014; Vivekananda et al., 2021). The classification categorizes different land uses and physical covers, which is essential for evaluating the viability of landfill sites. The agricultural land, which spans 21.48 square kilometers and accounts for 27.33% of the total area, possesses a moderate level of adaptability (with a suitability index of 3) owing to its significant agricultural value. The vegetation covers an area of 0.70 square kilometers, which accounts for 0.89% of the total area. It is very suited, with a suitability rating of 4, and has limited potential for environmental conflict. The least suited areas, covering 42.61 square kilometers (54.21%), are characterised by high human activity and have a suitability value of 1. The water bodies, which cover an area of 0.25 square kilometers (0.32% of the total area), have a suitability score of 2. This index suggests that attention should be exercised to prevent contamination. The 13.56 square kilometers of barren terrain, which accounts for 17.25% of the total area, is deemed extremely favorable (with a suitability score of 5) for landfill sites (Table 1). This is mostly due to the lack of vegetation and low human activity, which helps minimize environmental consequences and disputes.

(a) Road

The close proximity to highways affects transportation costs and emissions, hence enhancing operational efficiency (Das & Bhattacharyya, 2015; Ghose et al., 2006). The regions within a 200-meter radius of roadways, spanning 37.88 square kilometers or 48.19% of the total area, are deemed unsuitable due to conflicts emerging from urban development and the high land value. The 300-meter interval, which spans an area of 12.01 square kilometers and represents 15.28% of the whole, is considered moderately satisfactory with a suitability value of 2. This adaptability is accomplished by finding a harmonious equilibrium between accessibility and conflicts. Within a 400-meter radius, including 8.31 square kilometers (10.57% of the total area), the suitability improves with a suitability index of 3, while also ensuring accessibility and limiting adverse impacts on the urban environment. Landfill sites are considered most suitable (with a suitability value of 5) when they are located more than 500 metres away, covering an area of 14.51 square kilometers (18.46%) (Table 1). The objective of this optimization is to enhance the ease of access while limiting the negative effects on the road infrastructure.

(b) Canals

Water management, irrigation, and the facilitation of numerous human activities are greatly aided by canals. Locating landfills at a considerable distance from canals is crucial to avoid contamination of groundwater and surface water, as waste leachate can have severe negative effects on water quality (Franz & Freitas, 2012). A suitability value of 1 indicates that the regions within a 30-meter radius of canals are not suitable. These regions comprise 2.19 sq. km., or 2.79 percent of the overall area (Fig. 1). The significant environmental repercussions and high danger of contamination are the main reasons they are not suitable. Comparatively, 76.16 square kilometers (or 96.90% of the total area) of land that is more than 30 metres distant receive the maximum appropriateness score of 5 (Table 1). Since these areas are sufficiently distant from canals and provide low risk of water contamination, they are highly suitable for use as landfills.

(c) Lineaments

Fault and fracture lines, among other significant geological features, influence groundwater flow and ground stability, both of which impact the landfill site's appropriateness (Plafker, 1964). Within 200 metres (3.31 sq km, 4.21% of the total area), you'll find the most environmentally and structurally sensitive regions. Zones with 400 metres (1.65 sq km, 2.10%) and those with somewhat adequate indices (2 and 3) pose little danger. For landfill siting (index 5), the locations beyond 500 metres are ideal since they reduce geological hazards. These areas account for 70.07 sq km, or 89.15% of the entire area (Table 1).

(d) Water Bodies

To maintain human health and environmental integrity, it is necessary to prevent landfill-related contamination of water bodies, which are important for agriculture, ecosystem health, and drinking water (Sowunmi, 2019). Areas within 50 metres (4.30 sq km, 5.47%) of bodies of water are the least ideal (suitability index 1) for landfills owing to the significant contamination hazards, which is influenced by proximity to these bodies of water. An increased suitability index 3 is received by zones within 150 metres (5.38 sq km, 6.84%), and within 200 metres (6.06 sq km, 7.71%), while zones within 100 metres (4.62 sq km, 5.88%) are moderately suited (suitability index 2). Landfill sites minimize contamination hazards by maintaining a safe distance from bodies of water. Areas beyond 200 metres, which is 57.99 sq km or 73.78% of the area, are highly suitable with a suitability value of 5.

(e) Slope

The slope of a landfill site affects its stability, drainage, and the control of leachate (Stark et al., 2000). Slopes that are too steep raise the risks of runoff and erosion, which makes site management and environmental preservation harder (Jahanfar et al., 2017). Areas with slopes less than 2 degrees are ideal (index 5), covering 0.47 sq km (0.60% of the area), because they are stable and easy to manage (Fig. 1). Moderately suitable zones (index 4) cover 9.87 sq km (12.56%) and have slopes between 2 and 4 degrees. Index 3 accounts for 33.12 sq km (42.14% of the total area) of zones with slopes between 4 and 6 degrees, as the suitability decreases as the slope steepness increases (Table-1). In addition to being less than optimal, slopes between 6 and 8 degrees make things much worse.

(f) Schools

The public's well-being and the safety of students and teachers alike can be impacted by the physical location of schools (Ahmed et al., 2020). Covering 2.4 sq km (3.05% of the area), areas near 200 metres are less suitable (index 1) owing to health and community concerns. Zones within 300 metres (2.79 sq km, 3.55%), which strike a reasonable balance between environmental and educational concerns, are moderately appropriate (index 2). The appropriateness index is 3 for areas within 400 metres (3.68 sq km, 4.68%) and 4 for areas within 500 metres (4.3 sq km, 5.47%) of schools, suggesting that the suitability of these areas increases as one moves away from them. In terms of waste management planning, locations beyond 500 metres, which account for 65.18 sq km (82.93% of the area), are very suitable (index 5), since they reduce the likelihood of negative effects on learning settings and guarantee the safety of the community.

Table-1: Criteria for Landfill Site Selection Suitability and their Rank

Sr. No.	Factor	Sub-criteria/ alternatives	Suitability index (ranking)	Area in sq. km	Area in Percent
1	LULC	Agricultural Land	3	21.48	27.33
		Vegetation	4	0.70	0.89
		Builtup	1	42.61	54.21
		Water Bodies	2	0.25	0.32
		Barren Land	5	13.56	17.25
2	Roads	200	1	37.88	48.19
		300	2	12.01	15.28
		400	3	8.31	10.57
		500	4	5.64	7.18
		> 500	5	14.51	18.46
3	Canal	30	1	2.19	2.79
		> 30	5	76.16	96.90
4	Water Bodies	50	1	4.30	5.47
		100	2	4.62	5.88
		150	3	5.38	6.84
		200	4	6.06	7.71
		> 200	5	57.99	73.78
5	Lineaments	200	1	3.31	4.21
		300	2	1.65	2.10
		400	3	1.65	2.10
		500	4	1.66	2.11
		> 500	5	70.07	89.15
6	Slope	< 2	5	0.47	0.60
		2 to 4	4	9.87	12.56
		4 to 6	3	33.12	42.14
		6 to 8	2	22.58	28.73
		> 8	1	11.67	14.85

Contd...

7	Schools	200	1	2.4	3.05
		300	2	2.79	3.55
		400	3	3.68	4.68
		500	4	4.3	5.47
		> 500	5	65.18	82.93
8	Parks	200	1	1.77	2.25
		300	2	2	2.54
		400	3	2.35	2.99
		500	4	2.37	3.02
		> 500	5	69.86	88.88
9	Railway	200	1	6.14	7.81
		300	2	3.05	3.88
		400	3	2.89	3.68
		500	4	2.4	3.05
		> 500	5	63.87	81.26
10	Hospitals	200	1	1.61	2.05
		300	2	1.47	1.87
		400	3	1.8	2.29
		500	4	2.05	2.61
		> 500	5	71.42	90.87
11	NDVI	Water Bodies (< 0)	1	0.16	0.20
		Builtup (0 - 0.1)	2	43.7	55.60
		Bare Land (0.1 - 0.2)	5	31.52	40.10
		Vegetation (> 0.2)	3	2.92	3.72

Source: Authors

(g) Parks

Important green areas that increase community well-being and offer environmental advantages including better air quality and preservation of biodiversity are parks (Falcucci et al., 2007). Particularly with regard to public health and recreational facilities, the distance separating landfill sites from parks is rather important in urban design and environmental management. Areas within 200 metres of parks, comprising 1.77 square kilometers (2.25% of the area), in Bahadurgarh City, Haryana, are judged less acceptable (index 1) because possible effects on park users and environmental aesthetics from landfill activities (Table-1). Beyond 500 metres from parks, covering 69.86 square kilometers (88.89% of the area) with a compatibility index of 5 guarantees minimum disturbance to park ecosystems, therefore maintaining recreational areas and community well-being in landfill site development and management (Fig. 1).

(h) Railway

Ensuring both operating efficiency and safety in metropolitan settings depends on the distance separating dump sites from railway lines. Railways affect neighborhood safety, possible environmental hazards, and transportation logistics (Das & Bhattacharyya, 2015). Areas within 200 metres of railway lines cover 6.14 square kilometers (7.81% of the area) and are categorized as less acceptable (index 1) due of safety issues and logistical challenges related with garbage transportation near active railway corridors in Bahadurgarh City, Haryana (Fig. 1). Reflecting intermediate suitability with regard for transportation efficiency and safety procedures, zones within 300 metres (3.05 sq km, 3.88%) and 400 metres (2.89 sq km, 3.68%) get suitability indices of 2 and 3, respectively. Situated beyond 500 metres from railway lines, the most appropriate sites cover 63.87 square kilometers (81.26% of the area) with a suitability index of 5, so minimizing interference with railway operations and maximizing safety and logistical efficiency in landfill site planning and management.

(i) Hospitals

Operational safety and public health issues depend much on the distance separating dump sites from hospitals. Nearness of hospitals might influence operations of healthcare facilities, patient treatment, and possible health hazards related to waste management practices (Hamer, 2003). Health issues and operational interruptions make areas less suited (index 1), spanning 1.61 sq km (2.05% of the area) (Fig. 1). Within 200 metres. Covering 71.42 sq km (90.87% of the region), zones beyond 500 metres are very suited (index 5), therefore minimizing health-related effects and optimizing waste management planning.

NDVI

The NDVI is an essential tool for assessing the kinds of plant and land cover surrounding landfills, which have an impact on ecosystem vitality and ecological integrity (Lunetta et al., 2006). Areas with an NDVI showing water bodies (<0) comprising 0.16 sq km (0.20% of the total area) are deemed the least suitable (index 1) for dump sites because of environmental sensitivity and the need to protect water resources. Given that built-up areas (0 - 0.1 NDVI) encompass 43.7 sq km (55.60% of the total land area), a score of 2 suggests moderate appropriateness with respect to the effects of urbanization on these regions. The 31.52 sq km of undeveloped land (0.1 - 0.2 NDVI) that makes up 40.10 percent of the total area is ideal (index 5) due to its sparse plant cover and no ecological conflict. The area that is vegetated (> 0.2 NDVI) is 2.92 sq km (3.72% of the total), giving it an index of 3, which suggests modest adequacy in terms of balancing ecological advantages with landfill site compatibility (Table 1) (Fig. 1).

Selection of Suitable sites for Landfill

AHP is most useful in landfill site selection as it gives comprehensible structure to the factors that affect decision making and also helps in ranking these factors. In this regard, the AHP helps in the formation of a hierarchy of criteria like LULC, road network, canals, water bodies, lineaments or fault lineament, slope and so on, where weightage has been assigned according to their degree of importance. These weights are obtained using the analytic hierarchy process by the means of a scale of relative importance to represent the importance of each of the criterion in the identification of the appropriate landfill sites. For instance, LULC has tended to receive more importance than slope since the former has a direct bearing on the compatibility of the development with the surrounding environment as well as the regulatory requirements. The actions are carried out as a means of prioritizing these factors so as to capture key aspects thus leading to more informed and less invasive methods of reasoning. Another technique is the Weighted Linear Combination method in tandem with AHP that further amalgamates the weighted criteria into one suitability index to facilitate the selection of landfill sites (Fig. 1). For this purpose, WLC accumulates the normalized criteria layers following the weight assigned to a particular criteria layer and results in a final suitability map in which overall suitability score for each cell is computed based on the weighted criteria {("Hospital " * 0.05) + ("Lineament * 0.16) + ("Slope " * 0.04) + ("LULC " * 0.27) + ("Canal " * 0.07) + ("Water " * 0.10) + ("NDVI " * 0.03) + ("School" * 0.05) + ("Railway" * 0.06) + ("Transport" * 0.14) + ("Parks" * 0.04)}. This method does not only integrate numerous inputs of data but also mean trade-offs between those factors which are in conflict to each other like environmental sensitiveness, accessibility and regulatory compliances of certain areas for operation. The WLC method indicates the distribution of landfill suitability of Bahadurgarh City through its results. The results are classified into five categories. Covering 3.1 sq km, areas labelled as Very Low appropriateness indicate places least fit for dump sites because of significant

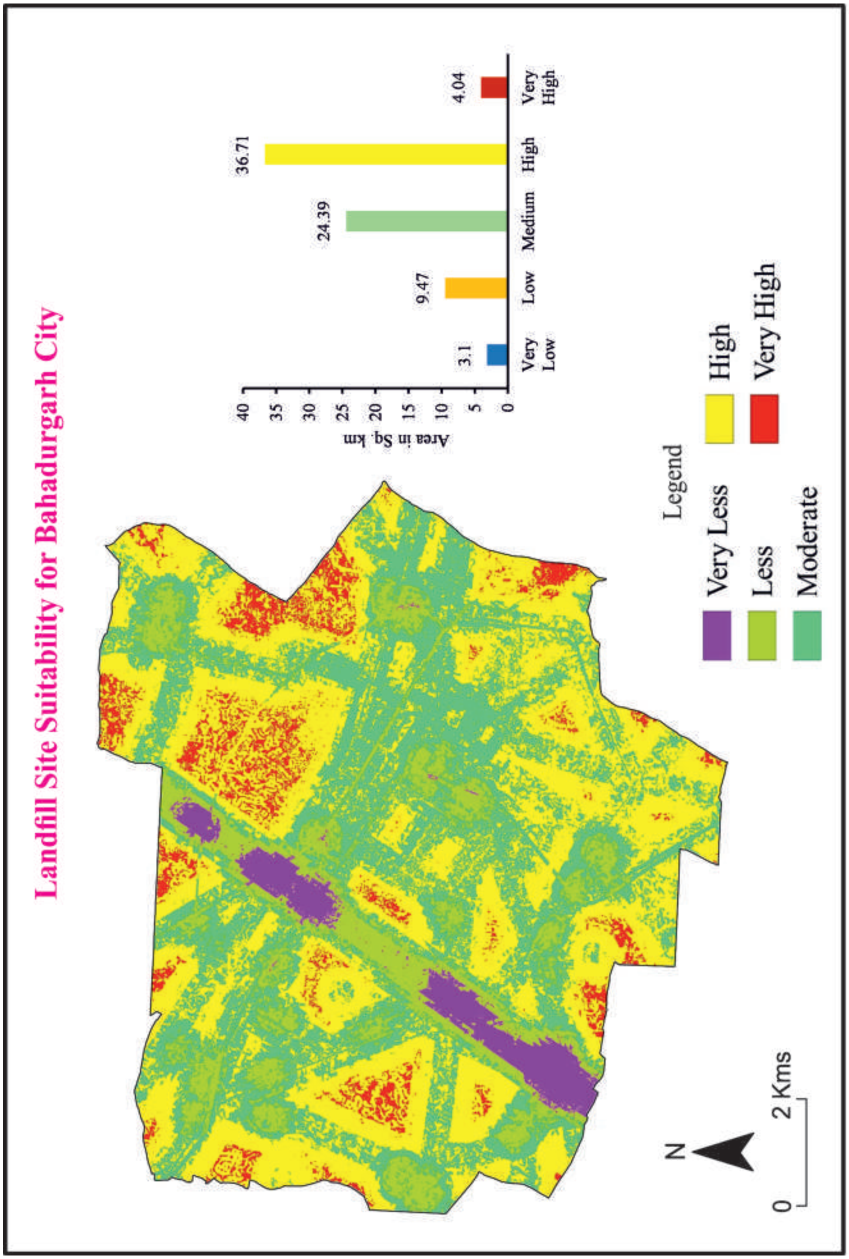
Landfill Site Suitability for Bahadurgarh City
Area in Sq. km
0
5
10
15
20
25
30
35
40
3.1
9.47
24.39
36.71
4.04
Very Low
Low
Medium
High
Very High
Legend
Very Less
Less
Moderate
High
Very High
N
0
2 Kms

Fig. 1

dangers and conflicts with social and environmental aspects. Low suitability zones comprise 9.47 sq km, where careful planning can help to control issues including mild environmental effect. With a total size of 24.39 sq km, medium adaptability regions point to reasonable choices with careful balancing for logistical and environmental aspects. Covering 36.71 sq km, high suitability zones show places fit for dump sites with little operational difficulties and environmental conflict. At last, Very High suitability regions extend 4.04 sq km, providing ideal sites extremely fit for landfill construction, minimum environmental impact and optimum operating efficiency.

Conclusion

This study has successfully mapped out potential areas in the identification of suitable sites for landfill development through the GIS-based Multi-Criteria Spatial Modeling. Assimilation of data including LULC from Sentinel 2B satellite imagery, road map, water bodies, canals, railway lines, hospitals, schools, parks from Google Earth Pro, lineaments from Survey of India, and slope data from ALOS PALSAR DEM was inevitable. The AHP and WLC methods helped in carrying out a sound evaluation based on the factors such as access, impact on the environment, geological conditions, and social aspects. The LULC analysis revealed that agriculture is the largest land cover, occupying 21. 48 sq km, 27. 33% of the area while barren land is highly suitable with 13. 56 sq km and suitability index of 5 because of least conflict with the environment and social setting. This was measured in terms of distance from roads whereby areas that were closer to roads were considered less suitable (36. 71 sq km, suitability index 4) due to likely conflicts with transportation systems. Similarly, distance from canals and water bodies played a critical role in preventing contamination risks, with areas beyond specified distances identified as highly suitable. According to the slope analysis, the portion of the study area with slopes less than 2 degrees (0.47 sq km, suitability index 5) and certain soil types were considered suitable for landfill. Distance from sensitive areas such as schools, hospitals, and parks were also pivotal, with locations beyond 500 meters from these facilities (schools: 65. 18 sq km, hospitals: 71. 42 sq km, parks: 69. 86 sq km) which were regarded as highly suitable (index 5) for reducing the effects on community health and recreational facilities. The study's final results categorize the area into five suitability classes: These include ‘Very Low,’ ‘Low,’ ‘Medium,’ ‘High,’ and ‘Very High.’ The ‘Very High’ suitability category with 36. 71 sq km, were identified as the most suitable for the development of landfill, thus, corresponding to the principles of sustainable waste disposal and environmental conservation in Bahadurgarh City.

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The Deccan Geographer
Vol. 62, No. 10 December, 2024, pp. 273-282
(ISSN-0011-7269)
UGC Care Listed Geography Journal

SOCIO-ECONOMIC CONDITIONS, OCCUPATIONAL HEALTH RISK OF INDUSTRIAL WORKERS AND THEIR SAFETY MANAGEMENT IN THE RANIA INDUSTRIAL AREA OF KANPUR DEHAT, UTTAR PRADESH

Shubhi Paliwal and Dr. Salahuddin Mohd

Abstract

The economic growth of a country is significantly linked to industrialization and technological advancement. This study investigates the socio-economic conditions, working environment, and health issues of industrial workers in the Rania industrial area of Kanpur Dehat, Uttar-Pradesh. The region's economy is primarily driven by agriculture and small-scale industries, with a significant portion of the workforce engaged in labor-intensive industrial roles. A survey conducted in February 2024, covering 204 workers, reveals critical findings regarding education, income, housing, working hours, and health problems. The study showed that only 18.13% of the workers interviewed were highly educated, and 67.15% earned less than Rs. 12,000 monthly. What was even more worrying was that 71.19% of the workers reported that clean drinking water was not available at their workplaces. Also, less than 50% of the workers had access to basic facilities like proper safety equipment PPE kits, gloves, helmets, glasses, shoes, etc. and due to lack of proper ventilation and cleanliness at the workplace, more than 60% of the workers commonly faced problems like chest pain, breathing problems, eye irritation, skin diseases, etc. These findings paint a dismal picture of the socio-economic condition of the Kanpur rural area, which shows that the local population has to face many health problems and challenges to earn a livelihood. To overcome these challenges, industrial owners and government organizations must give priority to providing proper facilities and resources to the workers. By doing so, they will not only improve the quality of life of the workers but will also contribute to the economic growth of the country.

Introduction

Industrialization brings about significant changes in all aspects of society, including economic, social, political, and cultural. As technology develops, labor productivity increases, results to new job opportunities. According to the US Department of Labor, American's factory workers declined by two-thirds from 1960 to 2014, but productivity has increased dramatically (Min.J.2019). The key to achieving rapid economic progress is to promote industrialization. It is essential to invest in fundamental and large-scale sectors to establish a strong foundation for industrialization. However, focusing only on large-scale enterprises could lead to unemployment, insufficient consumer goods and wealth concentration in a small number of people. This could worsen fundamental issues such as joblessness and a lack of foreign currency (Das, S., et al., 2017). Therefore, small-scale industries are more appropriate in this scenario because they require less capital and more labor. The rural development in China (rather in the eastern coastal China) has gradually attracted the interest in academic circles both at home and abroad, ranging from rural–urban migration (Liu, 2008, Ma, 1999, Rozelle et al., 1999, Zhang et al., 2004).The economic and social challenges facing small, resource dependent towns has long been of interest to social scientists. This body of work is particularly voluminous in North America where geographers, sociologists and regional scientists have established a venerable tradition of 'resource town' studies (e.g. Landis, 1938; Kaufman and Kaufman, 1946; Lucas, 1971; Himelfarb, 1976; 1996; Markey et al., 2008). In the process of industrialization, three main industries are given priority: large, medium, and small scale. Many developed and developing countries have recognized that the small-scale industrial sector can be useful for employment creation and development (Raszka, b., 2021). Around 80% of industrial workers in the private sector are employed by small and medium-sized businesses, making them a significant contributor to the country's economic framework. Small, medium, and micro industries play a crucial role in the socioeconomic transformation of developing social systems (Meher, R., 2008). As many rural areas are present, the process of transformation will either flourish within the rural sector or play a significant role later on by bringing it within its sphere of influence. Therefore, the nation should have a significant position in it. Rural development cannot take place outside the whole rural-urban continuum developmental process (Fattaha. M.A., 2022).

Study Region

This study delved into the socio-economic status of small-scale industry workers in the Rania industrial area of Kanpur Dehat, Uttar Pradesh. The area's economy is primarily dependent on the agricultural and industrial sectors. By examining employment opportunities and income generation, the study sought to identify ways to improve the workers' conditions and enhance their quality of life. Additionally, the research aimed to uncover the challenges and obstacles that the workers face, in order to develop targeted solutions that can help overcome them. The findings of this study are invaluable for policymakers, business owners, and workers alike, and can serve as a guide for future efforts to promote sustainable and equitable economic development in the region.

Objectives

(1) To analyze the socio-economic conditions of industrial workers in the Rania industrial area of Kanpur Dehat.
(2) To study the nature of work and analyses the working conditions of industrial workers in in the Rania industrial area of Kanpur Dehat.
(3) To identify and map the common health issues face by the workers due to nature of work and to inadequate working conditions, in the Rania industrial area of Kanpur Dehat.

Database and Methodology

A survey for this study was conducted in February 2024, utilizing primary data collected through structured schedules and questionnaires. The information was gathered from industrial workers in Kanpur Dehat District. The questionnaire was designed to capture key aspects such as demographic characteristics, household conditions, labor designations, health issues, and the use of safety equipment. After collecting both primary and secondary data, the analysis was performed using simple percentage methods. The results were presented using charts and diagrams, which were created with the help of MS Excel software. The survey was conducted in 2024 among industrial workers in Rania, a major industrial area in Kanpur Dehat district. Rania is a key industrial hub in the region, where a significant portion of the workforce is employed in small-scale industries, which play a crucial role in the local economy. The sample size of 204 workers was chosen based on a random sampling method, which ensures that the study captures a diverse and representative group of workers from the Rania industrial area. Given that there are approximately 4,090 industrial workers in the region, selecting 5% of the total workforce (204 workers) allows for a statistically significant sample that reflects the socio-economic conditions, working environment, and health challenges faced by workers in the area. The questionnaire addressed key topics such as household income, standard of living, health issues, and the facilities and safety measures provided by the industries. This method allowed for an in-depth understanding of the socio-economic conditions, health risks, and occupational safety concerns that industrial workers in Rania face, offering valuable insights into the challenges they encounter in their daily lives and workplaces.

Result and Discussion

A survey was conducted in the Rania industrial area which included 204 workers, selected at random. Data was collected regarding various aspects of their socio-economic status, demographic profile, educational qualification, working environment, health issues, safety equipment, and facilities provided by the industries. After analyzing the data, it was found that only 5.88% of the total population is illiterate, while 48.52% have received primary education, and only 18.5% have completed their secondary education. A measly 13% have higher education. Due to having vocational education, most of the workers are working at the labor level (80.39%), while those who have higher education (8.33%) are working on boiler posts and 11.27% are working on technical posts. In terms of housing, as most of the workers (61.27%) live in semi-pucca houses, and the same (38.72%) workers have permanent houses. As for working hours, 55.39% of workers work for about 8-10 hours, while 28.43% of workers work for 10-12 hours, and some workers (5.88%) work over more than 12 hours to earn more. The survey results are alarming. Moreover, after working tirelessly for 10-12 hours, 67.15% of workers earn less than Rs. 10,000 per month, which is an extremely low amount. This is unacceptable, especially when only 16.17% of workers receive Rs. 10-12,000 per month, and a meager 8.82% are paid 12-14000 rupees. Only 7.84% of workers receive monthly salaries up to 14000 rupees, which are those who have either been working in the industry for many years or are earning mostly by extra working (Table-1). This situation needs to change. It is time for the industry to step up and prioritize the safety and well-being of its workers.

Table-1: Socio-economic Characteristics and Respondents' Background

Variables	Description	Frequency	Percentage (%)
Educational status	Illiterate	12	5.88
	Primary education	99	48.52
	Secondary education	47	23.03
	Higher education	37	18.13
	Graduate	9	4.41

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Worker designation	Labor	164	80.39%
	Boiler	17	8.33%
	Technician	23	11.27%
Type of house	Pucca	86	42.15
	Semi-pucca	132	64.70
Safety equipment	Mask	182	84.21
	Helmet	191	93.62
	Gloves	187	91.66
	Uniform	90	45.09
	Belt	92	44.11
Working hour	>8 hour	21	10.29
	8-10	113	55.39
	10-12	58	28.43
	<12	12	5.88
Monthly Income	>10000	137	67.15%
	10-12000	33	16.17%
	12-14000	18	8.82%
	<14000	12	7.84%
Smoking Status	Ever smoker	125	61.27%
	Never smoker	79	38.72%

Source: Based on Primary Survey 2024.

Working Environment, Health Issues, and the Importance of Safety Equipment's for Industrial Workers

The efficiency of workers is affected by the environment of the industrial area they work in. To ensure that workers are comfortable, the working conditions should be suitable for their physical and mental well-being. This includes maintaining normal temperature, humidity, proper ventilation, light, and tolerable noise throughout most of the working hours. (Bulow, J. I., & Summers, L. H., 1986). Poor working conditions can make workers inactive, and physically and mentally reluctant to work (Table-2 and Fig. 1). In addition, it can negatively impact their health. (Min, J., Kim, Y., Lee. 2019). For example, during a survey, it was found that 64.70% of workers were troubled by ventilation problems, while 60.29% had

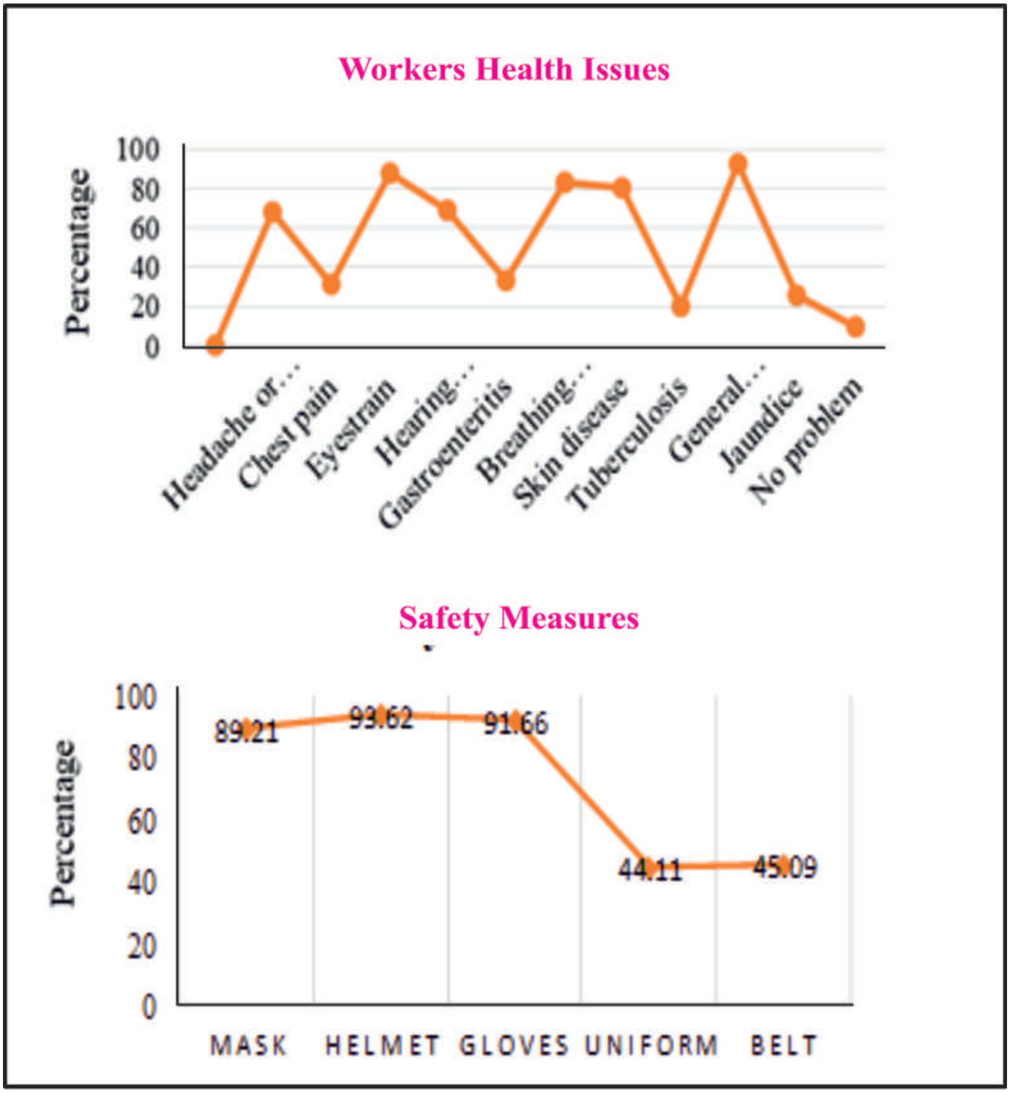
Workers Health Issues
Percentage
100
80
60
40
20
0
Headache or…
Chest pain
Eyestrain
Hearing…
Gastroenteritis
Breathing…
Skin disease
Tuberculosis
General…
Jaundice
No problem
Safety Measures
Percentage
100
80
60
40
20
0
89.21
93.62
91.66
44.11
45.09
MASK
HELMET
GLOVES
UNIFORM
BELT

Fig. 1

to work in unbearable heat. 60.78% of workers reported excessive noise from old machines, which was unbearable and affected their health. Moreover,

Table-2: Selected Factors and Their Frequency

Environmental Factors	Variables	Frequency	Percentage (%)
Ventilation	Satisfactory	72	35.29
	Unsatisfactory	132	64.70
Heat	Too much	123	60.29
	Normal	81	39.70
Noise	Tolerable	67	32.84
	Intolerable	124	60.78
	No noise	13	6.37
Smell	Pleasant	18	8.82
	Un pleasant	143	70.09
Worker health issues	Headache or Shoulder pain	140	68.62
	Chest pain	65	31.86
	Eyestrain	179	87.74
	Hearing problem	142	69.60
	Gastroenteritis	69	33.82
	Breathing difficulty	170	83.33
	Skin disease	165	80.88
	Tuberculosis	42	20.58
	General weakness	190	93.13
	Jaundice	53	25.98
	No problem	21	10.29
Safety measures	Mask	183	89.21
	Helmet	191	93.62
	Gloves	187	91.66
	Uniform	90	44.11
	Belt	92	45.09

Source: Field Survey, 2024

70.09% of workers reported that the chemicals used in the industry hurt their sense of smell. The study shows that working in a suffocating environment can reduce workers' will to live, and they may suffer from various types of diseases. Workers in industrial areas are facing a growing concern over their health. The negative impact of the industrial environment is causing a variety of diseases, due to the unpleasant surroundings, air and water pollution. (Kagamimori, S., Gaina, A., & Nasermoaddeli, A. 2009). The workers in the study area are exposed to these harmful factors 24/7. It's imperative to address these issues and take proactive measures to safeguard the health of the workers. According to a survey conducted in the study area, it has been found that a significant number of workers are suffering from health problems due to their work environment. About 68.62% of workers experienced head and shoulder pain due to an unclean work environment, while 31.86% of workers reported chest pain due to working in a chemical environment. A staggering 87.74% of people suffer from eye irritation, most likely due to dust or other airborne particles. Furthermore, 69.60% of workers who work with loud machinery reported ear-related problems, while 83.33% of workers who work in dusty environments also reported lungs related problems. Due to constant exposure to chemicals, about 80.88% of workers have complaints related to extreme diseases like itching in their hands.

Additionally, 43.13% of workers reported weaknesses in their bodies due to excessive physical labor in industries and a lack of sufficient protein-rich food. Shockingly, during the survey, only 10.29% of workers claimed not to experience any regular health-related problems. Workers in the industrial sector in India often operate heavy machinery and handle hazardous chemicals, making safety equipment essential to protect their health and well-being. Unfortunately, despite the existence of labor laws aimed at ensuring workplace safety, there is still a significant gap in safety awareness and provisions. The survey results are alarming, with a concerning percentage of workers lacking essential protective gear. According to Table-2, only 84.21% of workers are provided with masks, 93.62% with helmets, and 91.66% with gloves. However, a mere 45.09% are given uniforms, which is highly inadequate considering the risks they face. These shortcomings in safety equipment expose workers to preventable accidents, injuries, and even fatalities, reflecting a failure to fully implement safety measures outlined in laws like the Occupational Health and Safety Code of 2020, which mandates such protections. This situation underscores a serious issue in worker protection, as the lack of basic safety gear compromises not just their health but their lives. It also represents a clear violation of worker rights and a disregard for regulations meant to safeguard them. To address this, there must be a stronger commitment from both employers and the government to enforce safety standards, raise awareness, and ensure that workers are adequately equipped to handle the risks they face. Only through such efforts can the frequency of accidents in Indian industries be reduced and the overall safety of the workforce be improved.

Conclusion

In conclusion, the workers in the Rania area are facing dire circumstances that demand immediate attention. Their daily struggles with undernutrition, lack of essential safety equipment, inadequate housing, and unsafe drinking water reflect a systemic failure to prioritize their welfare. The fact that the workers live in small accommodations with just one room for sleeping and cooking exacerbates the situation. For drinking water, they are forced to rely on wells or public tube wells. It is imperative to give workers' access to adequate facilities and resources top priority these conditions not only jeopardize their health and safety but also hinder their potential for productivity and well-being. The absence of proper safety measures puts workers at risk of avoidable accidents, while poor living conditions erode their overall quality of life. It is imperative that both industrial owners and government organizations take swift, concrete action to address these issues. By providing proper safety equipment, improving living conditions, and ensuring access to clean water, we can significantly uplift the lives of these workers. This, in turn, will lead to increased worker productivity, a stronger economy, and a more equitable society. Moreover, investing in workers' welfare is a long-term solution that will pay dividends not only in terms of individual prosperity but also in fostering a healthier, more sustainable workforce. A workforce that is safe, well-nourished, and properly supported is one that can contribute more effectively to the country's economic development. The time to act is now—prioritizing the well-being of workers is not just a moral obligation but a strategic investment in the future growth and prosperity of the nation. Only through collective effort, driven by compassion and responsibility, can we create an environment where workers are empowered to thrive, and by extension, the economy can reach its full potential.

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The Deccan Geographer
Vol. 62, No. 10 December, 2024, pp. 283-296
(ISSN-0011-7269)
UGC Care Listed Geography Journal

EVALUATING WATER POLICIES OF INDIA: A CRITICAL REVIEW OF PROGRESS AND CHALLENGES

Shashi Bhushan Yadav and Dr. Prashant Singh

Abstract

India lies in the category of most water-stressed countries in the world. Progress has been made in water conservation and institutional frameworks, while key challenges such as inadequate funding and poor data collection remains. There are significant gaps and limitations in the implementation of the water policy such as water pricing, inadequate infrastructure, equity, the water-energy nexus, inter-state water disputes, impact of climate change and ground water management in the country. These problems become worse by regional differences and gap in the implementation of the policies. This paper critically assess the evolution of first National Water Policy of 1987 to National Water Policy of 2012 and their effectiveness in India, focusing on the future challenges in water sector and the progress made by us in last three decades. The study focuses on key recommendations and proposals for boosting public awareness, developing water saving techniques, enhancing institutional capacity, and encourages private sector participation to mitigate water scarcity in India besides suggesting the policy makers, researcher, and stakeholders to continue reforms for water security and sustainability throughout the country.

Introduction

Water resource has significant role in socio-economic and environmental setting. A water supply is essential for domestic needs, industry, agriculture, and for ecosystem health. However, growing population, rapid unplanned urbanization and climate change, all have contributed to the country's water scarcity. It mounts pressure on available water resources, which affects agriculture, industry, and human consumption. With a population of over 1.4 billion, India is facing significant challenges in terms of sustainability and water security (World Economic Forum, 2023). It sustains around 18% of the world's population despite possessing only 4% of the world's fresh water resources (World Bank, 2023). As per Yale University's 2022 study in unsafe drinking water index, India has been ranked 141 out of 180 countries (East Asia Forum, 2024). According to the Interconnected Disaster Risk Report 2023, India's water need is expected to be doubled by 2030 and almost 70% of drinking water in India is contaminated (EAF, 2024). This can impact agriculture sector of the country and destabilize its economy (India Water Portal, 2024). Water security is crucial for India's overall well-being which provides food security, and sustainable development. The Indian government has brought a number of water policies and programs during the past few decades including National Water Policies of 1987, 2002, and 2012. The significance of water for human survival was emphasized during the formulation of Sustainable Development Goals (SDGs) which were endorsed by the United Nations members in 2015; as a result "Clean water and sanitation" was stated as the sixth goal (UNEP, 2024). Despite these initiatives to tackle the country's water problems, India's water policies have come under fire for being disjointed, wasteful, and unproductive. Issue of excessive groundwater exploitation, surface water pollution, poor infrastructure, and regulatory hurdles are being prominent. Revision of the nation's water governance framework is necessary to handle new issues such as ground water depletion, climate change, and concern about water quality and safe drinking water supply.

