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Professor B. C. Vaidya

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ASSESSMENT OF DECADAL DYNAMICS OF LANDUSE AND LANDCOVER CHANGES IN JODHPUR CITY, RAJASTHAN

Gajendra Singh Rathore and Dr. Yuvraj Sigh Rathore

Abstract

The rapid growth of the population is changing the surrounding landscapes in Jodhpur city, Rajasthan. This result in environmental degradation and influences the quality of life. The geospatial techniques can be of great use in understanding the dynamics of these changes and for better planning in the direction of sustainable landuse. This study aims to identify landuse and landcover (LULC) changes in city for 2003, 2013 and 2023 as reference time periods. Multitemporal Landsat-TM (Thematic Mapper) and Landsat-OLI (Operational Land Imager) are used to estimate LULC patterns here. Unsupervised classification is performed to classify the LULC. The study found that the built-up, agricultural and Waterbody area is increasing continuously while thearea under fallow land and forest is decreasing. The validation of LULC was performed for the year 2023, which shows more than 91 percent accuracy. This study will help land use planners and policy makers to make suitable decisions for sustainable landuse by understanding the LULC change patterns.

Introduction

Land cover classification plays a crucial role in remote sensing and is vital for numerous applications, including land-use planning and natural resource management. India's extensive size and diverse landscapes present several obstacles for LULC, stemming from its varied topography, land use patterns, and climatic variations (Moulik, 2023). Therefore, the development of accurate and effective LULC methods specifically tailored for the unique characteristics of the Indian landscape is of utmost importance (Jarnagin, 2004). Due to the complexity of India's diverse terrain, land use patterns, and climate variations, developing customized and accurate methods for land cover classification is paramount in order to effectively address the challenges and enable informed decision-making for land-use planning and natural resource management in India. Land use changes can be classified as the result of complex interactions between structural and behavioral factors related to technological capacity, demand, and social relations that influence the environment and demand, as well as the environment of interest (Verburg et al. 2004). There is an endless cycle of changes that operate at various spatial scales. For the evaluation of land, the classifications of land use and land cover are important; they can serve as inputs to social and ecological information as well as models and perspectives. Urbanization advances and changes in environmental systems require a thorough understanding of the patterns and trends related to alterations in land use and land cover. This knowledge is essential for shaping sustainable urban development initiatives and disaster resilience strategies (Fekete, 2022; Senjana, 2023). Land management and planning can be simplified using Geographic Information Systems (GIS), which contain analysis tools that are easily prepared. By using Geospatial technology, one can examine the increasing demand for land use and land cover for various technological necessities (Jaganathan et al., 2010). Remote sensing data are multi-resolution, multi-date, and multi-spectral images; they provide information about land use categories, such as built-up lands, agricultural lands, forests, wastelands, and water bodies (Mohan, 2005). Consequently, land cover maps are generated using multispectral data and multiple dates, containing spatial details spanning several years, facilitating change detection assessments (Lambin et al., 2003). Remote sensing analysis thus offers crucial insights into evaluating the genuine alterations within a specific study area.

Study Region

This research focused on the city of Jodhpur, situated in the northwestern region of India within the state of Rajasthan. This city forms part of the Indian Thar Desert of Rajasthan, there are sand dunes and hill chains scatter around the area. Positioned at 26º 11'N to 26º 22'N latitude and 72º 55'E to 73º 08'E longitude, the city geographical total area 25395 hectare (Nagar Nigam, Jodhpur) rests at an average altitude of 224 meters above mean sea level. The city experiences a climate that oscillates between extremes, characterized by scorching summers and chilly winters. During the summer months, temperatures soar between 27.3º to 42.5º, subjecting residents to intense heat waves. Conversely, winter offers a respite with average maximum temperatures hovering around 27.5º, while the mercury plunges to a minimum of 9.5º, heralding cooler nights (CGWB, 2022).

This desert region depends heavily on precipitation, even if it is rare. Rainfall averages 373.7 mm per year, which provides a brief oasis in the middle of the desert, revitalizing the parched terrain. The socioeconomic makeup of a city is shaped by the patterns of rainfall, which have a substantial impact on agricultural techniques and water management plans. A provisional Census India 2011 count of 1,033,918 people, 52.62% male and 47.38% female, was Jodhpur's population. 80.56% of people were literate on average, with 88.42% of men and 73.93% of women being literate, and 12.24% of children under six. It comprises neighborhoods like Kuri Bhagtasani and Mandore Industrial Area and is governed by a Municipal Corporation inside the Jodhpur Urban Agglomeration. There are 599,332 men and 538,483 women in the 1,137,815 urban/metropolitan populations. After 395 villages were added in February 2021, the city's population increased to 2,330,000. By 2031, it is expected to have grown by 33.04%, surpassing 3.1 million (Population Censes, 2011). The water needs of the people of Jodhpur were met in the past by "Baories" (step wells) and surface reservoirs such as Umedsagar, Lalsagar, Takhatsagar, Kaylana, Baiji Ka Talab, and Balsamand. The frequency with which these ancient baories and surface water reservoirs are found indicates the dependence on these water sources for survival (CGWB, 2015).

Objectives

(1) This objective involves acquiring and analysing multi-temporal satellite imagery spanning several decades to track changes in land cover types such as built-up areas, vegetation, water bodies, agricultural land, and fallow land.

(2) Remote sensing analysis thus offers crucial insights into evaluating the genuine alterations within a specific study area.

Database and Methodology

Satellite images Landsat-TM (Thematic Mapper) and Landsat-OLI (Operational Land Imager) with Rows 149 and Path 42 were used to acquire information for the month of February for three different years 2003, 2013 and 2023 from the earth explorer USGS of the United State Geological Survey (USGS) (website https://earthexplorer.usgs.gov). The data obtained from these sources have been processed to gain the reflectance value that involves DN, to Radiance conversion and Radiance to Reflectance conversion. A detail of satellite used is given in Table-1 and 2.

Table-1: Details of Landsat 5-TM Specifications

Bands	Spatial Resolution	Wavelength (micrometer)	Spatial Resolution (meters)
Band 1	Blue- Green	0.45-0.52	30
Band 2	Green	0.52-0.60	30
Band 3	Red	0.63-0.69	30
Band 4	Near Infrared (NIR)	0.76-0.90	30
Band 5	Mid-IR	1.55-1.75	30
Band 6	Thermal Infrared (TIR)	10.40-12.50	120
Band 7	Mid-IR	2.08-2.35	30

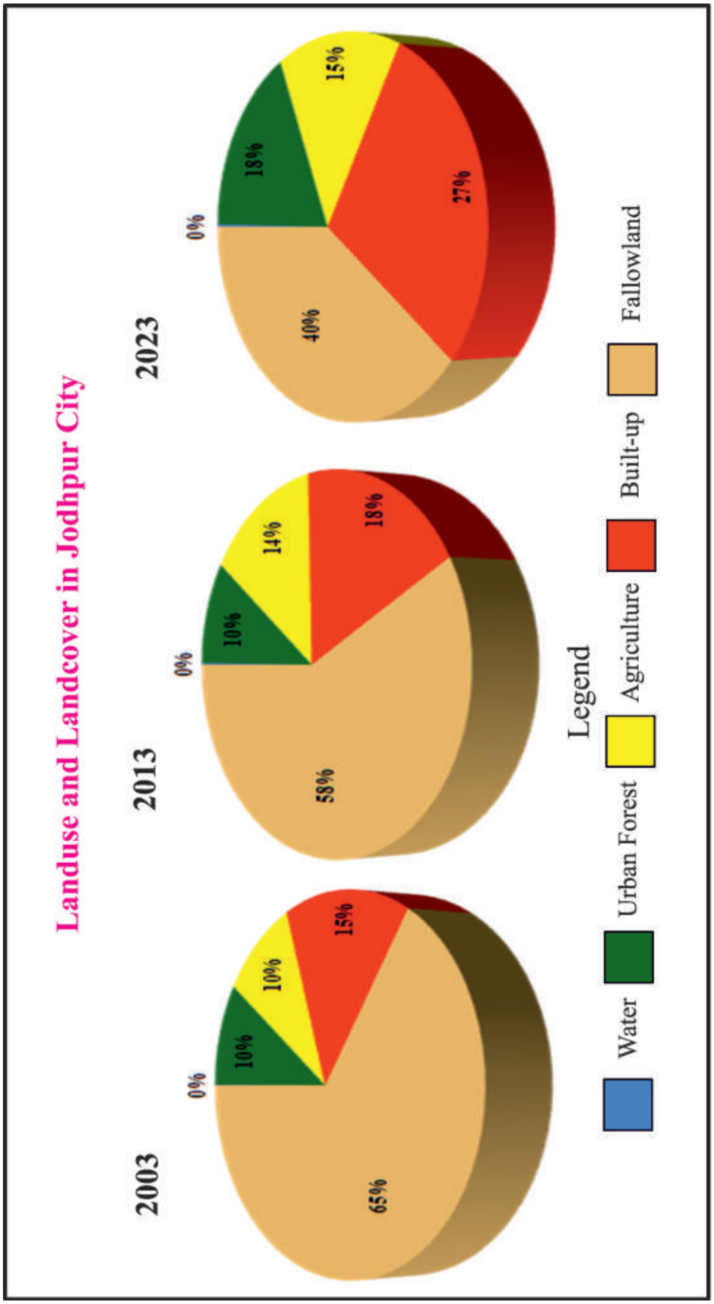
Source: NRSC, Hyderabad

Table-2: Details of Landsat 8-OLI Specifications

Bands	Spatial Resolution	Wavelength (micrometer)	Spatial Resolution (meters)
Band 1	Coastal aerosol	0.43-0.45	30
Band 2	Blue	0.45-0.51	30
Band 3	Green	0.53-0.59	30
Band 4	Red	0.64-0.67	30
Band 5	Near Infrared (NIR)	0.85-0.88	30
Band 6	SWIR1	1.57-1.65	30
Band 7	SWIR2	2.11-2.29	30
Band 8	Panchromatic	0.50-0.68	15
Band 9	Cirrus	1.36-1.38	30
Band 10	Thermal Infrared (TIRS)1	10.60-11.19	100
Band 11	Thermal Infrared (TIRS)2	11.50-12.51	100

Source: NRSC, Hyderabad

The study employed Landsat-5 and Landsat-8 satellite data to investigate changes in land use and land cover. A comprehensive methodology was utilized, encompassing various stages such as satellite data acquisition and processing, classification, analysis, map generation, and report/statistics generation. For image interpretability, Landsat data from both satellites were combined by stacking three bands: band 3 (Red), band 2 (Green) and band 1 (blue) and clipped to the study area.



Landuse and Landcover in Jodhpur City
2003
2013
2023
0%
10%
10%
15%
65%
0%
10%
14%
18%
58%
0%
18%
15%
27%
40%
Legend
Water
Urban Forest
Agriculture
Built-up
Fallowland

Fig. 1

Careful consideration was given to selecting the most appropriate combination of these bands based on their unique characteristics. Subsequently, LANDSAT-5 and 8 data were utilized to create a standard False Color Composite, facilitating the analysis of image characteristics such as tone/color, texture, pattern, shape, size, location, and shadow association. In this study, unsupervised classification was preferred, utilizing ERDAS software. The accuracy of the classification was validated using a confusion matrix, through which both overall accuracy and kappa coefficient were calculated to ensure the reliability of the results.