Objectives

(1) To evaluate the effectiveness of India's current water policies in solving crucial challenges such as water scarcity, quality management, and equitable distribution across regions and sectors.
(2) To analyze how India's water policies might develop in the future, taking into account global best practices, cutting-edge scientific advancements, and climate resilient strategies.

Database and Methodology

Since 1987, the Indian government and other decision makers have developed and modified a number of water policies that outline the real of the water resources and their management. In light of current opportunities and problems facing by water industry, this paper aim to critically evaluate these water policies and suggest suitable recommendations. In this context a comprehensive search was conducted and text was reviewed across multiple databases, including Google Scholar, JSTOR, Scopus and Web of Science. The study is based on secondary data with the analysis of existing water policies and review of research papers related to the policies. The main source of data is documents related to water policies and available literatures.

Results and Discussion

Evolution of India's Water policy

(a) Historical Evolution

Complex structure of socioeconomic, political, and environmental issues has influenced water policies of India over the years. In addition to addressing the issues such as pollution, droughts, floods, and water policy has changed to meet the demand of industry, urbanization, agriculture, and population growth. This is the timeline of significant changes to India's water policy. In ancient India, local communities or ruler constructed and maintained conventional water management systems, such as step wells, tanks and canals in their particular region. Arthashastra written by famous Indian scholar Kautilya in 4th century BC discusses the India's water management and irrigation techniques. During the Medieval Period Indian kings and empires created extensive water systems, particularly in arid regions. The Mughals focused on gardens and canal irrigation system whereas the Vijayanagara Empire built water reservoirs and canals. In spite of all this development India did not focus its attention towards water regulations and governance during pre – colonial time due to the relatively high availability of water resource in comparison to their requirements (Cullet, P. and Gupta, J., 2009). Its population was just about 100 million by 1600 and it stayed essentially unchanged until second half of the 19th century, when the 1881 census conducted it shows that it had increased to 255 million (Krishnan, P., 2010), which means the demand of water could be easily fulfilled by the available water resources. The main focus on development of irrigation system and canal construction was in 1866 when the British government decided to build irrigation project by the states through their own agencies and funded by the public loans (Siddiqui, M. S., 2008). This decision was made far before its time, given the current water crisis and the government's assertion of sole authority over it. During the time of British era, policies prioritized commerce over social issues and not for the welfare of society. British government categorized the agricultural work mainly into commercial or non-commercial. To encourage the production of cash crops, the British government established extensive irrigation projects, especially in the region of Punjab, Ganga-Yamuna basin, and the Krishna-Godavari delta region. However majority of their water policy are exploitative in nature, prioritizing income generation over the sustainable development. Indian Irrigation Commission (1903), recommended irrigation development. Gorge Nathaniel Curzon, the British viceroy of India, appointed a commission in 1901 with the task of creating a thorough irrigation plan for the country. The Lord Curzon's observation of the famine conditions shortly after his arrival in 1899 was the cause of this. In 1903, he suggested steps to irrigate an extra 10,200 square miles on top of the approximately 30,000 square miles that were previously irrigated (Britannica, 2024). After the independence of India, in order to promote the Green Revolution, the government gave water resources top priority. To increase agricultural output and guarantee food security, large dams were constructed such as the Bhakra Nangal, Hirakund, and Nagarjuna Sagar. Centralized planning was adopted by the government through managing rivers and large-scale projects. The key priorities continued to provide electricity, flood control and better irrigation system.

(b) National Water Laws

(i) River Board Act, 1956: River board Act was established to provide a regulatory board for the regulation and development of interstate rivers and river valleys. This Act aims to provide coordination between different states which have issues regarding water disputes and conflict of interest on water sharing and their effective use.

(ii) The Water (Prevention and Control of Pollution) Act, 1974: In order to prevent and manage water pollution and to maintain or restore the wholesomeness of the water supply to the people of the country, the Water (Prevention and Control of Pollution) Act 1974 was passed and amended in 1988. The Water (Prevention and Control of Pollution) Cess Act was passed in 1977 to facilitate the levying and collection of a cess on water consumed by individuals running and carrying out specific type of industrial operations to supplement the funds allocated to the Central Board and the State Boards comes under the Water (Prevention and Control of Pollution) Act, 1974 to preventing and controlling water pollution. The act was revised in 2003.

(iii) Environmental Protection Act, 1986: This act was enacted by the Parliament of India in 1986 to provide a framework for the protecting environment by controlling and regulating activities which may be harmful for the environment through a governing authority which empower the government to take necessary action against environmental pollution. The United Nations Conference on the Human Environment led to the enactment of the Act which was held in Stockholm in June 1972. India participated in it and prioritizes to take appropriate steps to improve the existing environmental condition which faces extreme challenges after Industrial development and rapid growth of urbanization.

(c) National Water Policies in India

(i) National water policy 1987: It was the first water policy formulated by the Ministry of Water Resources, Government of India considering water as a very critical resource with national importance and required coordination between states for proper management and effective utilization of water resource. The government feels an urgent need to adopt a national water policy at that time because of shortage of water in the country. India has their vast geographical expansion from North to South and from East to West with different geographical features having Mountains, Great Indian Desert known as Thar Desert, Northern plain, and hills and plateaus especially in south and eastern part of the country. The availability of water throughout the country is highly uneven distributed and mainly depends on precipitation during monsoon season. The monsoon is confined only for three months and also varies from 10 cm in Rajasthan to approx. 1100 cm in Cherrapunji (Mawsynram) of Meghalaya. As water is a part of large ecological system it does not respect state boundaries and as a result drought and floods occur in different parts of the country. About 9 million hectare of land is affected by flood every year in the county.

According to National Commission of floods around 40 million hectares of land is susceptible to floods. The first National Water Policy was adopted in September 1987 with main focus of Integrated Water management, multi-sectoral approach, water conservation, public participation and institutional framework. The main objective of the policy, to meet drinking water need for the people, to facilitate irrigation and agricultural development in the country, construction of dams and hydropower generation for industrial and commercial use. In addition, the policy acknowledged maintaining ecological balance, recycling and reuses water resources and significance of drinking water as the three main factors. The policy includes flood control and drought management and to improve the quality of water. It concentrated on the necessity of ensuring the safety of structures through appropriate maintenance and monitoring following the conclusion of development projects (Cullet P. and Gupta J., 2009). The main impact of the policy which we can see is increased water storage capacity and improved irrigation efficiency through hydropower project. It helps to enhance public awareness towards the importance of water and facilitate better water quality monitoring system. The policy of 1987 has certain limitations having centralized approach with limited community participation. The government did not allocate proper and efficient funding to implement the target set under the policy with lack of clear and proper accountability, so with certain changes we will see a new water policy 2002.

(ii) National Water Policy 2002: The average amount of water available per person in India has been decreasing over time, from approx 2300 liters per capita in 1991 to approx 1400 liters per capita as present data shows and it will only remain 1150 liters per capita in 2050 is clearly indicating that the nation is experiencing water scarcity (Paul D. et al., 2020). The policy tackles the issue of water shortage and the requirement to preserve water resource using the most effective, affordable, and sustainable, and possible fair methods. It provides an overview and revision of National Water Policy of 1987. A new water policy is required because of the centralized nature of the National water policy (1987) which has top to down approach which mainly emphasized national and state-level institutions with limited emphasis on water conservation and management at local level while National Water Policy 2002 has decentralized approach in nature with people participation having main focus on district level water management and with decentralized governance and community participation. It introduced water pricing with participation of private sector in water management and conservation, focusing on water quality improvement, prevention of pollution and waste water treatment with community led water management, educating the people and public awareness.

It also recognizes the impact of climate change on water resources and their consequences which lag in National Water Policy of 1987. Through rules and subsidies, the policy promotes the recycling and treatment of industrial wastewater and the development of new, water efficient technology. The policy also addresses erosion, water conservation water zoning, and other related issues (Food and Agriculture Organization of the United Nations, 2023). The majority of people suffer from water scarcity, especially the poor who rely on agriculture and lead extremely low lives. In support of these people this policy rationalized the rate for surface water and ground water which helps small and marginal farmers in the country. The policy suggests a master plan for drought and flood control and management in flood prone basin. National Water Policy (2002) has several limitations which create challenges in its proper implementation and water management in India. Some disadvantages include inadequate control of ground water exploitation, which raises concerns about excessive use of vital resources without appropriate social and environmental protections, and inefficient management of ground water resources. The issue of economic sustainability which shows lack of maintaining and operating water infrastructure, neglected effective traditional practices with shifting towards large scale infrastructural projects by sidelining the local historically used practices. When it comes to water distribution, the marginalized group is disproportionately impacted since their needs were not met in a way that was in line with social justice. Regional variations have diverse regional water issues with varying climate and geographical locations cannot be properly addressed.

(iii) National Water Policy 2012: It was implemented to direct the nation's strategy for managing its water resources. In order to promote sustainable water usages across several sectors, this policy lay out principles and recommendations in recognition of the challenges presented by population expansion, climate change, and conflicting water demands. India is facing a serious water problem that clams about 200,000 deaths in a year (EAF, 2024). To address the situation, the government needs to review water subsidies, implement targeted programs to address groundwater depletion, switch to a cropping pattern that uses less water than the current one and embrace efficient, modern technology to address the nation's water crisis which has impacted millions of people (Chaudhari, M., East Asia Forum, 2024). Climate change impacted the pattern of rainfall in past years as irregular precipitation which increases the dynamics of droughts and floods in the country.

From last few years we can perceive that the desert region of Rajasthan receives heavy rainfall which causes floods in the desert areas and disturb the ecological balance and climatic characteristics of the region, whereas many part of country which in known for the good monsoonal rainfall experiences drought which impacted the agricultural productivity and affected the farmers which depend on their agricultural land for their livelihood which is a cause of concern for the food security of the nation. The current state of the available water resources is the primary focus of new water policy that was developed and implemented in 2012. It also suggests a comprehensive framework to solve the issue at the national level and it was developed to address the nation's growing water stress and encourage sustainable water resource management. The main features of the National Water Policy, 2012 promotes Integrated Water Resource Management which acknowledge that water need to be managed holistically considering the entire watershed or river basin. Sustainable use of water which puts sustainability first by encouraging reuse of water, recycling, and conservation, and recommends the strategy through which use of water in households, industry and agriculture can be minimize. This policy promotes community-based water management system and discourages private ownership by highlighting water as a common pool resource that community is responsible for its protection. Water pricing is mentioned in order to promote the economic importance of water and advocates about a reasonable pricing to reduce water wastage. The policy emphasizes the necessity to adopt the measures to mitigate the challenge of climate change and its effects on water resources and acknowledge the ecological importance of lakes, ponds, rivers, and wetlands by advocating for a minimum ecological flow in rivers to sustain our ecosystem. As we all are aware about the fact that ground water depletion has become a challenge for water and food security in India so the policy recommended limited use of groundwater and regulate its extraction to avoid excessive use in critical region of the country and in spite of that it promotes artificial recharging and rainwater harvesting. In order to address water pollution this policy focuses on rehabilitating contaminated water bodies and raising water quality standards by imposing strict regulation on industrial and other sources of effluents. With the diverse geographical condition in India there are chances of flooding and drought due irregularity in precipitation so, the policy emphasize the need of particular attention to water management in vulnerable regions.

At the level of institutional and legislative reforms the policy advocates the creation of regulatory bodies and it includes water dispute tribunals at state and central levels. Regarding National water policy 2012, several steps has been taken by the Indian government to address water scarcity, sustainability and pollution towards improving water policy. These initiatives included everything from the development of new governmental frameworks to the introduction of targeted policies and programs for sustainable irrigation, urban water management, and water conservation. Atal Bhujal Yojana (2019) launched by Government of India with the main objectives of sustainable groundwater management, to address rapidly declining groundwater in different regions of India. The Government of India started Jal Jeevan Mission (2019) with main aim of connecting rural home to tap by 2024 in order to supply clean and sufficient drinking water. Looking at the present situation related to water, government felt the urgency of new water policy in the country and as a result an 11-member committee was formed under the chairmanship of Dr. Mihir Shah who has presented a draft for new water policy in the year 2020 which is still under consideration.

Comparative Analysis of India's Water Policies with Other Water-stressed Countries

Water-stressed situation is a big challenge for India's water policy with largest population size in all over the world having limited and unevenly distribution of resources. So a different approach has been emerged when we compare with other water-stressed countries such as Israel and Australia depending on climate, population, technology, and governance. Here we present a comparative analysis how India's water policies different from those of various nations:

(a) **Water conservation and managing demand:** India's water policies prioritize rainwater harvesting, water conservation, and sustainable ground water management. Atal Bhujal Yojana an initiative which concentrate on ground water conservation through community participation approach which the Jal Shakti Abhiyan promotes rainwater harvesting, watershed management, and water conservation measures. Israel, a nation using advance method for water recycling, reuse, and desalination and becomes world leader in water conservation. The majority of its urban needs are now met by desalinated water, while about 90% of wastewater is treated and used again in agriculture (Adams, H., 2023). Despite its arid climatic condition, Israel has a reliable water supply because of these advanced technologies. In Australia by establishing a balance between economic and environmental demands, Australia's National Water Initiatives encourages effective water use. Markets for water trade make it possible to shift the distribution of water from lower-value to higher value uses, especially in agricultural sector.

(b) **Water pricing and Regulation:** Water prices in India are low or subsidized particularly in the agricultural sector which uses about 80% of water resources, over-extraction and inefficient use, especially in agriculture due to lack of pricing reform (D'Souza, R., 2022). In an attempt to reduce over use of water, some governments are testing tiered charges for municipal water supplies. In Israel encourages efficiency, Israel implements tiered water pricing, with higher costs for excessive consumption and subsidies agricultural use. These price strategies have decreased overuse and encourage the use of cutting-edge irrigation technology. Australia has a well-established water market where users can exchange water rights particularly in the Murray-Darling Basin, resulting as a system where pricing reflects scarcity. This strategy encourages investment in water-saving technology and conservation.

(c) **Interventions with Technology:** In India the adoption rate of water-saving technologies, such as micro-irrigation, is comparatively low, despite some investment in these technologies in India. Micro-irrigation is encouraged by programs like the Pradhan Mantri Krishi Sichai Yojana (PMKSY), but scaling these solutions is still challenging. Israel is the leader in water technologies, especially in the areas of water reuse, recycle, desalination, and drip irrigation system. Israel contributes significantly to the advancement of water management in other water-stressed countries by exporting their technology in other countries. Australia makes investment in effective irrigation methods, sophisticated metering, and crop resistant to drought. Australia has been able to sustain agricultural productivity while consuming less water because of the development of these effective technologies.

(d) **Climate Change Response and Drought Control:** In India has rather than long-term adaptation, relief measures are the basis of India's drought management programs. The National Water Policy 2012 emphasis on climate resilience and the way by which climate adaptation is included into water planning may help in some improvement. Israel is adoptable towards variations in climatic conditions due to their effective irrigation system and diverse water supply system, which includes desalination, ground water, and surface water. In order to forecast water demand and maximize water distribution, the nation also incorporated climate modeling. Australia with its periodic drought, Australia has established strong and durable structures for managing drought condition. In order to manage water under changing conditions, the Murrey-Darling Basin Plan places a strong emphasis on adaptation by striking a balance between ecosystem requirements and human needs.

(e) **Major Challenges Facing Water Policies in India:** India is facing significant challenges in its policies related to water which need to be addressed in limited time frame otherwise the rate at which population is increasing and demand of water increases day by day may be disastrous for the country. Problem of over-exploitation and extraction of ground water, water pollution, and inadequate development of infrastructure, as Haryana and Punjab started agricultural practices which are based on excessive irrigation, particularly water intensive crops like paddy leading towards alarming rate of ground water depletion. Untreated sewage in urban areas, industrial discharge and agricultural runoff consisting remains of harmful chemicals used in agricultural field severally impacted groundwater and surface water. Approx 70% of surface water is unfit for consumption in India due to contamination (World Economic Forum, 2019). The pollution limits the availability of safe drinking water and sanitation, it has adverse impact on public health and to the ecosystem. The inefficient water infrastructure leads towards significant gaps in available sewage treatment capacity and required capacity in many cities. Most of the available treatment plants are either not functional or poorly operated, cause's pollution problem. Climate change and socioeconomic inequalities are mostly interrelated in the present context, as irregular precipitation pattern leading to severe drought as well as floods and this affect the availability of water and impact the water policy planning and their implementation (Stockholm International Water Institute, 2018).

(f) **Recommendations for Future Water Policies:** Our first National Water Policy came in 1987 and the government targets to meet the needs of drinking water provide irrigation facilities for agricultural development, install the infrastructure for hydro-power generation for industrial and commercial uses, taken initiative to control flood and drought management system and focuses on improving the quality of water. After a decade government has realized for a new water policy after the economic reforms in the country as National Water Policy (2002) which can help in economic development from a centralized approach to decentralized one which works from district to state and country level. The Water Policy (2012) provided a framework to ensure water security, conservation and their efficient use, enhance institutional framework and water governance system. Key provision of the policy holds management of groundwater related regulations, climate change resilience and support public private partnership in the policy. But there are still obstacle to overcome over-extraction and degradation of water quality, drought and flooding due to variation in precipitation, interstate disputes over water sharing and lack of public awareness. So, reforms should be focus to lessen water intensive agriculture in regions with low groundwater levels, initiatives of community based aquifer recharge, stringent groundwater regulations, and we have to promote crop diversification. Micro-irrigation method (drip and sprinkler system), sustainable cropping are few possible reforms. Interstate conflict may be reduced by establishing more robust frameworks for interstate water management agreement and greater cooperation. Long-term effect can be significantly impacted by policies that involve the public, motivate to behavioral change in consumption patterns, and support education about water conservation.

It is advised water rights to be kept distinct from land rights in order to guarantee the fair and appropriate distribution of water. Future policy should prioritize equal access, sustainable development and creative solutions to India's water Problems. The following suggestions are offered:

(a) Holistic management with organize water use in households, business, and agriculture. There should be effort of joint coordination between state and federal policy to manage water resources under a program like Management of Integrated Water Resources. Watershed and Basin-Level Management to address regional requirements and difficulties, place an emphasis on localized solutions at the watershed or river basin level.
(b) Encouragement of water efficiency through agricultural reforms to lessen the amount of water intensive crops in water scarce locations, as Australian government invested to develop effective irrigation system and crop which is resistant to drought in their country. Promote micro- irrigation (sprinkler, drip) as in 1960s Israel is credited to develop modern drip irrigation, micro-irrigation technique called drip Irrigation sends water strait to plant roots.
(c) Industry standards include requiring water audit for industries and implementing water-saving devices. Encourage the system which recycle and reuse water, enact strict wastewater treatment laws in industry, agriculture, and where practical, even for drinking.
(d) To reduce water loss in cities, incorporate combine digital metering and leak detection system. There should be strict regulation to rainwater harvesting in new construction to reduce runoff in water stressed region especially in cities, provision of incentives for infrastructure that already has it.
(e) Invest in energy-efficient desalination plants in coastal areas with limited water supply such as Karnataka and Tamil Nadu states which frequently remains in news due to their water scarcity. Only 1% of drinking water is obtained through the process of desalination globally but about 25% of Israel's drinking water comes from desalination facilities and it has reached to production of 585 million cubic meter annually (Down to Earth, 2023).

Conclusion

Primary aims of India's water policy is to provide safe and clean drinking water to their every citizen without discrimination to maintain their health and hygiene in the country but even today most of the people in the urban slums, low-income group and rural area is far away to the availability of clean drinking water. It aims to better irrigation facilities for agricultural crops to increase productivity of the farmers but due to lack of efficient planning there persist significant challenges at the management level. The National Water Policy, 2012 is formulated to mitigate the existing challenges of climate change on water resources; conservation of water and efficiency but the issue remains unsolved related to water governance. According to NITI Aayog prediction India's demand of water will be doubled till 2030 compared to available supply of water, so there is an urgent need to a proper and effective governance is required and we have to adopt sustainable management practices (India Water Portal, 2023). Focused investment to develop water infrastructure: in construction of dams, to install water treatment plants and drinking water supply schemes. India has achieved significant progress in addressing the complex issue of water management, distribution, and conservation through its water policies in recent decades. As the government have taken progressive steps to mitigate the problem of water crisis in India and make a significance progress from colonial period to present time.

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The Deccan Geographer
Vol. 62, No. 10 December, 2024, pp. 297-308
(ISSN-0011-7269)
UGC Care Listed Geography Journal

SOCIO ECONOMIC ASPECTS AND PROBLEMS OF INDIAN WOMEN EMPOWERMENT

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Abstract

Today's woman is playing entirely changed role in India as well as in arena of global phenomena. They can not only direct the direction in domestic affairs obviously can adopt sound feasible decision in regards to states, national, and international matters also. There are so many names we can memorize for their legendary contribution for building of a nation. From ancient Vedic India to medieval and medieval to present twenty first century we enshrine them in our heart. In ancient manuscript, epic and documentation we could draw the conclusion that woman at that time had enjoyed enough freedom and dignity, even they could opt self to choose their conjugal for their life. Some of the eminent name and scholars like Gargi, Maitrayee, Apala, Lopa Mudra, can never be forgotten. They had having equality with men in respect of all social sphere. However, in 500 BC the status of woman slightly declined in medieval age. Despite of many resistances in mediaeval stages woman had have held many leading positions in the dimension of political, educational, administrative, religious and statecraft art. Later in modern period Indian woman role can be bifurcated in to two ways. One is under British rule till mid eighteenth century and post independence period. Women participated actively in Indian history, Indian freedom movements, political, educational, administrative, welfare of society, and Satyagraha. The entire society regarded their discourse outstanding. We've lived through a magnificent age in which women have excelled in their positions and heralded in change. With regard to caste, creed, sex, religion, and other types of prejudice, the Indian Constitution has ensured equal rights and opportunity to both men and women. But today's India is exhibiting raised atrocities, exploitation, discrimination, and deprivation. The right to equality, the right to freedom, the right to fundamental rights, fundamental obligations, and directives principles are shielding human beings as well as women to reach complete personality development.

Introduction

Violence against woman (VAW) is nascent public issues and problem in society of our country. A majority of women related crimes are unsorted and unreported in our state. A number of factors have been blamed for crimes against women. Due to loophole of existing laws and enforced laws the numbers of incidence related VAW are increasing in our country. If we observe our “preamble” and constitution which clearly mentions devoid of any partial behavior to a person’s as well as women by our state. The constitution of the Indian Republic guarantees gender equality in all spheres of activity and life. In the fundamental rights section of the Indian constitution, it is stated clearly that "the state shall not discriminate against any citizen on the basis of only religion, caste, sex, place of birth, or any of them." Women in India today have equal access to opportunities in all spheres of life, including education, employment, and legal standing, making them eligible to take the position of national leadership. Unfortunately, there is not much strength in the way that the declared constitutional guarantees are actually implemented. India is an entire nation of diversity, the seventh-largest democracy in the world, and it possesses the world's largest constitution. With more than 1.21 billion people, it is essential to create a secure and homogenous atmosphere in order to maintain the HDI and GDI standards, which measure gender development. According to UNDP report India ranks 127th out of 160 countries in respect of Gender inequalities in 2017. Even the report published by them shows poor performance on global gender gap index (GGGI) which accounts only 0.665(2018) ranking 108th out of 149 countries surveyed. According to recent news from "the Economic times daily," India was positioned 108th in the WEF's gender gap index in December 2018—the same position it had in 2017—but there hasn't been much of a rise in wages for comparable jobs. India has made progress, even if it still ranks 142nd out of 149 countries in terms of economic opportunity and work participation, according to the WEF's 2018 report on the global gender gap. Economic opportunity, political empowerment, educational achievement, and health and survival are the four pillars used to quantify the gender gap. The WEF has maintained its ideas and values in order to lessen gender imbalance. According to the WEF, India continues to have the third-worst health and survival rates in the world despite having made the least progress over the past few decades on this sub-index. In India, the gender gap on this sub-index has actually grown over the past year. Positively, India has improved its ranking from 72nd to 70th in the WEF's ranking of high-quality salaries for comparable labour. The nation's tertiary education enrolment gaps have been narrowed for the third year in a row. India has one of the widest gender gaps in artificial intelligence (AL) and the second-largest AL workforce, with women filling only 22% of roles. With a reduction of more than 85.8% in the overall gender gap, Iceland topped the global ranking. Iceland is at the top of the list for the ninth year running. Norway (second, 83.5%), Sweden (third, 82.2%), and Finland (fourth, 82.1%) were all Scandinavian countries. The executive chairman of the WEF asserts that proactive measures that advance social inclusion, gender parity, and the rectification of past injustices are necessities for the health of the global economy and for the benefit of whole society. The house which represents parliamentarian democracy has represented merely 14.5 percent elected women though the standard norm is 33 percent. Only 39 percent woman above 25 years takes secondary education. It is really harsh to let you know that work participation index about women is very lows with 27.2 percents which indicates sub-standard socio-economic status of a nation. UNO, UNICEF, UNDP, ILO and famous economist of the worlds have opined their unanimous view that country's desired Excellency cannot be achieved unless standard women work participation maternal mortality rate 174 per one lakh population. Beyond that woman empowerment, sex ratio, global gender inequality index, literacy rate, woman wages, woman work participation, crime related to women, deprivation of women, gender inequality, dowry practices are all showing the declined status of woman in India.

Objectives

The present discussions and analysis are aimed to convey woman changing roles from ancient India to modern India. Women almost constitute half of the entire population. Without development of them a society can not acquire international respect. Marching forward for a nation seldom possible with having curse like inequality, deprivation, exploitation, discriminations, illiteracy, child marriage, sexual exploitation violence, feticide, crime related women etc. the study will help us to percept root causes of social problem, women crime's effect, laws and constitutional provisions, remedies for safe guard of women as well men.

Database and Methodology

The tone of the essay is both analytical and descriptive. It has been attempted to analyse the conditions, changing status, and evolutions for women in the Indian environment. Depending on the needs of the piece, the data are acquired from secondary sources such books, periodicals, journals, statistical analysis, daily news reports, research publications, and government documents.

Results and Discussion

Women status in ancient medieval modern and post-independence period

Ancient period

The history of women being abused in both ancient and mediaeval India was never taught to us. Researchers claim that in ancient India, women and men were treated equally in all spheres of society, including the practise of social service. According to the dualism of some ancient Indian thinkers like Patanjali and Katayayana, women were taught and educated during the early Vedic period. Rigvedic writings advise women to marry when they are fully grown and to have the freedom to choose their life partner (swayambhhar). Text on a sword, for example The Rig Veda and Upanishades referred a few female sages and soothsayers, but Gargi and Maitreyi stand out since they were known as outstanding intellectuals and their contributions are still appreciated today. Three of the panchyakanya, Ahilya, Tara, and Mandodari all lived at this time and are still warmly remembered in Indian culture together with Sita, Damayanti, and Draupadi.

Medieval period

Razia Sulatana, who lived in the Middle Ages from 1205 to 1240, was the only woman to ever hold the throne in Delhi. Durgabati (1524–1564), the Gond queen, reigned for fifteen years before she passed away from wounds, she received in a fight with Akbar's commander in the Mughal sultan Akbar's army in 1564. Mentioning well-known individuals like Chand Bibi, Nurjehan, Jahanara, Zebunnisa Jija Bai, Tara Bai, Chitradurga, Rani of Kittur, lakhmibi, etc. further highlights the dominance of women. These ladies were the empresses and the crown of mediaeval India.

Modern and post-independence period

There is glorious history of women who had contributed a lot before and after independence of India. In 1848 to 1900 we find the names like Savitri Phule, Jhon Elliot Drinkwater Bethune, Chandramukhi Basu Kadambaini Ganguly, Anadi Gopal Joshi, sister Nivedita those who had conducted different social work and took steps for social development. In 1916, the social revolutionist Dhondo Keshav Karve established the first women's college. In 1917, Annie Besant was chosen as the Indian National Congress' first female president. In 1925, Sorijini Naidu was chosen to lead the Indian National Congress as its first female leader. In 1936, Sarala Thakral became the first woman to fly an aircraft. On August 15, 1947, Sorojini Naidu was also chosen as India's first female governor. In 1951, Prem Mathur, a Deccan Airlines pilot, had become the first woman to fly a commercial aircraft. In 1953, Vijaya Lakshmi Pandit became the first Indian woman to be elected president of the UN General Assembly. In 1936, Sucheta Kripali became the state of Uttar Pradesh's first female chief minister. There are so many names Kamala Devi Chattopadhya for winning Ramon Marsay award, Indira Gandhi for first female prime minister, Kiran Bedi for IPS, the Nobel laureate Mother Teresa(1979), Kamaljit Sandhu for winning gold medal in Asian games , Bachendri pal for climbing mount Everest (1984) M. Fatema Beevi first judge of supreme court , Mumtaz Kazi for driving diesel Locomotive in 1991, Karnam Maleswari Sonia Gandhi , Pratibha Patil Meira Kumar, Mitali Madhumita for winning gallantry medal, Joyalalita, are all came out first female those who brought pride for our nation . We have a lot of women who have done or have been doing work for social progress.

Crime against women, Special Local Laws, and the Indian Penal Code:

The societal status of women is vulnerable and physical torture, sexual harassment, raping, molesting, acid attacking, blackmailing them, human trafficking, forced to adopt prostitution, mental torture, domestic violence, dowry or any types of mal practice against women have been increasing in past few decades. women are may often victimized of daily basis crimes as example of domestic violence, murder, robbery, cheating, raping, molesting, sexual exploitation, torture or any types of harassment which are abbreviated and characterized as "crimes against women". Different types of laws, legislations have been brought and amendment done in persisting laws with views to control this crime effectively. These are may be divided into two categories. Due to women's precarious position in society, harmful practices such as physical abuse, sexual harassment, rape, molestation, acid assaults, extortion, forced prostitution, domestic violence, dowry, and other forms of harm have increased during the past several decades. Women are commonly the targets of widespread crimes like homicide, robbery, deception, rape, molestation, sexual exploitation, torture, or any form of harassment, which are referred to as "crimes against women" and are occasionally abbreviated to just that. Numerous laws, pieces of legislation, and revisions to existing laws have been proposed in an effort to regulate these offences effectively. These can be separated into two categories.1. Criminal offences listed in the Indian Penal Code (IPC) 2. Crimes covered by local special laws (SLL). According to the IPC, rape (section 376 IPC), attempted rape (section 376/511 IPC), kidnapping and abduction of women (sections 363,364, and 366), kidnapping and abduction for ransom, forced marriage, and other purposes, death related to dowry (section 304 B), assault on women with the intention of outraging their modesty (section 354, voyeurism (section 354, and insult to the modesty. Even though not all laws are gender-specific, those that have a substantial impact on women have regularly had their provisions evaluated and changed to keep up with evolving needs. The SSL is made up of the Dowry Prohibition Act of 1961, the Independent Representation of Women (Prohibition) Act of 1986, the Commission of Sati Prevention Act of 1987, the Immoral Traffic Act of 1956, and the Acts of Prevention of Domestic Violence of 2005.

Table-1: Proportion of Crime against Women (IPC) towards Total IPC Crimes

Sl. No.	Year	Total IPC Crimes	Crime Against Women (IPC Cases)	Percentage to Total IPC Crimes
1	2010	22,24,831	2,13,585	9.6%
2	2011	23,25,575	2,19,142	9.4%
3	2012	23,87,188	2,44,270	10.2%
4	2013	26,47,722	2,95,896	11.2%
5	2014	28,51,563	3,25,327	11.4%

Table-2: Percentage Change in Incidence and Rate of Crime against Women (2004 to 2014)

Year	Percentage Change in Incidence	Percentage Change in Rate
2004	0.0	0.0
2005	-0.8	-0.8
2006	0.8	0.8
2007	6.8	3.4
2008	20.1	14.6
2009	26.9	19.3
2010	32.1	22.4
2011	38.4	26.4
2012	48.2	32.6
2013	58.3	41.9
2014	119.0	91.5

Statistical data analysis, Trend of women crimes

According to survey of the crime bureau of India 2014, the new trend and pattern of crimes has been found increasing in 2014 as compared to year 2011. A 9.2 percent crime has been increased in 2014 by over 2013 and 58.2 percent by over year 2010. Rape in 2014 saw a total of 36,735 cases under section 376 of the IPC reported. Rape incidents have increased from 2010 in this report, 2014. The incidence of highest raping is found in 1madhya Pradesh which is followed by 2. Rajasthan, 3. Uttar Pradesh 4. Maharashtra. Incestual rape and rape by blood relative cases rose by 25.7% in 2014 compared to 2013.The majority of these crimes have been reported in Delhi UT (140 incidents), Maharashtra (94), and Kerala (62). Kidnapping & abduction in 2014, there were 57,311 documented incidents of kidnapping and abduction of women, a jump of 10.5 percent over the previous year. With 10,628 events reported, Uttar Pradesh occupied the top rank and accounts for over 18.5 percent of all cases. When discussing to the national average of 9.6 percent, Delhi, UP, has the highest reported crime rate at 44.7%. Dowry is a curve line has also been seen in cases involving dowers. In total, 8,501 victims were documented under 8,455 dowry killing cases nationwide in 2014. With 2,469 cases registered, Uttar Pradesh is once again in first place, followed by Bihar. Assaults on Women in 2014, there were 16.3% more assaults on women with the goal to offend their modesty than there were in 2013 (from 70,739 to 82,235 incidents). Maharashtra, Madhya Pradesh, and Uttar Pradesh are those states where the most reported crimes took place, in that order. Delhi UT has a crime rate for assaults on women with the purpose to violate their modesty that is 47.9% higher than the national average of 13.7. In 2014, there were 82,620 victims nationwide of assaults on women with the purpose to violate their modesty, or less than 82,235 incidents. A total of 3,27,394 incidences of crime against women were registered in the nation in 2015, down from 3,37,922 cases in 2014, however this does not indicate that the necessary level and expectations have been met. Between 2011 and 2014, there were increasingly more crimes reported: 2,28,650 crimes in 2011, 2,44,650 crimes in 2012, 3,09,546 crimes in 2013, and 3,37,922 crimes in 2014. While Uttar Pradesh, which has 16.8% of the country's female population, reported nearly 10.9 percent of all crimes against women at the national level by registering 35,527 cases during the year 2015, West Bengal, which represents nearly 7.4 percent of the country's female population, has accounted for 10.1 percent of total cases of crimes against women at the national level. Delhi had the highest rate of crime in 2015, followed by Assam, Telangana, Odisha, Rajasthan, Haryana, and West Bengal, according to the crime bureau.

Table-3: Crime Head-wise Cases Registered under Crime against Women (2011-2015)

Sl. No.	Crime Head	2011	2012	2013	2014	2015	Percentage Variation in 2015 over 2014
1	Rape#	24,206	24,923	33,707	36,735	34,651	-5.7
2	Attempt to Commit Rape*	-	-	-	4,232	4,434	4.8
3	Kidnapping & Abduction of Women	35,565	38,262	51,881	57,311	59,277	3.4
4	Dowry Deaths	8,618	8,233	8,083	8,455	7,634	-9.7
5	Assault on Women with Intent to Outrage Modesty	42,968	45,351	70,739	82,235	82,422	0.2
6	Insult to the Modesty of Women	8,570	9,173	12,589	9,735	8,685	-10.8
7	Cruelty by Husband or His Relatives	99,135	1,06,527	1,18,866	1,22,877	1,13,403	-7.7
8	Importation of Girl from Foreign Country	80	59	31	13	6	-53.8
9	Abetment of Suicide of Women	-	-	-	3,734	4,060	8.7
A	Total IPC Crime Against Women	2,19,142	2,32,528	2,95,896	3,25,327	3,14,575	-3.3

Contd...

10	Commission of Sati Prevention Act	0	0	0	0	0	-
11	Indecent Representation of Women (P) Act	453	141	362	47	40	-14.9
12	The Dowry Prohibition Act	6,619	9,038	10,709	10,050	9,894	-1.6
13	Protection of Women from Domestic Violence Act	-	-	-	426	461	8.2
14	Immoral Traffic (Prevention) Act	2,436	2,563	2,579	2,007	2,442	17.1
B	Total SLL Crime Against Women	9,508	11,742	13,650	12,530	12,819	1.8
Total (A+B)	2,28,650	2,44,270	3,09,546	3,37,957	3,27,394	-3.1	

Dowry prohibition

2015 had a 1.6% drop in the number of cases lodged under the Dowry Prohibition Act compared to 2014 (10,050 incidents). The bulk of these incidents—2,766—were recorded in Uttar Pradesh, followed by Bihar (1,867 incidences), Jharkhand (1,552), and Karnataka (1,541). Relative to a national average of 1.6, Uttar Pradesh has the highest crime rate in the nation (2.7). Commission of Sati Prevention Act, 1987 No cases under the Commission of Sati Prevention Act have been reported countrywide in 2015, similar to prior years.

The cases of cruelty by husband or his relatives

In the country (1,22,877 cases) decreased by 7.7% in 2015 compared to 2014. The majority of these cases—20,163—were reported by West Bengal, followed by Rajasthan (14,383), Assam (11,255), and Uttar Pradesh (8,660); collectively, these four States accounted for 48.0% of all cases of this kind (54,461 out of 1,13,403 cases). The highest recorded crime rate was in Assam (71.5), which was higher than the 18.7 national averages.

Act of 2005 Protecting Women from Domestic Violence

461 incidents have been identified in total under this Act in 2015, an increase of 8.2% from 426 cases in 2014 to 461 incidents in 2015. The majority of instances (161) were reported in Bihar, followed by Kerala (132) and Madhya Pradesh (91). In 2015, Himachal Pradesh (15 instances), Rajasthan (14 cases), and Haryana (11 cases) saw the greatest number of these cases. In all, these six States were responsible for 92.0% of all such occurrences recorded nationwide in 2015.There have been 2,424 cases reported under the Immoral Traffic (Prevention) Act, however all of them solely involve crimes against women. Kerala (63 cases), Karnataka (48 cases), and Maharashtra (133 occurrences) have all recorded the highest numbers of seducing or soliciting for prostitution-related crimes.