Results and discussion

Temporal Landuse/Landcover Pattern

The land use/land cover analysis was conducted using the aforementioned methodology, leading to the preparation of land use/land cover (LULC) maps. The study area encompasses five LULC classes: water bodies, urban forests, agriculture, built-up areas, and fallow land. Figures 1 and 2 depict the LULC classifications results for the years 2003, 2013, and 2023. During the twenty-year period from 2003 to 2023, fluctuations in area coverage were observed across the different land use/land cover (LULC) classes, as illustrated in Table 3. Notably, a consistent decrease in fallow land was observed over time due to an increase in built up areas, while other land classes exhibited an increase, similar findings was also reported by Borana et al, 2017. It was observed that the alterations in land area for various land classes, such as agriculture (10 to 15%), built-up areas (15 to 27%), fallow land (65 to 40%), and urban forest (10 to 18%), occurred over the course of twenty years (2003-2023). Additionally, land use/land cover maps of Jodhpur city for the years 2003, 2013, and 2023 were generated using unsupervised classification, with color coding assigned to each class: blue for water bodies, dark green for urban forests, yellow for agriculture, red for built-up areas, and tan for fallow land (Fig. 2). Area calculations revealed that the majority of land area was occupied by fallow land, followed by built-up areas, agriculture, and urban forests, with water bodies covering the least area. Remote sensing technology facilitated change detection within a shorter timeframe and with improved accuracy (Table-3 and Fig. 1 and 2).

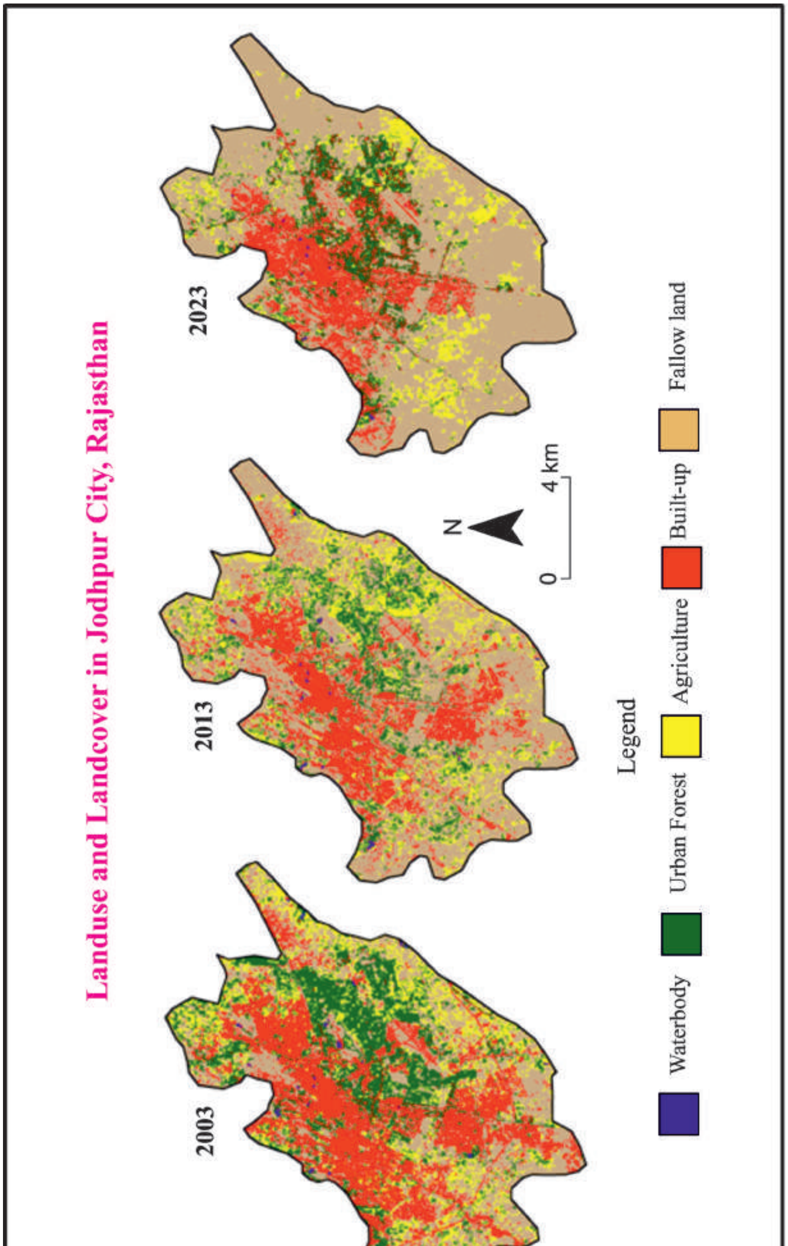

Landuse and Landcover in Jodhpur City, Rajasthan
2003
2013
2023
N
0
4 km
Legend
Waterbody
Urban Forest
Agriculture
Built-up
Fallow land

Fig. 2

Table -3: Temporal Landuse/Landcover Area

LULC Class	Temporal LULC Area (hac)			Change LULC Area (hac)		
	2003 (A)	2013 (B)	2023 (C)	B-A	C-B	C-A
Water	17	47	68	31	21	52
Urban Forest	2538	2542	4665	3	2123	2127
Agriculture	2512	3650	3732	1138	81	1219
Built-up	3727	4486	6780	758	2295	3053
Fallow land	16600	14670	10150	-1930	-4520	-6450

Source: Computed by Authors

Accuracy Assessment of LULC

In assessing the LULC classification accuracy, Table 2 and 3 represent different parameters of accuracy such as producer's accuracy (PA), user's accuracy (UA), over all accuracy and Kappa coefficient. The overall accuracy of classified image for the year 2023 is identified 91.16% with Kappa coefficient 0.87. Both the producer's and user's accuracies of individual classes are found to be extremely high (Table-4).

Table-4: Error Matrix of Landuse/Landcover Classification

LULC Class	Water	Urban Forest	Agriculture	Built-Up	Fallow land
Water	0	0	0	0	0
Urban Forest	2	41	0	1	1
Agriculture	0	0	25	2	1
Built-Up	0	1	2	52	3
Fallow land	0	0	1	5	78

Source: Computed by Authors

The producer's accuracy for different categories is found as 97.62% in urban forest, 89.29% in agriculture, 86.67% in built-up areas and 93.98% in fallow land. While the user's accuracies are found 91.11%, 89.29%, 89.66%, and 92.86% in urban forest, agriculture, built-up areas and fallow land categories respectively. The accuracies of classes calculated are better than the expected level. Less UA for the agriculture class is due to its mixing with Fallow land having similar signature.

Points from Google earth and ground truth (GCP) information covering different LULC classes has made it possible to access the classification results reliable with a good accuracy level (Table-5).

Table-5: Overall Classification Accuracy of Landuse Landcover Classification

LULC Class	Reference Totals	Classified Totals	Number Correct	Producers Accuracy	Users Accuracy
Water	2	0	0	---	---
Urban Forest	42	45	41	97.62%	91.11%
Agriculture	28	28	25	89.29%	89.29%
Built-Up	60	58	52	86.67%	89.66%
Fallow land	83	84	78	93.98%	92.86%
	215	215	196		
Overall Accuracy = 91.16%			Kappa Coefficient (K^) = 0.87		

Source: Computed by Authors

Conclusion

This study utilized Landsat-5 and Landsat-8 satellite data to analyze land use and cover changes over twenty years (2003-2023). Findings indicate shifts in land classes, notably a decrease in fallow land and increases in built-up areas. LULC mapping of Jodhpur city highlighted dominant land uses, with remote sensing proving valuable for accurate change detection with overall accuracy of 91% and kappa coefficient of 0.87. This research contributes to understanding land dynamics, emphasizing the significance of remote sensing in effective land resource management.

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DYNAMIC URBANIZATION AND POPULATION DISTRIBUTION IN JAUNPUR DISTRICT, UTTAR PRADESH

Dr. Shashi Prakash Shukla

Abstract

Over six decades, Jaunpur District witnessed steady urban population growth, marked by significant spikes in the 1970s and 1980s, followed by slightly slower yet substantial growth in later years. Factors such as urbanization, industrialization, and migration trends likely influenced this dynamic. By 2011, the urban population had surged to 346,580, showcasing ongoing urbanization and demographic shifts. Notable urban centers like Shahganj, Khetasarai, and Jaunpur itself played pivotal roles in this growth, offering diverse cultural, economic, and social opportunities. Smaller centers like Kerakat and Mahimapur also contributed to the district's urban landscape, each with its unique identity. Jaunpur, as the district's capital, emerged as a significant hub with a population of 180,362, shaping the region's administrative and cultural dynamics. Despite variations in size, all urban centers contributed to the district's rich tapestry of culture, commerce, and community life, reflecting its dynamism and growth trajectory in the 21st century.

Introduction

The urban population dynamics and distribution in Jaunpur District reveal a compelling narrative of growth and diversity over the past decades. From 1951 to 2011, the district experienced consistent urban population growth, punctuated by significant spikes in the 1970s and 1980s, indicating dynamic shifts in urbanization patterns. Notably, the 2011 census showcased a vibrant tapestry of urban centers, each contributing uniquely to the district's cultural, economic, and social fabric. From the bustling streets of Shahganj to the cultural richness of Khetasarai, and the economic vitality of Jaunpur, each urban center played a pivotal role in shaping the district's identity. Smaller centers like Kerakat and Mahimapur added further depth to the urban landscape, highlighting the district's diversity. Collectively, these urban centers encapsulated the essence of Jaunpur's growth trajectory, reflecting a blend of tradition and modernity. Through this lens, the district's urban evolution emerges as a testament to resilience, adaptability, and community spirit, setting the stage for continued development in the 21st century.

Study Region

The study area encompasses Jaunpur district, situated in the north-western part of the Varanasi division. Its geographical coordinates lie between 25°24' and 26°12' north latitude, and 82°7' and 83°5' east longitude. Bounded by Pratapgarh and Prayagraj to the west, Santkabirnagar to the south, Ghazipur and Azamgarh to the east, Varanasi to the southeast, and Sultanpur to the north, Jaunpur District exhibits a diverse landscape. Stretching approximately 85 kilometers from north to south and 90 kilometers from east to west, the district covers a total area of 4038 square kilometers. Despite artificial demarcations, some boundaries are delineated by rivers, which extend beyond the district's edges. Administratively, the study area is subdivided into six tahsils and 21 development blocks, highlighting its organizational structure. Moreover, it encompasses 13 urban centers, each contributing uniquely to the district's socioeconomic landscape. Through its diverse geography and administrative framework, the study area of Jaunpur District offers a rich tapestry for exploration and analysis, reflecting the interplay of natural and human elements within its boundaries.

Objectives

Analyze urban population trends in Jaunpur District over six decades, identifying patterns and changes.

(1) Investigate factors driving urbanization, including urbanization, industrialization, and migration trends during the 1970s and 1980s.
(2) Assess urban population distribution across various centers, analyzing their demographic, economic, and cultural significance.
(3) Understand urban development dynamics in Jaunpur District, focusing on key centers like Shahganj, Khetasarai, and Jaunpur's role in shaping the urban landscape and driving economic growth.

Database and Methodology

Gather historical census data from 1951 to 2011 regarding the urban population of Jaunpur District. Additionally, collect data on the geographical and administrative characteristics of the district, including its boundaries, area, and subdivision into tahsils and development blocks. Analyze the collected data to identify trends and patterns in urban population growth over the six decades, calculating growth rates and assessing the impact of various factors such as urbanization and industrialization. Utilize Geographic Information System (GIS) techniques to map the distribution of urban population across different urban centers in Jaunpur District, highlighting their spatial relationships and demographic characteristics. Conduct qualitative interviews and surveys with local stakeholders, including residents, government officials, and community leaders, to gain insights into the factors driving urbanization and the socio-economic dynamics of key urban centers. Compare the urban population trends and distribution in Jaunpur District with neighboring districts and regional trends, providing contextual insights into the district's urban development trajectory. Interpret the findings of the analysis to draw conclusions regarding the urban population dynamics and development patterns in Jaunpur District. Discuss implications for policy-making and future urban planning initiatives aimed at promoting sustainable urban growth and development.

Result and Discussion

Urban Population

In 1951, Jaunpur District had an urban population of 84,191 people. Over the next decade, from 1951 to 1961, the urban population increased to 91,413, with a growth rate of 8.57%. This shows a steady growth pattern in the district's urban population. The real shift in population dynamics came in the 1970s. By the 1971 census, the urban population had risen dramatically to 124,562, marking a substantial growth rate of 36.26%. This sudden surge could be attributed to various factors such as urbanization, industrialization, or migration trends during that period. The trend continued in the following decades. In 1981, the urban population further increased to 168,878, with a growth rate of 35.57%. This indicates continued urban expansion and possibly economic development within the district. The 1991 census showed a population of 221,339, indicating a growth rate of 31.06%. The pace of growth remained significant, albeit slightly slower compared to the previous decades. Moving into the 21st century, the urban population of Jaunpur District reached 289,411 by 2001, with a growth rate of 30.75%. This suggests that urbanization and developmental activities were still driving population growth in the district. Finally, in 2011, the urban population of Jaunpur District stood at 346,580, with a growth rate of 19.75% (Table-1). While this growth rate is lower compared to previous decades, it still reflects ongoing urbanization and demographic changes within the district. Overall, the data illustrates a consistent pattern of urban population growth in Jaunpur District over the six decades, with significant spikes in growth during the 1970s and 1980s, followed by a relatively slower but still substantial growth in later years. This reflects the dynamic nature of urbanization and development in the district over time.

Table-1: Population and Growth Rate in Jaunpur District

Year	Population	Growth Rate
1951	84191	9
1961	91413	8.57
1971	124562	36.26
1981	168878	35.57
1991	221339	31.06
2001	289411	30.75
2011	346580	19.75

Source: Census of India, 1951, 61, 71,81,9 and, 2001, 201)

Urban Population Distribution

Urban population distribution of Jaunpur District based on the data provided for the year 2011.Jaunpur District, a vibrant hub of various urban centers, showcases a diverse landscape of population distribution. Among these urban centers, Shahganj emerges as a notable node, with a population of 26,556. Its bustling streets and lively atmosphere make it a significant urban center within the district. Khetasarai, with a population of 19,438, stands as another prominent urban center contributing to the district's demographic mosaic. Its cultural richness and economic activities add to the dynamic urban fabric of Jaunpur. Kerakat, a smaller yet significant urban center, accommodates 13,525 residents. Despite its relatively smaller size, Kerakat plays a vital role in the local economy and social dynamics of the district. Moving further, Mahimapur and Rampur exhibit unique characteristics with populations of 5,280 and 6,212, respectively. These urban centers, though smaller in size, contribute to the district's urban landscape and offer distinct cultural and economic identities. Mariyahu, with a population of 22,778, serves as a bustling urban hub within Jaunpur District. Its diverse population and array of amenities make it a vital node in the district's urban network. Machhlishahar and Mungra badshahpur, with populations of 26,107 and 20,004 respectively, exemplify the district's urban vibrancy and economic vitality. These urban centers serve as key commercial and cultural hubs, attracting residents and visitors alike (Table-2).

Table-2: Urban Population in Jaunpur District

Urban center	Population
Shahganj	26556
Khetasarai	19438
Kerakat	13525
Mahimapur	5280
Mariyahu	22778
Rampur	6212
Machhlishahar	26107
Mungra badshahpur	20004
Jaunpur	180362
Jafrabad	10792
Gura badshahpur	5618
Banjarepur	5108
Kachgaov	4800
Total	346580

Source: Census of India, 2011

The district's capital, Jaunpur, stands out with its significant population of 180,362. As the administrative and cultural heart of the district, Jaunpur plays a pivotal role in shaping its urban landscape and driving economic growth. Other urban centers such as Jafrabad, Gura badshahpur, Banjarepur, and Kachgaov, though smaller in population size ranging from 4,800 to 10,792, contribute to the district's urban diversity and offer essential services to their residents. In total, the urban population of Jaunpur District in 2011 amounted to 346,580, with each urban center contributing to the district's rich tapestry of culture, commerce, and community life. This diverse urban landscape reflects the district's dynamism and growth trajectory in the 21st century.

Conclusion

A consistent pattern of urban population growth in Jaunpur District over six decades, characterized by significant spikes in the 1970s and 1980s followed by continued expansion into the 21st century. This growth underscores the dynamic nature of urbanization and development within the district, driven by factors such as industrialization, migration trends, and economic opportunities.

The urban population distribution across various centers reflects the district's vibrant diversity, with each urban node contributing to the rich tapestry of culture, commerce, and community life. Notably, the district's capital, Jaunpur, stands out as a pivotal hub, shaping the urban landscape and driving economic growth. Despite variations in population size, each urban center plays a vital role in fostering urban vibrancy and vitality. Overall, the diverse urban landscape of Jaunpur District mirrors its growth trajectory and underscores its resilience and adaptability in the face of demographic and socio-economic changes.

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SPATIO-TEMPORAL ANALYSIS OF HORTICULTURE FARMING IN HARYANA

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Abstract

The recent past has witnessed growing challenges and problems for agriculture in the world. They can be seen in the form of growing ecological crises as well as technological changes. Therefore, there is a need to apply intensive techniques and diversify agricultural practices by encouraging horticulture production. Horticulture is a different activity from agricultural farming. The term is derived from the Latin hortus, garden, and cultura cultivation (Denisen, 1958). This study discusses the development of horticulture farming (Vegetables, Fruits, Spices, Flowers, Mushrooms, and Medicinal plants) in Haryana from a temporal perspective over a period of nearly five decades. Published data records from the Horticulture Department of Haryana and Statistical Abstract of Haryana have been taken as the main source of data. The discussion relates to the period 1970-71 to 2020-21 but the yearly continuous data started from 1990 and used triennium averages data for the period 1991-94 to 2018-21. The result reveals that the total area under horticulture farming has increased from 0.71 percent to 8.16 percent during 1970-71 to 2020-21. The study highlighted that, vegetables occupy the top position in terms of area and production and it covered currently vegetables occupy 84.04 percent of the area under horticulture and contribute 87.62 percent of total production in 2018-21. Similarly, the fruit area and production have increased by more than three times and more than five times from 1991 to 2021. The share of spices in production has fluctuated but the overall performance area and production of spices recorded minor negative changes during the study period. Keeping in view, the overall performance under medicinal crops clearly shows the negative change in the area and positive changes in production. Further, the overall area under flowers increased by more than 5 times during the study period but in the form of production, the data of the table shows that the production increased by more than 300 times during 1991-94 to 2018-21, and the overall growth in production of mushroom during 2020-21 recorded above 9 times.

Introduction

The present paper provides a discussion on horticulture in Haryana. Here an attempt has been made to analyse decadal growth in area under horticulture farming both at the aggregate level as well as its sub categories. The income of small holders increasing and a stable farm income over the seasons is basically depends on the conservation and enhancement of "natural resources. In Haryana agriculture diversification is much more suitable for farmers to solve the employment problems because, horticulture farming, livestock products and other activities pulled the more labour work force than the traditional agriculture system. Suitable and diverse agro-climatic conditions are encouraging for cultivation of these types of farming in the state. So, the diversification of agriculture originates by the some opportunities that is offers the increasing produces, reduced the production and price risks, environmental balance, improving natural resource sustainability, sustaining productivity and growth and increasing flexibility. The state of Haryana is ideally suited to tap the potential of horticulture farming, "nearly being close to the area of national capital Region Delhi (NCR), in that case according to the suitable conditions has tremendous scope for commercial horticulture farming. On the basis on govt data this is evident the area under fruits in Haryana was less than one percent from all India in recent years despite higher potential of horticulture farming. It constituted 0.42 percent area under cropped area of total state agricultural land during 1996-97 and reached to 6.40 percent in 2020-21. The all figures related to horticulture farming show a distinct achievement and better status of" the state (Tuteja, 2011:10).

Study Region

The present study relates to the Haryana state which lies between 27º39" to 30º55" north latitudes and 74º28" to 77º36" east longitudes. It is situated in north-western part of India and is a part of Indo-Gangetic plain. The total area of the state is 44212 sq. km and it came into existence on November 01, 1966 due to partition of erstwhile Punjab. In the beginning, there were only seven districts, but at present the state is divided into twenty two districts. Haryana is a small state and covers 1.4 percent area of India. It is surrounded by the border of Himachal Pradesh in northeast; Uttar Pradesh & Delhi in east; Rajasthan in south and west; and Punjab in north.

Objectives

(1) To examine the Long- term horticultural farming growth in study region.

(2) To examine the Triennial Analysis of Area and Production Trends in Horticulture Farming: Haryana (1991-94 to 2020-21).

Database and Methodology

Generally, the term data means group of information that represent the qualitative or quantitative attributes of a variable or set of variables. The present study is based on secondary data from Department of Economic and Statistical Analysis, District Census Handbook, Statistical Abstract Haryana, Department of Horticulture (Haryana), Ministry of Agriculture and farmer's welfare and other Government Departments.

Result and Discussion

New Initiatives

Among new initiatives of the government mention may be made of the proposal for establishment of Horticulture University Karnal. In addition, there is proposal to set up Centres of Excellence in each district of the State. In some districts, for instance in Karnal, Sirsa and Kurukshetra, these centres have already been established. Other centres are in the queue and shall soon follow. In the state to support collective marketing of horticultural produces, Govt. of Haryana has made another 78 Organization for farmers, who covered twenty districts of the state. The state government has established many centres of Horticulture farming for farmers. Work on a Centre of Excellence for Flowers established in Jhajjar with a cost of 15 crores has already started. Another Technology Demonstration Centre of Guava at Bhuna (Fatehabad) with cost of one crore is proposed to be inaugurated. Next is (BBY) Bhavantar Bharpayee Yojna was started on dated 30.12.2017 Main purpose of this scheme is to ease threat of low prices for" horticultural produces in market and to inspire the farmers for diversification in agriculture (Horticulture Department of Haryana, 2018-19).