Steps to be followed for women security

In addition to legal advice for individuals who disclose sexual assaults, victims should also receive mental support, psychiatric care, and legal aid. 2. When a lady complains, police should take immediate action. 3. Legal assistance should be available at the police station to ease the complainant's anxiety. 4. Take proper action against accused 5. elimination of violence against women. 6. A list of advocates should be provided who are willing to help the victims. 7. stop the child marriage and sexual harassments. 8. make education gender sensitive, pay respect to them and empower girl and mother.9. give proper values the work of women. 10. Eradicate gender inequality, deprivation, discrimination and exploitation of women.11. make girls educated, more conscious. 12. Let them help to improve their economic development.13. ensure their right, freedom, needs, security liberty and dignity.14. stop domestic violence, sexual harassments, gender discrimination.15. create sound environment for their work participation, right to enjoy space of freedom in every sphere of life.16. foster the developed culture and practice to eliminate orthodox out-dated mentality. 17. Provide administrative help and justice to women immediately after crimes.

Conclusion

Thus, this cannot cease the pace of modernization and pace of civilization. It is very true that ancient India to medieval India women related crimes were to lest too count. As Data and statistics were also not available at that time. Modernization though having positive vibration and has brought significant changes, development in our civil society yet, some evils and curses like women related crime cannot be denied of. In last two century, world as well as India has faced "population explosion" hence man land ratio, man resource ratio is diminishing. Scarcity of resource has created inequality, deprivation, unstable circumstances which subsequently leads social mal practices and incidence of social crime hence Women are taken as most soft target. "World without women is incomplete (Shakespeare)" so for shake of women development we need to literate, educate, empower, secure, make conscious of them and strictly enforce the existing laws to protect them.

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The Deccan Geographer
Vol. 62, No. 10 December, 2024, pp. 309-319
(ISSN-0011-7269)
UGC Care Listed Geography Journal

CRIME AGAINST WOMEN IN INDIA: A GEOGRAPHICAL STUDY

Saumya Pandey and Dr. Sadhan Rani

Abstract

Crime against women is a global issue. One in three women around the world experience physical or sexual violence in her lifetime. This indicates that the problem affects 1 billion women all around the world. Crimes against women are continued to be a serious social issue, demonstrating long-standing disparities and systemic failures to ensure women's safety and dignity. This article examines the different crimes against women including domestic violence, sexual harassment, trafficking, dowry-related crimes, and rape etc. The persistence of these crimes illustrates the convergence of cultural, economic, and societal variables that contribute to gender-based violence. Despite legislative and advocacy advances, underreporting and societal stigma make it difficult for victims to receive justice. The role of patriarchal norms, insufficient law enforcement, and low awareness, the role of education, community engagement, and media campaigns in changing public perceptions are major impediments to change. The rate of crime against women at national level augmented from 57 in 2020 to 67 in 2022. In 2022, the reported crime rate against women per 100,000 women was 66.4, up from 58.8 in 2018. This reflects an increase in gender-based crime against women in India. Article 14 of the Indian constitution mention equality before the law, however women face numerous challenges of inequality from conception to death. Hence, the present paper will geographically analyse the crime data against women of the last 10 years. The aim of this paper is to evaluate the recent trend and spatial pattern of women's vulnerability in India. For data analysis and geographical representation, the standard deviation (SD) in relation to the national average approach is used to calculate the vulnerability of women towards crime in India's various states and union territories.

Introduction

Indian society is patriarchal. The prevailing patriarchal principles, which were articulated through particular cultural metaphors, governed sexuality, reproduction, and social production. Half of the world's population is women.

Gender discrimination, which views men as superior to women, contributes to violence against women. Aggression on a physical, psychological, and economic level are examples of violent manifestations. There are social and cultural elements that contribute to the emergence and propagation of violent behavior. The world human rights conference in Vienna, is the first that recognized gender-based violence as a human rights violation in 1933. United Nation Organisation (1933) defines violence against women as "any act of gender-based violence that result in or is likely to result in physical, sexual, or mental harm or suffering to women, including threats of such acts, coercion or arbitrary deprivation of liberty, whether occurring in public or in private life" Article 2 of the UN declaration clarifies and lists some forms of violence as, "Any act of gender based violence that results in, or is likely to result in, physical, sexual, and psychological violence in the family and the community. These acts include spousal battering, sexual abuse of female children, dowry related violence, rape, including marital rape, and traditional practices harmful to women, such as female genital mutilation. They also include non-spousal violence, sexual harassment and intimidation at work and in educational institutions, trafficking of women, forced prostitution, and violence perpetrated or condoned by the state, such as rape in war." World health organisation indicate that globally about one in every third (30%) women have been subjected to either physical or sexual intimate partner violence or non-partner sexual violence in their lifetime.

A study conducted by the International Centre for Research on Women, India (2000) found that 50.5% of men had abused their pregnant wives, 43.5% had abused their wives psychologically, 40.3% had abused their wives physically, and 50.5% had abused their wives at least once during their marriage. Additionally, it was stated that rural areas experience more violence than urban ones. According to Coomaraswamy (2003), there are various kinds of crimes against women. Report on "violence against women" from the United Nations. UNFPA (2004) define the document on 'Violence Against Women' to identify the pattern and trends of crime against women that the forms manifestation, and debilitating effect of violence against women throughout her life. As a result of its intersections with social, economic, and gender equality issues, crime against women can impede the achievement of the Sustainable Development Goals. Fawole (2008) drew the attention to the types of economic violence faced by women and also described its consequences on their health and development. According to India Human Development Study (IHDS) in 2011-12, two third of Indian women reported that it is very common rituals for husband to beat them for reasons like stepping out of home without taking permission. According to Deepala (2024), who used the NCRB reference to find the recorded crimes against women, the number of crimes against women grew by more than 30% between 2014 and 2022. On 9 Aug 2024, all people concerned about women's safety in India were raised by the alleged rape and killing of a postgraduate trainee doctor at the R.G. Kar Medical College and Hospital in Kolkata. In their study, Shukla and Tiwari (2021) examined the spatial pattern and trend of women's vulnerability in India as well as the relationship between several socioeconomic factors and the prevalence of crimes against women. The vulnerability of women in India's various states and union territories is measured using the standard deviation (SD) technique in relation to the national average.

The National Crime Records Bureau (NCRB) received reports of 445,256 crimes against women in 2022. Between 2018 and 2022, there was a 12.9% increase in reports of crimes against women due to both an increase in incidents and improved reporting. According to the National Family Health Survey-5, approximately one-third of Indian women between the ages of 15 and 49 reported having been victims of violence. The annual reports of rapes have regularly exceeded 30,000 occurrences per year since 2012, except for a dip during the 2020 Covid-19 pandemic. This indicates that the number of rapes remains exceptionally high. Attacks on women reached a peak in 2016 of about 39,000. In 2018, a rape was reported every fifteen minutes nationwide, underscoring the startling regularity of these crimes. The fact that more than 31,000 rape incidents were reported in 2022 shows how serious the problem still is. The conviction rate for rape has stayed low despite strict rules. It ranged from 27% to 28% between 2018 and 2022. The crime rate against women increased from 56.5 per 100,000 women in 2020 to 64.5 in 2021. Reverse migration, social isolation, and economic distress were some factors that led to this. Crime against women increased from 359,849 cases in 2017 to over 445,000 cases in 2022, according to the Women and Men in India 2023 report. This represents an average of 1,220 daily cases and 51 First Information Reports (FIRs) each hour. After the Protection of Women from Sexual Harassment Act, 2013 (POSH Act) was passed, sexual harassment in the workplace continues to be an issue. There were 422 incidents in 2022 compared to 402 in 2018. But because of social prejudices and apprehension about the consequences, these figures are probably underreported. Women's Safety Index in terms of women's inclusion, justice, and security, India ranked 128 out of 177 nations with a score of 0.595 out of 1, according to the Georgetown Institute 2023 Women Peace and Security Index. According to the ranking, India is ranked among the top 10 nations with the worst rates of political violence against women in 2022.

Objectives

(1) To analyse the statistical data of crime against women for ten years (2013 to 2022).

(2) Geographical representation of data of vulnerability of crime against women of 2022.

Database and Methodology

The present study is a descriptive study and is based on secondary data collected from the National Crime Records Bureau (NCRB) website for the 2013 to 2022 reports. NCRB provides data on 'crime against women' on annual basis. Data is analysed with the help of suitable statistical techniques (Mean and Standard Deviation) and cartographic methods using MS excel and ArcGIS software. The main purpose of the study is to observe the trend of 'crime against women' in India. The current study deeply analyses the 10-year data and will provide the valuable output from the study of that data

Results and Discussion

Causes of Inappropriate Reporting of Crime Against Women

(a) Police forces across different areas still don't consistently follow stringent laws, such the Criminal Law (Amendment) Act of 2013, which was enacted following the Nirbhaya case in 2012.

(b) Organizations are failing to fully implement regulations, such as the formation of Internal Complaints Committees (ICCs). In 2018, the Securities and Exchange Board of India (SEBI) compelled listed firms to retain an annual record of any sexual harassment incidents; nonetheless, the data remains inaccurate and untrustworthy.

(c) Attempt to prevent crimes against women may be hampered by the corruption of the legal and law enforcement systems. Because to bribes and corruption, cases may be handled improperly or dismissed (Table-1).

(d) Because people are frightened of retaliation and don't trust the system, or believe the judicial system is ineffective, many violent acts go unreported.

(e) Deeply ingrained societal beliefs and practices may jeopardise legal protections. Some groups may not take violence against women seriously or may even normalise it.

(f) Women may be discouraged from reporting crimes or seeking help by cultural stereotypes and the fear of social rejection and shame brought on by victim-blaming.

(g) Conviction rates could be low because victims bear a disproportionate amount of the burden of proof. The difficulty of the legal system and the requirement for substantial evidence may deter victims from pursuing justice.
(h) Justice for victims may be delayed and protracted trials may result from the onerous nature of the legal system. This might discourage survivors from reporting crimes.
(i) The legal system can be burdensome, leading to protracted trials and a postponement of victims' justice. Survivors may be discouraged from reporting crimes as a result.
(j) The economics may also play a significant role. Financially dependent women may find it challenging to leave abusive relationships, despite the existence of legal protections.
(k) Opposition to reform among institutions and lawmakers may hinder or delay efforts to improve laws and regulations. Legal institutions may not change quickly enough to address emerging forms of violence or changes in public sentiment.
(l) It is common for women to be unaware of their legal rights and the resources that are available to them for assistance. People might not be able to access justice because of this ignorance.

Table-1: Classification of Violence Against Women

Life Stage	Violence Against Women
Infancy	Infanticide; psychological and physical abuse; differential access to food and medical care
Childhood	Incest and sexual abuse; psychological abuse; differential access to food, medical care and education; prostitution; trafficking; school related gender-based violence
Adolescence	Dating and courtship violence; economically coerced sex; sexual abuse in the workplace; rape; sexual harassment; forced prostitution; trafficking; psychological abuse; forced marriage; dowry abuse; retribution of the crimes of others
Adult	Intimate partner abuse; marital rape; dowry abuse; honour killings; partner homicide; psychological abuse; sexual abuse in the work place; abuse of women with disabilities; forced prostitution; trafficking, battering
Old age	Widow abuse; elderly abuse; rape; neglect

Table-1 represents crime trends over the last decade (2013-2022). The table clearly states that, there is an overall increase of 30.45% in crime against women in last ten years. The patterns of crime against women during the past ten years reflect the actual state of such crimes in India. It is evident from the table that there has never been a drop in crime against women. The rate of crime against women has been steadily rising over the past ten years, from 3,09,546 in 2013 to 4,03,805 in 2022, indicating a major increase in crime. Indian families are so rife with cruelty from husbands and their family members that it ranks as the most common crime against women each year. It is evident from the table that the total registered cases of cruelty by husband in year 2013 was 118866, in year 2014 it was 122877 and in the year 2022 it was 140019 cases. It shows the gradual increase in crime against women and its variation is 17.79% between the year 2013 to 2022. The cases reported under the dowry deaths category have decrease from 8083 cases in 2013 to 7466 cases in 2017 and further to 6450 in 2022. It shows the negative (-20.20%) variation in period of 2013 to 2022. According to NCRB, 51881 cases registered under the crime head of kidnapping and abduction in the year 2013 and in the year 2022 it is 107588 showing the phenomenal growth in kidnapping and abduction of women. NCRB data reveals an increasing trend in the crime category of assault on women to outrage her modesty as its rate has gone up from 70739 cases in year 2013 to 83344 cases in year 2022.

This data showing approximately 18% rise over the 9-year period. Cases of rape have also shown an increasing trend from 33707 cases in year 2013 to 38947 cases in year 2016 again in the year 2020 these cases were 28046 that shows decline but in year 2022 cases reported were again increased to 31982. The cases reported under the sexual harassment have increased from 12589 cases in year 2013 to 19417 cases in year 2022. Crimes like kidnapping and abduction, dowry related violence, sexual harassment, cruelty by husband, outraging modesty and rape have obviously increased dramatically, while crimes like importation, immoral traffic prevention, indecent representation, etc. have decreased, which is a positive indication that women's rights are being protected in society. For achieving the second objective of the study vulnerability level of the women was determined. For determining the vulnerability level of women in States/ UTs on basis of crime against women’s data, quantitative analysis has been done on NCRB data from the year 2013 to 2022. State and UTs wise average crime rate from 2013 to 2022 is taken as a standard variable. Then mean value of these standard variable is calculated which comes to be 58.7. In the next step the deviation of each state/ UTs is calculated from the National Average Crime Rate. The square of this deviation is taken and standard deviation (SD) is calculated which was calculated as 33.5. On the basis of 'standard deviation' and 'mean' of the standard variables, states and UTs have been categorized into five levels of vulnerability, which showed a particular spatial pattern of crime against women in India. Following Table-2 is showing different states and UTs for crime against women in India (Fig. 1).

Table-2: Vulnerability of States and UTs for Crime Against Women in India

No.	Level of Vulnerability	Rate of crime Against Women	States/ UT's
1	Very High	More than 125.7	Delhi
2	High	92.2-125.7	Andhra Pradesh, Haryana, Odisha, Rajasthan, Telangana, Andaman & Nicobar, Rajasthan
3	Medium	58.7-92.2	Uttar Pradesh, Uttarakhand, West Bengal, Assam, Chhattisgarh, Kerala, Madhya Pradesh, Maharashtra
4	Low	58.7-25.2	Arunachal Pradesh, Bihar, Goa, Himachal Pradesh, Jharkhand, Karnataka, Meghalaya, Sikkim, Tripura, Chandigarh, D&D and DNH , J&K, Lakshadweep
5	Very Low	25.2	Tamil Nadu, Ladakh, Puducherry, Gujarat, Manipur, Mizoram, Nagaland

From the observation of Table-2 and the map it is evident that Delhi showed a very high level of vulnerability which was 144.4 or above. Andhra Pradesh, Haryana, Odisha, Rajasthan, Telangana, Andaman & Nicobar were showing high range of vulnerability. The states and UTs which showed a moderate range of vulnerability were Assam, Chhattisgarh, Kerala, Madhya Pradesh, Maharashtra, Uttar Pradesh, Uttarakhand, and West Bengal. The statistical value of vulnerability

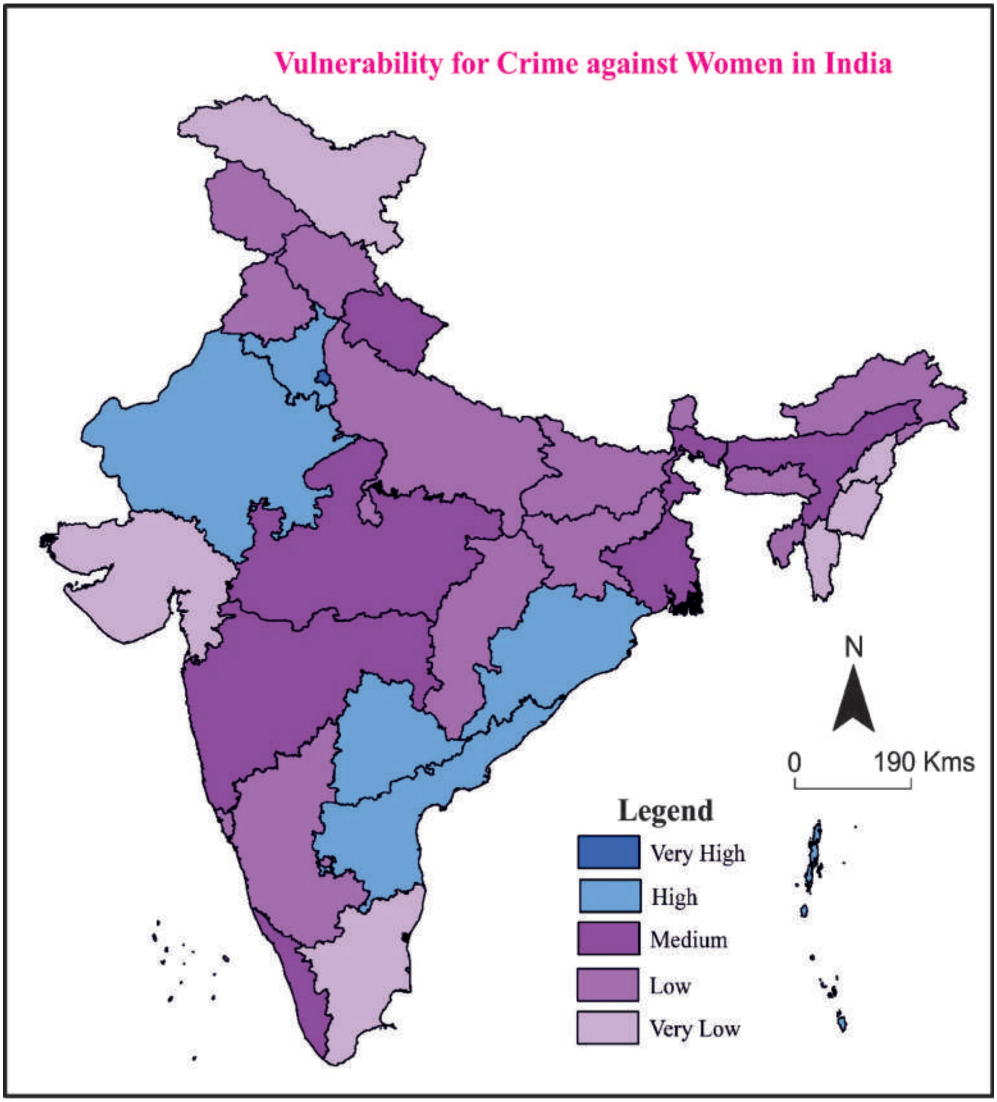
Vulnerability for Crime against Women in India
N
0
190 Kms
Legend
Very High
High
Medium
Low
Very Low

Fig. 1

lies between 58.7 to 92.2. States and UT's, that had a low rate of vulnerability with a statistical value ranging between 58.7 to 25.2 were Arunachal Pradesh, Bihar, Goa, Himachal Pradesh, Jharkhand, Karnataka, Meghalaya, Punjab, Sikkim, Tripura, Chandigarh, Jammu & Kashmir, Daman & Diu and Dadar & Nagar Haveli, and Lakshadweep. Very low range of vulnerability with a statistical value ranging less than 25.2 shown by the states and UTs of Gujarat, Mizoram, Nagaland, Tamil Nadu, Ladakh, and Puducherry.

Conclusion

Incidence of crime against women have been increasing consistently during last ten years. As per the analysis, the crime rate has steadily increased from 2013 to 2022 by 30.45%. The number of serious crimes against women has significantly increased, including, husband cruelty, dowry deaths or attempts, sexual harassment, physical and mental torture, assault on women with the intention of outraging the modesty, kidnapping and abduction, and cases under the Dowry Prohibition Act. The vulnerability of women in the states and UT's in 2022 like Delhi (144.4%) Haryana (118.7%), Telangana (117.0%), Rajasthan (115.1%), Odisha (103.1%) is found to be very high while it lower in Nagaland (4.6%), Ladakh (11.5%), Manipur (15.6%) as compared to the national average (66.4%). The vulnerability of women to crime differs significantly across states and union territories (UT's) in India. A complex interaction of socioeconomic, cultural, and institutional elements leads to this discrepancy. High vulnerability states frequently have systemic problems such low female literacy rates, patriarchal norms, gender inequality, a lack of economic possibilities for women, and insufficient law enforcement. States with less vulnerability, on the other hand, typically have more effective government, better gender sensitization, and stronger social infrastructure. Crime is a social problem for which there is not a proper cure, but there is a solution to it. The first step towards a healthier society with fewer violent incidences is educating girls. Effective strategies include campaigns to raise awareness and alter attitudes about gender inequity among men and boys. As individuals and responsible citizens, we must raise awareness and report any violence against women that occurs in our community. The nation, the village, and the family all move forward when women do. It is crucial because their values and ways of thinking shape the formation of a decent family, a healthy society, and eventually a great country. The government is strengthening current laws by reviewing and amending them as needed, as well as building new institutional processes such as National and State Commissions for Women, all-women police stations, and so forth. On the other hand, it is implementing projects that assist disadvantaged women, such as short-stay houses, hostels for working women, and the rehabilitation of victims of violence through programs such as Swadhar. The National Commission for Women and many non-governmental organizations (NGOs) are also running gender awareness and orientation workshops for judiciary and police officers, with a focus on violence against women.

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The Deccan Geographer
Vol. 62, No. 10 December, 2024, pp. 320-333
(ISSN-0011-7269)
UGC Care Listed Geography Journal

ASSESSMENT OF FREQUENCY RATIO AND ANALYTIC HIERARCHY PROCESS MODELS IN LANDSLIDE HAZARD ZONATION MAPPING: A COMPARATIVE STUDY FOR AIZAWL DISTRICT, MIZORAM, INDIA

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Abstract

Aizawl is a hilly topography due to its tectonic genesis. The geological component comprises of highly fragile and brittle shale, highly jointed sandstones and siltstones which were intercalated by thin layers of clay bands. Consequently, landslide is one of the most common geological hazards in Aizawl city and the region of Mizoram as a whole during unfavorable meteorological conditions. Landslide hazard zonation (LHZ) is one of the mandatory scientific research projects that reached to the public as an extension of scientific research to the community for real time application. Landslide Hazard Zonation (LHZ) was done based on Analytic Hierarchy Process (AHP) and Frequency Ratio (FR) models. The resultant LHZ map for both models can be categorized into five classes: Very Low, Low, Moderate, High, and Very High Hazard zones. The performances of the two models are evaluated using Receiver Operating Characteristic (ROC) and Area Under Curve (AUC) curve. The success rate and prediction rate for both models show good results. Overall, the FR model shows better performance than the AHP model. The resultant LHZ maps can be used for future management of landslides in the study area.

Introduction

In a hilly terrain like Mizoram which are geologically young and influenced by geodynamic activities, Landslide Hazard Zonation (LHZ) is an essential part for hazard mitigation and preparedness to disaster response. The LHZ tries to divide land surface into homogeneous areas or domains and their ranking to degrees of actual and/or potential hazard caused by mass movement (Varnes 1984; Bera et al., 2019). Amongst all the natural or man-made disasters, landslides are one of the most disastrous phenomena to occur in Mizoram, India. The present study, therefore, deals with the spatial prediction of probable locations of future landslides in the form of LHZ mapping. In Aizawl district, landslides have been a problematic hazard faced especially during the monsoon seasons every year. Since, Aizawl is the capital city of Mizoram, the population is continuously increasing which make it important to generate landslide hazard zonation map so as to prevent, reduce or mitigate landslide disasters which may impact the livelihood, infrastructure, and even the life of the people. In the State of Mizoram, there are limited researches in assessing and mapping landslide hazard zones using Frequency Ratio (FR) and Analytic Hierarchy Process (AHP) models. The models have always given good results according to the validations with the landslide inventories. There are few LHZ maps based on AHP method for the districts of Mizoram other than Aizawl District (Lallianthanga & Laltanpuia, 2013; Lallianthanga, Lalbiakmawia and Lalramchhuana, 2013; Lallianthanga and Lalbiakmawia, 2014; Laltanpuia, Chenkual & Lalbiakmawia, 2016). Rao& Barman (2019) have done landslide zonation map in a small-scale area of Upper Tuirial watershed for the purpose of watershed management. Since then, there have been several changes in Aizawl City and the district as a whole such as growth in urban areas or built-up areas, decrease in vegetation cover, etc. Therefore, an updated version of LHZ using AHP model is very much required in the region which can help manage and mitigate landslide disaster preparedness and risk reduction.

Study Area

Aizawl district is located in the north central part of Mizoram, in north-east corner of India. The district is geographically located between 92° 37′ 03"E to 93° 11′ 45" E longitudes and 23° 18′ 17"N to 24° 25′ 16" N latitudes. The district falls under Survey of India toposheet No. 83D/15, 83D/16, 84A/9, 84A/10, 84A/11, 84A/13, 84A/14, 84A/15, 84E/1, 84E/2, 83H/3 and 83H/4. The terrain is primarily composed of sandstone-shale-siltstone intercalations which are highly inclined, folded and faulted with numerous joints and fractures. The unconsolidated material of thick and thin top soils, colluvium and recent alluvium constitute the upper layers of the sedimentary strata. The topography of Aizawl District is geologically immature and geomorphologically at young stage where weathering is widespread and incisions of valleys is still active along the rivers and on the general topographic slopes. The region shows N-S trending anticlinal-synclinal tectonic upliftment of the sedimentary strata. The region displays dissected ridges with deep gorges, spurs, keels, etc. Faulting in many areas has produced steep fault scarps causing the hilly terrain of Aizawl District and the entire Mizoram extremely prone to landslides.

Objective

The primary objective of the study is to prepare the LHZ map using conditioning factors through application of AHP and FR techniques.

Database and Methodology

The work is broadly divided into four stages include field geological survey for ground validation and field data acquisition, data acquisition for digital digitization of different maps, determination of landslide conditioning factors and generation of LHZ maps which are explained in the following sections. Different sources were used for the acquisition of landslide conditioning factors, the details of which are shown in Table-1.

Table-1: Data and its Description

Data	Source	Date of Acquisition	Spatial Resolution	Variables Extracted
Cartosat-1 (2005-2014)	https://bhuvan-app3.nrsc.gov.in/data/download/index.php	07.09.2022	2.5m	Slope, Aspect, Drainage density, TWI
Sentinel-2 (2021)	https://earthexplorer.usgs.gov/	20.10.2022	10m	LULC, NDVI
GSI	https://bhukosh.gsi.gov.in/Bhukosh/Public	15.09.2022	-	Geomorphology, Lineament density
IMD Pune (2021)	https://www.imdpune.gov.in/	25.08.2022	0.25°	Rainfall
Thematic Maps	https://mirsac.mizoram.gov.in/page/geological-map-of-mizoram	25.08.2022	-	Lithology
Landslide Points (2010-2021)	https://data.nasa.gov/Earth-Science/Global-Landslide-Catalog	24.08.2022	-	Landslide Inventory
	Field Report	21.08.2022	-	
SEDAC Gridded World Population density	https://earth.gov/ghgcenter/data-catalog/sedac-popdensity-yeargrid5yr-v4.11	2020	1 km	Population density

Source: Authors

The landslide conditioning factors are topographical factors which include the slope angle, slope aspect and TWI, hydrological factors which include the drainage density and rainfall, geological factors which include lithology and lineament density maps, and geomorphological factors which include the geomorphology, LULC and NDVI maps. Landslide incidents occur when these factors act independently or in unison which may lead to serious disaster. The selection of these landslide conditioning factors was based on past researches, previous literatures, and how the individual factors have significant impact on the study area. After the selection and determination of landslide conditioning factors is done, the main steps involved in the methodology include creation of thematic layers of conditioning factors and historical landslide occurrences, generating the landslide hazard zonation map using the AHP and FR model, and Model Validation (success rate and prediction rate) using the Receiver Operating Characteristics curve (ROC) and Area Under Curve (AUC) method.

Results and Discussion

Landslide Inventory Map

A number of landslides of 33 points from 2010 - 2021 were identified and collected from NASA Global landslide points and field reports. The total number of generated location datasets was pooled and divided randomly into two groups, 75:25 training and testing datasets. Consequently, 25 landslide points were used as training sets and the remaining 8 landslide points were used as testing sets or validation sets.

Creation of Thematic Layers

Analytic Hierarchy Process (AHP) is a method for organizing and analysing complex decisions developed by Thomas L. Saaty. Relative rating values of each thematic layer was assigned for the subclasses based on their causative factor on the landslide triggers. For this purpose, the pair-wise comparison matrix using Saaty's nine-point weighing scale was applied in which each criterion was rated against all other criterion by assigning a relative scale between 1 and 9. The resulting weights were input into the percentage influence of factors and were analysed using the weighted overlay analysis in Arc GIS environment to get the landslide hazard zonation map of AHP model. Frequency Ratio approach propose the possibility of a future event based on past information and derive the spatial relation between the number of landslide pixels (landslide location) and different landslide conditioning factors (Nohani et al., 2019; Pradhan & Lee, 2010; Agrawal et al., 2022). Higher value of FR represents higher risk for landslide occurrence. To obtain LHZ using the FR method, the sum of the PR values and the factors were calculated using raster calculator in the Arc GIS environment to get the desired landslide hazard zonation map of Frequency Ratio Model. Receiver Operating Characteristic (ROC) curve is frequently used for evaluating the performance of binary classification algorithms. It provides a graphical representation of a classifier's performance, rather than a single value like most other metrics. (Steen, 2020). It is produced by calculating and plotting the true positive rate against the false positive rate for a single classifier at a variety of thresholds. AUC stands for Area Under the (ROC) Curve. Generally, the higher the AUC score, the better a classifier/model performs for the given task. The prediction rate curve is based on a comparison of the susceptibility map with the landslides used in the testing dataset (Pradhan and Kim 2014; Sangeeta et al., 2022). Using the data mentioned in Table-1, the maps of thematic layers or landslide conditioning factor generated for the study area are represented in Fig. 4. The above ten maps in Fig.1 represent the thematic layers generated for each conditioning factors. From the lithology map of Mizoram prepared by MIRSAC as referred in Table-1, the lithological map was extracted and re-digitized to represent the study area for the present research purpose.

It is observed that the study area is made up predominantly of sandstones, shale, siltstones and pocket limestone. Only few lineaments were observed in the study area. The steeper slopes with high angle led to an increase in shear stress and reduces shear strength, and therefore, the areas with higher slope angles are more susceptible to landslide than the lower ones. The study area has steep slopes due to tectonic upliftment that throw the lithological strata into highly inclined rock beds. The geomorphology of the study area consisted predominantly of highly and moderately dissected structural hills and valleys. In the study area, most of the lands are covered with vegetation. It is observed that the settlement and its surrounding areas have the lowest vegetation index. The rainfall in the study area is observed to be more on the northern side of the study area and decreases as it goes down to south. The weight or rank was both calculated using the methods above for both FR and AHP models. The calculated results are as given below in Table-2 and Fig. 1.

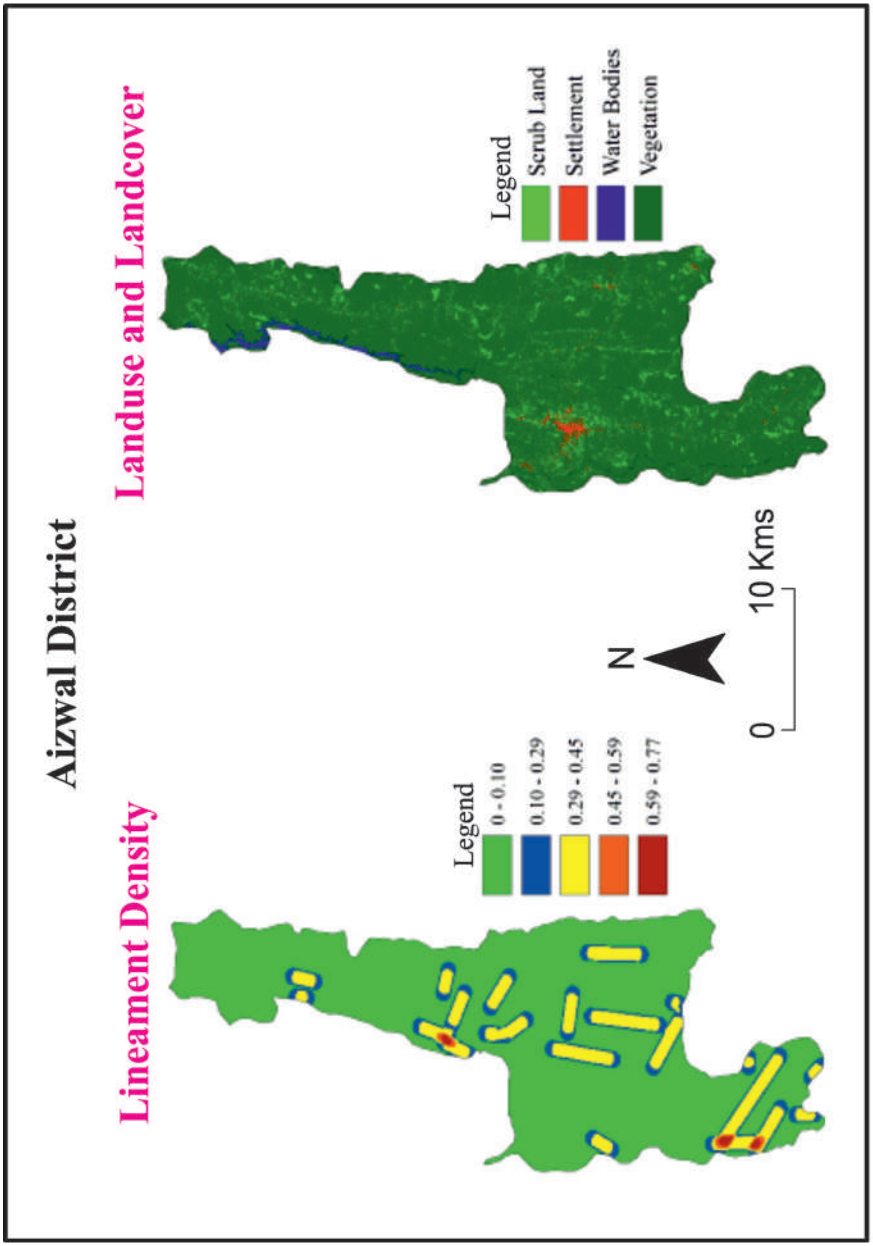
Aizwal District
Lineament Density
Legend
0 - 0.10
0.10 - 0.29
0.29 - 0.45
0.45 - 0.59
0.59 - 0.77
Landuse and Landcover
Legend
Scrub Land
Settlement
Water Bodies
Vegetation
N
0
10 Kms

Fig. 1

Table-2: Landslide Hazard Weight Values Assigned Using AHP and FR

Factors	Classes	Area (sq, km)	Weight	
			AHP (%)	FR
LULC	Scrubland	127.62	29	3.96
	Settlement	40.50		
	Water Bodies	29.40		
	Vegetation	2439.16		
NDVI	0.46-0.14	28.52	21	2.38
	0.14-0.46	61.66		
	0.46-0.65	189.061		
	0.65-0.77	644.17		
	0.77-0.99	1713.38		
Slope (degree)	0-13.37	375.98	15	1.92
	13.37-21.46	654.02		
	21.46-28.42	760.27		
	28.42-36.26	610.36		
	36.26-71.07	235.62		
Rainfall (mm)	1479.38-1578.04	1153.53	11	4.75
	1578.04-1724.34	827.65		
	1724.34-1925.08	301.15		
	1925.08-2115.61	152.02		
	2115.61-2346.96	202.47		
Lithology	Limestone	84.2	8	3.04
	Sandstone	1271.4		
	Shale & Siltstone	1281.1		
Lineament Density	0-0.10	2164.26	6	4.75
	0.10-0.19	185.344		
	0.29-0.45	269.427		
	0.45-0.59	8.875		
	0.59-0.77	8.626		

Contd...

Drainage Density	0-0.22	1242.5	4	4.75
	0.22-0.68	694.76		
	0.68-1.25	403.17		
	1.25-2.01	203.00		
	2.01-3.86	93.10		
TWI	3.19-3.83	48.13	3	2.99
	3.83-3.90	246.62		
	3.90-3.95	553.97		
	3.95-4.00	832.45		
	4.00-4.05	955.01		
Aspect (degree)	Flat (-1)	231.20	2	1.00
	N (0-22.5)	536.24		
	NE (22.5-67.5)	281.07		
	E (67.5-112.5)	280.50		
	SE (112.5-)	291.24		
	S (157.7-202.5)	263.62		
	SW (202.5-247.5)	267.81		
	W (247.5-292.5)	246.30		
	NW (292.5-337.5)	238.26		
	N (337.5-360)			
Geomorphology	Highly dissected Structural hills and valleys.	1531.71	1	4.75
	Low dissected Structural hills and valleys.	11.92		
	Moderately dissected Structural hills and valleys.	998.31		
	Pond	3.90		
	River	6.75		
	Younger Alluvial Plains	83.92		

Source: Authors

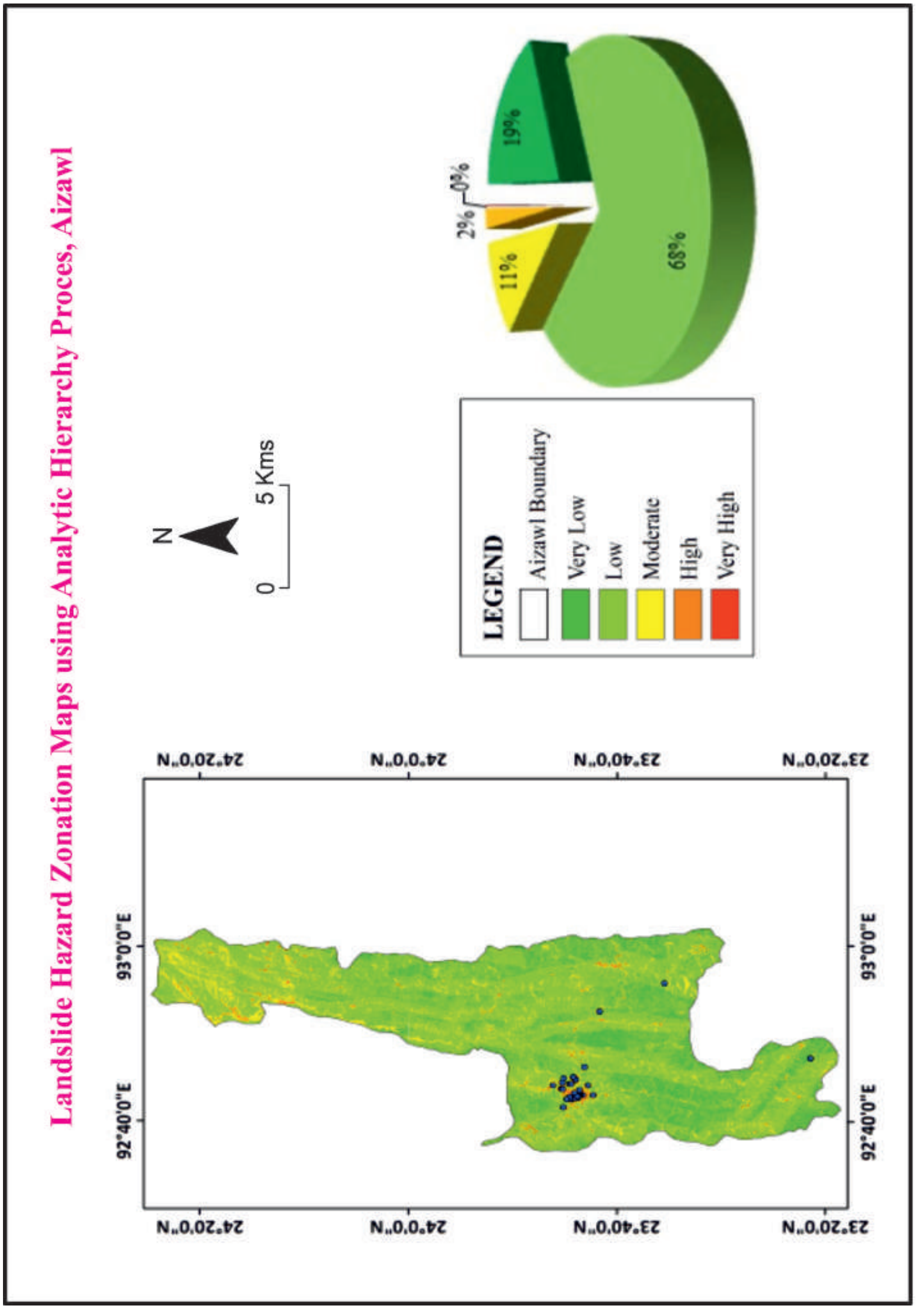
Landslide Hazard Zonation Maps using Analytic Hierarchy Proces, Aizawl
24°20'0"N
24°0'0"N
23°40'0"N
23°20'0"N
92°40'0"E
93°0'0"E
N
0
5 Kms
LEGEND
Aizawl Boundary
Very Low
Low
Moderate
High
Very High
68%
19%
11%
2%
0%

Fig. 2

The resulting weights were input into the percentage influence of factors or calculated using raster calculator in ArcGIS environment to get the desired LHZ map of AHP and FR models respectively.

Landslide Hazard Zonation using AHP Model

The priority weight for the 10 landslide conditioning factors were calculated and analysed using the weighted overlay analysis which resulted in the LHZ map for AHP model as shown in Fig. 2. The study area is mostly covered with very low and low hazard zones. High hazard zones are found covering very small part of the study area, mainly the settlement areas or the central part of the study area. The landslide hazard zonation map of the study area can be divided into five categories as follows:

(a) Very Low Hazard zone: covering 492.74 sq.km. which is 19% of the total area.
(b) Low Hazard zone: covering 1775.76 sq.km. which is 68% of the total area.
(c) Moderate Hazard zone: covering 286.94 sq.km which is 11% of the total area.
(d) High Hazard zone: covering 61.62 sq.km 2% of the total area.
(e) Very High Hazard zone: covering 5.4 sq.km. which is more or less non-existent.

Landslide Hazard Zonation using FR Model

From the LHZ map obtained through FR method as shown below in Fig. 2 and 3 , it is observed that very high hazard zones are found in the southern part and cover most of the study area. The very low and low hazard zones are found mainly in the northern part of the study area. Based on the FR-LHZ model, the study area can be divided into five landslide hazard zonation categories as follows:

(a) Very Low Hazard zone: covering 98.3 sq.km. which is 4% of the total area.
(b) Low Hazard zone: covering 421.07 sq.km. which is 16% of the total area.
(c) Moderate Hazard zone: covering 2851.01sq.km which is 9% of the total area.
(d) High Hazard zone: covering 922.59 sq.km which is 35% of the total area.
(e) Very High Hazard zone: covering 934.59 sq.km. which is 36% of the total area.

Validation of LHZ Models

The resultant LHZ maps were validated using the ROC and the AUC curves. The AUC and ROC curves were generated using the ArcSDM toolbox extension

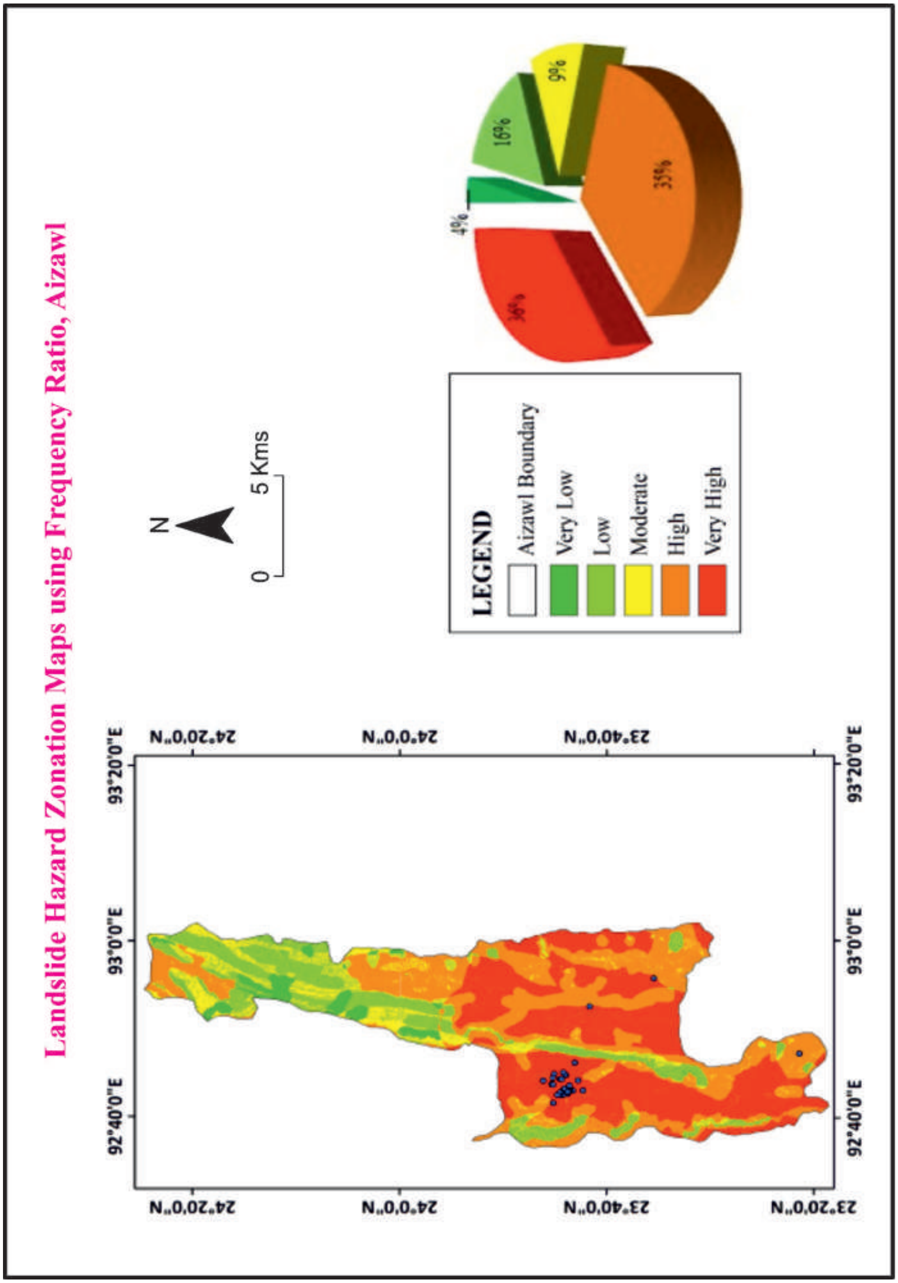
Landslide Hazard Zonation Maps using Frequency Ratio, Aizawl
N
0
5 Kms
LEGEND
Aizawl Boundary
Very Low
Low
Moderate
High
Very High
36%
4%
16%
9%
35%
92°40'0"E
93°0'0"E
93°20'0"E
24°20'0"N
24°0'0"N
23°40'0"N
23°20'0"N

Fig. 3

in ArcGIS environment which directly calculated the ROC and AUC values in GIS environment. The success rate curve was obtained using the training datasets (75%) and the prediction rate using the Testing datasets (25%). The success rate curve for the present models indicates that the AUC for the training dataset of FR is 0.916, which indicates 'excellent' and the AUC for the training dataset of AHP is 0.879, which indicates 'good'. The prediction accuracy assessment was performed to obtain the consistency of LHZ (Anbalagan et al., 2015). The AUC of prediction rate curves was counted based on each landslide susceptibility map and testing landslide dataset (Gupta et al. 2022). AUC was achieved graphically based on the relationship between the LHZ areas and landslides in cumulative percentages (Sangeeta et al., 2022). Higher AUC value implies that the model can predict future events better. The prediction rate curve was obtained using the testing datasets, i.e., 8 landslide points (25%). The prediction rate of the study area shows 0.798 and 0.750 for FR and AHP respectively.

Conclusion

In this study, AHP and FR methods were used to generate and assess landslide prone areas as they prove to be reliable according to the literature review. The LHZ map acquired using ten causative factors from both AHP and FR models was classified into five categories: Very Low Hazard zone, Low Hazard zone, Moderate Hazard zone, High Hazard zone, and Very High Hazard zones. Since both models show good performances according to the validation using the AUC and ROC curves, i.e. for FR and AHP models, the success rates are 0.916 and 0.879, and prediction rates are 0.798 and 0.750 respectively, the LHZ maps can be functional in future development planning and be used to scheme mitigation measures within the study area. Overlay the LHZ map using the best technique reveals critical correlation between high population density in Aizawl city area (800-1200 persons/sq. km) and elevated landslide risk. The maps can be used to help organizations, government or individuals in the management of landslides, to identify the landslide prone areas, and to make them aware of the possible adversity before undertaking construction. Buildings or other constructions should be done based on the capability of the land to hold the weight of the construction. All problems related unwise development activities might be solved. Therefore, the work will enable the public or any government undertaking construction works to maintain sustainable development. The study can be improved by collecting more landslide points through detailed field surveys to enhance the accuracy of the LHZ maps.

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Acknowledgements

The authors acknowledge the authorities of North Eastern Hill University and Mizoram University for their support in the present work.

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The Deccan Geographer
Vol. 62, No. 10 December, 2024, pp. 334-342
(ISSN-0011-7269)
UGC Care Listed Geography Journal

REMOTE SENSING BASED ANALYSIS OF LAND USE AND LAND COVER CHANGES IN TANDA BLOCK, AMBEDKARNAGAR DISTRICT, UTTER PRADESH

Shubham Patel and Prof. D. K. Tripathi

Abstract

Ambedkarnagar district is a part of eastern Uttar Pradesh which is divided into nine development blocks namely Bhiti, Katehri, Tanda, Jalalpur, Ramnagar, Jahangirganj, Akbarpur, Bhiaon and Baskhari. My study area Tanda block is situated in the north-west part of Ambedkarnagar district. The river Ghaghra (Saryu) through its north. In this block land is one of the important resources which plays dominant role in determining human economic, social and cultural progress. Land use/Land cover (LULC) Pattern is mainly determined by economic, institutional and physical structure. Agricultural land in this block is ample but that needs proper care to survive and sustain. For this, continuously Remote Sensing based analysis to changing LULC pattern of the study area should be done. The proper utilization of the land is the economic backbone of a region. The main objective of the paper is to outline the changing LULC Pattern in Tanda Block during (2004 to 2024). RS & GIS technique has been used for the study of LULC Pattern. Satellite data of Landsat 7 ETM+(2004) and Landsat 8 OLI/TIRS (2024) has been used for the study. The findings, spanning the decade from 2004 to 2024, reveal notable changes in various land use categories, including a substantial decrease in Water Body, Vegetation and Barren Land while Builtup Area and Agricultural Land has increased.

Introduction

Land is an important natural resource and vital component of our life. Its use and misuse has a large consequence on our life and environment. As we know India has overtaken China as the world's largest populous country in 2023 (WDI, World Bank, 2023). Now a days rapid growth in urbanization and industrialization have increased pressure on land, water and environment. Land use and land cover change are perhaps the most prominent form of global environmental change since they occur at spatial and temporal scales immediately relevant to our daily existence (CCSP, 2003). Technically, land use and land cover change means quantitative changes in areal extent (increase or decrease) of a given type of land use and land cover respectively. Land use and land cover change are a manifestation of forces both anthropogenic and environmental – climate driven factors (Liu et al, 2009). The changes in land use in various spatial and temporal domains are the material expressions, and also indicate environmental and human dynamics and their interactions mediated by land availability (Lambin et al., 2003). Land use and land cover changes, apart from changing the physical dimension of the spatial extent of the land use and land cover classes, also influence many of the secondary processes which lead to the eventual degradation of the ecosystems of the earth (Dregne and Chow, 1992). Land use and land cover changes are critical for understanding environmental dynamics, resource management and urban planning. The loss of a vegetation cover, in turn, leads to many other deleterious effects on the environment, namely, loss of biodiversity, climate change, changes in radiative forcing, pollution of other natural ecosystems with a reduction in their quality, changes in hydrological regimes, and the list continues (Niyogi, et al. 2009). Land use and land cover (LULC) changes are pivotal factors influencing environmental sustainability, socio-economic development and resource management. In recent decades, rapid urbanization, population growth and agricultural expansion have reshaped landscapes across India, particularly in regions like Tanda Block in Ambedkarnagar District, Uttar Pradesh.

This area, characterized by its diverse agricultural practices and emerging urban centers, faces increasing pressures that necessitate a detailed understanding of LULC dynamics. Remote Sensing technology offers powerful tools for monitoring these changes over time, providing a comprehensive view of land transformations that traditional methods may overlook. By analyzing satellite imagery, researchers can effectively capture the spatial and temporal aspects of LULC, enabling informed decision-making for land management and policy formulation. This study aims to utilize remote sensing techniques to assess LULC changes in Tanda Block over the past two decades. By examining the interactions between agricultural land, built-up areas, forest cover, and water bodies, the research seeks to identify trends and driving forces behind these changes. The findings will contribute to a deeper understanding of how local ecological and socio-economic conditions influence land use patterns, ultimately supporting sustainable development strategies in the region. Through this analysis, we aim to address critical questions regarding the implications of LULC changes for food security, urban planning and environmental conservation in Tanda Block. This research not only highlights the utility of Remote Sensing in environmental studies but also emphasizes the importance of integrating technological advancements with local land management practices. Tanda Block, located in the Ambedkarnagar District of Uttar Pradesh, is undergoing rapid transformation due to population growth, urbanization, and agricultural practices. This study employs remote sensing techniques to assess LULC changes over time, providing valuable insights for policymakers and planners.

Study Region

Tanda block is found in the north-west part of Ambedkarnagar district which is situated in the eastern part of the state of Uttar Pradesh. Tanda block shares border with Akbarpur & Katehari block in south and Baskhari block in east, Ayodhya district in the west. River Ghaghra (Saryu) passes through its north. The present study area Tanda block is in Ambedkarnagar District located between 260 28' 35" N to 260 39' 8" North latitude and 820 26' 59" E to 820 47' 58" East longitudes. Total geographical area of the block is 29266.1471Sq. Km. There are 244 inhabited villages with a total population of 272551 inhabitants as per the 2011 census of India.

Objectives

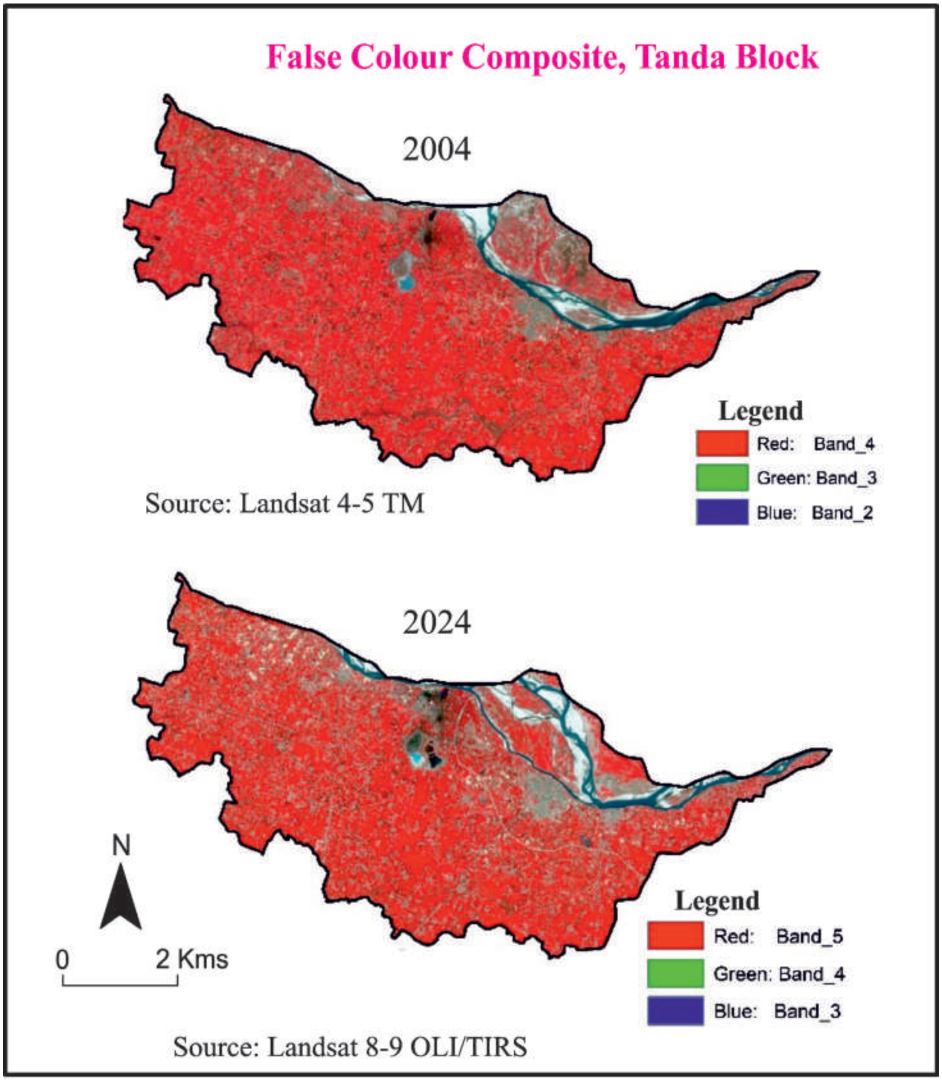
This research work aims to examine the Land use and Land cover changes in the Tanda Block between the time periods from 2003 to 2023.

Database and Methodology

This Research paper is mainly based on the secondary data. Following data or research materials were used in this study-

(1) Landsat4-5TM (Thematic Mapper) data (Band- 4,3,2; Resolution-30m), Path-143, Row-042, Date-12/03/2004.
(2) Landsat8-9 OLI/TIRS (Operational Land Imager/ Thermal Infrared Sensor) data (Band-5,4,3; Resolution-30m) Path-143, Row-042, Date: 19/03/2024.
(3) Survey of India topographical sheets No. 63J/6, 63J/10, 63J/11 and 63J/14.
(4) Arc GIS Version 10.8 (ESRI) Software.

In this research paper LULC changes have been analyzed by comparing the year of 2004 and 2024. For this advanced technology such as remote sensing (RS) and geographic information system (GIS) has been used extensively in this research work for the analysis of spatio-temporal changes in LULC (Fig. 1). The Landsat4-5TM (2004) and Landsat8-9 OLI/TIRS (2024) multispectral data has been downloaded through internet from Earth Explorer of USGS (United States Geological Survey). The above satellite images have used of one to



False Colour Composite, Tanda Block
2004
Legend
Red: Band_4
Green: Band_3
Blue: Band_2
Source: Landsat 4-5 TM
2024
N
0
2 Kms
Legend
Red: Band_5
Green: Band_4
Blue: Band_3
Source: Landsat 8-9 OLI/TIRS

Fig. 1

seven bands which converted to an image by using composite bands. Now extracted the study area by extraction tool & make FCC (False Color Composite) and then created training samples for five classes. Cross check these training sample with Toposheet and Google earth pro. For supervised classification click on Maximum Likelihood classification in classification tool and calculate the area of five LULC Classes. The whole processes were finishing by ArcMap 10.8 software. Finally exported the attribute table in excel sheet and draw Flow chart & table of the study area.

Result and Discussion

This research study shows that between the years 2004 and 2024, there have been impressive changes in various classes of land use and land cover pattern in the study area Tanda block of Ambedkar Nagar district, whose study can effectively contribute to the sustainable development of this block. Remote sensing techniques using satellite imageries coupled with field survey for training data collection were followed for digital change detection in land use/ land cover during the research period. Applying maximum likelihood algorithm based image classification techniques gave good results for digital change detection in land use/ land cover classes. The study area, Tanda block has witnessed remarkable changes in LULC during the research period of 20 years (2004-2024). The spatial analysis of changes in classes of LULC patterns during the research period is given below-

Waterbody

Water is the most essential part of our life and it plays an important role in various human activities such as agricultural, industrial, fishing, energy sources, transportation, forestry and drinking etc. (Kumar S. 2018). With the rapid increase in footprints of industrial activities and also residential, commercial, institutional and other supportive activities, there is a tremendous rise in the water demand in the study area. So the pressure on available water resources has increased. Hence, there has been decrease in the waterbodies in Tanda block between 2004 and 2024. For the sustainable development of the study area, it is noticeable that increasing population continuously has adversely affected the quantity and quality of water sources in the region. Hence excessive exploitation of water resources would create difficulties for the population of the study area. In 2004, waterbody was 10.44% (3051.77ha) of the total area. Next, twenty years waterbody has decreased and it was 7.78% (2277.769ha) from the total area in 2024. Total decrease in waterbody was observed 774.001 ha (-25.36%) during this research period (Table-1 and Fig.1& 2).

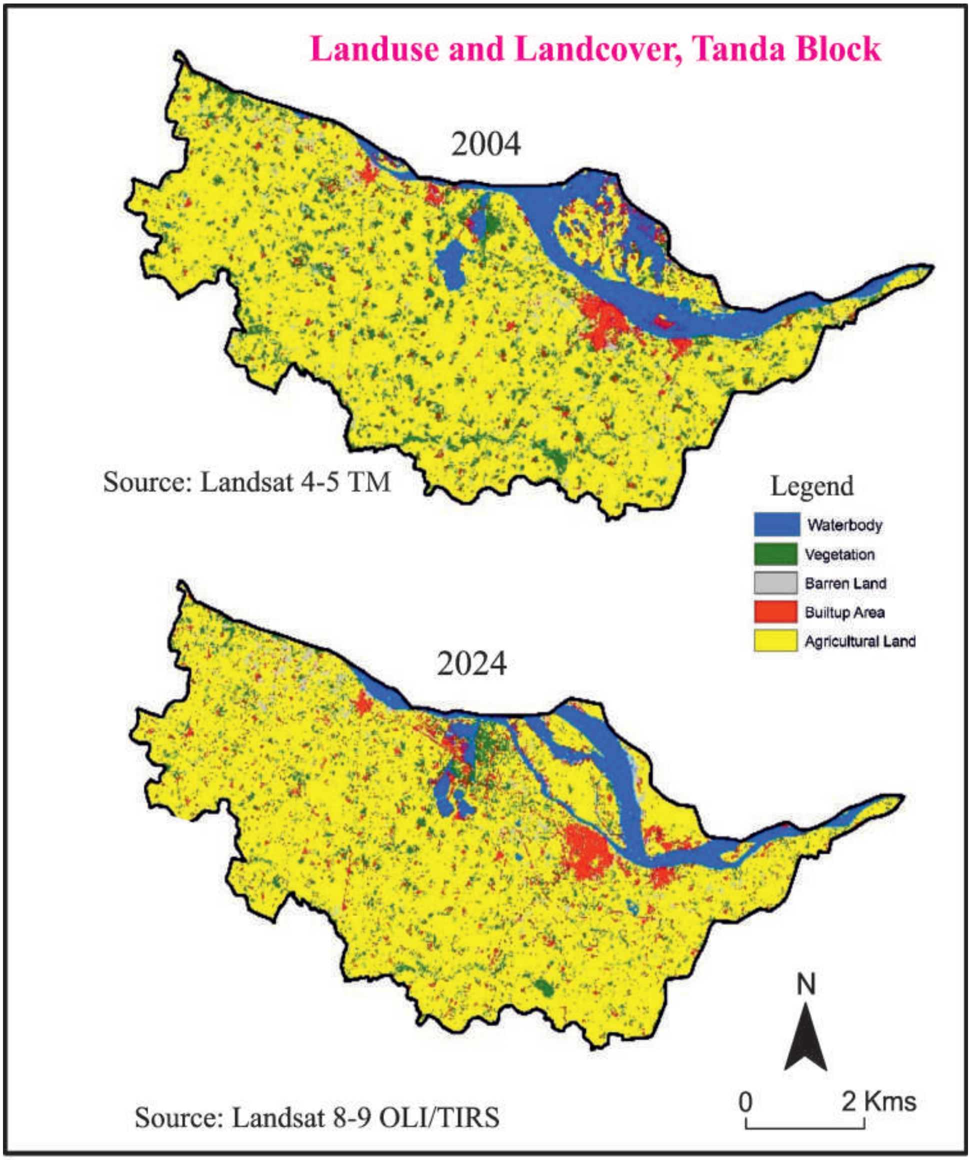

Landuse and Landcover, Tanda Block
2004
Source: Landsat 4-5 TM
Legend
Waterbody
Vegetation
Barren Land
Builtup Area
Agricultural Land
2024
N
0
2 Kms
Source: Landsat 8-9 OLI/TIRS

Fig. 2

Vegetation and Built-up Area

Vegetation is a valuable resource for sustainable development of the study area Tanda block. There has been a negative change in the area of vegetation resources during the research period of the twenty years. In 2004, Vegetation was 10.98% (3209.73ha) of the total area. Next, twenty years Vegetation has decreased and it was 6.94% (2030.173ha) from the total area in 2024. Total decrease in Vegetation was observed 1179.56ha (-36.75%) during this research period (Table-1 and Fig.1&2). With Increasing agricultural activities and also residential, commercial, institutional and industrial activities are responsible for the decrease in vegetation area in the study area. So strong decisions are required for Vegetation protection. If the Vegetation cover decreases continuously, then an emerging deforestation situation will occur which will directly and indirectly impact the human activities and Regional Sustainable Development. During the research period, the major change occurring in the study area is Built-up Area. In 2004, Built-up Area was 4.264% (1246.8ha) of the total area. Next, twenty years Built-up Area has increased and it was 6.61% (1935.877ha) from the total area in 2024. Total increase in Built-up Area was observed 689.08ha (55.27%) during this research period (Table-1 and Fig. 1 and 2). Although, it does not denote the huge jump from 2004 in terms of total area change in Built-up Area but it can alter the natural ecosystem through increasing pressure on existing resources.

Table-1: Tanda Block: Landuse and Landcover, 2004-2024

Sl. No.	LULC Classes	Area, 2004		Area, 2024		Change (2004-2024)	
		In Hectare	In %	In Hectare	In %	In Hectare	In %
1	Waterbody	3051.77	10.44	2277.769	7.78	-774.001	-25.36
2	Vegetation	3209.73	10.98	2030.173	6.94	-1179.56	-36.75
3	Builtup Area	1246.8	4.264	1935.877	6.61	689.08	55.27
4	Barren Land	1274.23	4.358	925.1481	3.16	-349.082	-27.4
5	Agricultural Land	20458.1	69.96	22097.18	75.5	1639.1	8.012
	Total	29240.63	100	29266.1471	100	-	-

Source: Authors

Barren Land and Agricultural Land

One of the most interesting changes was seen in Barren Land. In 2004, Barren Land was 4.358% (1274.23ha) of the total area. Next, twenty years Barren Land has decreased and it was 3.16% (925.1481ha) from the total area in 2024.

Total decrease in Barren Land was observed 349.082ha (-27.4%) during this research period (Table-1 and Fig. 1 & 2). It denotes a good trend and efforts should be made to convert Barren Land into Vegetation and Agricultural Land. The most occupied class in the study area is Agricultural Land. In 2004, Agricultural Land was 69.96% (20458.1ha) of the total area. Next, twenty years Agricultural Land has increased and it was 75.5% (22097.18ha) from the total area in 2024. Total increase in Agricultural Land was observed 1639.1ha (8.012%) during this research period (Table-1 and Fig. 1 & 2).

Conclusion

RS and GIS techniques are very useful and authentic for mapping and monitoring of LULC and their changing pattern over the years. These techniques are very fruitful in Development Planning, Research Utilization and Sustainable Development. This research work has amply demonstrated the utility of RS and GIS techniques for mapping and monitoring of LULC and their changing pattern. This study may also prove to be a better input into sustainable development and planning in the study area. Exploring spatial pattern and changes in LULC can serve as a guiding tool in sustainable development planning and management in the study area.

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Declaration

This is my original article and has not been submitted/published to any journal in India/foreign.

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The Deccan Geographer
Vol. 62, No. 10 December, 2024, pp. 343-354
(ISSN-0011-7269)
UGC Care Listed Geography Journal

ASSESSING THE IMPACT OF CLIMATE CHANGE ON APPLE PRODUCTION IN KUMAUN REGION OF UTTARAKHAND

Nisha Tamta and Dr. Deepak

Abstract

The horticulture sector a component of agriculture has faced many of the severe threats of climate change. Horticulture is an important part of agriculture that has faced numerous severe threats caused by climate change. The present study aims to analyze the impact of climate change on temperature and rainfall trends of apple production 20 years (2001-02 to 2020-21) on climate and apple production data collected in the Kumaun region of Uttarakhand. The data has been analyzed using Karl Pearson's Correlation Coefficient method through statistical tools to establish a cause-effect relationship between rainfall and temperature characteristics on apple production in the study area. It is clear from these results that rainfall distribution is significantly correlated with apple fruit. The study reveals that the total production of apples in 2001-02 was recorded 41526 MT which has decreased to 19971 MT in 2020-21. The rainfall is very high correlated with apple production ($r = 0.99$), and temperature variations are equally low correlated ($r = 0.042$) with apple production. The rising temperature and fluctuating rainfall during winters alter the pattern of blossoming and bearing and Due to excessive rainfall, the fruit flowers fall. Because of this under Kumaun region is being affected the apple production and the quality of fruit is also decreasing. Thus, the consequences of climate change are visible in the production of apple.

Introduction

Climate is characterized as the typical weather patterns observed over an extended period, typically 30 years. Climate change is defined as a long-term change in the climate caused due to natural or human activity. (IPCC, 2007).The climate plays an essential role in crop production, determining the region's suitability for temperate fruits such as apples (Malus domestica) and influencing the production and quality of fruits. Apples are a significant source of vitamins, minerals, antioxidants, and fiber in the human diet. Originating in Europe and Western Asia, Apples have spread across the globe. They belong to the family "Rosaceace" and the genus "Malus". There are more than 8000 varieties/cultivators of apple all over the world. Apples thrive in cool climates and have specific growth characteristics. The chilling requirement refers to the number of effective chilling hours needed to rejuvenate bud growth potential in the spring. (Kumar 2018). Chilling requirements for apples ranges from 1200 to 1500 hours, depending on the different varieties. Below 1000 hours, the growth suffers, resulting in low production of the fruit. At least 1200 chilling hours are required for proper bud and flowering for sparkling deliciousness. (Jindal and Mankotia (2004),) A delay in early cold during December and January negatively impacts the fulfillment of chilling requirements. (Vedwan and Robert, 2001). In the present scenario, climate change has emerged as one of the major factors to bring about changes in maximum and minimum temperature, precipitation patterns, and frequency of extreme weather events. Apple is been widely grown under a large area in the Himalayan regions of India because of the favorable climatic conditions.

However, mountains are among the most fragile environments, subject to extreme weather conditions like rising temperature, irregular precipitation, spring hailstorms, and cold waves, all of which significantly impact the production of temperate fruits. Climate uncertainty and variability have a high impact on horticultural crops. Apple is the most popular horticulture crop in Uttarakhand hills. Apple fruit crop is extensively grown along the North Himalayan ridge, which includes the states of Jammu and Kashmir, Himachal Pradesh, and Uttarakhand. Apple contributes more than half of the area under fruit cultivation and production in Uttarakhand (State Horticulture Mission, Government of Uttarakhand, 2016-2017), but due to significant climate changes, the area and production of apples in Uttarakhand are declining. The apple cultivation in the Kumaun region is under stress due to climate change. Winter chilling is a physiological requirement for low temperatures to allow normal spring growth and insufficient winter chilling results in a significant decrease in both productivity and fruit quality. The entire apple belt in the Uttarakhand Kumaon region is shifting as a result of climate uncertainties such as warmer winters, lack of chilling temperature, precipitation, and prolonged heat stress in summer. Climate changes, along with many other environmental factors, are perceived to be the main causes of the decrease in production and productivity of the apple crop.

Study Region

The Kumaun region lies between 28043’45’’ to 30020’12’’ North Latitudes and 78044’30’’to 80012’45’’ East Longitudes having a total geographical area of 21035 km2 and is situated at the tri-junction of Nepal, Tibet, and India. The Kali and Ramganga River systems are the main river system drains the study area. The Kumaun region has four geological/physiographic zones, the Outer Himalayas, the Lesser Himalayas, the Greater Himalayas, and the Trans-Himalayas. Administratively, the study area is divided into six districts (Almora, Bageshwar, Nainital, Champawat, Pithoragarh, and Udham Singh Nagar), 41 development blocks, 38 tehsils, 6999 villages, and 46 urban centers. The study area's terrain is not equal, so it is divided into three distinct regions: Hilly, Bhabhar, and Tarai. The Kumaun region has a total population of 4228998, which accounts for 41% of Uttarakhand total population, with a population density of 201 per km^2.

Objectives

(1) The present study aims to analyze the trend of apple production from 2001-02 to 2020-21.
(2) To assess the effects of climate change on apple fruit crop production over the 20 years.

Database and Methodology

The present study is entirely based on secondary data compiled from the Statistical Section of Statistical Horticulture Directorate Chaubatia Ranikhet, Kumaun region during the period from 2001-02 to 2020-21. The study is focuses on the area, production, and productivity of apple crops. Climatic data was obtained from the Indian Meteorological Department (IMD). The study examines apple production by applying Karl Pearson’s Correlation Coefficient method and statistical tools to determine the cause-and-effect relationship between rainfall, temperature characteristics, and apple production in the study area. Karl Pearson’s coefficient of correlation method has applied. The correlation coefficient stands as a frequently utilized statistical tool for examining relationships between two variables. It measures only linear relationships and may not capture more complex associations. The Karl Pearson’s coefficient of correlation was measured actual mean method, the formula is-

$$r = \frac{\sum\left(X-\bar{X}\right)\sum\left(Y-\bar{Y}\right)}{\sum\sqrt{\left(X-\bar{X}\right)^2}\sum\sqrt{\left(Y-\bar{Y}\right)^2}}$$

Whereas,

$\bar{X}$= Mean of X Variable, $\bar{Y}$ = Mean of Y variable

In the range of 1 to +0.75, there exists a strong positive correlation, signifying that an increase in one variable corresponds to a positive increase in the other. Within the +0.75 to +0.25 range, the correlation is moderate, and values between +0.25 and <0 indicate a lack of significant correlation, mirroring the same pattern for the negative values. A coefficient of correlation at +1 or -1 denotes a perfect positive or negative correlation, respectively. The value of r if 0 suggest that the variables have no linear relationship. In which, results have been represented through diagrams and tables with the help of MS Excel.

Results and Discussions

As a result, to evaluate the impact of climate change on apple production, this study concentrates on the Kumaun region. The study examined climatic patterns and production trends, as well as the magnitude of the observed changes. The Himalayas, which are highly responsive to climate change, experience rapid change. The delicate ecology of the Himalayas, shaped by its evolutionary history and geological composition, is gradually shifting towards an imbalanced state, resulting in noticeable changes in its resources and temperature. The analysis of apple production trends in the district-wise of Kumaun region. Overall apple production in the Kumaun region in 2001-02 was 43226 Mt under 23458 Ha but has seen a significant decline to 19970 Mt with less than 4879 Ha area in 2020-21. Although the annual average temperature fluctuates roughly the same, the average annual rainfall fluctuates far more. The relationship between production and productivity has not been consistent over the past two decades. The Nainital district was a leading producer of apples in 2001-02, with 38462 Mt observed, while 4734 Mt were observed in 2020-21, indicating a significant decline in production. There is an overall decrease in growth trend from 2001-02 to 2020-21 followed by a fluctuating pattern in subsequent years (Fig. 1). Nainital district productivity decreased to its lowest point in 2001-02 (2.93 Mt/Ha), and it represents at 3.79 Mt/Ha in 2020-21. The Nainital, Almora, and Pithoragarh districts have favorable climatic conditions for growing apples, but changing climatic conditions and unseasonal rainfall are the main causes of decreased apple fruit production in the Kumaun region.