Growth of Horticulture in Haryana (1966–2021)

At present fruits, vegetables, flowers, mushrooms, spices and medicinal crops are important horticulture crops grown in Haryana. Every effort is being made to achieve the target of 10 percent in next few years. There are small areas under spices, medicinal and aromatic plants in the state. There have been significant changes in the cropping pattern which has a profound impact on the production, utilization and demand of inputs and therefore has a profound impact on the economy of the farmers and the State. Some kind of incentive is required to motivate the farmers to change the existing cropping pattern and protect the income of farmers for alternative development. That is why there has been a change in the Haryana agricultural crop system from time to time for additional income of farmers, protected natural resources and employment generation etc. In the overall cropping pattern of the study area the total area under horticultural activities was only 0.42 percent of total cropped area in the period of 1966-67. It increased to 6.40 percent from total cropped area in 2020-21. Table-1 shows the decadal change of horticulture area from total cropped area. In the early 1970s, the horticulture sector in the region encompassed a mere 35.05 (000) hectares, constituting a meager 0.71 percent of the total agricultural land in the state. Over the ensuing decades, there was a remarkable transformation in the horticultural landscape, with a significant expansion to 417.83 (000) hectares by the year 2020-21, representing more than 6 percent of the total agricultural land. This impressive growth marked an increase of 382.78 (000) hectares from 1970 to 2021.The trajectory of horticultural expansion exhibited notable fluctuations over the years. In the initial decade from 1970 to 1980, the state experienced a period of robust growth in horticultural farming. Subsequently, in the decade spanning 1980 to 1990, the growth rate exhibited a deceleration. However, in the subsequent years, there was resurgence in the rate of growth (Table-1).

Table-1: Temporal Changes in Area under Horticulture Farming

Years	TCA (‘000’ Ha)	Area under Horticulture (in ‘000 hectares)	As percent to TCA
1970-71	4957	35.05	0.71
1980-81	5452	63.22	1.16
1990-91	5619	68.05	1.21
2000-01	6115	181.11	2.94
2010-11	6505	415.93	6.39
2020-21	6528	417.83	6.40

Source: Horticulture and Revenue and Disaster Management Department of Haryana

A comprehensive analysis reveals a remarkable 20-fold surge in horticultural land between 1966-67 and 2020-21. Notably, within the more recent timeframe of 1970-71 to 2020-21 alone, there was a substantial 12-fold increase, as summarized in Table-1. These developments underscore the significant expansion and evolution of the horticulture sector within the region, reflecting its growing importance in the agricultural landscape (Table-2).

Table-2 : Horticulture Farming in Haryana

Year	Area ((000) ha)	Production ((000) mt)	Productivity (mt/ha)
1991-94	84.82	1141.57	13.46
1994-97	121.49	1540.72	12.68
1997-00	159.46	1675.27	10.51
2000-03	198.03	2536.41	12.81
2003-06	258.60	3228.15	12.48
2006-09	336.80	3866.71	11.48
2009-12	403.42	5032.69	12.48
2012-15	442.25	6045.34	13.67
2015-18	503.22	7409.42	14.72
2018-21	496.98	8399.25	16.90

Source: Horticulture Department of Haryana

The area dedicated to horticulture has grown steadily from 84.82 thousand hectares in 1991-94 to 496.98 thousand hectares in 2018-21. This expansion is indicative of the growing importance of horticultural crops in the state's agriculture. Simultaneously, horticulture production has also seen a significant rise, increasing from 1141.57 thousand metric tons to 8399.25 thousand metric tons during the same period. This remarkable increase in production underscores the state's success in improving crop yields and production practices. Productivity, measured in metric tons per hectare, has generally seen an upward trend, with variations in different triennium periods. The most recent data (2018-21) indicates a productivity of 16.90 mt/ha, which suggests improved efficiency and management practices in horticultural farming. The table showcases the positive trajectory of horticulture farming in Haryana from 1991-94 to 2018-21. The steady increase in area, production, and productivity underscores the state's commitment to agricultural development and its potential for further growth in the horticultural sector (Table-3). These statistics provide valuable insights for policymakers, researchers, and stakeholders to make informed decisions and investments in the state's horticultural industry.

Table-3 : Area and Production of Vegetables in Haryana (1991-94 to 2018-21)

Years	Area in (000 Hectare)	Percent of Change	Production in (000 Tonnes)	Percent of Change Production
1991-94	68.54	0	1020.47	0
1994-97	92.33	34.71	1383.33	35.56
1997-00	11.90	-87.11	1764.83	27.58
2000-03	150.40	1163.87	2165.06	22.68
2003-06	214.71	42.76	2888.83	33.43
2006-09	284.62	32.56	3512.46	21.59
2009-12	334.67	17.58	4506.01	28.29
2012-15	364.30	8.85	5287.60	17.35
2015-18	422.92	16.09	6492.67	22.79
2018-21	415.55	-1.75	7082.54	9.08
Percent change	506.28		594.04	

Source: Horticulture Department of Haryana

The table provides an in-depth analysis of the evolution of vegetable cultivation in Haryana over the specified period. Notably, the total area under vegetable cultivation increased by 506.28%, reflecting substantial growth. This expansion was particularly prominent between 1991-94 and 1994-97, when the area increased by 34.71%. However, the period from 1997-00 saw a drastic decrease in area by 87.11%, which could be attributed to various factors such as land-use changes or crop rotation strategies. Vegetable production also exhibited remarkable changes during the same period. The total production increased by 594.04%, indicating improved farming practices and productivity. The most significant growth occurred between 1994-97 and 2000-03 when production rose by 35.56% illustrates the dynamic changes in vegetable farming in Haryana from 1991-94 to 2018-21. The considerable increases in both area and production signify the state's responsiveness to the evolving agricultural landscape. These statistics serve as a valuable resource for policymakers, researchers, and stakeholders to understand the trends in vegetable cultivation and to make informed decisions for the future of the agricultural sector in Haryana (Table-4).

Table-4: Area and Production of Fruits in Haryana (1991-94 to 2018-21)

Years	Area in (000 Hectare)	Percent of Change in Area	Production in (000 Tonnes)	percent of change in Production
1991-94	15.12	0.00	119.89	20.53
1994-97	20.01	32.34	144.50	33.92
1997-00	26.22	31.03	193.52	21.72
2000-03	31.29	19.34	235.55	2.68
2003-06	27.59	-11.82	241.87	2.58
2006-09	33.84	22.65	248.10	52.77
2009-12	44.91	32.71	379.03	56.07
2012-15	53.52	19.17	591.54	29.72
2015-18	62.17	16.16	767.37	20.53
2018-21	68.78	10.63	1202.65	56.72
Percent change	354.89		903.12	

Source: Horticulture Department of Haryana

Table-5 provides a detailed overview of the evolution of fruit cultivation in Haryana over the specified time period. Notably, the total area under fruit cultivation increased by 354.89%, illustrating significant growth. The most substantial increase occurred between 1994-97 and 1997-00, with a 32.34% growth in the area under cultivation. This suggests a growing emphasis on fruit farming in the region. Fruit production also exhibited remarkable changes during the same period, with a total production increase of 903.12%. The most significant growth was observed between 2009-12 and 2018-21 when production surged by 56.72%. Conclusion: Table-4 highlights the dynamic changes in fruit cultivation in Haryana from 1991-94 to 2018-21 The substantial increases in both area and production indicate the state's responsiveness to changing agricultural needs and market demands. These statistics serve as a valuable resource for policymakers, researchers, and stakeholders, providing valuable insights into the trends in fruit cultivation and offering guidance for the future development of the fruit farming sector in Haryana.

Table-5: Area and Production of Spices in Haryana (1991-94 to 2018-21)

Years	Area in (000 Hectare)	percent of change in Area	Production in (000 Tonnes)	percent of change in Production
1991-94	*	0	*	0
1994-97	*	0	*	0
1997-00	11.99	0	80.88	0
2000-03	14.47	20.68	96.15	18.88
2003-06	89.72	520.04	44.19	-54.04
2006-09	11.19	-87.53	43.10	-2.47
2009-12	16.30	45.67	77.10	78.89
2012-15	16.55	1.53	91.21	18.30
2015-18	12.06	-27.13	78.34	-14.11
2018-21	8.56	-29.03	67.78	-13.48
Percent change	-28.61		-16.2	

Source: Horticulture Department of Haryana

Spices emerge as the 3rd largest crop in area and production under horticultural activities. In 1994-97, spices were grown over 10.28 percent of all area horticulture and contributed 4.86 percent production. Table-5 presents triennium average area and production of spices during 1991-94 to 2018-21. Spices recorded negative change from total horticultural activities during study period. But in form of figures area under spice crops has been changed in positive or negative manners. Maximum area recorded under spice crops in Haryana in the year of 2003-06. But after that the area of spices went down continuously till 2021.The share of spices in production has been fluctuated but in the overall performance area and production of spices in Haryana recorded minor negative change during study period (Table-6)

In the changed scenario, cultivation of medicinal plants is also becoming a rewarding area to get more benefits for the unit sector. The state has very favourable soil and climatic conditions for cultivation of a wide range of medicinal plants. In this category of horticulture farming, there is no data from 1991 to 2003 under the medicine plant, we will discuss the data from 2003 to 2021.The study shows that the area under medicinal plants had the highest in 2003-06, thereafter, there has been a continuous area decreased till 2021. But the production of medicinal plants during 2003-06 to 2018-21, three times increase has been seen. The overall performance under medicinal crops in Haryana clearly shows negative change in area and positive changes in production (Table-7 and 8).

Table-6: Area and Production of Medicinal Plants in Haryana (1991-94 to 2018-21)

Years	Area in (000 Hectare)	percent of change in Area	Production in (000 Tonnes)	percent of change in Production
1991-94	*	0	*	0
1994-97	*	0	*	0
1997-00	*	0	*	0
2000-03	*	0	*	0
2003-06	2.48	0	0.48	0
2006-09	1.37	-44.6414	0.38	-20.607
2009-12	1.25	-8.86847	0.66	72.60769
2012-15	1.51	20.97857	0.96	44.37089
2015-18	0.36	-76.1384	1.92	99.58598
2018-21	0.29	-19.45	3.15	64.06
Percent change	-88.30		556.25	

Source: Horticulture Department of Haryana and compiled by the researcher

Table-7: Area and Production of Flowers in Haryana (1991-94 to 2018-21)

Years	Area in (000 Hectare)	percent of change in Area	Production in (000 Tonnes)	percent of change in Production
1991-94	0.94	0	0.18	0
1994-97	1.75	86.17	10.70	5844.44
1997-00	2.25	28.57	38.18	256.82
2000-03	2.38	5.78	34.40	-9.90
2003-06	4.83	102.94	46.71	35.78
2006-09	5.76	19.25	55.94	19.76
2009-12	6.28	9.03	61.93	10.71
2012-15	6.35	1.11	64.35	3.91
2015-18	5.69	-10.39	58.56	-9.00
2018-21	3.8	-33.21	43.13	-26.34
Percent change	304.25		23861.11	

Source: Horticulture Department of Haryana

Table-8: Production of Mushroom in Haryana (1991-94 to 2018-21)

Period	Production in 000 Tonnes	percent of change in Production
1991-94	1.01	0
1994-97	2.18	115.84
1997-00	2.91	33.49
2000-03	4.55	56.36
2003-06	6.05	32.97
2006-09	6.71	10.91
2009-12	7.93	18.18
2012-15	9.66	21.82
2015-18	10.54	9.11
2018-21	11.26	6.83
Percent change	1114.85	

Source: Horticulture Department of Haryana.