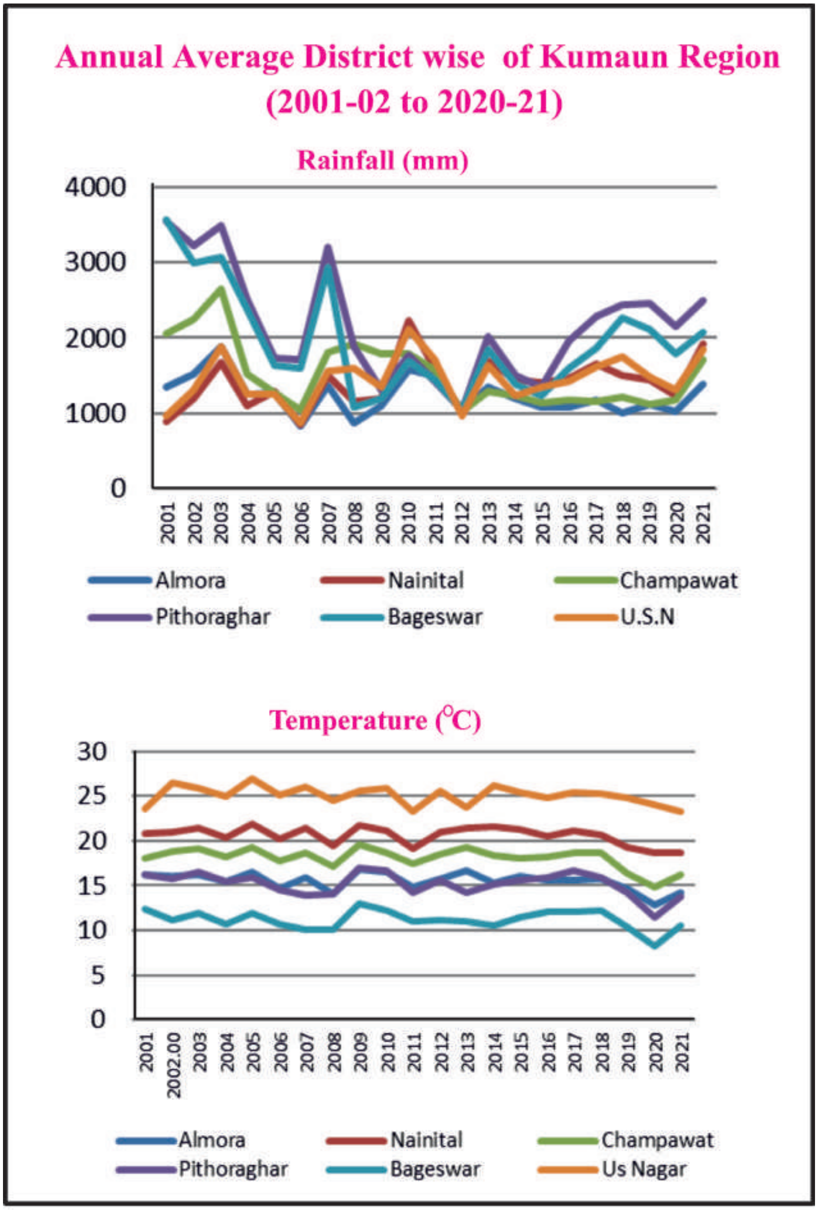
Annual Average District wise of Kumaun Region
(2001-02 to 2020-21)
Rainfall (mm)
4000
3000
2000
1000
0
2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Almora
Nainital
Champawat
Pithoraghar
Bageswar
U.S.N
Temperature (°C)
30
25
20
15
10
5
0
2001 2002.00 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Almora
Nainital
Champawat
Pithoraghar
Bageswar
Us Nagar

Fig. 1

The second highest apple production district, Almora, produced 2430 Mt in 2001-02 but declined with slight fluctuations to 11835 Mt in 2020-21. Pithoragarh district produced 1720 Mt under the 1518 Ha area with 1.13 Mt/Ha productivity declined, and 3044 Mt under 1622 Ha area with 1.88 Mt/Ha productivity in 2020-21. Fig. 1 clearly shows the average annual rainfall in the top three highest-producing districts of the Kumaun region. In 2001-02, Nainital district recorded 889mm of rainfall, and this amount has since increased by 1920 mm. Similarly, rainfall in the Almora district increased from 1355 mm to 1385 mm, while Pithoragarh recorded 3546 mm to a low of 2492 mm relative to 2001-02. Rainfall has increased in Nainital and Almora districts over the last 20 years, resulting in a decrease in production. The graph shows that temperature has a smaller impact on apple production than rainfall. The district-wise temperature distribution shows that the temperature has not made much difference to the production during this trend in 20 years. Also, a lot of fluctuations have been seen in the temperature trend in the trend years. This affects several stages of apple crop development, including flowering, fruiting, fruit set, and fruit size. Rising temperatures and fluctuating winter rainfall disrupt blooming and bearing patterns. Excessive rainfall cause fruit flowers to fall, and insufficient chilling hours (1500-1800 hours) further impact the crop. As a result, apple production and fruit quality in the Kumaun region are being adversely affected.

Relationship between Apple Production with Rainfall and Temperature.

Fig. 2 presents the Annual average Rainfall and annual average Temperature in the different Districts of the Kumaun region. The 2020-21-year annual average temperature that has been noticed is almost the same. However, annual average rainfall has fluctuated. The data analysis conducted in the years from 2001-02 to 2020-21, states that Rainfall distribution is significantly correlated with apple production $r = 0.99$ indicating with very high correlation between rainfall and production, indicating a high tendency for production to rise with a decrease in rainfall. The years with high rainfall tendency for decreased production than usual, and in years with low rainfall, there is a moderate tendency for higher production. Whereas, the coefficient correlation of total apple production with temperature is $r = 0.042$ indicates low correlation. The apple production has decreased in 20 years of variations in Temperature and rainfall. An attempt is made, as per the study objectives, to find out the relationship between Rainfall and Temperature of apple production and their climate change information needs. The Karl Pearson correlation coefficient methods results obtained are presented in Table-1 and 2 and Fig. 2 and 3.

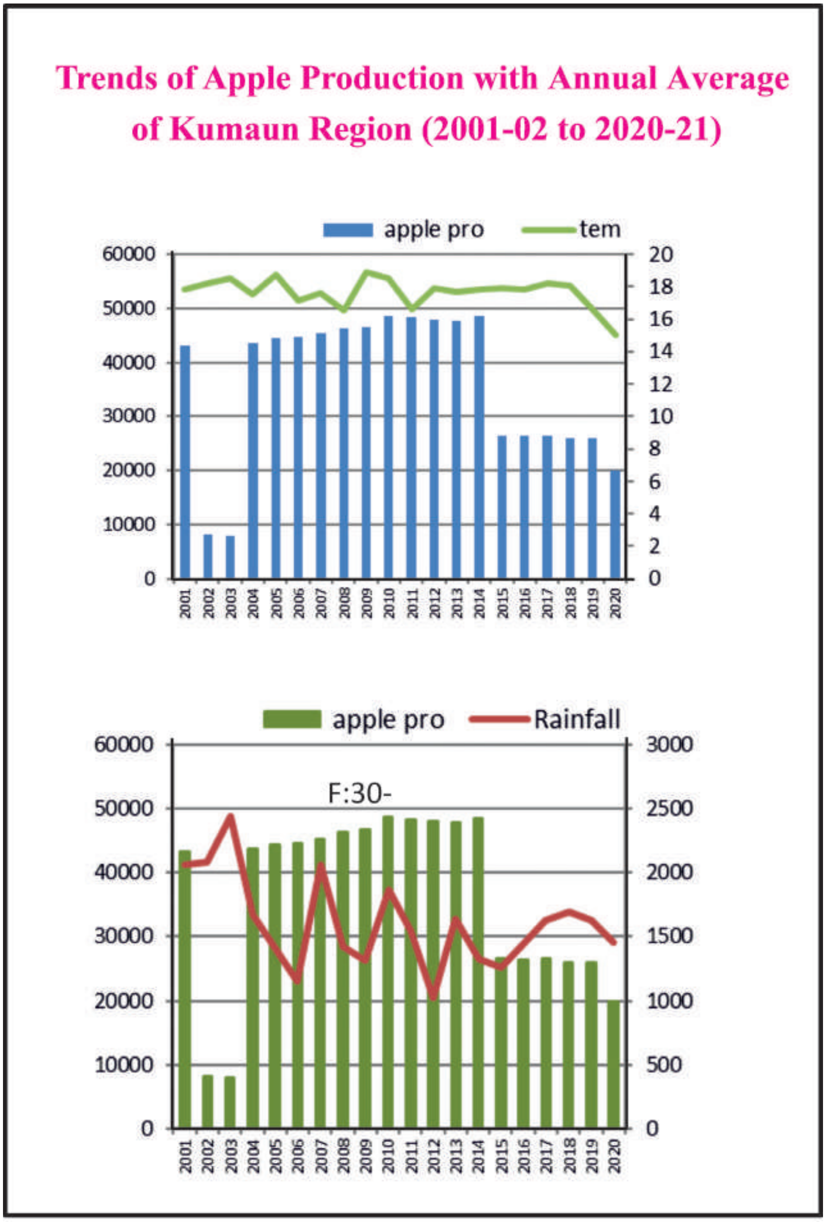
Trends of Apple Production with Annual Average
of Kumaun Region (2001-02 to 2020-21)
apple pro
tem
60000
50000
40000
30000
20000
10000
0
20
18
16
14
12
10
8
6
4
2
0
2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
apple pro
Rainfall
F:30-
60000
50000
40000
30000
20000
10000
0
3000
2500
2000
1500
1000
500
0
2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020

Fig. 2

Table-1: Correlation Analysis between Apple production and Rainfall

Year	Production (X)	Rainfall (Y)	$x\text{-}x^2$	$y\text{-}y^2$	$(x-\bar{x})(y-\bar{y})$	$(x-x^{-})^2$	$(y-y^{-})^2$
2001	43226	2065.593	-679936	-30049.3	20431601525	486156959744.00	902960490.59
2002	8158	2082.52	-715004	-30032.4	21473267539	511398745956.00	901943488.08
2003	7923	2442.327	-715239	-29672.6	21222977149	486025642431.00	880461232.37
2004	43633	1669.373	-679529	-30445.5	20688614440	461247976504.00	926929748.96
2005	44386	1408.122	-678776	-30706.8	20843019871	460527795168.00	942905846.66
2006	44694	1158.008	-678468	-30956.9	21003256531	459875108952.00	958328790.82
2007	45348	2059.215	-677814	-30055.7	20372160006	458709946686.00	903343840.15
2008	46413	1419.315	-676749	-30695.6	20773202393	457828819488.00	942218570.15
2009	46650	1319.848	-676512	-30795	20833218160	456324933312.00	948334858.14
2010	48636	1863.182	-674526	-30251.7	20405566289	455232201192.00	915166078.93
2011	48270	1545.588	-674892	-30569.3	20630980065	455663457180.00	934482469.32
2012	47997	1023.033	-675165	-31091.9	20992136332	456015893310.00	966703820.44
2013	47748	1638.917	-675414	-30476	20583901529	455660625546.00	928785174.10
2014	48523	1330.98	-674639	-30783.9	20768028957	469962972346.00	947649361.16
2015	26548	1258.518	-696614	-30856.4	21494983511	485302412626.00	952115939.85
2016	26503	1449.27	-696659	-30665.6	21363482950	485315649147.00	940380495.31
2017	26529	1625.707	-696633	-30489.2	21239773807	485659785849.00	929590523.92
2018	26009	1698.17	-697153	-30416.7	21205110387	486016031032.00	925177098.89
2019	26018	1623.86	-697144	-30491	21256641407	490226083648.00	929703154.39
2020	19970	1453.348	-703192	-30661.5	21560953855	494478988864.00	940130403.11
N=20	ΣX=723182	ΣY=32134.89	ΣX^2=723162	ΣY^2=32114.8	ΣXY=419142876701	$X\text{-}X^2$=9457630028981.0	$Y\text{-}Y^2$=18617311385

Mean can be calculated by

$$r = \frac{419142876701}{\sqrt{9457630028981}\sqrt{18617311385}}$$

Since r = 0.99, it means that there is a very high Correlation between both Rainfall and Production variables.

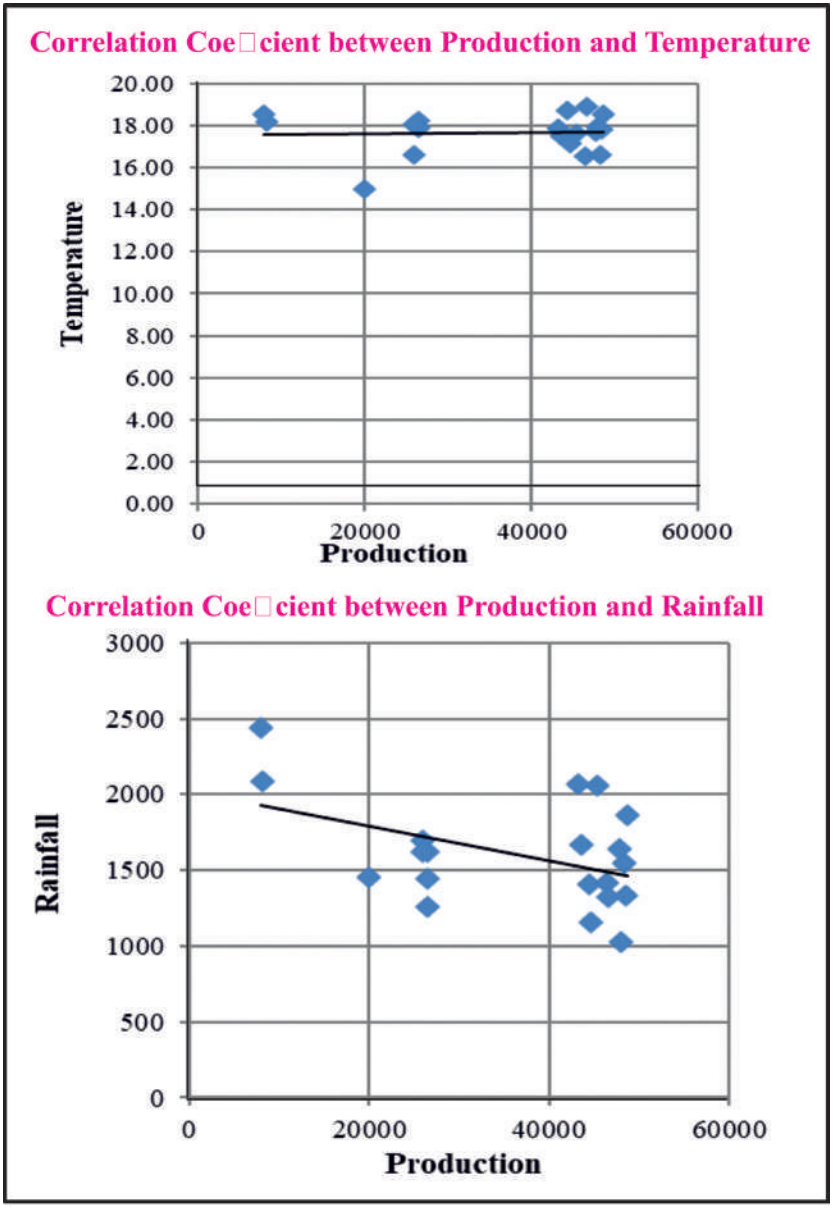
Correlation Coe□cient between Production and Temperature
Temperature
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0
20000
40000
60000
Production
Correlation Coe□cient between Production and Rainfall
Rainfall
3000
2500
2000
1500
1000
500
0
0
20000
40000
60000
Production

Fig. 3

Table-2: Correlation Analysis between Apple production and Temperature

Year	Production (X)	Temperature (Y)	x-x^2	y-y^2	$(x-\bar{x})(y-\bar{y})$	$(x-x^{-})^2$	$(y-y^{-})^2$
2001	43226	17.85	-7066.90	0.19	-1315.62	49941075.61	0.03
2002	8158	18.20	28001.10	0.53	14803.25	784061601.2	0.28
2003	7923	18.51	28236.10	0.84	23845.39	797277343.2	0.71
2004	43633	17.50	-7473.90	-0.16	1218.25	55859181.21	0.03
2005	44386	18.72	-8226.90	1.06	-8682.12	67681883.61	1.11
2006	44694	17.16	-8534.90	-0.50	4307.28	72844518.01	0.25
2007	45348	17.63	-9188.90	-0.04	372.15	84435883.21	0.00
2008	46413	16.55	-10253.90	-1.12	11463.86	105142465.2	1.25
2009	46650	18.93	-10490.90	1.26	-13204.55	110058982.8	1.58
2010	48636	18.53	-12476.90	0.86	-10765.49	155673033.6	0.74
2011	48270	16.60	-12110.90	-1.06	12873.89	146673898.8	1.13
2012	47997	17.93	-11837.90	0.26	-3071.94	140135876.4	0.07
2013	47748	17.69	-11588.90	0.02	-235.64	134302603.2	0.00
2014	48523	17.83	-12363.90	0.16	-2033.86	152866023.2	0.03
2015	26548	17.94	9611.10	0.27	2574.17	92373243.21	0.07
2016	26503	17.85	9656.10	0.18	1717.18	93240267.21	0.03
2017	26529	18.26	9630.10	0.59	5668.92	92738826.01	0.35
2018	26009	18.08	10150.10	0.41	4139.55	103024530	0.17
2019	26018	16.60	10141.10	-1.07	-10839.15	102841909.2	1.14
2020	19970	15.00	16189.10	-2.66	-43138.56	262086958.8	7.10
20	$\Sigma X=723182$	$\Sigma Y=353.34$	$\Sigma X^2=36159.10$	$\Sigma Y^2=17.67$	$\Sigma XY=-10303.04$	X-$X^2=3603260104$	Y-$Y^2=16.09$

Mean can be calculated by

$$r = \frac{^{\circ}-10303.04}{\sqrt{3603260104}\sqrt{16.09}} = 0.042$$

Since r = 0.042, it means that there is a low Correlation between both Temperature and Production variables.

Conclusion

The findings of the study says that the highest apple-producing district in the Kumaun region is Nainital, followed by Almora and Pithoragarh. It has been observed over the last 20 years that the production of year-to-year apples in the districts is decreasing. The main cause of this decrease in production is climate change. Because apples are grown in temperate climates, they require 1800-2500 chilling hours, which can only be found at elevations of 1000-1500 meters. This altitude region includes Nainital, Almora, and Pithoragarh. After studying the data of 20 years, it has become clear that climate change is taking place in these areas, whose direct impact is visible on Apple production. In the study area, there is no significant difference in apple production due to temperature fluctuations over the past 20 years. Whereas, rainfall is increasing year to year and fluctuates. Due to rainfall caused by climate change, it has been observed that fluctuating rainfall during winters alters the pattern of blossoming and bearing. Excessive Rainfall causes fruit flowers to fall and, rainfall and hailstorms during fruit maturation have an impact on fruit quality and increase fruit drop, ultimately affecting production. In the year 2001-02, the total production of Nainital district was 38462 Mt, with rainfall of 889 mm, while the production of apples 4737 Mt with rainfall of 1243 mm in the year 2020-21compare to 2001-02 production has become very low. The Karl Pearson correlation coefficient method has been used to calculate the relationship between temperature, rainfall, and apple production in the Kumaun region. The demonstrated that there is a high positive correlation between production and rainfall, but no correlation between production and temperature.

This demonstrates that rainfall significantly impacts apple production in the Kumaun region, with production decreasing when rainfall is high and increasing when rainfall is low. Due to changing climates, the majority of the Kumaun region's apple production has been replaced by peach, apricot, and other horticulture species. To address the challenges posed by climate change, key strategies will include developing low-chilling cultivars, crops that tolerate high temperatures, and varieties resistant to pests and diseases while maintain good production under stress conditions. Additionally, ongoing research, innovation, and knowledge sharing are crucial for creating new strategies and technologies that enhance the adaptability of fruit production. These efforts may lead to increased fruit production in the region.

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The Deccan Geographer
Vol. 62, No. 10 December, 2024, pp. 355-366
(ISSN-0011-7269)
UGC Care Listed Geography Journal

CLIMATE VARIABILITY AND TREND OF RAINFALL ON SEASONAL CROP BAJRA AND WHEAT IN RAJASTHAN

Dr. Rashmi Singh, Dr. Vipin Chandra Lal and Dr. Teja Ram Nitharwal

Abstract

Climate change can affect agriculture in a variety of ways. Beyond a certain range of temperatures, warming tends to reduce yields because crops speed through their development, producing less grain (Cline, 2008). Climate variability in terms of Precipitation means an increase and decrease in precipitation, precipitation decreases, especially since mid-century, dominate large regions of the tropics and subtropics from North Africa east to Southeast Asia and the Indian subcontinent. Many of these areas with recent decreases are areas where droughts usually accompany El Nino episodes (IPCC 1992). Climate variability affects the rainfall pattern in Rajasthan, which in turn affects the production and yield of crop bajra (pearl millet) (Kharif) and wheat (rabi) seasonally. Trend analysis of rainfall in JJAS and ONDJ period from 1966-2017 with crop bajra and wheat has been done to analyse the pattern of rainfall on two seasonal staple crops of Rajasthan. Monthly Data for rainfall was acquired from the Indian Meteorological Department, Pune for 52 years (1966-2017), The Standard Precipitation Index has been used to know the rainfall deficient years and find out the severe drought years of the state during 1966-2017. Several drought indices are available nowadays, and SPI is one of the most widely used and commonly accepted ones. It is recommended for agricultural and hydrological drought analysis by WMO (World Meteorological Department) because it is very simple, spatially consistent, probabilistic and peculiar with the ability to represent droughts on both spatial and temporal scales, providing better results.

Introduction

Climate is one of the main factors for agricultural production and yield. Climate parameters, mainly rainfall and temperature directly affect cultivation, and any change in them is bound to have a significant impact on crop yield and production.

There is a growing concern all over the world about the effects of climate variability on agricultural production. Several studies have already shown the considerable impact of variations in climate parameters on the average crop yield. Most of the crops and, specifically, the kharif season crops are sensitive to their growing conditions, especially rainfall and temperature, which consequently come under the key factors influenced by climate variation. Kharif crops are usually sown with the beginning of the first rains during the advent of the southwest monsoon season, and they are harvested at the end of the monsoon season (October–November). Rajasthan is ranked one in bajra (pearl millet) production and ranked fourth in wheat production in India during 2015-16. The climate of Rajasthan is generally dry and hot. The state can broadly be divided into Arid, Semi-Arid and Sub-Humid Regions, on the basis of rainfall intensities. However, the climate of Rajasthan can be divided into four seasons, namely summers, winters, monsoon and post-monsoon. The hottest season of Rajasthan, summer, extends from April to June. The temperature in this season ranges from 32° C to 45° C. However, the nights in Rajasthan are pretty cool, with the night temperature falling considerably. Extending from December to March is the winter season. The coldest month of the season is January. The temperature ranges from 10° C to 27° C. During the period of July to September, lies the monsoon.

The temperature ranges from 35° C to 40° C. The state receives approximately 90% of its annual rainfall in this season only. It is the most humid season in Rajasthan and eastern Rajasthan benefits most from this season. From October to November is the post-monsoon season. The total geographical area of Rajasthan is 34.2 million hectare and the cultivable area is 25.633 million hectares (74.9% of total geographical area) and the net sown area is 17.096 million hectare (66.7% of cultivable area) (GoR, 2015-16). The gross cropped area of the Rajasthan is 21.664 million hectares while the area sown more than once is 5.11 million hectares with the cropping intensity of 124.5% (GoR, 2015-16). The net irrigated area is 5.239 million hectare including canals 25.08%, Tube wells 72.7% and others 2.22%. The gross irrigated area is 8.09 million hectare and the percentage of net irrigated sown area is 30.6% in the region (GoR, 2015-16). In India, 80% of annual rainfall comes from southwest monsoon, and very important for the whole country, especially for the low rainfall belts like Rajasthan state. Any kind of deficiency in monsoon, mostly because of climate change causes higher frequencies of droughts in these areas as high as once in every four years.

Study Area

The state of Rajasthan lies between 23° 04' North to 30° 11' north and 69° 29' to 78 ° 17' East, occupying 342,239 km square and 10.4 1% of the land area of the country and 5.67 per cent of total population of India (Government of India 2011). The state physiographical can be divided into four major regions, namely (1) the Western desert with Baron Hills, Rocky Plains and Sandy Plains; (2) the Aravali Hill running Southwest to the Northeast starting from Gujarat and ending in Delhi; (3) Western Plains with rich Alluvial soils; and (4) the South Eastern plateau. Mahi, Chambal and Banas are three major rivers of the state.

Objectives

To analyse the trend of rainfall on wheat and bajra crop season wise and to study drought years due to rainfall in the area (Standard Precipitation Index method has been used to know the rainfall deficient years).

Materials and Methods

In this paper rainfall data of Rajasthan has been analyzed for period of 1966-67 to 2017-18. Monthly and annual rainfall data has been collected from Indian Meteorological Department, Pune. Some missing values were filled in using interpolations between the previous and next month's data. Data of rainfall has been analyzed for seasonal crops Bajra (rabi) wheat (kharif) from 1966-2017. Firstly, trend of seasonal rainfall has been shown with bajra and wheat crop seasonally using anomaly data calculated by raw data. To calculate anomaly values formula was used value of each year minus long term mean. Trend is defined as the general movement of a series over an extended period of time or it is the long-term change in the dependent variable over a long period of time. Trend is determined by the relationship between the two variables of temperature, rainfall and their temporal resolution. Secondly, standard precipitation index calculated and represented in table and chart year wise (1966-2017) of each crop season wise. The Standardized Precipitation Index (SPI) is a widely used index to characterize meteorological drought on a range of timescales. It quantifies observed precipitation as a standardized departure from a selected probability distribution function that models the raw precipitation data. The SPI values can be interpreted as the number of standard deviations by which the observed anomaly deviates from the long-term mean. The SPI can be created for differing periods of 1-to-36 months, using monthly input data. For the operational community, the SPI has been recognized as the standard index that should be available worldwide for quantifying and reporting meteorological drought. The SPI index given below was calculated using the gamma distribution formula (McKee et al., 1993) defined as:

$$g(x) = \frac{x^{\alpha-1} \cdot e^{-\frac{\chi}{\beta}}}{\beta^{\alpha} \cdot \Gamma(\alpha)} \quad for\, x > 0$$

Where, α>0 is a shape parameter, β>0 is a scale parameter, χ is the precipitation amount and $\Gamma(\alpha)$ is the gamma function.

Results and Analysis

The rainfall is a prime source of water for crops in the state and is confined only to 3 to 4 months under southwest monsoon. The behaviour of monsoon is usually erratic and uncertain in Rajasthan. On account of this erratic behaviour, the level of rainfall for the state on average depicts wide monthly as well as yearly variations.

Trend of Rainfall with Bajra Area, Production and Yield Anomaly

Bajra is a Kharif crop of Rajasthan dependent on rainfall in June, July, August and September, in fig. 1. In fig. 1, a trend of monsoon rainfall and bajra has been depicted Production wise, production of bajra and rainfall has been high. Similarly, in Fig. 1, the trend of monsoon rainfall and bajra yield has been depicted. Yield of bajra with monsoon has been high. In conclusion low trend of production and yield with rainfall has been seen. Thereafter bajra production and yield has been growing while rainfall in year 2015, 2016 and 2017 has declined. So, there is positive correlation of rainfall with bajra crop.

Trend of Rainfall with Wheat Area, Production and Yield

The trend of wheat with seasonal rainfall of winter i.e. October, November, December and January has been shown in the following figures. Winter rainfall is very low in Rajasthan; it occurs sometimes with western disturbances. Therefore, wheat is less dependent on rainfall. In Fig. 1, the trend of rainfall with the wheat crops is high.

Fig. 1, depicts the trend of wheat production with rainfall, in this high trend of wheat production and rainfall. Similarly, in Fig. 1, the trend of wheat yield with winter rainfall has been shown, in this figure high trend of wheat yield with winter rainfall. In conclusion, we can say that the wheat crop is a rabi crop i.e. grown in

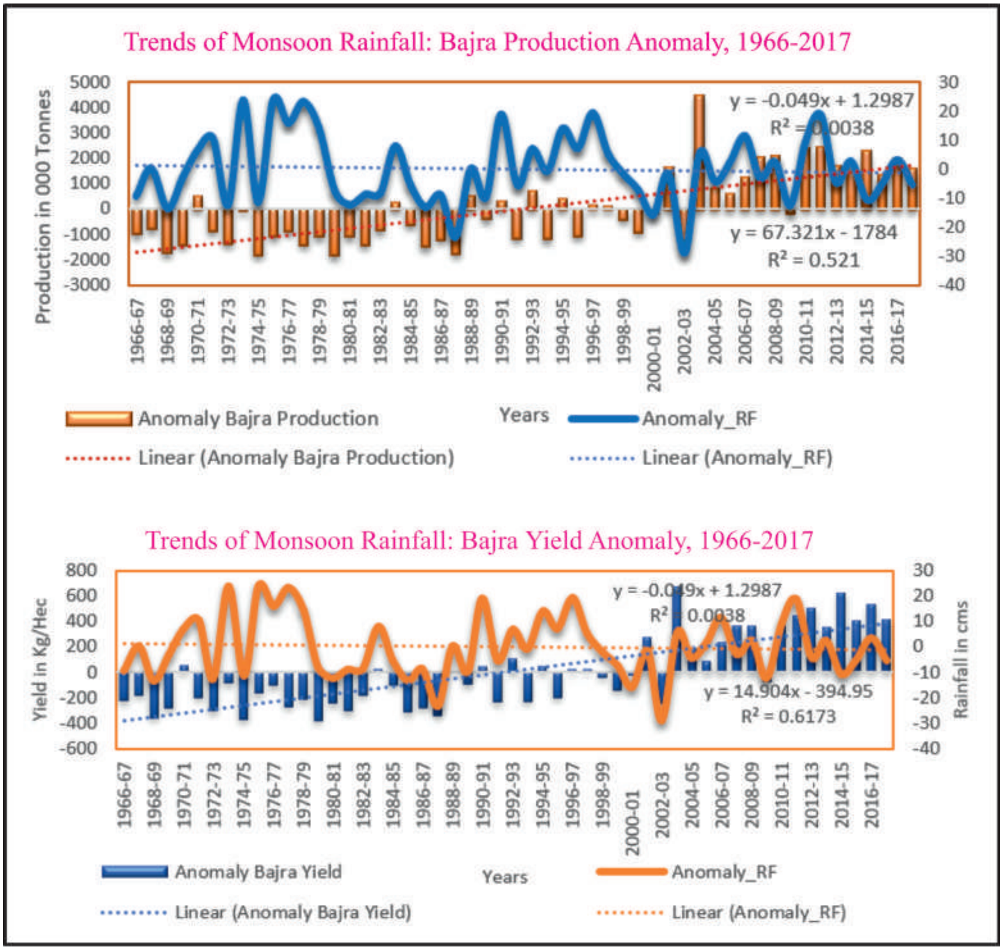
Trends of Monsoon Rainfall: Bajra Production Anomaly, 1966-2017
Production in 000 Tonnes
y = -0.049x + 1.2987
R² = 0.0038
y = 67.321x - 1784
R² = 0.521
Years
Anomaly Bajra Production
Anomaly_RF
Linear (Anomaly Bajra Production)
Linear (Anomaly_RF)
Trends of Monsoon Rainfall: Bajra Yield Anomaly, 1966-2017
Yield in Kg/Hec
Rainfall in cms
y = -0.049x + 1.2987
R² = 0.0038
y = 14.904x - 394.95
R² = 0.6173
Years
Anomaly Bajra Yield
Anomaly_RF
Linear (Anomaly Bajra Yield)
Linear (Anomaly_RF)

Fig. 1

October, November, December, and January, this may vary from region to region. Hence, during the winter season in Rajasthan, rainfall is less as in India Northeast monsoon occurs in this season which is limited to Eastern India only, and Rajasthan receives very little rainfall in this season. Therefore, rabi crops are less dependent on the winter rainfall of the state. Wheat being the rabi crop of the state is also less dependent on rainfall rather it is based on irrigation in the state. Though, some years (1985-86, 1997-98, 1998-99 and 2010-11) show a good relationship between wheat crop and winter rainfall in area, production and yield were due to sufficient rainfall in the state during this season.

The Standardized Precipitation Index (SPI)

The Standardized Precipitation Index (SPI) is a very useful tool as well as an index to monitor meteorological drought which is exclusively based on precipitation data. The SPI gives an easy and flexible way to monitor drought at a different scale (Table-1) ranging from near normal (−0.99) to extreme drought conditions (<−2.0) and it has been recommended by various studies for its suitability to estimate meteorological drought at different time lag. Yield changes under four drought categories (i.e. moderate, severe, extreme and exceptional droughts) are examined to quantify the sensitivity of yield response to the increase in drought severity. Besides SPI, we use a drought index that includes the effects of temperature, given the critical role of temperature in crop growth and yield.

Table-1: Classification Scheme of SPI Value

SPI Value	Category	Probality
>2.0	Extremely wet	2.3
1.5-1.99	Very wet	4.4
1.0-1.49	Moderately wet	9.2
-0.99 to 0.99	Near normal	68.2
-1.0 to -1.49	Moderately dry	9.2
-1.5 to -1.99	Very dry	4.4
<-2.0	Extremely dry	2.3

Source: Authors

SPI index was calculated using rainfall data of JJAS and ONDJ as discussed in methodology, classification scheme and calculated values given below in Table-1. Highlighted years represent severe drought periods in Rajasthan.

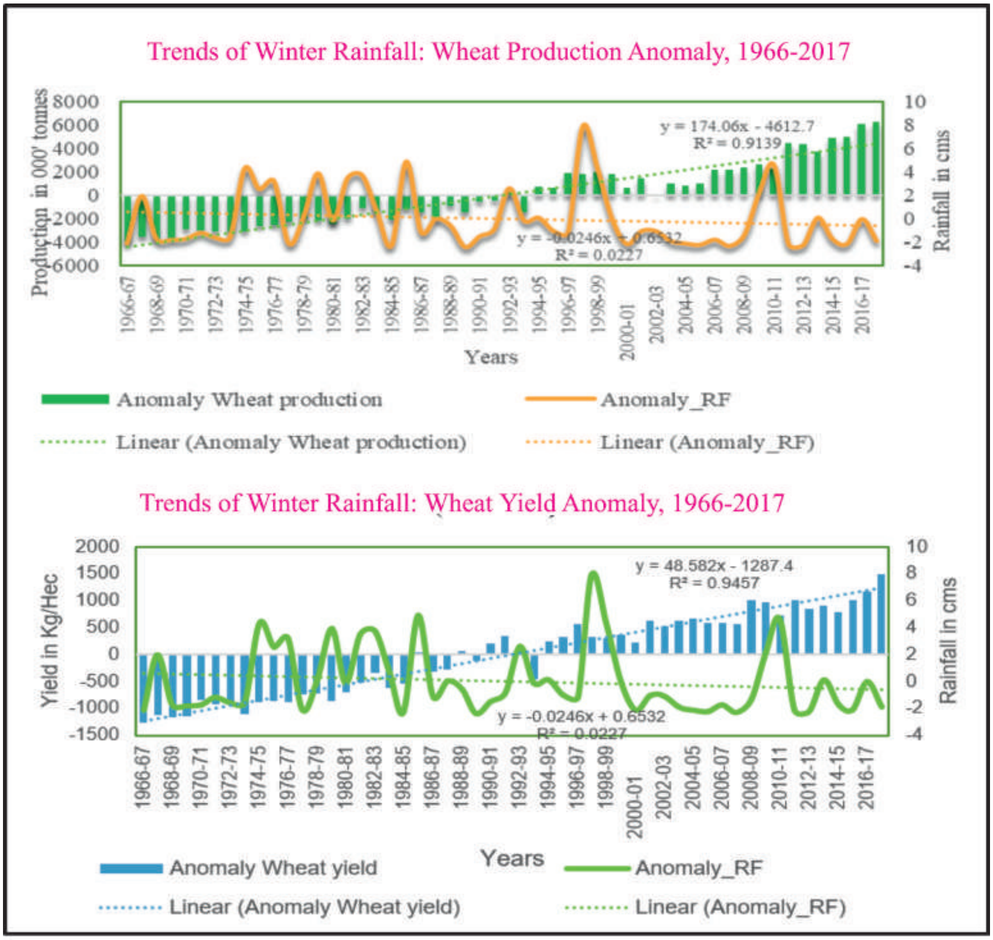
Trends of Winter Rainfall: Wheat Production Anomaly, 1966-2017
Production in 000' tonnes
Rainfall in cms
y = 174.06x - 4612.7
R² = 0.9139
y = -0.0246x + 0.6532
R² = 0.0227
Years
Anomaly Wheat production
Anomaly_RF
Linear (Anomaly Wheat production)
Linear (Anomaly_RF)
Trends of Winter Rainfall: Wheat Yield Anomaly, 1966-2017
Yield in Kg/Hec
Rainfall in cms
y = 48.582x - 1287.4
R² = 0.9457
y = -0.0246x + 0.6532
R² = 0.0227
Years
Anomaly Wheat yield
Anomaly_RF
Linear (Anomaly Wheat yield)
Linear (Anomaly_RF)

Fig. 2

Table-2: Analysis of SPI, of JJAS and ONDJ Season-wise, Rajasthan, 1966-2017

SPI VALUE	CATEGORY	PROBABILITY (%)	SPI RESULT YEARS (JJAS)	SPI RESULT YEARS (ONDJ)	El Nino years
>2.0	Extremely wet	2.3		1997	1965-66, 1969-70, 1972-73, 1976-77, 1977-78, 1982-83, 1986-87, 1991-92, 1992-93, 1994-95, 1997-98, 2002-03, 2004-05, 2006-07, 2009, 2015-mid 2016
1.5-1.99	Very wet	4.4		1966, 1974, 1979, 1981, 1982, 1998, 2010	
1.0-1.49	Moderately wet	9.2	1973, 1975, 1977, 1990, 1996, 2011	1967, 1975, 1976, 1992, 2009	
-0.99 to 0.99	Near normal	68.2	1966-72, 1974, 1976, 1978-86, 1988-89, 1991-95, 1997-98, 2000, 2001, 2003-07, 2009-10, 2012, 2013, 2014-17	1968, 1970, 1971, 1972, 1973, 1978, 1980, 1983, 1986, 1987, 1988, 1990, 1991, 1993, 1994, 1995, 1996, 1999, 2001, 2002, 2008, 2013	
-1.0 to-1.49	dry Moderately	9.2		1969, 2003, 2006, 2011, 2016	
-1.5 to-1.99	Very dry	4.4	1987	1977, 1984, 2000, 2004, 2005, 2012, 2105	
<-2.0	Extremely dry	2.3	2002	1989, 2007	


SPI Index, JJAS Season of Rajasthan, 1966-2017
SPI
Years
SPI Index, ONDJ Season of Rajasthan, 1966-2017
SPI ONDJ
Years

Fig. 3

From the above table and index, it can be found that in the case of JJAS, in the year 2002, only year as per the SPI index came in the range of <-2.0 i.e. extremely dry. As we all know 2002 has been severe drought in Rajasthan history. In the year 2002–2003, India faced one of the worst and most exceptional drought episodes in terms of magnitude, spacing, dispersion and duration. The arid tract of the western part of India is under threat of severe droughts due to paucity, abnormality of rainfall and severe climatic characteristics. In the case of ONDJ season years that come under the index are, in the range of >2.0 i.e. extremely wet. The same data of the SPI index has been represented in Fig. 2 and 3 (SPI ONDJ). In above Table-2, results of SPI, 2002-03 came under extremely dry, and 1986-87 as very dry. Hence, these two years have been a severe drought year and crop production declined in those years drastically. 1987 and 2002-03 have also been the El Nino years. Therefore, scanty rainfall and drought for the above two years have been influenced by El Nino events. The above SPI results are also represented in Fig. 2, season-wise. Global food demand is expected to roughly double by the 2050s. Typically, farmers would be more capable of adapting to the gradual changes in local mean climate conditions than extreme events, calling for the need for an improved understanding of the impacts of climate extremes on agricultural production. Drought, as an extreme weather phenomenon, is one of the major climatic constraints to crop yield. Overall, crop yield variability can be explained by the drought index (i.e. SPI) for the study period. Such a relation holds for all crops but exhibits differentiating strengths.