At the time of reorganisation of the State, cultivation of commercial flowers was non-existent. Keeping in view the growing demand for flowers and cut-flowers for the domestic and export market, the department has planned to start commercial floriculture after 1989-90. In the year of 1991-94 average area and production of flowers were only 1.19 percent and 1.01 percent respectively. There is a continuous increase in terms of area and production over the period. Maximum change was recorded between 2000-03 and 2003-06. Of late there has been a shrink in area and production of flowers in the state. If we talk about overall performance of flowers in Haryana, the study shows that the area of flowers increased by more than 5 times during study period but in the form of production the data of table shows that the production increased by more than 300 times during 1991-94 to 2018-21. Mushroom is an important crop produced in Haryana. This type of crop was non-existent at the time of bifurcation of the state in 1966-67. It is a nutritionally rich food product. Cultivation of mushrooms has picked up during 1989-90. Cultivation of Mushroom is a high income and employment generating activity. The average production of mushroom during 1991-94 was 1.01 (000) tonnes. It increased to 11.26 (000) tonnes by the end of 2018-21. The overall growth in production during 1991 to 2021 recorded above 11 times.

Conclusion

The state of Haryana is ideally suited to tap the potential of horticulture production, being close to the area of the national capital Delhi, which is one of the largest markets in the country. In order to promote the development of horticulture in the state, the Haryana government formed an independent department of horticulture from the Department of Agriculture in 1990-91. Since then, the department has made an important role to the development of horticulture farming in the state of Haryana. The Data indicates a remarkable growth in terms of area and production in horticulture farming during the period under study. Overall area and production of horticulture in Haryana increased by more than 5 and 6 times respectively during 1991-2021. A wide variety of horticulture farming including major vegetables, fruits, spices, medicinal and aromatic plants, flowers and mushrooms are being cultivated in the state of Haryana. Cultivation of vegetables has made the largest contribution in horticultural practices followed by fruits, flowers, spices, medicinal and mushroom. Fruits and vegetables both are the dominant crop system in Haryana under horticulture activities.

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ASSESSMENT OF ECONOMIC EMPOWERMENT OF WOMEN THROUGH SOCIAL WELFARE SCHEME IN LAKHMIR BHANDAR, WEST BENGAL

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Abstract

Despite economic and social progression of women in recent times, a substantial gender gap in financial security makes women more dependent than men upon Social Welfare Scheme. The Government of West Bengal provides economic assistance through social welfare schemes to the non-working females in the state. A community based cross sectional study carried out in one ward of KMC from Nov 2023 to February 2024 with a structured questionnaire administered on 122 women who received Lakhmir Bhandar allowances. This paper summarizes the experience and performances of women belong to low, middle and high-income households with respect to selected economic and social indicators in Ward number 98 of Kolkata Municipal Corporations. The statistical analysis was performed using SPSS software. There was statistically significant co-relation found between household family income, the hours spend in household work and decision taking power of the beneficiary of Lakhmir Bhandar in a family ($P < 0.001$). Lakhmir Bhandar is highly popular Welfare scheme in West Bengal. The awareness about the scheme was significantly greater though marginally among the females across literate, socio-economically classes with the age group 25-30 years. Finally, it is said that Lakhmir Bhandar scheme can be used as good potential opportunity to sensitise women in the household as well as in the community about economic empowerment. Particular attention must be paid to the poor female participation in and their access in household decision making powers.

Introduction

Social Safety Net (SSN) is used as a tool to mitigate the possible adverse effects of reform measures on poor and marginalised population in a society. Low literacy level and reduced mobility out of the households to access the welfare schemes due to gender-based roles and associated social norms inhibits the women to attain basic personal needs. The situation becomes worsen due to poverty which leads to vicious circle between education, gender stereotyping and poverty which is hard to broken without an intervention. Social protection schemes are non-contributory transfer programs designed to protect households from hardship and destitution by providing a minimum level of income (Grosh and others 2008). These also support human and physical capital accumulation by households, improve job opportunities and help breaking intergenerational transmission of poverty and inequality (OECD 2019).There are several such programmes and schemes runed by the different ministries of both the Central and State Government for the welfare of people. Khadyosathi (giving 5 kg rice/ wheat per family per month at Rs 2 per kg), Swastho sathi (health insurance scheme), Kanyashree (empowering girl child through education), Gatidhara (loan to buy car for commercial use), Anandadhara (anti-poverty programme for rural poor), Gitanjoli (housing scheme), Sishu alloy (advanced Anganwadi centre) etc. are few of the schemes that are framed and executed by the Government of West Bengal. As a part of social safety net strategy, the Hon'ble Chief Minister, West Bengal Ms Magmata Banerjee has introduced Lakhmir Bhandar to safeguard decent life with dignity for women who are considered as socially marginalised population. The monthly average expenditure consumption of West Bengal households is Rs. only 5,249. From September 2021, the government is providing an amount of Rs 1000 per month to women heads of Scheduled caste and Scheduled tribe category and Rs 500 for those belong to general category.

The women aged between 25 years except the permanent employees in government and private sectors and 60 years and permanent resident of West Bengal are eligible to apply. The general category females who owns two hectares or more land and likewise are not considered for the scheme. The cash is directly credited into the bank account of beneficiary. Casual workers are also eligible to get the money if they applied for the same through proper channel. The main objective behind starting the scheme was to provide financial assistance to the household women to meet the daily needs expenses. This scheme is expected to cover 10 to 20 per cent of the monthly expenditure of the beneficiaries. The government received the application throughout the year. The scheme is very popular among the women and within the span of only two years i.e. from September 2021 to 2023 about 1.98 crore women in the State are getting benefits of the scheme. Emphasising on social security scheme and focussing the women empowerment, the State Government has raised the allowances under Lakhmir Bhandar Scheme from Rs 1000 per month to Rs 1200 per month for Scheduled Caste and Scheduled Tribe women and for general category Rs 1000 in place of Rs 500 per month. The enhanced financial assistance will come into effect from April, 2024. An additional budgetary allocation of Rs 12,000 crore has been approved for this purpose. When women beneficiary attains the age of 60 years, Lakshmir Bhandar Scheme benefits will automatically transfer to Old Age Pension Scheme.

Study Region

The State of West Bengal within which Kolkata Municipal Corporation (KMC) is located is a middle level state in terms of its key social and economic indicators (Shaw, 2012). According to 2011 Census report, the residential population in KMC was 4.5 million spreading over 144 wards. Ward number 98 (22028/N, 88021/E) comprises the total population of 31,708 among which 16,302 (51.41 per cent) are females. There are 8904 households found in the ward. The average literacy rate is 90.02 per cent for females and 92.06 per cent for males.

Objectives

The present study was undertaken to evaluate the impact of Lakhmir Bhandar scheme on the economic empowerment of women belong to different socio-economic strata in Kolkata. An attempt was also made to assess whether the level of education and income of the household affect the knowledge and utilisation of the scheme.

Database and Methodology

A single ward (Ward Number 98) of Kolkata Municipal Corporation was randomly selected for the execution of the study. Female individuals of age 25 to 60 years having no permanent employment either in government or in private sector and living in same ward for at least 24 months were considered as eligible study participants. Through stratified random sampling procedure 122 recipients was selected for the study. In order to capture both the daily or conventional and unconventional or innovative use of Lakhmir Bhandar money, in depth interview was conducted with a life history approach. A structured questionnaire was prepared. Apart from socio-economic attributes the questionnaire comprised the questions to understand the women's position within the household. Secondary data are collected from Census report, government reports and internet-based materials as available on the topic. Multiple regression is done to analyse the relationship between women empowerment (dependent variable) and other socio-demographic variables (independent variables).

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3$$

Where Y= dependent variable, a= constant or intercept, b=slope

The coefficient of determination (R2) is a statistical metric used to measure how much of the variation in outcome can be explained by the variation in the independent variables. Chi square statistic is calculated to assess whether observed counts are significantly differ from expected counts.

Socio-economic Profile of the Participants

For the present study the data analysis was performed for 122 participants. Table-1 depicts socio-economic profile of the participants (Table-1).

Table-1: Socio-economic Profile of Participants (n=122)

Parameters	Classes	Number	Percentage
Age	< 30 years	22	18.03
	30-45 years	57	46.72
	45-60 years	43	35.25
Caste	General	72	59.02
	Scheduled Caste	29	23.77
	Scheduled Tribe	21	17.21
Educational Status	Illiterate	19	15.57
	Up to class IV	24	19.67
	Up to Class X	17	13.93
	Up to Class XII	15	12.30
	Graduation & above	47	38.53
Monthly Income (Rs)	<20,000	26	21.31
	20,000-40,000	40	32.79
	40,000-60,000	25	20.49
	>60,000	31	25.41

Source: Field Survey, 2012

Result and Discussion

Utilisation of Money

Lakhmir Bhandar Scheme is a significant initiative by the Government of West Bengal to provide financial assistance to women. It aims to empower women and ensure their financial independence. The usage of the allowance money is broadly divided into five broad categories-household expenses, education for children, self or family members health expenses, own expenses and investment in small business (Table 2).

Table 2: Usage of Lakhmir Bhandar Cash by the women

Items	% of women
Household expenses	44
education for children	15
self or family members health expenses	10
own expenses	18
investment in small business	13

Source: Field Survey, 2012

Regarding utilisation of the scheme, among the participants 54 (44%) are contributed in household expenses. In some cases, particularly women in poor and middle income household spent the money to repay the loan that had taken by the family during emergency. It is revealed that empowered women are capable of making more self- reliant and improved investments in their children's health and educational outcomes. Therefore 18% women spent the money to meet up own expenses and 13% women invest the money to start a new business of her own. It is interesting to note that some women who were not being able to save the money every month earlier are now started to save the money that will be using for their daughter's education or marriage in future. About 15% women reported that they spend primarily for children's education such as to buy books, pay tution fees, do photocopy etc. Previously, many poor households remain ill-treated as there was no Swastha Sathi Scheme (linked with Lakhmir Bhandar Scheme) and fall in vulnerable situation. Lakhmir Bhandar allowances helps them to buy medicine/ go for surgery or whatever items they feel to buy important for the family. This allowance acts as social security for the recipient's health too. They started to visit the health centre or nearby hospitals and take prescribed medicine which otherwise become tough due to lack of money.

Linkage between Socio-demographic Statuses:

The Social Welfare Programme and its Beneficiary

Lakhmir Bhandar scheme is designed for those women who work in informal, home-based jobs that results in lower or no pay and no access to most social protection programs, which are typically framed with formal sector workers in mind. A statistical exercise is carried out to establish a relationship Lakhmir Bhandar recipients and economic empowerment. It is hypothesized that Lakhmir Bhandar allowances play a contributory role in the improvement of female's position in the household. The estimated equation reported, depicts good fit and expected signs of explanatory variables (Table 3). Lakhmir Bhandar benefits are aimed to provide financial security to all dependent women and therefore statistically significant relationship is found with household income and the hours they spent on household works. For financially weak households, this cash benefit improves the women's position in the family. They take part in household's decision (Table-3).

Table-3: Regression Result: Dependent Variables Women's Position in Household

Variables	Co-efficient	t statistics	P value
constant	63.31		
Age of the recipient	0.12	0.61	0.54
Caste	-1.45	-0.55	058
Household Family income (Rs)	0.01	-4.94	0.00
Female Literacy	0.26	0.19	0.85
Hours spent on Household chores	1.96	2.25	0.03
R2	0.42		
Adjusted R2	0.38		

Note: Statistically Significance at 0.005

Table-4 indicates the awareness level of the participants about Lakhmir Bhandar Scheme. It shows that people belonging to different socio-economic strata is quite aware of the scheme. As there is flexible eligibility requirements with no income and caste limitations, females who otherwise have no options to earn a single paisa or those concentrated in informal sector find a decent way to earn of their own.

Table-4: Prevalence of Knowledge and Awareness of Lakhmir Bhandar Scheme

Attributes	Classes	Aware	Not aware	Chi Square	P*
	< 30 years	13	9		
Age	30-45 years	40	17	1.12	0.57
	45-60 years	26	17		

Contd...

Caste	General	48	24	0.52	0.77
	Scheduled Caste	19	10		
	Scheduled Tribe	12	9		
Educational Status	Illiterate	9	10	6.28	0.18
	Up to class IV	16	8		
	Up to Class X	10	7		
	Up to Class XII	9	6		
	Graduation & above	35	12		
Monthly Income (Rs)	<20,000	18	8	5.8	0.12
	20,000-40,000	24	16		
	40,000-60,000	14	11		
	>60,000	23	8		

Note: Statistically Significance at 0.005

Co-ordination between People and Local Administration

It is found from the survey there exists good connection between government and community. Availability of the scheme and entitlement automatically leads to easy access by large number of women across socio-economic class. Duare Sarkar (Government at Door steps) is an initiative by the Government of West Bengal of 30 days duration to delivery the services and welfare schemes at the door step of the people through outreach camps organised at Village panchayet and municipality Ward level. These camps act as service providers of specific services and nodes for issuance and collection of application for welfare schemes. It is easy accessible for the females to reach Duare Sarkar camp and applied for Lakhmir Bhandar scheme. Lakhmir Bhandar Scheme won SKOCH Award (the highest civilian honor in the country conferred by an independent organization, which recognizes people, projects and institutions that go the extra mile to make India a better nation) for women and child welfare. The award recognises the State Government as well as about two crore beneficiaries who received economic support under this scheme. The Hon'ble Chief Minister of Government of West Bengal Ms Magmata Banerjee introduced the scheme to offer basic income support to female households in order to meet the daily expenses.

Welfare for Women in State

Lakhmir Bhandar Scheme is very much popular among the females in West Bengal. It is worth to mention that during past ten years, there have been many important schemes introduced in more inclusive form of social security. There remains a kind of complementarity between the needs that addressed and the form of support involved (Table-5). The risks women face in daily lives particularly in developing country like India are different from men in biological attributes and social norms (Luttrell, C and C. Moser, 2004) through the life cycle. Lakhmir Bhandar scheme is designed in a holistic way- financial inclusion, health insurance, pension benefit.

Table-5: Reduce Women's Risk and Vulnerability through Lakhmir Bhandar Scheme

Lifecycle Stage	Women's risks and vulnerabilities	Lakhmir Bhandar Scheme options
Young adulthood	• maternal and reproductive Health risk	• Swastha Sathi card
	• social norm and discrimination restricting work participation	• monthly allowances
	• job insecurity or voluntary withdrawn from job because of pregnancy and take care of children	• cash directly transferred to beneficiary's account in each month
	• lack of access to asset building opportunities	• micro-finance for new investment
Middle age	• employment insecurity and decreased productivity	• financial assistance
	• social expenses of children's education and marriage	• monthly savings
	• widowhood	• monetary support
Old age	• risk of inadequate family income and longer life expectancy	• Lakhmir Bhandar scheme automatically transfer to Old age Pension scheme after attaining 60 years

Source: Compiled by Authors

Conclusion

Women tend to have more frequent breaks in job due to child birth, child care, family responsibilities and when they are working, usually they receive lower wages than male counterparts. Female Life expectancy is longer and may therefore more dependent on social security. Lakhmir Bhandar scheme targeted to all women irrespective of their socio-economic-marital status aged between 25 and 60, therefore, women belong to upper caste, highly educated, well off families receive the same monthly benefit as women of lower caste, low literacy, poor household do. In reality, women with low level of literacy and economically poor families have a far greater risk of poverty and vulnerability than others.

Women still mostly takes the responsibilities like burden of household work, caring of elder persons, bringing up children and unable to pursue their professional career even having the requisite quality and qualifications. Lakhmir Bhandar scheme provides financial support to the women. Since money comes directly to beneficiary bank account and women can decide how to spend it as per their own choice, they enjoy financial freedom than they did before. They have felt a sense of financial security, an amount that they can claim as their own. This monetary support encourages many women in West Bengal to start microbusiness and other side jobs with flexible working hours. More individualised social security entitlement help in women's emancipation, financial autonomy and make the women to realise and generate awareness to exert right on their own name.

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A SPATIAL ANALYSIS OF AMBIENT AIR QUALITY STATUS IN PATNA CITY, BIHAR

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Abstract

Air pollution is a major environmental issue that has significant impacts on human health and the environment. Its widespread effects on health and well-being have progressively led to its recognition as a serious problem for cities. The study aims to analyze the annual concentration of air pollution status in the Patna city. These studies have shown that the air pollution levels in Patna exceed the limits set by the National Ambient Air Quality Standards (NAAQS) for industrial, commercial, and residential areas, exposing more than three-quarters of the Indian population to higher levels of pollution. This paper was addressing these problems based on central pollution control board (CPCB) ground-based monitoring station data and an in-depth review of published research articles for a comprehensive study. We were also used geospatial techniques (Inverse Distance Weighted) to study the temporal and spatial distribution change in air pollution. In general, the baseline levels in the Indian cities are higher than the WHO air quality guidelines. The annual concentration of PM2.5 ranges from 69 to 100 μg/m3 and PM10 ranges from approximately 135 to 210 μg/m3 during the year 2020 to 2022. This range reflects that the Patna city falls under the severe category city of India. Therefore, the trends-based study helps us to frame efficient policies regarding the mitigation of air pollution, ensuring good health and well-being, and making cities inclusive, safe, resilient, and sustainable.

Introduction

Air pollution is a major environmental issue that has significant impacts on human health. Unfortunately, the quality of air in many cities across the world is very poor, and this affects the well-being of people who live there. According to the World Health Organization over 80% of urban dwellers are affected by air pollution. The most common air pollutants include carbon monoxide (CO), particulate matter (PM), nitrogen oxides (NOx), volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAHs), ozone (O3), and sulfur dioxide (SO2) (WHO 2018). Emissions of these pollutants have increased rapidly in developing nations due to industrialization and urbanization. The continuous deterioration of air quality in urban areas is a significant concern for scientists and people alike because air pollution exposure has harmful short-term and long-term effects on human health. In the fifth World Air Quality Report by IQAir, it is noted that 39 Indian cities rank among the 50 most polluted globally, measured by the annual average level of PM2.5 pollutant in the air (The Indian Express, March 2023). In mostly Indian cities studies of particulate matter (PM) concentrations depict seasonal variability, with the significantly highest during the winter and the lowest during the summer in Dhanbad (Gupta et al. 2017); Guwahati (Dutta et al. 2021); Delhi (Kolluru et al. 2023); Mumbai (Chattopadhyay et al. 2021); Lucknow (Pandey et al. 2013). Air Pollution is one of most leading cause of premature death in India. It has been India's second leading risk factor for disease burden after malnutrition (Mahapatra et al. 2020).

A significant portion of India's population is facing the adverse health effects of air pollution, which includes illnesses like chronic obstructive pulmonary disease (COPD), diabetes, ischemic heart disease (IHD), stroke, lung cancer, lower respiratory infection (LRI), and even death (WHO 2018). According to WHO 2014, Patna was listed as the second most polluted city in India, right after New Delhi. Air pollution in Patna City has detrimental effects on the physical and social environment. There has been significant concern about these pollutants in the Gangetic Plains region. It is a densely populated area and has been identified as a key source of PM2.5 and PM10 emissions because of the widespread use of cowdung, kerosene and wood in traditional cookstoves (Arif et al. 2018). Additionally, coal burning is a significant contributor to PM2.5 pollution in the area, along with microscopic dust particles like PM 2.5 and PM 10, which are present in the air due to construction work and climate conditions (UNDARK, Aug 2023). In 2014, the WHO reported a city as one of the top 100 most air-polluted cities in the world due to its rapid urban expansion. As a result of this expansion, the city has experienced a significant increase in air pollution. Over the past two decades, the number of vehicles emitting pollutants has nearly tripled. According to the Office of the Registrar General & Census Commissioner's 2011 report, approximately 32% of households own a two-wheeler, while 10% own a four-wheeler. These factors collectively contribute to the deteriorating air quality in Patna City.

Study Region

Patna (Patliputra) is the capital of Bihar state. It is the largest city of Bihar and second largest city in eastern India after Kolkata. Patna city is located at 25° 35′-25° 40′ N latitude and 85°03′-85° 20′ E longitude, covering an area of 108.87 km². The city is divided into 75 wards and organized into 6 administrative circles. It is the most populated city in the state of Bihar having 16,84,222 population in which 7,90,823 are female and 8,93,399 are male as per 2011 census. The topography of Patna is mainly Gangetic plain, and the city has a subtropical climate with hot summers from late March to early June and a monsoon season from late June to late September. Currently, Patna city has emerged as a centre of heightened investment in technology, educational institutions, real estate, and is deeply involved in various commercial and industrial endeavours, fostering a surge in urbanization. The Road Transport Office (RTO) in Patna notes a rise in registered vehicles alongside the growing population. India's air quality standards are classified into industrial, residential, and commercial categories.

Objective

The main objective of this study to analyze the annual concentration of ambient air pollution (PM2.5 and PM10) status in the Patna city.

Database and methodology

For this study, five ground- based monitoring site has been selected that is: 1. Govt. High School, Shikarpur, 2. IGSC Planetarium Complex, 3. Muradpur, 4. Rajbansi Nagar and 5. Samanpura. To fulfil the objective of the study, an Inverse Distance Weighting (IDW) methodology has been used to analyze the secondary data. The findings have been represented by graphical and pictorial diagrams. There are two types of indicators selected for air pollutants, namely PM2.5 and PM10, which were analyzed over a three-year period from 2020 to 2022. The data was gathered from the Bihar State Pollution Control Board in Patna and the official website of the CPCB in Delhi. The Bihar State Pollution Control Board (BSPCB) is responsible for carrying out the operations and maintenance of monitoring sites in CPCB. Table-1, provides detailed information on the NAAQS for relevant air pollutants, along with the procedures for observational data measurements, including 24-hour averages and annual averages. The metrics used to assess data characteristics at five ground-based observation sites, in which the annual concentration averages have been used to prepare maps using GIS (Table-1).