Specifically, the year-to-year variation of the bajra crop shows the highest correlation with the drought index, followed by wheat. Previous studies have discussed the potential impact of drought on crop production in the United States, China, Australia, South Africa, the Republic of Moldova, Czech Republic and the whole globe. Although these studies have provided valuable insights into the possible impacts of droughts, they are mainly based on deterministic approaches, reporting the overall yield fluctuation associated with drought. Recently, probabilistic methods have been adopted to account for uncertainty from climate data. To date, probabilistic estimation of yield changes under a given drought of specific severity has not been conducted across global agricultural regions. The World Bank Group (WBG) is currently scaling up climate-smart agriculture. In its first Climate Change Action Plan (2016-2020), as well as the forthcoming update covering 2021-2025, the World Bank committed to working with countries to deliver climate-smart agriculture that achieves the triple win of increased productivity, enhanced resilience, and reduced emissions. In 2020, 52 per cent of World Bank financing in agriculture also targeted climate adaptation and mitigation.

Conclusion

In this paper, the climatic parameter rainfall was selected to see the trend and pattern of rainfall from 1966 to 2017. Rainfall pattern season-wise was related to crop seasons, for example, rainfall of monsoon months (JJAS) was correlated with monsoon crop bajra and similarly wheat crop of rabi season with seasonal rainfall of ONDJ. It was found that bajra crop is still dependent on rainfall while the wheat crop is less dependent on rainfall. SPI was calculated seasonally, through which severe drought years in 1987-88 and 2002-03 were found. Rajasthan is a semi-arid and arid state whenever rainfall is below normal and temperature is high drought-like conditions occur which results in crop failure and economic loss of farmers and the state economy. Extreme events like drought also restrict the development of the state in terms of food security, health, transportation and Infrastructure.

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The Deccan Geographer
Vol. 62, No. 10 December, 2024, pp. 367-378
(ISSN-0011-7269)
UGC Care Listed Geography Journal

A GEOGRAPHICAL STUDY ON INTENSITY OF IRRIGATION, INTENSITY OF CROPPING, AND ITS RELATIONSHIP IN THE TUNGABHADRA RIVER BASIN OF KURNOOL DISTRICT, ANDHRA PRADESH

Dr. Y. Sujatha and B. Appanna

Abstract

Irrigation is pivotal in crop production, serving as a critical input that directly influences agricultural outcomes in various regions. Cropping intensity, conversely, serves as a significant indicator reflecting the extent of cultivation in a specific region. The rainfall in the basin is characterized by its erratic nature, insufficiency, and uneven distribution. On average, the basin receives approximately 668 mm of rainfall annually. The present study focuses on analyzing the spatial pattern of the Intensity of Irrigation, the Intensity of the cropping pattern, and the Relationship between the two. Karl Pearson's Product Moment Correlation Coefficient method has been employed to determine this Relationship. Data on irrigation sources and cropping patterns at the Mandal level have been collected from the Chief Planning Office (C.P.O.) and the Directorate of Economics and Statistics (DES-AP). Arc GIS 10.4 has been utilized to prepare maps for this study. The paper reveals that the north and northeastern mandals of the basin enjoy high levels of Irrigation and cropping Intensity compared to the western and southern manuals. A very weak positive correlation exists between the two variables, which indicates that other Irrigation does not solely govern the cropping intensity in various manuals of the basin but also by other natural, sociocultural, economic, political, technological, and infrastructural factors.

Introduction

India's agrarian landscape is characterized by its heavy reliance on agriculture, with approximately 70% of the population directly or indirectly engaged in farming activities. The backbone of this sector is the monsoon season, upon which most crops depend for water. However, the unpredictability and insufficiency of rainfall expose farmers to the vagaries of nature, impacting cropping systems and yields. Given the critical role of agriculture in India's economy, ensuring a continuous and reliable water supply to agricultural fields becomes paramount. Various irrigation methods have been employed nationwide to mitigate the challenges of erratic rainfall. Traditional approaches include canals, tube wells, and tanks, while modern techniques such as lift irrigation, drip irrigation, and sprinklers have gained prominence. These methods aim to provide artificial water application to plants, offering a means to overcome the limitations of natural weather patterns (Krishnaiah, Y.V., 2013). The strategic use of Irrigation helps secure water for crops and contributes to increased cropping intensity, a key indicator of regional agricultural development. Cropping intensity, influenced by factors such as the availability of labor, quality of irrigation water, rainfall patterns, soil moisture retention, and the utilization of high-yielding seeds with shorter growth durations, plays a pivotal role in shaping agricultural outcomes. The dynamic interplay of these elements determines the success of farming ventures and directly impacts the economic growth of different regions. As emphasized by experts like Nag. A.K. (2009) and Jasim. H.R. (2018), the augmentation of cropping intensity signifies a higher level of agricultural development, underscoring the importance of adopting sustainable practices and advanced technologies to overcome the challenges posed by climate variability and water scarcity in Indian agriculture. The studies on the Intensity of Irrigation, Intensity of Cropping patterns, and their Relationship have been widely studied and mapped by various researchers in India. Among those who have studied the Intensity of Irrigation and the Intensity of Cropping patterns are Chanchal Kumar Dey (2018) and Deshmukh. M.S. (2017), Gajraj Negi (2018), Javaid Ahmad Andrabi (2018), Kumar, Sathish (2019), Reshmi Sarkar (2018), Sandipan Ganguly (2016), Sakila Haque (2015), Tarun Kumar Mondal (2021), Vanita Ahlawat (2016).

Study Area

The study area of the Tungabhadra River basin is in the northwestern region of the Kurnool district in Andhra Pradesh, India. It lies between North Latitude 150 15’00" to 160 0’00" and East Longitude 770 0’0" to 780 15'00". The area falls within the Survey of India (S.O.I.) Toposheet Nos. 57E/1 to 57E/16 and 57I/1 to 57I/5. The total area of the basin is 6,934 square kilometers. The basin consists of 30 mandals, with 21 mandals fully covered and nine mandals partially covered.

The basin receives an average annual rainfall of 670 mm and experiences temperatures ranging from 26°C to 46°C in the summer and 12°C to 31°C in the winter. The northwestern portion, which includes Adoni, Peddakadubur, Alur, Aspari, Chippagiri, Halaharvi, Holagunda, Pathikonda, Devanakonda, Krishnagiri, Veldurthy, Kodumur, and Kallur mandals, has a desolate appearance with vegetation mostly limited to small pockets of reserve forests. This portion of the basin covers an area of 41,712 hectares, which accounts for 4.46% of the total geographical area. The terrain in this region slopes from south to North and is drained by the river Hundri, which joins the Tungabhadra at Kurnool. The soils in the northwestern parts traversed by the river Hundri are black cotton, while the southeastern parts are predominantly pure red soils. Geologically, the basin is underlain by the crystalline rock of the Peninsular Gneissic Complex (PGC), which includes the granite gneisses and granite in the western and southern parts of the basin.

Objectives

(1) To assess the degree of Intensity of Irrigation and the level of Intensity of cropping Pattern

(2) To examine the correlation between Intensity Irrigation and the extent of intensity of Cropping Pattern.

Database and Methodology

The research uses secondary data from the Chief Planning Officer (C.P.O.) and the Directorate of Economics and Statistics (DES-AP). The analysis is performed at the Mandal level as the unit of analysis. The data is organized and processed using M.S. Excel, while the spatial distribution maps for the Intensity of Irrigation and Intensity of Cropping are created using Arc GIS 10.3 software. Karl Pearson's Moment of Correlation Coefficient method examines the Relationship between the Intensity of Irrigation and the Intensity of cropping patterns. The provided equations are utilized to calculate the Intensity of Irrigation and the Intensity of cropping patterns.

1). Intensity of Irrigation $= \frac{\text{Net Irrigated area}}{\text{Net sown area}} \times 100$

2). Intensity of Cropping Pattern $= \frac{\text{Gross cropped area}}{\text{Net sown area}} \times 100$

Result and Discussion

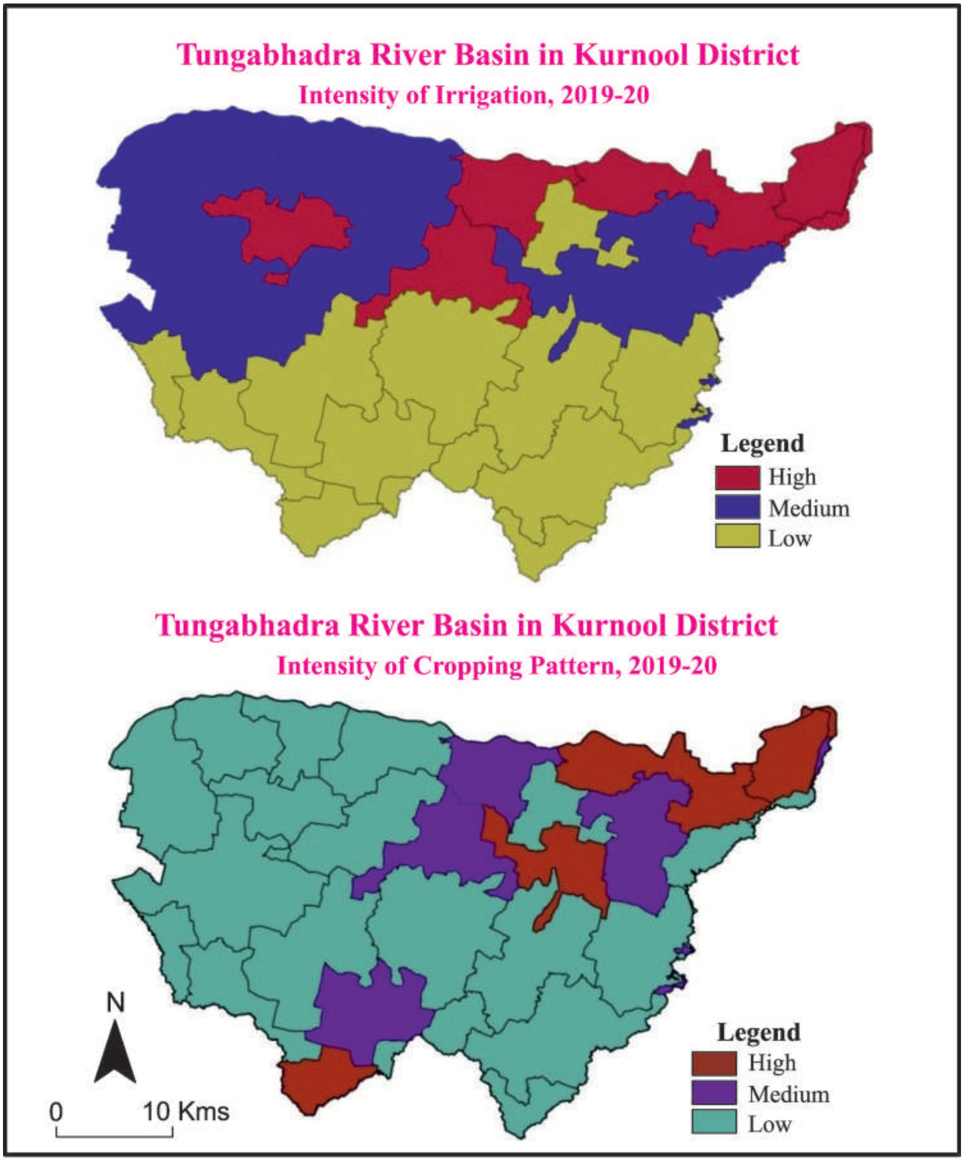
Irrigation Intensity

The irrigation intensity within the Tungabhadra River basin exhibits significant variation across different mandals. Table 1 and Fig. 2 show that the minimum irrigation intensity is recorded at 1.62% in the Alur mandal, while the maximum Intensity is observed at 68.84% in the Pagidayala Mandal. On average, the irrigation intensity in the basin stands at 14.82%. In terms of specific mandals, there are eight mandals, namely Kurnool, C. Belagal, Nandikotukur, Miduthur, Pagidayala, Jupadubunglow, Peddakadubur, and Gonegandla, where the irrigation intensity exceeds 20%. These mandals are predominantly located in the basin's northern and northeastern parts. There are several mandals where the irrigation intensity ranges from 10% to 20%. These include Kallur, Orvakal, Kodumur, Bethamcherla, Adoni, Kowthalam, Kosigi, Yemiganur, Nandvarm, and Mantralayam mandals. These mandals are distributed across the northwestern and eastern parts of the basin. Lastly, there are mandals with less than 10% irrigation intensity. These mandals include Gudur, Dhone, Veldurthy, Krishna Giri, Peapully, Alur, Aspari, Holagunda, Pattikonda, Devanakonda, Tuggali, and Maddikera. The Spatial distribution of the Intensity of the Cropping Pattern is shown in Fig-1 and Table -1.

Table-1: Mandal-wise Intensity of Cropping Pattern in Tungabhadra River Basin

Sr. No .	Mandal	Intensity of Irrigation	Sr. No.	Mandal	Intensity of Irrigation
1	Kurnool	20.16	16	Adoni	11.44
2	Kallur	11.86	17	Kowthalam	11.9
3	Orvakal	13.51	18	Kosigi	18.05
4	Kodumur	11.87	19	Peddakadubur	28.23
5	Gudur	5.63	20	Yemmiganur	16.47
6	C. Belagal	30.65	21	Nandavaram	15.28
7	Dhone	5.44	22	Mantralayam	13.11
8	Bethamcherla	12.18	23	Alur	1.62
9	Veldurthy	6.28	24	Aspari	2.08
10	Krishnagiri	7.59	25	Holagunda	8.2

Contd...



Tungabhadra River Basin in Kurnool District
Intensity of Irrigation, 2019-20
Legend
High
Medium
Low
Tungabhadra River Basin in Kurnool District
Intensity of Cropping Pattern, 2019-20
N
0
10 Kms
Legend
High
Medium
Low

Fig. 1

11	Peapully	7.45	26	Pattikonda	4.47
12	Nandikotukur	24	27	Devanakonda	9.66
13	Miduthur	21.4	28	Tuggali	2.93
14	Pagidayala	68.84	29	Maddikera	3
15	J. Bunglow	30.93	30	Gonegandla	20.51

Source: Authors

Intensity of Cropping Pattern

The Intensity of cropping patterns exhibits significant variation across different mandals in the basin. The minimum Intensity is observed in Mantralayam Mandal, with a value of 101.91%, while the maximum Intensity is found in Nandikotukur Mandal, reaching 134.87%. On average, the Intensity of the cropping pattern in the basin is 110.51%. This information is presented in Table 2 and Fig. 2. Certain mandals, namely Kurnool, Kodumur, Nandikotukur, Pagidayala, and Madikera, demonstrate a cropping pattern intensity exceeding 120%. In contrast, the Intensity of cropping patterns ranges from 110% to 120% in mandals such as Kallur, C. Belagal, Bethamcherla, J. Bunglow, Pattikonda, and Gonegandla. These mandals are distributed across the northern and southern parts of the basin. In contrast, mandals including Orvakal, Gudur, Dhone, Veldurthy, Krishnagiri, Peapully, Miduthur, Adoni, Kowthalam, Kosigi, Peddakadubur, Yemmiganur, Nandavaram, Mantralayam, Alur, Aspari, Holagunda, Devanakonda, and Tuggali exhibit an intensity of cropping pattern below 110%. These mandals are located in the basin's western, southern, and southeastern regions. The Spatial distribution of Intensity of Cropping Pattern is shown in Fig. 2 and Table-2.

Table-2. Mandal Wise Intensity of Cropping Pattern in Tungabhadra River Basin in Kurnool District (2019-20).

Sr. No.	Mandal	Intensity of Cropping Pattern (in %)	Sr. No.	Mandal	Intensity of Cropping Pattern (In %)
1	Kurnool	130.83	16	Adoni	102.04
2	Kallur	114.05	17	Kowthalam	102.15

Contd...

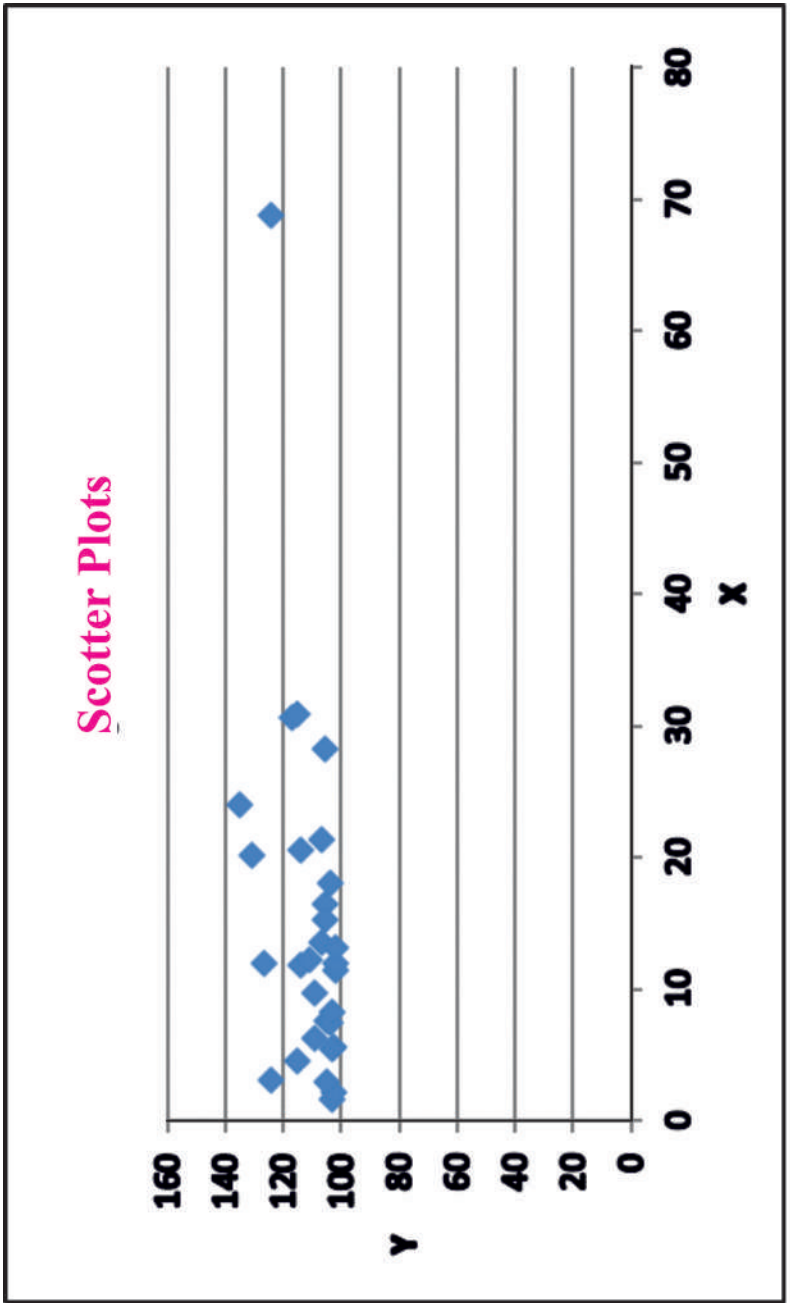

Scotter Plots
Y
160
140
120
100
80
60
40
20
0
0
10
20
30
40
50
60
70
80
X

Fig. 2

3	Orvakal	107.05	18	Kosigi	103.91
4	Kodumur	126.89	19	Peddakadubur	105.93
5	Gudur	102.77	20	Yemmiganur	105.51
6	C.Belagal	117.31	21	Nandavaram	105.49
7	Dhone	103.06	22	Mantralayam	101.91
8	Bethamcherla	110.79	23	Alur	103.33
9	Veldurthy	109.00	24	Aspari	102.64
10	Krishnagiri	105.00	25	Holagunda	103.09
11	Peapully	104.01	26	Pattikonda	115.14
12	Nandikotukur	134.87	27	Devanakonda	109.13
13	Miduthur	106.99	28	Tuggali	104.83
14	Pagidayala	124.49	29	Maddikera	124.26
15	J. Bunglow	115.14	30	Gonegandla	113.82

Source: Authors

Correlation between Intensity of Irrigation and Intensity of Cropping Pattern

Table-3 shows the Statistical Relationship between the Intensity of Irrigation and the Intensity of Cropping. The study also reveals the fact that there exists a weak positive correlation between the Intensity of Irrigation and the Intensity of cropping patterns in the Tungabhadra River basin, with a value of 0.1057. This correlation is very weak, indicating a tendency for high scores in the Y variable (cropping intensity) to be associated with low scores in the X variable (Intensity of Irrigation) and vice versa (Table-3 and Fig. 2). Furthermore, this suggests that the Intensity of cropping patterns in the study area is not solely dependent on Irrigation but is also influenced by various natural, sociocultural, economic, technological, and infrastructural factors. The analysis of the degree of correspondence among different sources of irrigation and cropping intensity in the mandals indicates that surface and groundwater irrigation have nearly equal impacts on the cropping intensity of the Tungabhadra River basin. However, it is essential to note that groundwater resources are limited in this basin due to the prevalence of granite and granitic genesis, resulting in a declining groundwater level day by day.

Table-3: Relationship between Intensity Irrigation and Intensity of cropping pattern

S. No.	Mandal	Intensity of Irrigation	Intensity of Cropping Pattern	X-MX	Y- MY	(X-MX)2	(Y-MY)2	(X-MX) (Y-MY)
1	Kurnool	20.16	130.83	5.33	20.31	28.43	577.50	108.31
2	Kallur	11.86	114.05	-2.97	3.53	8.80	31.09	-10.48
3	Orvakal	13.51	107.05	-1.31	-3.46	1.72	-5.97	4.55
4	Kodumur	11.87	126.89	-2.95	16.38	8.72	142.84	-48.36
5	Gudur	5.63	102.77	-9.19	-7.75	84.49	-654.60	71.22
6	C.Belagal	30.65	117.31	15.82	6.80	250.38	1701.88	107.55
7	Dhone	5.44	103.06	-9.38	-7.46	87.98	-656.20	69.96
8	Bethamcherla	12.18	110.79	-2.64	0.28	6.99	1.95	-0.74
9	Veldurthy	6.28	109.00	-8.54	-1.51	72.93	-110.18	12.90
10	Krishnagiri	7.59	105.00	-7.24	-5.51	52.37	-288.64	39.88
11	Peapully	7.45	104.01	-7.38	-6.50	54.43	-353.84	47.96
12	Nandikotukur	24.00	134.87	9.17	24.36	84.12	2048.92	223.40
13	Miduthur	21.40	106.99	6.57	-3.53	43.23	-152.52	-23.20
14	Pagidayala	68.84	124.49	54.02	13.98	2918.10	40789.01	755.08
15	J.Bunglow	30.93	115.14	16.11	4.63	259.43	1200.86	74.56
16	Adoni	11.44	102.04	-3.38	-8.47	11.45	-97.00	28.67
17	Kowthalam	11.90	102.15	-2.93	-8.36	8.56	-71.58	24.47
18	Kosigi	18.05	103.91	3.22	-6.61	10.39	-68.67	-21.30
19	Peddakadubur	28.23	105.93	13.41	-4.58	179.75	-823.65	-61.43

Contd...

20	Yemmiganur	16.47	105.51	1.64	-5.00	2.69	-13.47	-8.21
21	Nandavaram	15.28	105.49	0.46	-5.02	0.21	-1.04	-2.29
22	Mantralayam	13.11	101.91	-1.72	-8.61	2.95	-25.40	14.79
23	Alur	1.62	103.33	-13.20	-7.18	174.37	-1252.27	94.83
24	Aspari	2.08	102.64	-12.75	-7.87	162.53	-1279.19	100.34
25	Holagunda	8.20	103.09	-6.62	-7.43	43.85	-325.68	49.18
26	Pattikonda	4.47	115.14	-10.36	4.63	107.23	495.98	-47.90
27	Devanakonda	9.66	109.13	-5.16	-1.39	26.64	-36.97	7.16
28	Tuggali	2.93	104.83	-11.89	-5.68	141.46	-804.02	67.60
29	Maddikera	3.00	124.26	-11.82	13.74	139.73	1920.55	-162.47
30	Gonegandla	20.51	113.82	5.68	3.30	32.27	106.59	18.76

Source: Authors

Conclusion

According to the analysis, it can be concluded that the North, Northeastern, and a single Mandal in the Northwestern part of the basin exhibit a high proportion of Intensity of Irrigation. Additionally, the highest percentage of Intensity of the cropping pattern can be observed in the northeastern part of the basin. This suggests no correlation between the Intensity of Irrigation and the Intensity of the cropping pattern in the basin. The study categorizes the Intensity of Irrigation and Intensity of cropping pattern into three categories: high, moderate, and low. High irrigation intensity is found in eight mandals, medium, ten mandals, and low in twelve manuals. On the other hand, the Intensity of cropping pattern is high in five mandals, medium in six mandals, and low in fifteen mandals. The study also suggests that there needs to be a more substantial positive linear relationship between irrigation intensity and cropping intensity in the basin. This further indicates that the cropping intensity in the study area is not solely dependent on Irrigation but is also influenced by other factors such as natural, sociocultural, economic, technological, and infrastructural factors.

Acknowledgment

The author expresses sincere gratitude for the financial support provided by the Department of Science and Technology (DST) under the DST Inspire fellowship. Additionally, the author extends heartfelt thanks to Dr. Y. Sujatha, Assistant Professor and Head; Chandrayudu, Associate Professor; and Mr. Mothinene Joshi Sai Prakash Chowdary, Research Scholars from the Department of Geography at S.V. University. Their valuable suggestions and continuous technical support are needed to complete this work.

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The Deccan Geographer
Vol. 62, No. 10 December, 2024, pp. 379-392
(ISSN-0011-7269)
UGC Care Listed Geography Journal

HEALTH CARE FACILITY SYSTEM: A BLOCK LEVEL ANALYSIS FOR UTTAR DINAJPUR DISTRICT, WEST BENGAL (INDIA)

Shantanu Paul and Sushma Rohatgi

Abstract

Human health has long been seen as one of the most important measures of human progress. The general health of a population is a good indicator of the quality of health-care services offered in that location. In recent years, there has been renewed emphasis on efficiency in resource utilization in the healthcare sector. Most studies in the Indian context have focused on block level analysis. This paper explores block level health system efficiency in the district of Uttar Dinajpur, West Bengal. The analysis estimates the efficiency of the healthcare system at block level using data for 2017-2018 district level data. The goal of this study is to examine several aspects of health-care facilities in order to determine the state of the health-care system in the Uttar Dinajpur district of West Bengal, India. To do so, the Health Care Facility Index (HCFI) is calculated to assess the district's total health care situation. The Raiganj block in Uttar Dinajpur district has a higher average HCFI rating (0.9452) than the Itahar CD block (0.0625). There is a substantial difference in performance between the most efficient block of Raiganj and the least efficient block of Itahar, resulting from inadequate utilization of available health care resources. The study also identifies complementarities of private health care resources and the role of other factors, such as Health Care Institution Population Ratio (HCIPR), Bed Population Ratio (BPR), Doctor Population Ratio (DPR), Doctor Health Care Institution Ratio (DHCIR) and Bed Health Care Institution Ratio (BHCIR). The results suggest a need for better utilization of budgetary resources, both under the state department of health and the National Rural Health Mission, to increase health manpower and improve quality through training and better management resources in order to improve district health systems in Uttar Dinajpur.

Introduction

"Health is a condition of complete physical, mental, and social well-being, not only the absence of sickness or disability," (World Health Organization, 1948).

This definition explains the significance of health, which is seen as a fundamental human right and a key indication of human growth. People's health must be promoted and protected in order to achieve long-term economic and social growth and a higher quality of life. The International Conference on Primary Health Care held in Alma Ata, Russia in 1978 and co-sponsored by WHO and UNICEF, emphasised the need of all people across the globe achieving a level of health that allows them to live a socially and economically productive life (WHO, 1978). Out of the 8 goals, 18 objectives, and 48 indicators, the United Nations (UN) Millennium Development Objectives highlight the importance of health, with 6 goals, 8 targets, and 18 indicators directly related to it. A well-functioning health-care system, according to the World Health Organization (WHO, 1948), requires a financing mechanism, a well-trained and adequately compensated workforce, reliable data on which to base decisions and policies, and well-maintained health-care facilities to deliver quality medicines and technologies. In recent years, there has been renewed emphasis on efficiency in resource utilization in the healthcare sector. A number of studies have focused on the overall performance of the healthcare system and its impact on health outcomes (Murray & Frenk 1999; World Health Organization [WHO] 2000). Some notable studies, for instance, have concentrated on hospitals, nursing homes, Health Maintenance Organizations (HMOs) and district health authorities (Wang et al. 1999; Evans et al. 2001; Jamison et al. 2001; Salomon et al. 2001; Hollingsworth & Wildman 2002; Worthington 2004; Sankar & Kathuria 2004). India had made remarkable progress in the field of health.

The first important initiative was made in 1943, by Health Survey and Development Committee Report and known as Bhore Committee (KPMG and ASSOCHAM 2011). The initiatives' list included the adoption of a National Health Policy in 1983, the 73rd and 74th Constitutional Amendments devolving power to local institutions in 1992, the National Nutrition Policy in 1993, the National Policy on Indian System of Medicine and Homeopathy and Drug Policy in 2002, introduction of a first health insurance schemes for poor people in 2003 and the inclusion of health in the Common Minimum Program of Government in 2004 (Fugazzola, 2015). In order to improve the National Health System of India it is therefore necessary to evaluate and assess the health services in terms of quantity, quality, cost and sustainability (Capolongo et al. 2016b, 2015a). Specific terms of valuation are defined and supervised by the Ministry of Health and Family Welfare (MoH, FW). The aim of the World Health Organization, in collaboration with the Indian Government, is to identify approaches that support the continuous improvements in the field of health. Summarizing the fields of interest of the

Indian Health are International Regulations for healthcare, pharmaceutical, health administration, financial protection, quality, health for mothers and children, morbidity, health services, etc. WHO has to improve the way in which health service delivery institutions in the public and private sectors are managed, introducing professional decision-making in the use of resources (Capasso et al. 2017), serving the client and maximizing quality and productivity (Strategic Priority, 2017). Moreover, most important aspects are the adjusting service delivery structures to meet the health needs of the population in terms of quantities and modalities of networked, affordable and sustainable evidence-based services (Buffoli et al. 2015) and modernizing outdated structures (Strategic Priority, 2015). Currently India has 0.6 beds every 1,000 inhabitants. This scenario is worsened by the scarcity of architectures for health and support staff that leads to have 50% of beds in the public health sector and 30% in the private one not utilized totally. Nevertheless, the situation has, however, slightly improved by NRHM, founded by 85% the Union and the remaining 15% by the states, which aims to bring its action in rural areas strategic, engaging more than 800,000 workers paid according to the performances (Fugazzola, 2015).

The public health is mainly guaranteed by primary levels, with differences between rural and urban areas; in urban areas there is a double level system: a Basic Health Post for few thousand inhabitants and a Health Centre Urban, or Urban Family Welfare Centre, for 100,000 people attached with a general hospital. Instead, in rural areas there is a triple level system: a Sub-Centre for 5,000 inhabitants manages by two professionals (a man and a woman); a Primary Health Care Centre for 30,000 people with medical and paramedical staffs; a Primary Hospital with 30 beds per 100,000 inhabitants and some basic specializations (WHO, India 2012). The last cases include primary care services, which mean that they are specialized, mainly, in vaccinations, prevention of malnutrition, pregnancies, postnatal care and treatment of common diseases (Brahmochary, 2015). These activities are essential although not specialized because they guarantee basic health services in place that would otherwise be totally devoid (Fugazzola, 2015). The current study aims to examine the health-care facility system in the Uttar Dinajpur district of West Bengal on a block wise. Health infrastructure in Uttar Dinajpur District is found to be insufficient due to high population pressure, with only one Community Health Centre for nearly three lakh people, when the national standard is one lakh; Primary Health Centers and Sub Centers are also found in a similar condition, with double or triple the number of patients. This diminishes their efficiency, resulting in poor health care. Although the district of Uttar Dinajpur contains 160 basic health care service facilities and sub-centres, their distribution is not uniform. Because the district is rural in character and the bulk of the inhabitants reside in rural regions, the population relies on these service centres for routine outpatient treatments, preventive, promotional, and emergency care. Simultaneously, these facilities act as focal points for the implementation of national health programmes, mostly through nurse personnel and outpatient department services.

Study Area

After the split of the previous West Dinajpur District, Uttar Dinajpur was formed on April 1, 1992. The district spans an area of 3,140 square kilometers and is situated between 87o 49' East longitudes and 90°00' East longitude, between latitudes 25o 11' North and 26o 49' North. The district is bordered on the east by the Bangladesh districts of Panchagarh, Thakurgaon, and Dinajpur, on the west by the Bihar districts of Kishanganj, Purnia, and Katihar, on the north by Darjeeling district and Jalpaiguri district, and on the south by Malda district and Dakshin Dinajpur district. The region is divided into 2 sub-micro regions i.e. (a) Islampur-Goalpokhar Plain (b) Sudhani Mahananda-Gamari Plain. Uttar Dinajpur comprises of 2 sub-divisions namely Raiganj and Islampur with 9 C.D blocks namely Chopra, Islampur, Goalpokhar I, Goalpokhar II, Karandighi, Raiganj, Hemtabad, Kaliyaganj and Itahar. Uttar Dinajpur district has 4 municipalities and 98 Gram Panchayats covering 1,494 villages during 2011 Census. The total population of Uttar Dinajpur district as per Census 2011 is 30, 07134 out of which 26, 44,906 reside in rural areas and 3,62,228 are from urban areas. In the 2011 Census, the district's sex ratio was 939, with rural at 941 and urban at 921, which is lower than the total and rural. The effective literacy rate is 60.13 %, which is much lower than the national and state averages.

Objectives

To determine the block wise disparities in health care facilities in Uttar Dinajpur District by using Health Care Facility Index (HCFI).

Database and Methodology

The research was carried out using secondary data from the Census of India, 2011, and the Uttar Dinajpur district Statistical Handbook, 2015. The total population of the municipalities of Raiganj, Kaliaganj, Dalkhola, and Islampur has been added to the populations of the corresponding C.D blocks in Uttar Dinajpur. All the hospitals including rural hospitals, Block Primary Health Centers (BPHC), Primary Health Centers (PHC), Sub-Centres (SC) other clinical departments of Govt. of West Bengal including State Govt. Undertakings, local bodies, and Govt. of India including Central Govt. undertaking, N.G.O. / Private Bodies (Nursing Homes) have been considered as Health Care Institutions (HCI). Total number of beds and total number of doctors of each C.D blocks have been collected from District Statistical Handbook of Uttar Dinajpur, 2015.

In the present study, five dimensions have been selected to measure the extent of Health Care Facility System. At first, Health Care Facility System of Uttar Dinajpur district has been analyzed on the basis of secondary data collected from District Statistical Handbook, Uttar Dinajpur, 2015. Five basic dimensions of Health Care Facility System have been identified and calculated using the following formula:

$$HCIPR = \frac{\text{Health Care Institution (HCI)} \times 1,00,000}{\text{Total Population}} \qquad (1)$$

$$BPR = \frac{\text{Number of Bed in HCI} \times 10,000}{\text{Total Population}} \qquad (2)$$

$$DPR = \frac{\text{Number of Doctor in HCI} \times 1,00,000}{\text{Total Population}} \qquad 3)$$

$$DHCIR = \frac{\text{Number of Doctor in HCI}}{\text{Health Care Institution (HCI)}} \qquad 4)$$

$$BHCIR = \frac{\text{Number of Bed in HCI}}{\text{Health Care Institution (HCI)}} \qquad (5)$$

Deprivation Method

The deprivation indicator I^{ij} for the j^{th} district (j = 1, 2, 3 …6) with respect to the i^{th} indicator (i =1, 2, 3 ….18) is given by-

$$Iij(Dimension\ Index) = \frac{Actual\ Value - Minimum\ Value}{Maximum\ Value - Minimum\ Value}$$

Health Care Facility Index (HCFI)

Considering all the five dimensions, i[th] C. D. Block can be represented by a point (d_1, d_2, d_3) in three-dimensional Cartesian space like $0 \leq d_1, d_2, d_3 \leq 1$. In the three-dimensional Cartesian space, the point '0' would indicate the worst condition whereas '1' would indicate the ideal or perfect condition. HCFI is measured by the Normalized Inverse Euclidean Distance of the point (d_1, d_2, d_3) from the best or perfect point (1, 1, and 1).

Therefore, taking into account the equal weight for each dimension we can explain the formula for calculation of HCFI as follows-

$$HCFI = 1 - \sqrt{\frac{(1-d_1)^2 + (1-d_2)^2 + (1-d_3)^2 + (1-d_4)^2 + (1-d_5)^2}{5}}$$

The value of HCFI ranges from '0' to '1'. The value '0' indicates the worst health care facilities system and '1' indicates the perfect health care facilities. On the basis of the HCFI values, the C. D. Blocks are classified into three categories-

(1) $0.5 < HCFI \leq 1.0$ indicates 'High' or 'Very Good' health care facility system;
(2) $0.1 < HCFI \leq 0.5$ indicates 'Moderate' health care facility system and
(3) $0 < HCFI \leq 0.1$ 'Low' or 'Poor' health quality facility system.

Result and Discussion

The table provides various health-related ratios for different Community Development (C.D.) Blocks, which help in assessing the distribution and efficiency of healthcare resources in these areas. Below is an explanation of each metric and the interpretation of the data (Table-1). Health Care Institution Population Ratio (HCIPR) represents the number of healthcare institutions available per unit of the population. A higher HCIPR indicates better accessibility to healthcare facilities for the population. Example: Raiganj has the highest HCIPR (3.02), showing relatively good availability of healthcare institutions, whereas Goalpokhar-I has the lowest (0.61), indicating poor healthcare accessibility (Fig. 1). Bed Population Ratio (BPR) indicates the number of hospital beds available per unit of the population. A higher BPR suggests better hospitalization facilities and readiness to handle inpatient care. Example: Raiganj stands out with the highest BPR (13.71), highlighting better hospital infrastructure. Goalpokhar-I (1.23) and Chopra (1.76) have low BPRs, showing limited inpatient facilities. Doctor Population Ratio (DPR) indicates the availability of doctors per unit of the population. A higher DPR suggests better access to medical expertise for the population. Example: Islampur has a remarkably high DPR (12.32), implying a greater concentration of doctors. Itahar (0.99) has the lowest DPR, showing a potential shortage of medical professionals (Fig. 1).