Table-1: National Ambient Air Quality Standards Concentration in Ambient Air

Pollutant (µg/m3)	Time weighted average	Industrial area	Residential, rural and other areas	Sensitive area
SO2	Annual	80	60	15
	24-h	120	80	30
NOx	Annual	80	60	15
	24-h	120	80	30
SPM	Annual	360	140	70
	24-h	500	200	100
PM10	Annual	120	60	50
	24-h	150	100	75

Source: CPCB, Delhi

Inverse Distance Weighting (IDW)

The IDW method utilizes Tobler's first law: 'everything is related to everything else, but near things are more related than distant things' (Chin & Liu, 2012). This method is a precise, local, non-geostatistical spatial interpolation technique. It estimates values for unknown points by summing the known values of neighbouring points and weighting them inversely based on the distance. The calculation for the IDW method is as follows:

$$x(u) = \frac{\sum^{n} i = 0\, wi\,(x)\, ui}{\sum^{n} i = 0\, wi\,(x)} \text{..........................(1)}$$

$$wi(u) \quad \frac{1}{d\,(x, xi)^{p}} \text{....................................(2)}$$

Where, The IDW method is used to estimate values of unknown points based on the values of known points. In this method, the estimated values of unknown points are represented by u(x), while the known values are represented by (ui). The IDW weighting functions are represented by wi(x), and they are used to calculate the influence of the known points on the estimation of unknown points. This method works by taking into account the distance (d) between the known points (xi) and the unknown points (x), and it uses a factor called p to control the

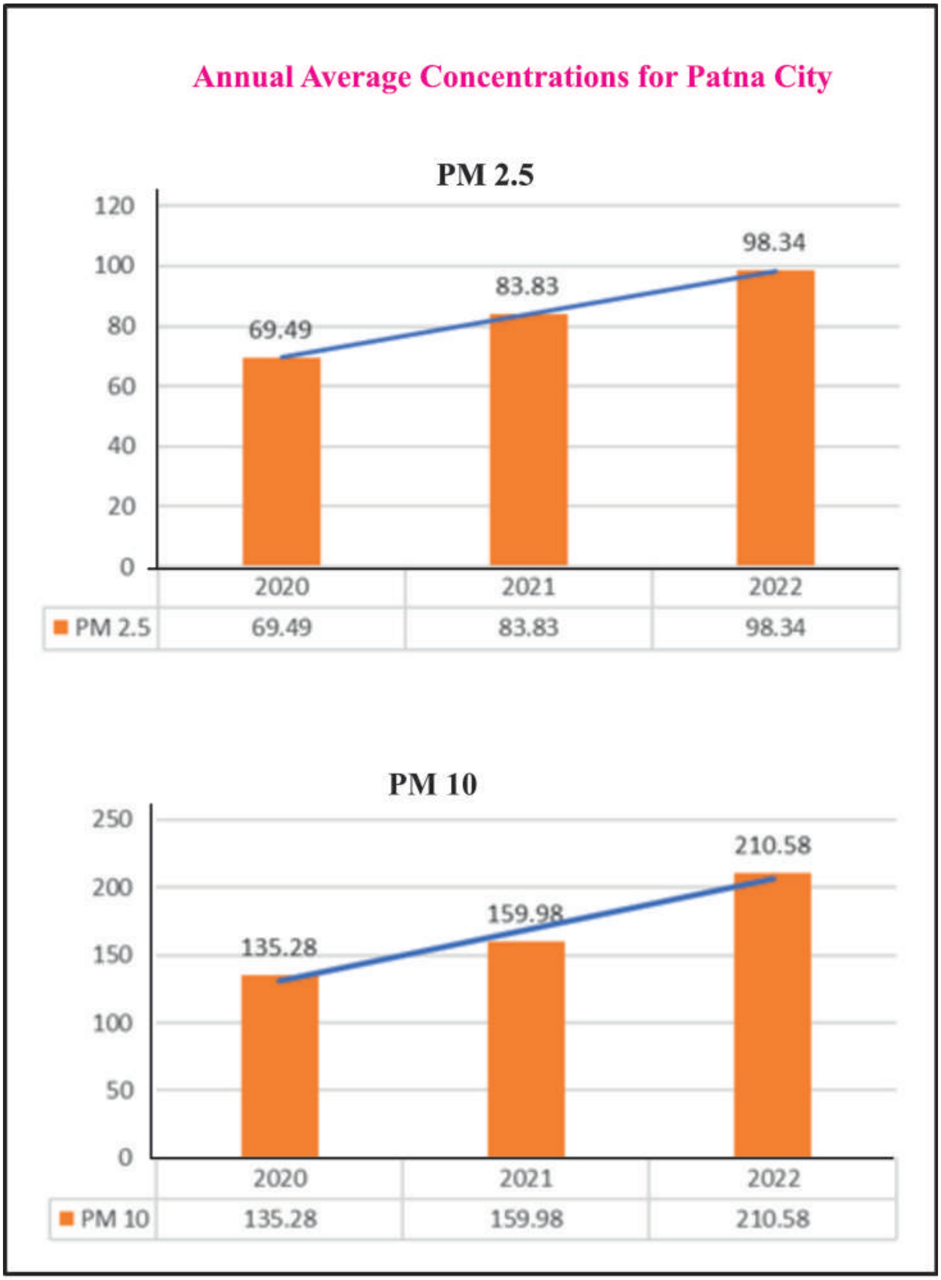
Annual Average Concentrations for Patna City
PM 2.5
120
100
80
60
40
20
0
69.49
83.83
98.34
2020
2021
2022
PM 2.5
69.49
83.83
98.34
PM 10
250
200
150
100
50
0
135.28
159.98
210.58
2020
2021
2022
PM 10
135.28
159.98
210.58

Fig. 1

influence of the known points on the estimation of unknown points. The value of p affects the estimation, with lower values focusing more on nearby points and higher values focusing on points further away. The number of known points used in the interpolation is represented by N (Morillo et al., 2022).

Results and Discussions

In this study, the annual concentrations of air pollutants in Patna city is analyzed by using data from ground-based monitoring stations. Key indicators examined were the annual concentrations of PM2.5 and PM10.

PM2.5 Annual Concentration

The annually average PM2.5 concentrations between 2020 and 2022 vary from around 69 µg/m3 to 100 µg/m3, surpassing the NAAQS in Patna city, as illustrated in (Fig. 1). The trendline of annual PM2.5 averages indicates minimal yearly fluctuations at ground-based monitoring locations in Patna city, yet consistently surpasses the NAAQS over the three-year period. There is a steady increase in the annual concentration trendline from 2020 to 2022. Fig. 2 represents the IDW interpolation map of PM2.5 concentration from high value (pink) to low value (green) over the period 2020- 2022. This IDW interpolation is based on CPCB ground-based monitoring stations in the Patna city. The IDW interpolation maps of each year represent different sites. Fig. 2 (in-top) shows that the highest PM2.5 concentration was 103.53 µg/m3, while the lowest was 61.16 µg/m3 during the period 2020. Higher concentration was observed in commercial areas compared to industrial and residential areas. Fig. 2 (in-middle) shows the highest concentration value of PM2.5 for the year 2021, ranging from 57.35 to 139.88 µg/m3. Similarly, Fig. 2 (in-bottom) represents the concentration value of PM2.5 for the year 2022, ranging from the highest value of 103.27 µg/m3 to the lowest value of 90.12 µg/m3. Fig 2, shows the IDW interpolation map clearly highlights that the concentration of PM2.5 is comparatively higher in the year 2022 as compared to the other years (Fig. 3).

PM10 Annual Concentration

The annual average concentration of PM10 in Patna City from 2020 to 2022 exceeds the NAAQS, ranging from approximately 135 µg/m3 to 210 µg/m3 as shown in (Fig. 1). Annual PM10 concentrations exhibit significant annual fluctuations across Patna city ground-based monitoring sites but remain above the NAAQS for all three years. The annual average concentration of PM10 significantly

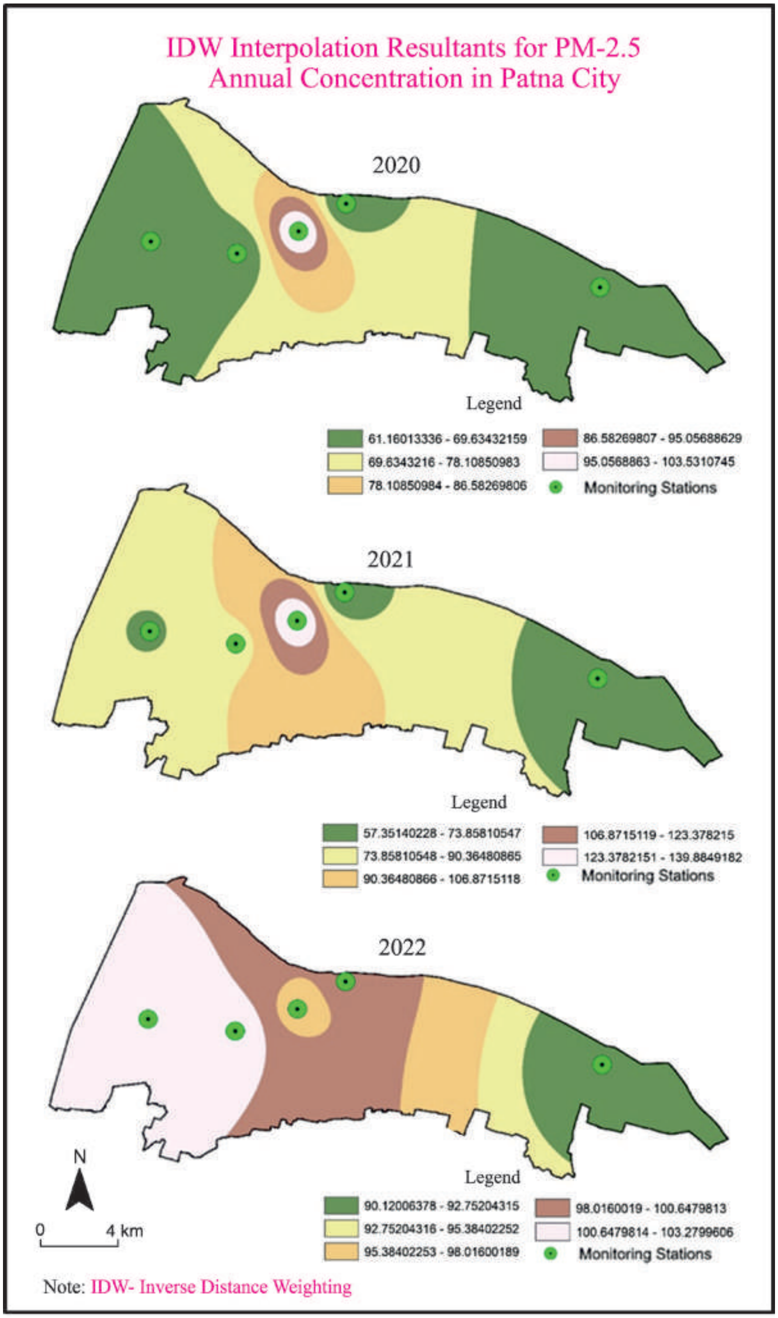
IDW Interpolation Resultants for PM-2.5
Annual Concentration in Patna City
2020
Legend
61.16013336 - 69.63432159
69.6343216 - 78.10850983
78.10850984 - 86.58269806
86.58269807 - 95.05688629
95.0568863 - 103.5310745
Monitoring Stations
2021
Legend
57.35140228 - 73.85810547
73.85810548 - 90.36480865
90.36480866 - 106.8715118
106.8715119 - 123.378215
123.3782151 - 139.8849182
Monitoring Stations
2022
N
0
4 km
Legend
90.12006378 - 92.75204315
92.75204316 - 95.38402252
95.38402253 - 98.01600189
98.0160019 - 100.6479813
100.6479814 - 103.2799606
Monitoring Stations
Note: IDW- Inverse Distance Weighting