Doctor Health Care Institution Ratio (DHCIR) measures the average number of doctors per healthcare institution. A higher DHCIR suggests a better staffing level of doctors at healthcare institutions. Example: Islampur (4.22) and Kaliaganj (3.67) have higher DHCIR values, indicating well-staffed institutions. Itahar (0.75) and Chopra (1.00) reflect fewer doctors per institution, potentially straining healthcare delivery. Bed Health Care Institution Ratio (BHCIR) indicates the average number of beds available per healthcare institution. A higher BHCIR signifies larger or better-equipped healthcare institutions. Example: Raiganj (45.40) has the highest BHCIR, showing that its institutions are well-equipped. In contrast, Chopra (12.50) and Karandighi (13.00) have relatively low BHCIRs, suggesting smaller or less-equipped facilities (Fig. 1).

Blockwise Insights

Chopra: Low HCIPR (1.41) and DPR (1.41), indicating limited healthcare access and doctor availability. BHCIR (12.50) is low, suggesting small healthcare institutions. Islampur: High DPR (12.32) and moderate HCIPR (2.92), showing good doctor availability but less accessibility to healthcare institutions. BHCIR (29.67) indicates relatively well-equipped facilities. (1) Goalpokhar-I: Lowest HCIPR (0.61) and low BPR (1.23), highlighting poor healthcare accessibility and infrastructure. BHCIR (20.00) indicates moderate healthcare institution size. Goalpokhar-II: Moderate HCIPR (1.03) and BPR (1.58), reflecting a slight improvement over Goalpokhar-I but still below par. BHCIR (15.33) suggests smaller healthcare institutions. Karandighi: Moderate HCIPR (1.09) but low BPR (1.41) and DPR (2.44), indicating limited infrastructure and doctor availability. BHCIR (13.00) suggests small healthcare institutions. Raiganj: Best-performing block in HCIPR (3.02), BPR (13.71), and BHCIR (45.40), indicating excellent healthcare access and infrastructure. High DPR (11.62) and DHCIR (3.85), showing good doctor availability and staffing levels. Hemtabad: Moderate HCIPR (2.11) and BPR (3.24), indicating relatively good healthcare access and infrastructure. BHCIR (15.33) and DHCIR (1.00) suggest smaller institutions with limited staff. Kaliaganj: HCIPR (1.34) is slightly above average, and BPR (3.84) is relatively good (Table-1 and Fig. 1). High DHCIR (3.67) and BHCIR (28.70) reflect well-staffed and equipped institutions. Itahar: Moderate HCIPR (1.32) but low DPR (0.99), highlighting poor doctor availability. BHCIR (13.00) indicates smaller healthcare institutions.

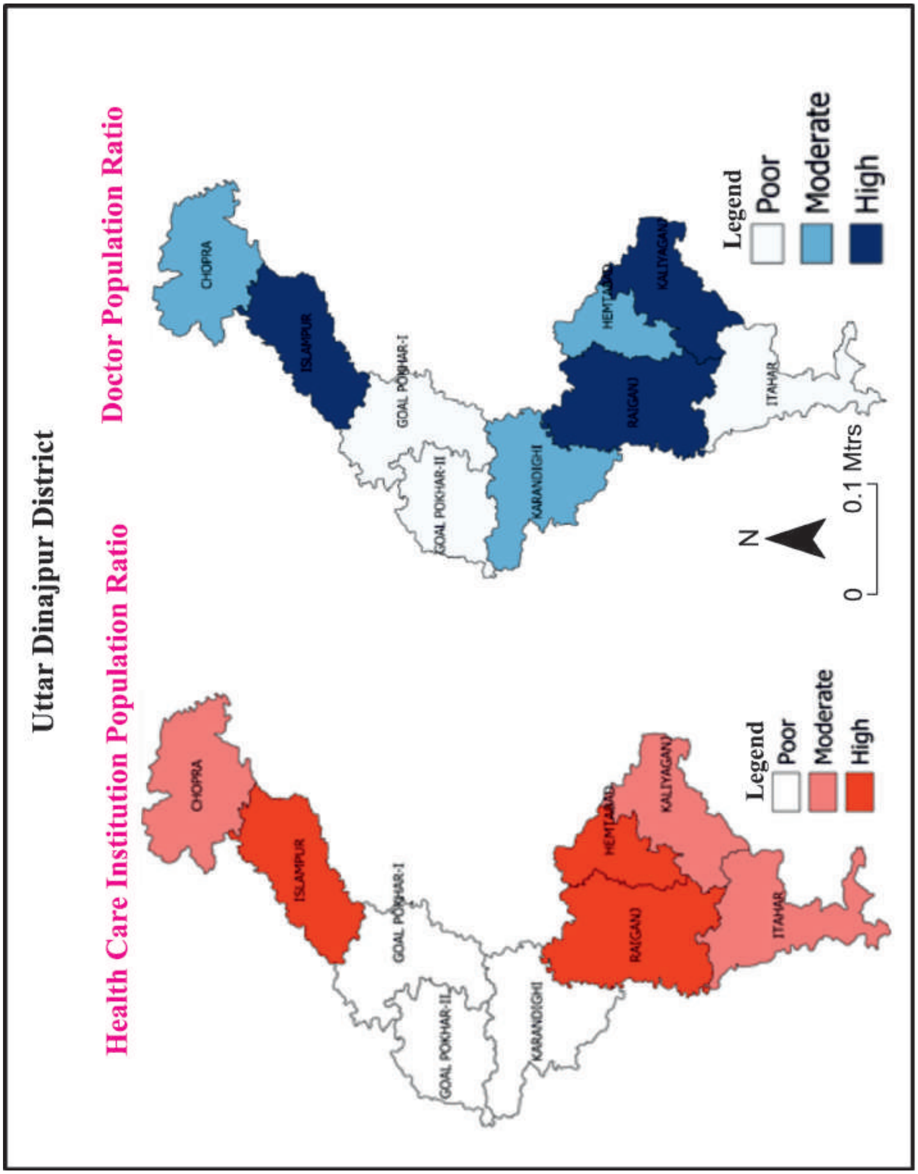
Uttar Dinajpur District
Health Care Institution Population Ratio
Doctor Population Ratio
CHOPRA
ISLAMPUR
GOAL POKHAR-I
GOAL POKHAR-II
KARANDIGHI
RAIGANJ
HEMTABAD
KALIYAGANJ
ITAHAR
Legend
Poor
Moderate
High
N
0
0.1 Mtrs

Fig. 1

Table-1: Block Level Health Care Facility Dimensions of Uttar Dinajpur District

Sl. No.	C.D Blocks	Health Care Institution Population Ratio (HCIPR)	Bed Population Ratio (BPR)	Doctor Population Ratio (DPR)	Doctor Health Care Institution Ratio (DHCIR)	Bed Health Care Institution Ratio (BHCIR)
1	Chopra	1.41	1.76	1.41	1.00	12.50
2	Islampur	2.92	8.65	12.32	4.22	29.67
3	Goalpokhar-I	0.61	1.23	1.23	2.00	20.00
4	Goalpokhar-II	1.03	1.58	1.37	1.33	15.33
5	Karandighi	1.09	1.41	2.44	2.25	13.00
6	Raiganj	3.02	13.71	11.62	3.85	45.40
7	Hemtabad	2.11	3.24	2.11	1.00	15.33
8	Kaliaganj	1.34	3.84	4.91	3.67	28.70
9	Itahar	1.32	1.71	0.99	0.75	13.00

Source: Computed by Authors, 2024

Raiganj is the most well-equipped block in terms of healthcare institutions, hospital beds, and doctors. Islampur excels in doctor availability but needs more institutions to balance accessibility. Goalpokhar-I and II require significant improvements in healthcare infrastructure and staffing. Chopra and Karandighi have limited facilities and small institutions, indicating the need for upgrades. Kaliaganj and Hemtabad have moderate setups but could benefit from more doctors and better infrastructure (Fig. 1). Itahar faces challenges in doctor availability and institutional capacity. There are some recommendations are namely, (a) Increase Healthcare Institutions in Underserved Blocks: Priority: Goalpokhar-I, Goalpokhar-II, Chopra, and Karandighi. (b) Enhance Doctor Availability: Focus: Itahar, Chopra, and Goalpokhar-II to meet minimum standards. (c) Upgrade Hospital Infrastructure: Invest in facilities in Goalpokhar-II, Chopra, and Karandighi to increase BHCIR and BPR. (d) Balance Resource Distribution: Blocks like Raiganj and Islampur should act as benchmarks for resource planning. These interventions would help bridge the disparities and ensure equitable healthcare delivery across all blocks. The data (Table-1) highlights significant disparities in healthcare resources across Community Development (C.D.) Blocks.

Raiganj emerges as the best-equipped block with the highest Health Care Institution Population Ratio (HCIPR), Bed Population Ratio (BPR), and Bed Health Care Institution Ratio (BHCIR), indicating excellent accessibility and infrastructure. Islampur stands out with the highest Doctor Population Ratio (DPR) and Doctor Health Care Institution Ratio (DHCIR), reflecting well-staffed institutions. In stark contrast, Goalpokhar-I and Itahar face severe shortages, with Goalpokhar-I recording the lowest HCIPR (0.61) and BPR (1.23), and Itahar struggling with the lowest DPR (0.99) and DHCIR (0.75). Chopra also lags with the lowest BHCIR (12.50), indicating smaller, under-equipped facilities. These variations call for urgent interventions in underperforming blocks to improve healthcare access, infrastructure, and staffing, while leveraging successful models from Raiganj and Islampur for equitable development. After the block wise calculation of Health Care Facility Index (HCFI) of Uttar Dinajpur district (Fig. 2), we have placed each block according to their rank. Table number 4 portrays the rank wise distribution of each block of Uttar Dinajpur district.

In Uttar Dinajpur district, Raiganj block and Islampur block get the first and second position with HCFI value of 0.9452 and 0.7189 respectively. Thus, it can be stated that Raiganj and Islampur block have the perfect condition of health care facilities. Raiganj block gets the first position due to the good health care facilities of Raiganj Municipality which has been added with this Block. Kaliaganj, Hemtabad, Karandighi and Goalpokhar-I follow respectively with the 3rd, 4th, 5th and 6th position. These four blocks are considered under the medium or moderate condition of health care facilities. Whereas, rest of the three blocks of this district fall under very poor condition of health care facilities. The last three blocks are in this list are Goalpokhar-II, Chopra and Itahar. In Uttar Dinajpur district, Raiganj block has the maximum density of Health Care Institution Population Ratio (HCIPR) with 3.02, on the other hand Goalpokhar –I have the lowest density of HCIPR with 0.61. Thus, highest density of health care institution indicates the good condition of health care where lowest density indicate the worst condition of health. In case of bed population ratio, the highest density is found in Raiganj block where Goalpokhar-I has the lowest position. Another important dimension is doctor population ratio, where Islampur block have the first position and Itahar has worst condition. Thus, it can be started that, population pressure is higher in Itahar than Islampur block. Doctor health care institution ratio is higher in Islampur block, where Itahar block have the 9th position. Bed health care institution ratio is the last indicator, where again Raiganj block have the 1st position and Chopra block has the 9th position (Table-2).

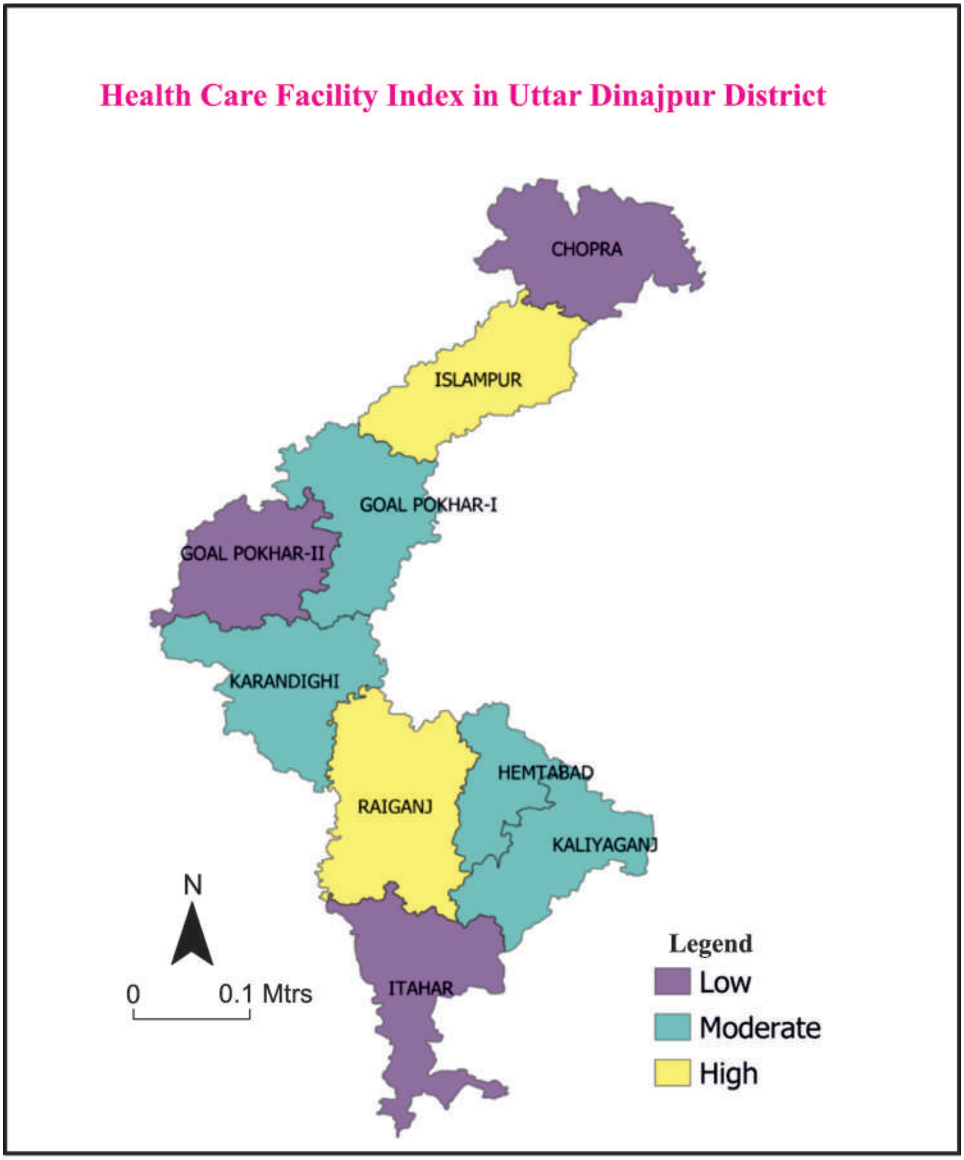
Health Care Facility Index in Uttar Dinajpur District
CHOPRA
ISLAMPUR
GOAL POKHAR-I
GOAL POKHAR-II
KARANDIGHI
RAIGANJ
HEMTABAD
KALIYAGANJ
ITAHAR
N
0
0.1 Mtrs
Legend
Low
Moderate
High

Fig. 2

Here both the government as well as the private health services exists simultaneously and both of them are widely utilized by different sections of the population depending upon their health needs and health resources (Fig. 2). Though these health care facilities provide both preventive as well as the curative health needs, the urban community in India perceives the curative health care needs better than the preventive health care needs (Yesudian, 1988).

Table-2: Health Care Facility Index (HCFI) of Uttar Dinajpur District

Sl. No.	Block Name	HCFI	Rank	Remarks
1	Raiganj	0.9452	1	High
2	Islampur	0.7189	2	High
3	Kaliaganj	0.3958	3	Medium
4	Hemtabad	0.1809	4	Medium
5	Karandighi	0.1438	5	Medium
6	Goalpokhar-I	0.1095	6	Medium
7	Goalpokhar-II	0.0956	7	Low
8	Chopra	0.0884	8	Low
9	Itahar	0.0625	9	Low

Source: Computed by Authors, 2024

The correlation matrix provides insights into the relationships between healthcare resource variables in the blocks of Uttar Dinajpur district. The Health Care Institution Population Ratio (HCIPR) shows a strong positive correlation with both Bed Population Ratio (BPR) ($r = 0.896$, $p < 0.01$) and Doctor Population Ratio (DPR) ($r = 0.875$, $p < 0.01$), indicating that as healthcare institutions increase, the availability of beds and doctors also improves. Similarly, BPR and DPR are highly correlated ($r = 0.931$, $p < 0.01$), reflecting the intertwined nature of infrastructure and staffing. Bed Health Care Institution Ratio (BHCIR) correlates significantly with most variables, particularly with BPR ($r = 0.928$, $p < 0.01$) and DPR ($r = 0.870$, $p < 0.01$), suggesting that better-equipped healthcare facilities tend to have more beds and doctors. However, the Doctor Health Care Institution Ratio (DHCIR) has weaker correlations, particularly with HCIPR ($r = 0.577$), indicating variability in the staffing levels of doctors across institutions. These findings underscore the interconnectedness of healthcare metrics and the need for a balanced approach in resource distribution.

Conclusion

Health care facility is one of the basic indicators to measure the wellbeing of a society. In this study different dimensions of health care facilities have been measured to analyze the health care system of Uttar Dinajpur District. Health Care Facility Index (HCFI) value of each CD block shows the health care facilities condition and position of those blocks within the district. The Mean HCFI value of Uttar Dinajpur district is 0.304511 which indicates very worst situation of health care facilities of this District. The Government may look for a way to enhance the quality of health care facilities from the grassroots level since wellbeing of a society is closely associated with the improvement of the health care facilities of that region. The analysis of healthcare resource distribution across the blocks of Uttar Dinajpur district highlights significant disparities in infrastructure, staffing, and accessibility. Blocks like Raiganj and Islampur emerge as better equipped, with high availability of healthcare institutions, beds, and doctors, serving as benchmarks for resource allocation. Conversely, blocks such as Goalpokhar-I, Itahar, and Chopra show critical deficits in healthcare infrastructure and staffing, necessitating urgent interventions. The correlation analysis underscores the interdependence of healthcare variables, indicating that improvements in infrastructure, such as beds or institutions, often correlate with better staffing levels and accessibility. However, the inconsistent Doctor Health Care Institution Ratio (DHCIR) across blocks suggests unequal distribution of doctors within institutions, pointing to the need for equitable staffing strategies. To address these disparities, an integrated approach focusing on increasing healthcare institutions, improving hospital infrastructure, and ensuring equitable distribution of doctors is essential. Blocks with critical gaps require targeted investments, while successful strategies in Raiganj and Islampur can be adapted for underperforming regions. Overall, this data-driven assessment provides a roadmap for optimizing healthcare resources and ensuring equitable access and quality of care across Uttar Dinajpur district.

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The Deccan Geographer
Vol. 62, No. 10 December, 2024, pp. 393-405
(ISSN-0011-7269)
UGC Care Listed Geography Journal

A COMPARATIVE ANALYSIS OF URBAN SPRAWL IN FATEHPUR CITY: SPATIAL DYNAMICS AND SOCIOECONOMIC TRANSFORMATIONS FROM 1994 TO 2024

Shiv Bahadur Singh and Prof. Indrajit

Abstract

This study conducts a comparative analysis of urban sprawl in Fatehpur City, focusing on its spatial dynamics and socioeconomic transformations between 1994 and 2024. The research examines the transition from a compact and centralized urban form in 1994 to a fragmented and dispersed pattern by 2024, driven by rapid population growth, economic diversification, and infrastructure development. Utilizing high-resolution satellite imagery and GIS tools, the study maps the spatial distribution and extent of urban sprawl areas over three decades. The findings reveal that in 1994, urbanization was confined to a dense core cantered around the Central Business District (CBD), with minimal expansion into surrounding rural areas. The compact urban form reflected limited infrastructural development and a predominantly agriculture-based economy. By 2024, Fatehpur City exhibited significant horizontal expansion, characterized by ribbon and leapfrog development patterns facilitated by improved transportation networks. Peripheral regions, once agricultural, now feature residential, commercial, and industrial zones, marking a substantial conversion of rural lands into urbanized areas. The study identifies critical challenges associated with unplanned urban sprawl, including environmental degradation, resource depletion, and strain on infrastructure. It highlights the need for sustainable urban planning to balance growth while preserving agricultural and natural landscapes. The research proposes strategic interventions, such as controlled development zones, green belt conservation, and infrastructure improvements, to mitigate the adverse effects of urban sprawl. By integrating spatial and socioeconomic data, this analysis provides actionable insights for policymakers, urban planners, and researchers to promote balanced and sustainable development in Fatehpur City.

Introduction

Urban sprawl, a phenomenon marked by the horizontal expansion of cities into surrounding rural and natural landscapes, is a critical subject for urban studies due to its profound impact on land use, infrastructure, and socioeconomic conditions. Fatehpur City, located in Uttar Pradesh, India, presents a compelling case for analysing urban sprawl over three decades, from 1994 to 2024. This research investigates the spatial dynamics and transformations shaping Fatehpur's urbanization during this period. In 1994, Fatehpur was characterized by a compact and centralized urban structure, with most development concentrated in the Central Business District (CBD). The surrounding areas remained largely rural, with minimal built-up zones. The city's economy was primarily agriculture-based, and infrastructural development was limited. Urban growth followed a modest trajectory, constrained by local economic activities and a lack of migration-driven expansion. By 2024, rapid population growth, economic diversification, and improved transportation infrastructure transformed Fatehpur's urban landscape. The city expanded horizontally, transitioning from a dense core to a sprawling, fragmented urban form. Peripheral areas, once dominated by agriculture, have seen significant conversion into residential, commercial, and industrial zones. This transformation reflects the interplay of socio-economic drivers, including rising housing demand, enhanced connectivity, and the influx of migrants seeking employment opportunities. Urban sprawl in Fatehpur has both positive and negative implications. While it fosters economic growth and improves access to services, it also leads to challenges such as environmental degradation, resource depletion, and unplanned urbanization. The loss of green cover and agricultural land, coupled with increased congestion and pollution, underscores the need for sustainable urban planning. This study employs Geographic Information Systems (GIS) and high-resolution satellite imagery to compare the urban sprawl of Fatepur city.

Study Area

Fatehpur City, located in the Fatehpur district of Uttar Pradesh, India, lies between 25°51'0"N and 25°57'0"N latitude and 80°48'0"E and 80°51'0"E longitude. Strategically positioned along National Highway 19 (formerly NH 2), it serves as a vital administrative, commercial, and transportation hub, linking major cities like Kanpur and Prayagraj (Allahabad). Situated in the fertile Gangetic Plain, the city benefits from flat, alluvial soil that supports extensive agriculture. The Yamuna River, flowing along the district's southern boundary, influences irrigation, land use, and urban development. The region's subtropical climate, with hot summers, monsoons, and mild winters, shapes settlement and infrastructure patterns. Historically, Fatehpur's economy cantered on agriculture, producing staples such as wheat, rice, and pulses. Over time, the city has diversified into trade, small-scale industries, and services, spurred by its advantageous location along major transportation routes. This economic diversification, coupled with demographic growth driven by rural-to-urban migration and natural population increases, has transformed the city into a district-level urban center. Culturally, Fatehpur holds significance as a melting pot of traditions and historical influences. The city is home to numerous religious and historical landmarks, such as temples, mosques, and old administrative buildings, reflecting its rich heritage. The Bhitaura Ghat on the Yamuna River is a spiritual site associated with Hindu rituals, while places like the Hathgaon area house ancient temples and architectural remnants that attract pilgrims and tourists alike. The city also celebrates a variety of regional festivals, such as Holi, Diwali, and Eid, fostering communal harmony and cultural vibrancy. Administratively, Fatehpur serves as the district headquarters, housing key government offices and institutions that manage local governance, law, and development initiatives. The city hosts educational institutions ranging from schools to degree colleges, contributing to its role as an educational center for surrounding rural areas. Fatehpur's administrative and cultural significance is complemented by its role as a transportation hub, with National Highway 19 and nearby railway connectivity facilitating movement of goods and people, further strengthening its regional importance.

Objectives

(1) To analyse the spatial distribution and extent of urban sprawl in Fatehpur City in 1994 and 2024.
(2) To examine the changes in the density and spatial pattern of urbanized areas over three decades.
(3) To compare the compact urban form of 1994 with the fragmented and dispersed development of 2024.
(4) To propose recommendations for sustainable urban planning and balanced resource management.

Database and Methodology:

(a) Acquire high-resolution satellite images for the years 1994 and 2024 from reliable sources (e.g., NASA, Landsat, or private satellite providers).
(b) Collect demographic, economic, and infrastructure development data for Fatehpur City from government reports, census data, and municipal records.

(c) Use GIS software (e.g., ArcGIS or QGIS) to process satellite images and extract spatial data.
(d) Digitize the maps to identify urban footprints, built-up areas, and land use changes between 1994 and 2024.
(e) Calculate the extent of urban sprawl using metrics such as the land consumption rate and built-up area expansion.
(f) Analyze spatial patterns of urbanization, including centralized growth, ribbon development, and leapfrog expansion.
(g) Compare population density and built-up area changes using statistical techniques.
(h) Assess the extent of land use conversion from rural/agricultural zones to urbanized areas.
(i) Overlay spatial data for 1994 and 2024 to visually compare urban sprawl.
(j) Analyze the differences in urbanization patterns over three decades.
(k) Cross-check findings through field visits and ground surveys to ensure data accuracy.
(l) Corroborate results with existing academic literature and secondary data.
(m) Develop strategies for sustainable urban planning, focusing on optimizing land use and minimizing environmental degradation.
(n) Suggest policies for managing urban sprawl, such as controlled development zones and green belt conservation.
(o) Propose infrastructure improvements to support balanced growth while preserving agricultural and natural landscapes.
(p) This methodology provides a robust framework for understanding and addressing urban sprawl in Fatehpur City, ensuring actionable insights for sustainable urban development.

Result and Discussion

Urban Sprawl 1994

The 1994 map of urban sprawl in Fatehpur City offers a detailed and comprehensive visualization of the city's built-up areas, capturing the early stages of its urbanization. Titled "Fatehpur City Urban Sprawl 1994," the map focuses on the spatial distribution of built-up zones during a period when urban development was significantly less extensive. These markers provide precise spatial references and facilitate integration into broader geographic studies or GIS platforms for deeper spatial analyses (Fig. 1). The red dots or shaded areas on the map signify built-up regions, encompassing residential neighborhoods, commercial hubs,

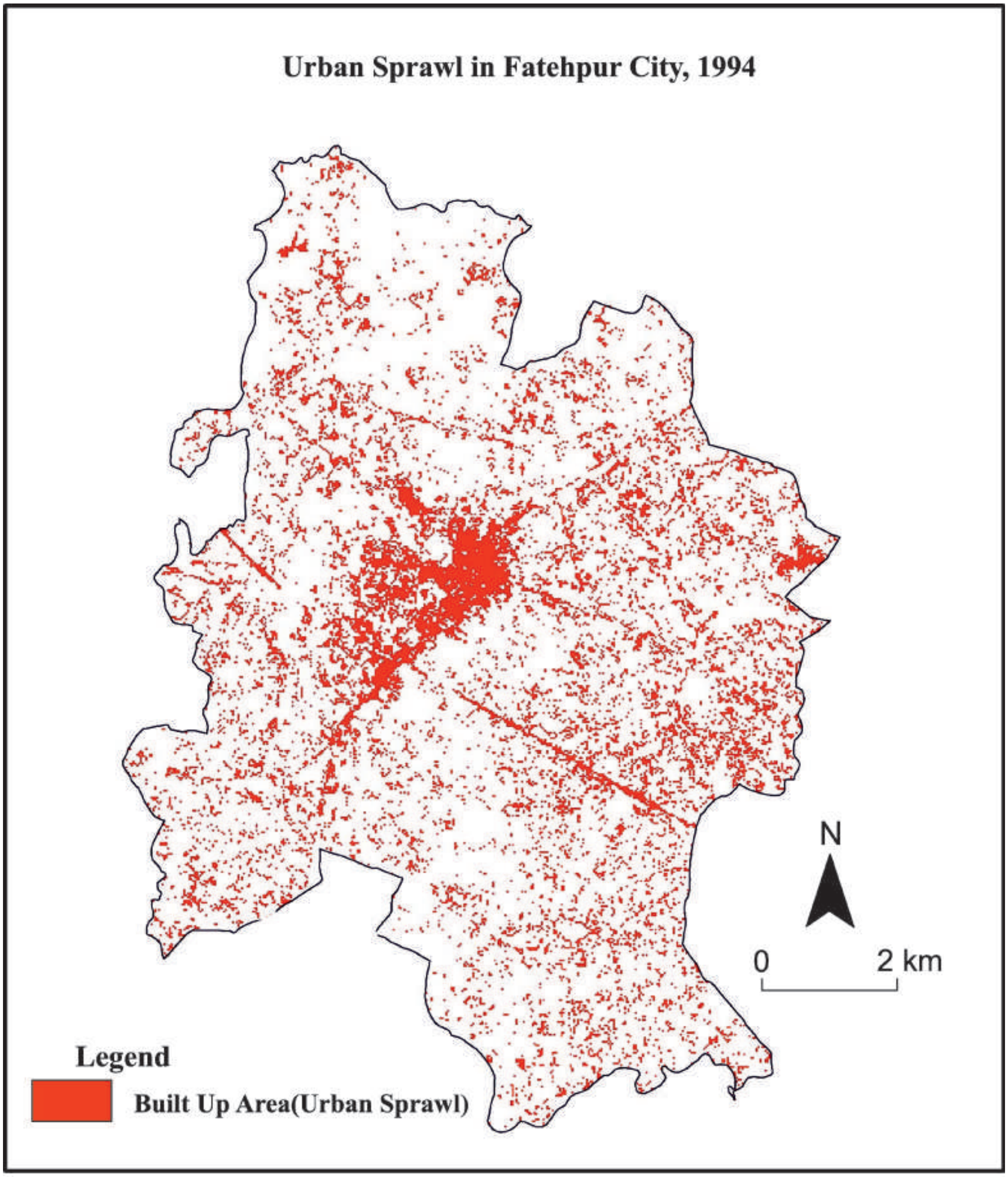
Urban Sprawl in Fatehpur City, 1994
N
0
2 km
Legend
Built Up Area(Urban Sprawl)

Fig. 1

and industrial establishments. Compared to later years, the density and spread of these areas were sparse and confined, reflecting a compact and centralized urbanization pattern predominantly restricted to the city's core, with minimal sprawl into peripheral or rural areas. The scale bar, ranging from 0 to 4 kilometers, helps estimate the size of urbanized zones and assess their spatial relationships. The legend clearly designates red as built-up areas, aiding in the interpretation of urbanized versus non-urbanized zones, while the north arrow ensures proper directional alignment, making the map intuitive for spatial analysis. Analysis of the map reveals that urbanization in 1994 was concentrated in the central part of the city, likely the Central Business District (CBD) or administrative and economic hub. Surrounding areas remained predominantly rural, with minimal or negligible urban sprawl. Visible gaps in urbanized areas suggest the presence of undeveloped land used for agriculture or open spaces, with transportation networks influencing linear growth patterns. Early transportation infrastructure connected the core to surrounding regions, facilitating limited suburban expansion. The density of built-up areas was highest in the core, with most population and economic activities confined to a small area, while the outskirts showed minimal development. When compared to the 2024 map, it is evident that the city has transformed dramatically. The compact urban form of 1994 has transitioned to a sprawling and fragmented development pattern, driven by infrastructure improvements and socio-economic changes. The 1994 urban sprawl reflects a localized economy reliant on agriculture, with urbanization shaped by population growth, limited migration, and infrastructural constraints. The lower demand for housing and commercial space resulted in a tightly clustered urban form, which contrasts sharply with the dispersed and expansive pattern seen in 2024. This 1994 map is a valuable resource for researchers, urban planners, and policymakers. It provides a historical baseline for analyzing urban growth trends, assessing changes in land use, and evaluating the effectiveness of past policies. By identifying areas of concentrated or unplanned urbanization, the map can inform sustainable planning efforts, ensuring balanced growth that minimizes environmental impact. It also offers insights into the socio-economic conditions and infrastructural limitations that shaped Fatehpur's early urban development, serving as a tool for evaluating past and future urbanization patterns to guide sustainable city planning.

Urban Sprawl 2024

The 2024 map of urban sprawl in Fatehpur City provides a detailed visualization of the extent and distribution of built-up areas within the city's geographical limits, offering valuable insights into spatial development patterns, urban expansion, and infrastructure planning. These markers provide precise locational references and facilitate integration with Geographic Information Systems (GIS) for further analyses. The red dots and shaded areas on the map represent built-up zones, including residential, commercial, and industrial areas. The clustering of these dots in the central part of the city reflects a dense concentration of human activity, likely marking the Central Business District (CBD) or the city's economic and administrative core. In contrast, the scattered red dots in peripheral areas illustrate suburban growth and the gradual urbanization of rural landscapes, indicative of horizontal urban expansion. The scale bar, ranging from 0 to 4 kilometers, allows users to estimate distances and the spatial extent of built-up areas, while the legend clearly defines red as "Built-Up Area (Urban Sprawl)," ensuring easy interpretation of urbanized versus non-urbanized zones. Additionally, the inclusion of a north arrow ensures proper orientation, making it easier to understand spatial relationships and align the map with real-world directions. Analysis of the map reveals a transition in Fatehpur's urban growth patterns (Fig. 2). The dense urban core, characterized by limited open spaces, contrasts with the peripheral regions, which display a more dispersed and fragmented development pattern. This shift from a compact urban form to sparsely developed outskirts is typical of cities experiencing urban sprawl. Linear gaps between built-up clusters suggest the presence of transportation networks such as roads, highways, or railways, which serve as critical arteries for urban expansion by connecting the city core to its outskirts.

These networks facilitate the spread of development along major corridors, while natural barriers such as rivers or topographical features may influence the spatial arrangement by restricting or redirecting growth. Fatehpur City, situated in Uttar Pradesh, India, is part of a region undergoing rapid urbanization due to factors such as population growth, migration, infrastructure development, and economic diversification. As a district-level urban center, the city serves as a hub for trade, education, healthcare, and administrative functions, attracting an influx of people from surrounding rural areas. This growing population drives the expansion of built-up areas, resulting in new residential neighborhoods, commercial zones, and industrial clusters. However, unplanned or haphazard urban growth can strain resources, degrade the environment, and disrupt agricultural and natural landscapes, highlighting the need for strategic planning. This map serves as a critical resource for urban planners, geographers, policymakers, and researchers. It provides essential insights into the spatial distribution of urban growth, helping to plan infrastructure, allocate resources, and identify areas requiring improved connectivity and public services.

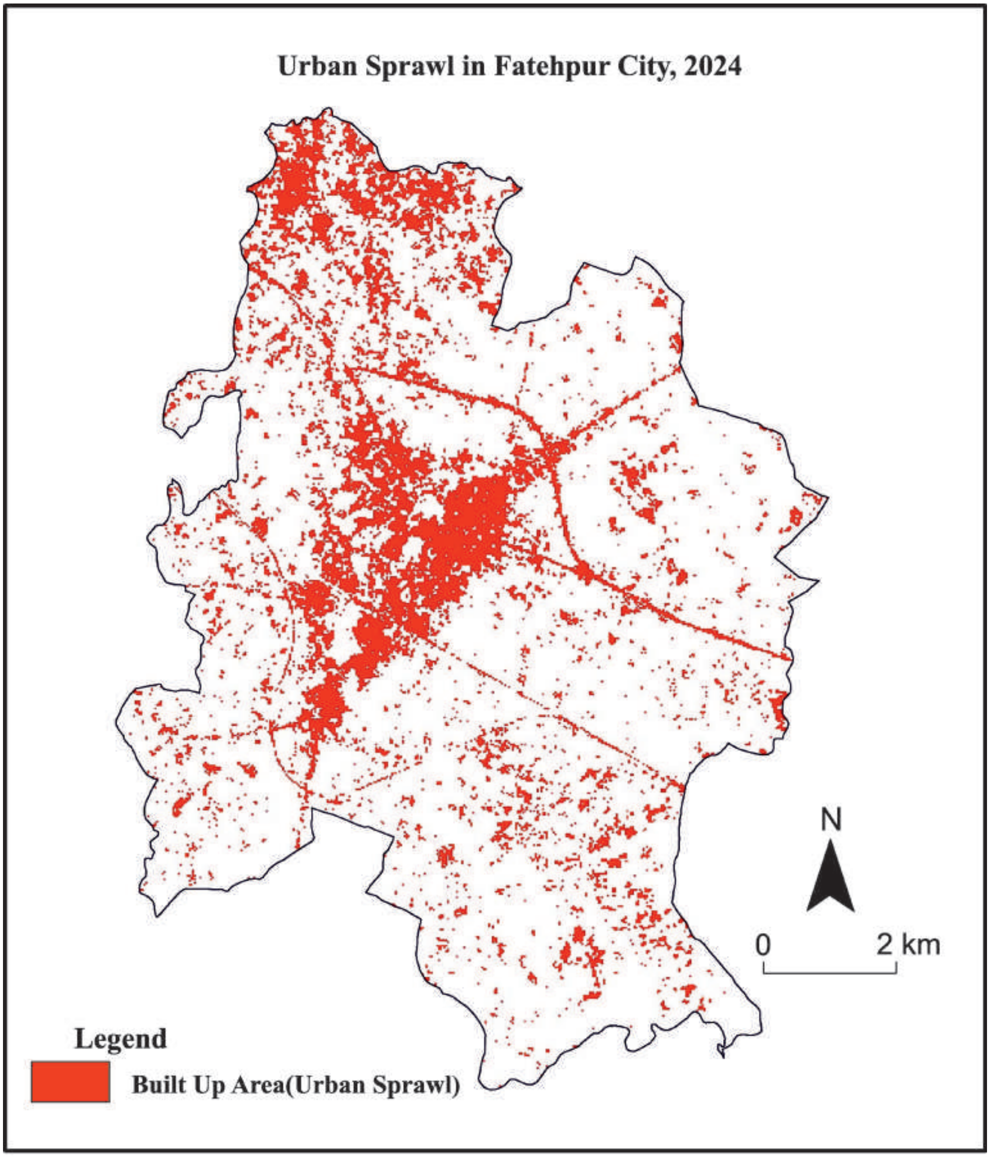
Urban Sprawl in Fatehpur City, 2024
N
0
2 km
Legend
Built Up Area(Urban Sprawl)

Fig. 2

It also enables stakeholders to monitor the environmental impact of urbanization and formulate strategies for sustainable development. By comparing this map with historical or future urban sprawl data, stakeholders can assess trends in urbanization, plan for controlled and balanced development, and ensure the sustainable growth of Fatehpur City while preserving its environmental and agricultural resources.

Comparison of urban sprawl

The comparison of urban sprawl in Fatehpur City between 1994 and 2024 highlights significant changes in the city's spatial development, urban density, and infrastructure. In 1994, the urban core was highly dense and compact, with most activities concentrated in the Central Business District (CBD). The development was focused within the city limits, with minimal or no expansion into peripheral areas. The urbanized area was small and centralized, reflecting limited population pressure and moderate growth. Early-stage transportation networks shaped linear urbanization along key routes, while the surrounding rural areas were predominantly open spaces or agricultural lands. Infrastructure was limited, restricting outward growth, and urbanization was mainly influenced by local trade and administrative functions. This compact and centralized development pattern had a minimal environmental impact, with the rural areas and natural landscapes remaining largely intact. By 2024, Fatehpur City experienced dramatic urban expansion and significant changes in its spatial pattern. The urban core, though still dense, has expanded outward, reflecting growth in both commercial and residential areas due to increased population and economic activities. Urban sprawl into suburban and rural-urban transition zones is now evident, driven by infrastructural improvements and population pressure. The total urbanized area has grown substantially, with scattered clusters extending across the district, creating a fragmented and dispersed pattern characteristic of modern urban sprawl. Advanced transportation networks, including roads and highways, have facilitated this expansion, connecting the urban core to peripheral and rural areas.

The conversion of vast rural and agricultural lands into urbanized zones indicates significant land use changes. Improved infrastructure, including utilities and public services, has supported widespread horizontal growth, while urbanization is now driven by economic diversification, migration, and housing demands. However, this growth has come at a cost, with increased environmental impact due to the loss of open spaces and natural resources. Overall, the compact and centralized urban form of 1994 has transformed into a sprawling and fragmented urban pattern by 2024, reflecting broader socioeconomic and infrastructural developments.

While these changes present opportunities for growth, they also pose challenges related to sustainability, environmental conservation, and resource management. This comparison underscores the need for balanced urban planning and sustainable development strategies to address the pressures of urban sprawl while ensuring the efficient use of resources.

Table-1: Comparing the Urban Sprawl of Fatehpur City for the years 1994 and 2024

Attribute	1994	2024
Urban Core Density	Highly dense and compact. Most urban activity concentrated in the city center (CBD).	Urban core remains dense but expanded significantly, indicating growth of commercial and residential areas.
Peripheral Growth	Minimal or no significant urban sprawl into peripheral areas.	Significant spread of built-up areas into the suburbs and rural-urban transition zones.
Total Urbanized Area	Small, concentrated within the city limits.	Larger, with scattered clusters across the district boundary.
Connectivity	Early-stage transportation networks influencing linear urbanization.	Well-developed networks facilitating sprawl along major roads and highways.
Rural Areas	Predominantly rural, with vast open and agricultural lands.	Significant conversion of rural areas into urbanized zones, reflecting land use change.
Infrastructure Development	Limited infrastructure, restricting outward growth.	Advanced infrastructure driving horizontal expansion and increased sprawl.
Socioeconomic Influence	Urbanization influenced by local trade and administrative needs.	Urban sprawl driven by economic diversification, migration, and housing demand.
Environmental Impact	Minimal due to limited urbanization.	Significant, with potential pressure on natural resources and agricultural lands.

Contd...

Spatial Pattern	Compact and centralized.	Fragmented and dispersed, characteristic of modern sprawl.
Urban Core Density	High density, compact development concentrated in the center.	High density in the core, but expanded further with more urban activity.
Peripheral Development	Minimal development, confined primarily to the city limits.	Significant growth into suburban and rural areas, showing urban sprawl.
Total Urbanized Area	Small, concentrated, and compact built-up area.	Vastly expanded, with scattered and dispersed built-up areas across the district.
Spatial Pattern	Compact, centralized growth.	Fragmented, dispersed urban sprawl, extending into new regions.
Connectivity	Limited transportation infrastructure influencing growth corridors.	Well-developed roads and transport networks driving expansion along major routes.
Land Use Conversion	Mostly rural or agricultural land around the core.	Significant conversion of rural/agricultural land to urban use.
Population Pressure	Moderate, manageable population growth within the core.	High population pressure leading to outward expansion.
Infrastructure Development	Limited infrastructure supporting basic needs.	Advanced infrastructure, encouraging rapid urbanization.
Environmental Impact	Minimal due to small urban footprint and limited sprawl.	Considerable impact due to loss of open spaces and increased urban activity.
Urban Expansion Drivers	Administrative and local trade hubs influencing growth.	Economic diversification, migration, and housing demands driving expansion.

Source: Authors

Conclusion

The analysis of urban sprawl in Fatehpur City from 1994 to 2024 reveals a dramatic transformation in the city's spatial development, urban density, and land use. In 1994, the city exhibited a compact and centralized urban form, with most built-up areas confined to the Central Business District (CBD) and minimal sprawl into peripheral rural areas. Limited infrastructure, a predominantly agriculture-based economy, and moderate population growth contributed to this controlled urbanization. However, by 2024, rapid urban expansion, driven by population growth, migration, economic diversification, and infrastructural improvements, resulted in a sprawling and fragmented urban landscape. The shift from a compact urban core to a dispersed and suburbanized pattern underscores the influence of modern transportation networks and increased land use conversion. While this growth has fostered economic opportunities, improved connectivity, and better access to services, it has also led to significant environmental challenges, including the loss of green cover, agricultural land, and open spaces. The unplanned expansion poses risks to resource management, sustainability, and the ecological balance of the region. This study highlights the need for strategic urban planning to manage urban sprawl effectively. Sustainable development strategies, such as green belt conservation, optimized land use policies, and infrastructure improvements, must be implemented to balance growth with environmental preservation. The findings provide valuable insights for policymakers, urban planners, and researchers to ensure Fatehpur City's future development is both balanced and sustainable, addressing the challenges of urban sprawl while leveraging its potential for economic and social progress.

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The Deccan Geographer
Vol. 62, No. 10 December, 2024, pp. 406-416
(ISSN-0011-7269)
UGC Care Listed Geography Journal

VEGETATION INDICES IN ASSESSING THE CHANGES AND LOSS OF FOREST COVER IN GOALPARA DISTRICT, ASSAM

Alinda Hazowary and Dipak Baruah

Abstract

Assessment of forest cover change is an essential part of long-term forest resource management. The current paper focuses primarily on the quantitative measurement of forest cover change using spectral indices such as the Normalized Vegetation Index (NDVI), Enhance Vegetation Index (EVI), and Soil Adjusted Vegetation Index (SAVI) using geospatial approach. The Landsat imageries has been used, which are downloaded from the UGGS Earth Explorer for the years 1993, 2003, 2013, and 2023 at a 10-years' periodical interval. But, in the past few decades, various forest-related challenges has been raised, viz. encroachment, human-elephant conflict, and expansion of agricultural land etc. To grasp these challenging issues, it is necessary to examine the forest cover in the area. The major results of this research work reveal that in between 1993 and 2003, there was a total forest cover loss measuring an area of (-)50 km^2 against the increase of forest cover measuring 25 km^2 in between 2003 and 2013. Again, the area coverage under forest has shown a severe change between 2013 and 2023 with the loss measuring an area coverage of (-) 122 km^2. Overall, the net change from 1993 to 2023 is -146 km^2 indicating the declining trend of forest area annually at the rate of 4.86 km^2 (3.325%).

Introduction

Forest is considered as one of the major components of global terrestrial ecosystem, covering approximately 31% of the Earth's land surface. The presence of forest cover is considered a crucial indicator of environmental conditions (Keenan, RJ, et al., 2015), as it serve mankind with several benefits, including fresh water and water flow regulation (Ssentongo A.A. et al., 2017). Forests offer the highest species richness and diversity of any terrestrial environment (Medhi and Kar, 2016). Forest also account is an essential component of our environment; it maintains environmental and ecological balance through energy exchange, carbon cycling, and climatic change (Yuan et al., 2020), keeping ecosystems balanced on a regional and global scale between human beings, plants, animals, and other abiotic components (Liu et al., 2020).The worldwide forest cover is an important indicator of the health of our planet, it is essential for sustaining life on the Earth (Pan, Y, et al., 2011).

Despite increasing recognition of the value of these ecosystems, global deforestation rates have remained alarmingly high in recent decades (FAO, 2010). However, due to unlawful cutting, overgrazing, clearing, agricultural extension, and fatal fires, the global forest is shrinking year after year, resulting in a loss of total forest cover area. Effective assessment is of paramount importance because resources vary both spatially and temporally due to human interaction, which leads to degraded forest ecosystems that have both direct and indirect impacts on the forest ecosystem and ecological balance. Remote sensing is an efficient technique for assessing spatio-temporal changes in land cover. It gives wide information about land cover usage on a local, regional, and global scale, whereas aerial photos on a time scale are expensive and inaccessible to everyone (Baumann et al., 2012). Many researchers have studied on forest cover change in globally, nationally as well as regionally, but in the present study area (Goalpara district) needs to scientific assessment of forest using various approaches and techniques, including geospatial techniques, have not seen in previous studies (Medhi and Kar, 2016; Rabha, K.Bipul, 2016; Deka, Sangeta, et al., 2019). In order to assess the forest cover quantitatively, the current research theme has been chosen for investigation based on satellite imagery data and various relevant vegetation indices viz. NDVI, EVI, and SAVI performed on GIS platform.

Study Region

The study area, Goalpara district of Assam is located between 250 33'N and 26012'N latitudes and 9007'E to 9105'E longitudes, covering a geographical area of 1824 km^2. It is located in the western part of the state of Assam, India. The district is bordered by Kamrup district to the east, Dhubri and Bongaigoan districts to the west, and the Garo hills of Meghalaya to the south and the Brahmaputra River to the north and west. The district was had a total 236.55 km^2 RF area during 2005-06, and it accounts of 1.7% of Assam's total RF area. However, the most recent studies show that the district losing forest cover at the rate of 0.64% per year, which is of great concern (Deka, Sangeta, et al., 2019). This is due to the decrease in forest area from 389 Km^2 in 1999 (21.33%) to 337 Km^2 in 2011 (18.48%) (Rabha K. Bipul, 2016).

Objectives

(1) to assess the forest cover change using spectral indices using NDVI, SAVI and EVI and
(2) to detect the decadal forest cover loss and gain in the study area.

Database and Methodology

The entire analysis is based on satellite data, collected from USGS Earth Explorer (https://earthexplorer.usgs.gov/). Landsat satellite imageries of 1993 (March), [Landsat 5MSS, 2003 (January)], [Landsat 7 ETM+, 2013 (December)], and [2023(January) Landsat 8/9 OLI/TIRS] has been used to assess forest cover in the study area (Fig. 1). Further, the imagery has been processed using Erdas Imagine 2015 software. The vegetation indices (i.e. NDVI, EVI, and SAVI) has been processed in Arc GIS (v-10.4) software based on Red and NIR wavelength and map algebra (raster calculator) spatial analysis tools. For 1993 and 2003, Landsat 5 MSS and Landsat 7 ETM+ of imagery have been used, where wavelength ranges between band3-visible red (0.63–0.69 µm) - Band4 NIR (0.77 - 0.90 µm), and for the year 2013 and 2023 Landsat 8 OLI and Landsat 8/9 OLI, wavelength ranges band4-red (0.64-0.67µm) to band5-NIR (0.85-0.88µm). The NDVI, SAVI, and EVI are among the most often used vegetation monitoring indices (Nath, Biswajit, &Acharjee, Shukla, 2013). Vegetation indices, the mathematical combination of two or more bands related to vegetation's spectral characteristics, have been widely used for phonological monitoring, vegetation classification, and biophysical derivation of radiometric and structural vegetation parameters (Matsushita, B. et al., 2007). NDVI is commonly utilized for spatio-temporal monitoring of the presence of vegetation and vegetation health on the surface, it allows for the identification of changes in the pattern of the vegetation cover (Liu et al., 2015), which is used for various land uses at the regional and global levels. Rouse et al., 1973 first introduced the fundamental concept of NDVI, which was later expanded by Hossain and Easson (2015). The NDVI index considers the two bands-red and infrared. The red band absorbs electromagnetic radiation (EMR) from vegetation's chlorophyll pigments, while the infrared band is reflected by the leaves' cellular structure (Islam et al., 2023). The NDVI values vary from +1 to -1. A positive high NDVI value suggests the presence of high vegetation, while a low or negative value implies non-vegetative cover (Islam et al., 2023), Weier and Herring (2000) categorized NDVI values as 0.1 or below for water bodies, bare soil, built-up areas, sand, rock, or snow; 0.2-0.3 for grassland and shrubs; and 0.6 or higher for dense vegetation or tropical rain-forests. Equation 1 illustrates how the NDVI values are classified using the red and NIR bands.

$$NDVI = \frac{(NIR - RED)}{(NIR + RED)} \qquad (1)(\text{Huyen et al., } 2017)$$

SAVI

SAVI is a formula that quantifies vegetation growth and productivity while adjusting for soil brightness (https://www.usgs.gov). A transformation technique is proposed for minimizing soil brightness impacts caused by spectral vegetation indices employing red and near-infrared (NIR) wavelengths. The change is visually represented by a shift in the origin of reflectance spectra in the NIR-red wavelength, which compensates for soil-vegetation interactions and differential red and NIR reflection across vegetation canopies (Huete, 1988).

For the calculation of SAVI following equation 2 was applied:

$$SAVI = \frac{(NIR - RED)}{(NIR + RED)} \times (1 + L) \qquad (2)$$

Where "L" is 0.5, the default value.

EVI

EVI, like NDVI, can determine the greenness of vegetation. However, EVI takes into account a variety of weather conditions as well as canopy background noise, making it more sensitive in forested environments. For EVI computation, the "L" value is taken into account as a canopy cover, "C" values as atmospheric resistance coefficients, and values from the blue band (B) are also considered. Thus EVI is characterized as a modified NDVI since it boosted sensitivity to high biomass regions and improved vegetation monitoring capabilities by separating the canopy background signal and reducing the atmospheric effect (Huete, 1988).

$$EVI = 2.5 \times \frac{(NIR - RED)}{(NIR + 6 \times RED - 7.5 \times BLUE + 1)} \qquad (3)$$

Here, 2.5 is the default value

Classification of Forest Class

Forest and non-forest cover (other LULC classes, such as water bodies, farmland, barren land, sandbar, and built-up area) are extracted through the threshold value of each class for the extraction of vegetation cover based on maximum and minimum raster grid values. Three categories of forest cover have been identified: open forest (0.18 to 0.28), moderate forest (0.28 to 0.60), and dense forest (0.6 to 0.90). Where near negative or low values of indices indicate low or unhealthy vegetation cover; on the other hand, high positive values indicate healthy and high vegetation cover.

Result and Discussion

Analysis of Vegetation Indices and Forest Change Detection

Three indices, the NDVI, EVI, and SAVI, have been used to measure forest cover area and extension. The investigation under study reveals that the coverage of average forest area for the year 1993, 2003, 2013, and 2023 has been found as 750.5 km^2 (40.0%), 696.9 km^2 (38.2%), 792.1 km^2 (33.7%), and 600.6 km^2 (34.5%), respectively. Similarly, the area coverage under non-forest category of Goalpara district continues to increase from 1993 to 2023. The non-forest cover area has been measured as 1073.5 km^2 (60%) in 1993, 1127.1 km^2 (61.8%) in 2003, 1031.9 km^2 (66.3%) in 2013, and 1223.4 km^2 (65.5%) in 2023. The changes in the total area in these two groups indicate that forest area had decreased, nevertheless, the changes of the non-forest area indicate the major changes in the district's land use-land cover pattern. Overall, out of the three forest classes, the maximum forest area is covered by open forest, which is found increasing. In contrast, the dense forest has lost its area coverage as shown in Table-1 and Fig. 1, and the moderate forest has slightly increased.

Net Area Change (Based on three indices' average area)

The net forest change analysis helps to understand the changes in forest cover, which gives a clear measurement of change over the periods. Table-2 depicts the category-wise forest periodical change of forest in the study area. The net area changes have been measured through three (i.e. NDVI, EVI, and SAVI) vegetation indices on average for each time period. During the periods of 1993-2003 the total cover loss was around -50 km^2, whereas category wise moderate forest has loss of -36 km^2 area where non-forest forest show the increase of an area of 54 km^2. While during the period of 2003-2013 the forest cover shows an increase of 25 km^2, but highest declined have been found in open forest -69 km^2. Again, in the period of 2013-2023 the forest area have shown a drastic change during the period of 2013-2023 (Table-1 and 2 and Fig. 1). During the selected periods the forest cover loss measures an area of -122 km^2, where open forest loss an area of -72.9 km^2, dense forest -29.2 km^2 and -19.9 km in moderate forest.

Table-1: Net Forest Cover Change in Goalpara District (Average of NDVI, SAVI, EVI)

Category	1993		2003		2013		2023		Net area Changes			
	Area km^2	%	Area km^2	%	Area km^2	%	Area km^2	%	1993-2003	2003-2913	2013-2023	1993-2023
Non-Forest	1079.4	59.2	1133.4	62.1	1107.6	60.7	1229.6	67.4	54	-25.8	122	150.2
Open Forest	480.1	26.3	467.4	25.6	398.4	21.8	325.5	17.8	-12.8	-69	-72.9	-154.6
Moderate Forest	196.5	10.8	160.1	8.8	235	12.9	215.1	11.8	-36.4	74.8	-19.9	18.5
Dense Forest	64.1	3.5	63.1	3.5	83.1	4.6	53.9	3	-1	19.9	-29.2	-10.2
Total Area	1824	100	1824	100	1824	100	1824	100				
Total Forest Area	740.7	40.6	690.6	37.9	716.4	39.3	594.4	32.6	-50.1	25.8	-122	-146.3

Table-2: Summary of Spatio-temporal forest cover change in the study area (1993-2023)

Forest cover	1993-2003		2003-2013		2013-2023		1993-2023	
	Area(km²)	%	Area(km²)	%	Area (km²)	%	Area (km²)	%
Initial Year	755.54		708.04		801.68		755.54	
Final Year	708.04		801.68		600.09		600.09	
Forest (Persistence)	534.87	70.79	511.74	72.2	586.53	73.1	413.25	54.6
Forest Loss	217.20	28.75	289.69	40.9	121.18	15.11	340.74	45.1
Forest Gain	173.14	22.92	88.17	12.4	213.26	26.6	186.79	24.7
Annual Loss	21.72		28.97		12.12		34.07	
Annual Gain	17.30		8.82		21.33		18.68	
Annual Change	39.02		37.79		33.44		52.75	
Net Change	-47.49	-6.29	93.64	13.2	-201.59	-25.15	-155.45	-20.5

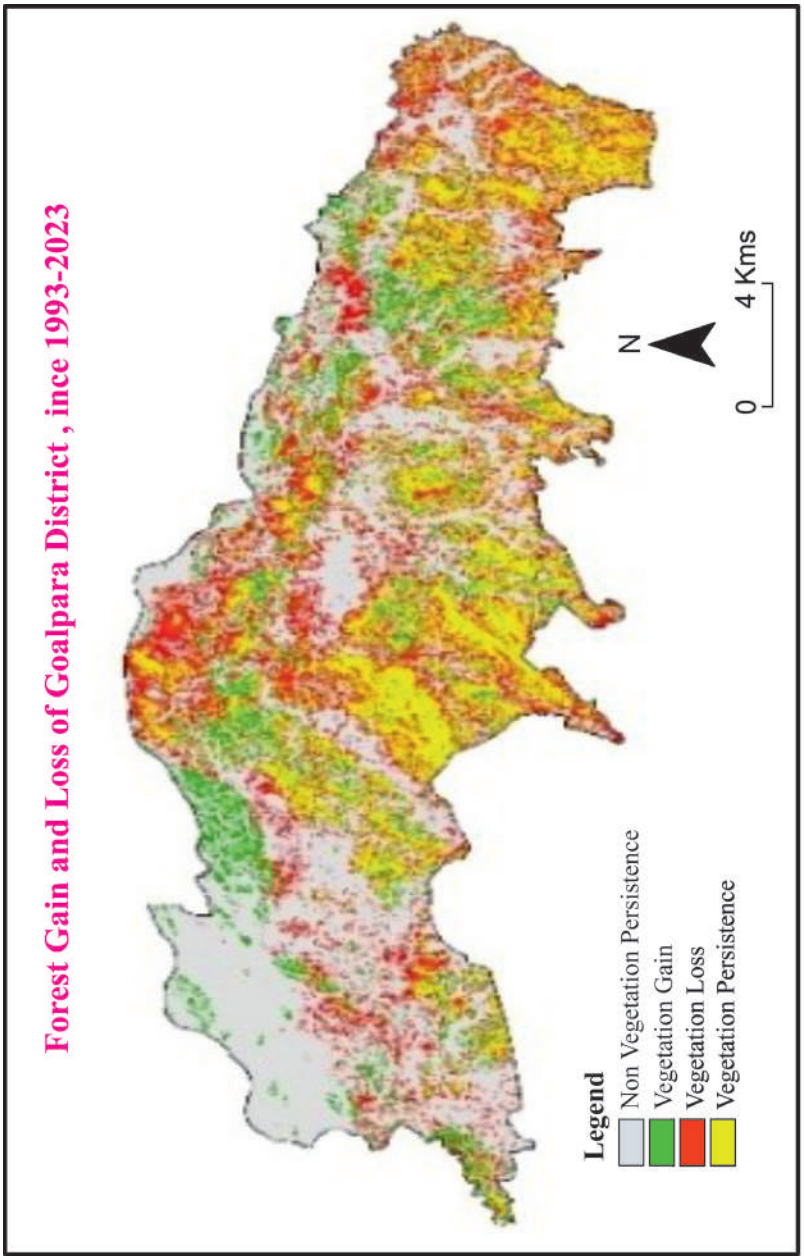
Forest Gain and Loss of Goalpara District , ince 1993-2023
Legend
Non Vegetation Persistence
Vegetation Gain
Vegetation Loss
Vegetation Persistence
N
0
4 Kms

Fig. 1

Overall, the net change are found -146 km^2 from 1993-2023, which demonstrate the forest area have declining in the study area.

Forest Gain and Loss

Afforestation (forest gain) and deforestation (forest loss) have been calculated using two different periods (initial year and final year), which are shown in Table-2. The decadal forest cover change has been measured using based on vegetation indices value in the Arc GIS platform. Afforestation (forest gain), deforestation (forest loss), forest persistence, and Net area change were calculated over two distinct periods with 10-year time intervals. Since forest cover is very dynamic in study area, it observed that highest forest gain detects an area of 93.64 km^2 (13.2%) in 2003-2013, while highest forest loss have been found in 2013-2023 with an area of -201.59 km^2 (-25.15%), -155.45 km^2 (-20.5%) in 1993-2023, and -47.49 km^2 (-6.29%) in 1993-2003. The highest annual forest cover loss has been detecting 34.07 km^2 during 1993-2023. Whereas, the highest consistency or forest persistence area was detected during 2013-2023 with an area of 586.53km^2 (73.1%), again the highest annual change of forest cover have been observed in 1993-2023 (52.75 km^2).

Conclusion

Remote sensing data and GIS platform support to quantify the spatio-temporal change of forest cover using vegetation indices. For improvement of classified result three vegetation indices has been specifically used, because sometimes it occurs for a variety of reasons, including object reflectance, slope, aspect, cloud cover, and soil moisture change. During the selected interval periods, the total area of forest cover is decreasing, particularly in the core of the RF and PRF, which is particularly noticeable in the district's eastern portion and the isolated hills area. It was also found that the annual rate of net forest cover change is 4.86 km^2. At the same time, in the case of open and dense forests, that is transformation into non-forest regions and moderate forests, as shown in Table 3. Remarkable net total change of forest area has been detected from 2013 to 2023, with net area change measuring an area of -122 km^2. It could be owing to the large Sal Forest (Shorearobusta) being turned into rubber plantations, banana cultivation, and vegetable farming in the forest or periphery region, as witnessed during a field visit. From the investigation, it is suggested that the declining forest cover is a clear indicator of the future ecological imbalance in Goalpara district.

That is why, in the near future, a comprehensive measurement or inquiry will be required to ensure effective resource management and conservation.

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The Deccan Geographer
Vol. 62, No. 10 December, 2024, pp. 417-425
(ISSN-0011-7269)
UGC Care Listed Geography Journal

FACTORS ANALYSIS AND HEALTH RELATED IMPLICATIONS OF QUALITATIVE PARAMETERS OF GROUNDWATER OF THE RURAL AREAS OF JHAJJAR DISTRICT, HARYANA

Sonia Ahlawat and Inder Jeet

Abstract

The paper examines the factors analysis of the qualitative parameters of groundwater and their health relating implications of the Jhajjar district of Haryana. The study is based on the secondary source of data, obtained from the groundwater cell, Jhajjar. The health-related information has been gathered from the Chief Medical Office, Jhajjar. The study is aimed at analysis the factors, affecting the quality of the groundwater of the study area. In order to get the desired objectives of the study, a coefficient of correlation and the multivariate correlation have been worked out to find out the relationship between the qualitative parameters and their impact on the proximities of the relating diseases; taken for the study. The findings of the study show that there is very poor +ve correlation between the two variables, taken for the study. Further, the multivariate correlation worked out values shows the varied correlation values between the dependent and the independent variables among them, shows the impact of an individual factors to varied parameters, taken for the study.

Introduction

The groundwater source is one of the significant water resources for the drinking purposes in the rural and urban areas of a country. In this context, various studies show that the situation of groundwater, as a drinking water is far from satisfactory in most of the southern part of Haryana. Jhajjar district of the Haryana state is one of the problematic districts of Haryana; where the quality of the groundwater is the steady declining to a great extent in almost whole the district. The most horrible situation has been developed by the excessive concentration of the fluoride and excessive EC in most of the villages of the Jhajjar district. The situation of the other qualitative parameters have also far from satisfactory, but they shows a considerable block wise disparity; across the district (Jena and Sinha, Overexploitation doesn't mean the total depletion; but rather a significant reduction in the groundwater stocks

(Jeet, 2001). 2017). Further, the scholars of the qualitative aspects of the parameters and its impact on the health conditions of the inhabited population of Haryana with special reference of Jhajjar district. The analyzed data are compared with standard values recommended by Bureau of Indian Standard and Indian Council of Medical Research, New Delhi; which are the true yardsticks; generally, measures with their standarsed (Gupta Ruchi, 2018). The quality of the groundwater of Jhajjar district of Haryana in terms of several excessive concentrations of dissolved the salts and the minerals like fluoride, chloride, salinity, TDS, etc. The objective of this work was to assess the overall groundwater quality of the district based on Water Quality Index (WQI), and find out the factors leading to continuous deterioration in groundwater quality. The study demonstrates that groundwater quality of Jhajjar district is totally unsuitable for drinking purposes and is directly or indirectly influenced by geogenic factors. About 60-70 per cent of the samples analyzed show high fluoride content. Other parameters such as hardness, electrical conductivity, Total Dissolved Solids (TDS), and Chloride are also above the permissible limits. Hydro-geologically the study area (Yadav, Latha, 2003). In case of Jhajjar district, the situation of Fluoride salt is much concentrated in the groundwater reserves which occur in the various places in the world. A critical area for such type of the contamination in the district Jhajjar which include the five blocks (Jhajjar, Bahadurgarh, Matanhail, Beri, and Sahalawas, belonged to the Jhajjar District adjacent to U.T of New Delhi. The impact of fluoride on the human health is quite visible, when a study was carried out on the school children within the age group 6 to 18 years, as a result, it was found that the association between the levels of the water fluoride and diagnosed diseases of the dental fluorosis among school going children of the district Jhajjar of Haryana (Gupta, Misra, 2018).

Study area

This study area is surrounded by some of districts of Haryana and union territory of Delhi. In the north, Rohtak district touches its boarder. On the other hand, there is Union Territory of Delhi which touching boarder along with Nazafgarh and Badli. The Charkhi Dadri district located in the east and the southern border touches with Mehendergarh, Rewari and Gurugram districts. District Jhajjar is situated within the 28o 22’ to 28o 49’ North latitudes and 76o 18’ to 76o 59’ Eastern longitudes. The area of Jhajjar district is 1834 sq.km, sharing the 3.77 per cent its total area of the state. As per 2011 census, the district is having 956,907 number of population which includes 514,303 numbers of males and 4, 42,604 numbers of Females. The density of population of the Jhajjar district is 522 people per sq. km.

The occupational structure of the district shows that there are 66 per cent of the rural population, directly or indirectly engaged in the agriculture and its allied activities. With regarding to secondary sector, it was observed that the district is backward in the large scale industries; but there are some of the small scale industries which are confined to Jhajjar city and its sub-urban areas with some of the agro and agro-based industries in the different blocks headquarters; across the district. The district, now well connected with the road network and the railway with Rohtak and Rewari city. Other industrial plant is Jharli villages, where the power plant has been established for power generation. Establishment of AIIMS, All India Institute of Medical Sciences at the district Headquarters is another landmark as health infrastructure in the district. The district Jhajjar has an ancient Gurukul, where the thousands of the students have acquired formal spiritual education through traditional education system through Gurukul education system.

Objectives

(1) To examine the qualitative parameters in terms of factor-analyses in terms of health implications;
(2) To test the hypothesis of the health relating implications of the sample villages of the study areas.

Database and Methodology

In order to get the desired results of the study various qualitative parameters of the groundwater have been selected and there are total 71 sample villages, belonged to different blocks have also been selected for establish a cause-effect relationship. Further, the co-efficient of correlation between the two variables and the multivariate correlation has also been worked out and made a matrix to get the desired objectives of the study.

Table-1: Selected Variables of Jhajjar District, Haryana

Variables	No. of villages and Percent
X^1= % of villages; contaminated groundwater due to excessive alkali concentration	46 (64.78)
X^2= % of pH Value in groundwater over BIS (6.5-8.5) in accor. with specification	6 (8.45)

Contd...

X^3= % of EC excessive in groundwater over BIS (1500 mg/ L max.) specification	7 (9.86)
X^4= % of Alkalinity excessive in groundwater BIS (200 mg/ L max.) specification	6 (8.45)
X^5= % of Fluoride excessive in groundwater BIS (1 mg./ L. max.) specification	12 (16.90)
X^6= % of Chloride excessive in groundwater BIS (250 mg /L. max) specification	9 (12.67)
X^7= % of Sulphate excessive in groundwater BIS (200 mg/ L. max) specification	7 (9.86)
X^8= % of Total Hardness excessive in groundwater BIS (300 mg/ L max.) specification	14 (19.72)
X^9=% of Calcium Hydrate, excessive in groundwater BIS (75 mg/L max.) specification	03 (4.23)
X^{10}= % of TDS, excessive in groundwater BIS (500 mg /L.max.) specification	07 (9.86)
Total No of the villages of the Jhajjar district, taken for the study	= 71 (100)

*Percentages are given in brackets

Table-2:

% of villages, have excessive with particular salt in groundwater X	Type of disease occur due to particular	Number of cases of disease related to particular salt/ mineral in groundwater Y
X^1= 46 (64)	Numerous of viral diseases	36
X^2= 07 (9)	Acidity, dysentery	13
X^3= 08 (10)	Lower the available nutrients	18
X^4= 07 (9)	Dysentery, diarrhea	14
X^5= 12 (16)	Fluorosis, dental fluorosis	24
X^6= 08 (13)	Laxative effect & taste problem	18

Contd...

X^7= 07 (10)	Gastroenteritis etc.	11
X^8= 14 (20)	Cardiovascular diseases	12
X^9= 03 (4)	Eczema and other skin diseases	11
X^{10}=08 (10)	Hepatitis A, Typhoid, diarrhea etc.	23
	Total numbers of cases of diagnosed	patients from the sample 70 villages
	120	180 (2020-21)

Source: Civil Hospital, Jhajjar, 2020-21 *Percentages are given in the brackets

The coefficient of Correlation between X and Y has worked out with the help of formula, as follows:

$$r = \frac{\sum\left(X-\bar{X}\right)\sum\left(Y-\bar{Y}\right)}{\sum\sqrt{\left(X-\bar{X}\right)^2}\sum\sqrt{\left(Y-\bar{Y}\right)^2}}$$

Where, X= mean of X variable

Y= mean of Y variable

Hence, it is obvious that the correlation between the numbers of the villages which have excessive concentration of varied parameters have a negative weak correlation with the numbers of patients suffer from various types of diseases. At the 5@ sample village, it indicates an insignificant of –ve correlation between the two variables, taken for the study. Further, in terms of individual presence of excessive quantum of salts/ minerals in the groundwater and its impact with the all the parameters with X1 to X 10 correlated as multivariate correlation matrix (Singh & others, 2019). It has been worked out and tabulated with varied correlation values which show the varied degree of affecting factors on the available groundwater which are tabulated as follows:

Table-3: Multivariate Correlation in Jhajjar district, Haryana (2020-21)

Variable	X^1	X^2	X^3	X^4	X^5	X^6	X^7	X^8	X^9	X^{10}
X^1	--	+0.29	+0.33	+0.41	+0.64	+0.49	+0.55	+0.33	+0.61	+0.65
X^2	--	--	+0.45	+0.55	+0.47	+0.46	+0.48	+0.51	+0.52	+0.51
X^3	--	--	--	+0.53	+0.48	+0.54	+0.52	+0.49	+0.51	+0.52
X^4	--	--	--	--	+0.49	+0.55	+0.54	+0.52	+0.53	+0.49

Contd...

X^5	--	--	--	--	--	+0.51	+0.52	+0.48	+0.37	+0.33
X^6	--	--	--	--	--	--	+055	+0.51	+0.38	+0.34
X^7	--	--	--	--	--	--	--	+044	+0.52	+0.51
X^8	--	--	--	--	--	--	--	--	+0.51	+0.52
X^9	--	--	--	--	--	--	--	--	--	+0.50
X^{10}	--	--	--	--	--	--	--	s--	--	--

Source: Groundwater Cell, Jhajjar.

In this multivariate correlation matrix, all the qualitative parameters of the groundwater shows that the X1 qualitative parameter is correlated with the X^2, X^3, X^4, X^5, X^6, X^7, X^8, X^9 and X^{10} parameters.

Similarly, X^2 qualitative parameter is positively correlated with varied correlated values X^3, X^4, X^5, X^6, X^7, X^8, X^9 and X^{10} parameters. Further, the X^3 qualitative parameter is positively correlated with the varied values X^4, X^5, X^6, X^7, X^8, X^9 and X^{10} qualitative parameters. Similarly, X4 is positively correlated with varied values to X^5, X^6, X^7, X^8, X^9 and X^{10} qualitative parameters.

Further, the qualitative parameter X^5 is positively correlated with varied values with other rest of the qualitative parameters such as X^6, X^7, X^8, X^9 and X^{10} qualitative parameters of the groundwater across the Jhajjar district. In the same way, the X^6 qualitative parameters is also positively correlated with the varied correlated values to the other rest of the qualitative parameters like X^7, X^8, X^9 and X^{10} qualitative parameters. Further, X^7 qualitative parameter is also positively correlated with varied correlated values with the rest of the qualitative parameters such as X^8, X^9 and X^{10} qualitative parameters. Similarly, X^8 qualitative parameter has also been positively correlated with the varied correlated values with the last two qualitative parameters like X^9 and X^{10}. Lastly, X^9 qualitative parameter is positively correlated with its X^{10} value. It is therefore, it is quite obvious that every qualitative parameter is positively correlated with fluctuating values of the correlation which indicate it's an adverse impact on the human health in a particular village, located in a particular block of the Jhajjar district. The correlation range of the varied values from +0.29 to +0.65 indicates the varied degree of impact of a specific parameter on the specific disease in a particular area, across the district. Thus, the health relating implications are worked out in terms of specific dissolved salt/ mineral in the dissolved in the ground water in a particular village and the cases of the patients, identified with the related disease which has occurred due to excessive concentration of salt/ mineral or pH value, EC in a particular village. Hence, the multivariate correlation matrix shows a varied degree of impact values of the selected qualitative parameters with the relating disease which was occurred due to that particular either salt/ mineral deficiency or the excessive concentration in the ground water of the study area (Kothari, 2004).

Testing of Hypothesis

Suppose there is strong positive correlation values between the concentration of specific salt or mineral, or excessive either the pH value or EC or TDS or excessive fluoride, concentration in the ground water across the Jhajjar district which gives the worked out value of the correlation between the two variables are worked out as follows:

$$r = \frac{\sum\left(X-\bar{X}\right)\sum\left(Y-\bar{Y}\right)}{\sum\sqrt{\left(X-\bar{X}\right)^2}\sum\sqrt{\left(Y-\bar{Y}\right)^2}}$$

Where, X= mean of X variable

Y= mean of Y variable

∑ (0) x (-5)

r=___________

____

$\sqrt{1364 \times 1160}$

r = + 0.012

The insignificant +ve impact of the excessive concentration of the groundwater shows that the majority of the affected rural population; receive their domestic water from the state-owned public health drinking water facilities in the affected population. Meaning thereby, the impact of the groundwater of the sample village population is found a negative insignificant impact. It is due to consistent efforts, taken by the state-owned preventive and curative measures, taken from time to time, particularly in those villages; where the Probability of infested the contaminated water diseases among the villagers which are located within the affected areas; as tested by a Hypothesis with alternative hypothesis.

Conclusion

In this context, the selected parameters which include pH value, E-C, Calcium, Chloride, Sulphate, fluoride, TDS and Turbidity are some of the qualitative parameters of the groundwater which affect the human health. On the contrary, most of the affected villages are regularly supplied by the drinking water by the public health department. Even then, a considerable number of the villages are consuming the groundwater through hand pumps. The impact of the groundwater is quite visible in form of water borne diseases. It is therefore, it impacts of the qualitative factors is analysis through multivariate correlation which shows a cause-effect relationship amongst various qualitative parameters of the groundwater of various villages, belonged to different blocks of the Jhajjar district. Further, the multivariate correlation matrix shows a varied degree of impact values of the selected qualitative parameters with the relating disease which was occurred due to that particular either salt/ mineral deficiency or the excessive concentration in the groundwater of the study area. The insignificant –ve impact of the excessive concentration of the groundwater shows that the majority of the affected rural population; receive their domestic water from the state-owned public health drinking water facilities in the affected population. Meaning thereby, the impact of the groundwater of the sample village population is found a negative insignificant impact. It is due to consistent efforts, taken by the state-owned preventive and curative measures, taken from time to time, particularly in those villages; where the Probability of infested the contaminated water diseases among the villagers which are located within the affected areas; as tested by a Hypothesis with alternative hypothesis.

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