Fig. 2

increased from 2020 to 2022, as represented in the trend line. Fig. 3 shows the IDW interpolation map of PM10 concentration, ranging from high (pink) to low (green) values, over the period from 2020 to 2022. This IDW interpolation was created using data collected by ground-based monitoring stations of CPCB located in Patna city. Each year has its own IDW interpolation map that represents different location. The IDW maps in Fig. 3 (in-top) shows the levels of PM10 concentration recorded during the year 2020. The highest value recorded was 153.89 µg/m3, while the lowest was 124.44 µg/m3. Commercial areas had a higher concentration of PM10 compared to industrial and residential areas. Fig. (in-middle) shows the highest concentration of PM10 recorded during 2021, ranging from 123.34 µg/m3 to 184.73 µg/m3. Similarly Fig. 3 (in-bottom) displays the PM10 concentration, ranging from the highest value of 236.35 µg/m3 to the lowest value of 183.89 µg/m3 during 2022. Fig. 3, IDW interpolation map, represents a highest concentration of PM10 during 2022 rather than other annual years. PM10 and PM2.5 annual concentrations for the past three years have consistently been higher than the national standards. These standards have been set at 120 µg/m3 for industrial areas and 60 µg/m3 for residential areas. Air pollution from traffic, road dust, vehicle emissions, various developmental projects, government and private building construction, and bio-fuel burning are the primary reasons for air pollution in Patna city. It is also most populated city in the state of Bihar. The air pollutants PM2.5 & PM10 of Patna city is very poor as compared to the air pollutants of other cities of India. This brings Patna under the severe category city of India.

Conclusion

In this study, air pollutants, sources, and annual variation of PM2.5 and PM10 were analyzed to assess the air quality of Patna city. The results showed that the annual average concentrations of PM2.5 and PM10 exceeded the standard limit set by the NAAQS of CPCB and European Union. This implies a critical level of PM2.5 and PM10 pollution in Patna city, which needs appropriate control measures to avoid risks to human health. In 2022, the concentration of PM2.5 and PM10 was higher than any other year. It seems that vehicle emissions and road dust are the major contributors to particulate matter in the air. To address this issue in Patna city, there are several air pollution control measures that can be implemented. Several solutions can reduce air pollution, including improving fuel quality or switching from diesel fuel to compressed natural gas (CNG), promoting the use of 4-stroke engines in two-wheelers, enhancing public transportation, and managing traffic to

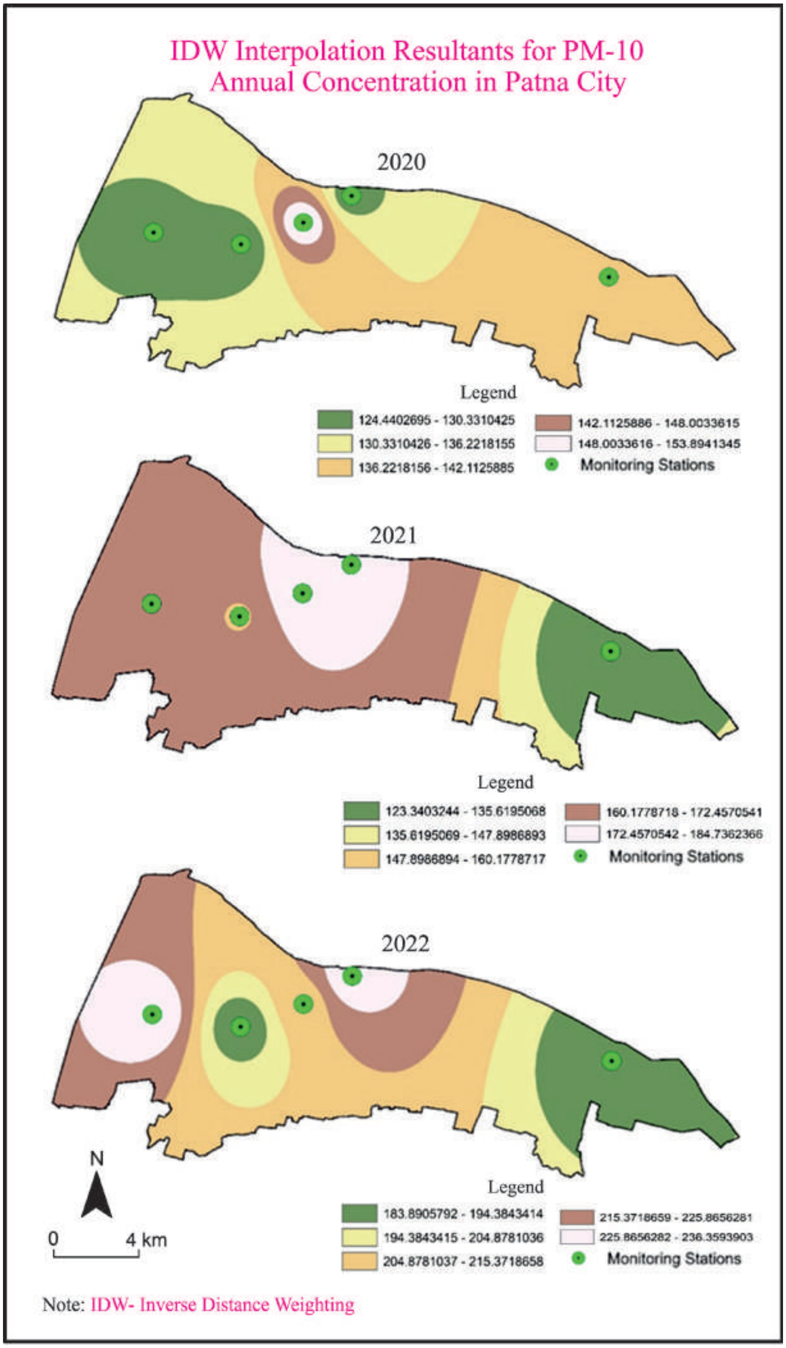
IDW Interpolation Resultants for PM-10
Annual Concentration in Patna City
2020
Legend
124.4402695 - 130.3310425
130.3310426 - 136.2218155
136.2218156 - 142.1125885
142.1125886 - 148.0033615
148.0033616 - 153.8941345
Monitoring Stations
2021
Legend
123.3403244 - 135.6195068
135.6195069 - 147.8986893
147.8986894 - 160.1778717
160.1778718 - 172.4570541
172.4570542 - 184.7362366
Monitoring Stations
2022
N
0
4 km
Legend
183.8905792 - 194.3843414
194.3843415 - 204.8781036
204.8781037 - 215.3718658
215.3718659 - 225.8656281
225.8656282 - 236.3593903
Monitoring Stations
Note: IDW- Inverse Distance Weighting

Fig. 3

reduce congestion. By adopting these measures, levels of air pollutants in the city can be reduced. Reducing air pollution contributes to achieve SDGs in several ways. Therefore, the annual concentration-based study helps to frame efficient policies regarding the mitigation of air pollution, ensuring good health and well-being, and making cities inclusive, safe, resilient, and sustainable.

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DWELLINGS AND HOUSE TYPES IN RURAL AREAS IN ROHTAK DISTRICT

Kavita Rani and Sudhir Malik

Abstract

The present research work examine the village-wise distribution of dwellings and house types based on number of rooms, number of storey and building materials in rural areas of Rohtak district. Primary data of 500 sample households has been collected from 10 villages by selecting two villages of each block of Rohtak district. It is observed that 66 percent households have three and four rooms. While one percent households have only one room. It is recorded that 99.80 per cent house's walls are made of brunt brick. Stone has been used to make roof of 78 percent households. On the other hand, marble has been occupied about 32 percent houses' floor. Only 0.2 per cent of the houses are kaccha. Kaccha houses has been found in Chiri village. The proportion of mixed houses in the study area is also only one percent. 98.8 per cent houses are pacca in rural Rohtak. It is observed that 60.2 per cent houses are occupied by double storey, 38.4 per cent houses are occupied by single storey and 1.4 per cent houses are occupied by triple storey. Triple storey hoses are found in Kehrawar, Chiri and Khidwali villages. Here the condition of the households is quite good. So we can say that people are financially prosperous in the rural areas of Rohtak district.

Introduction

House is the third important need of man after food and clothing. The house is a shelter built by man to protect himself from the vagaries of climate and to meet the basic physiological requirement of the body. Thus the house is a universal feature of the inhabited world. India is a country of villages. Households are the universal and basic element of settlement geography. Many researchers like Tiwari (1984), Kiss, E and Singh, J. (1997), Chamar (2002), B.R. Thakur (2011) have studied the dwellings in different forms in western world as well as India. Human dwelling forms an essential element of cultural landscape, as it is the best manifestation of man's material progress and his relationship with the environment. According to Finch and Trewartha (1946), "The term not only includes residential houses ranging from the humblest huts of poor to the most elaborate and massive city mansions, but all other human structures as well, where people congregate or where their goods and stored."

In any study of rural area, the investigation about peasant dwellings is very important because it is the center of combined living, functional space and social status in society. In this way, rural house type is the true indicators of its environmental conditions and the living standard of the people. Although from the point of view of architectural style it is very simple but it is important from geographical point of view. In most cases the houses are to rectangular or square in shape which contain one veranda in front. The courtyard is square in shape, surrounded by small rooms in all directions. In rural areas the houses are generally of one story which either lacks window or if it is found, its location must be in upper part of the backside wall having small in size. Finally, we can say that the character of the rural dwellings is normally determined by the nature of building materials available, their abundance and the ease of handling.

More popular recognitions of pattern have been attempted by many geographers like Tiwari. According to Tiwari, "The house is one of the three basic needs of the mankind. Its importance varies in various climatic conditions yet the basic need remains more or less the same, as it provides shelter and protection from the rigors of climatic. Therefore, it is essential to consider the location, architectural style, building materials, shape and size, house plan, cost, classification and occupancy rate of houses." Unni defined (1965) "house is a social concept; its nature and cognition are varying with cast, class, religion and region." As per census 2001, "The word has been used as a synonym for census house, which is defined as, 'a building or a part of a building having a separate main entrance from the road or common courtyard or staircase, etc., used recognized as a separate unit. It may be occupied or vacant. It may be used for a residential or non-residential purpose or both. In a simplistic way, a house is a 'shelter' to live in. It is one of the basic human entitlements which connect its occupant with the society." K. V. Chamar (2002), has worked on 'Rural Dwelling and House Types in Desert Land of Haryana: A Case Study of Bhiwani District' in which examined distribution of rural dwellings, their types, size of households, their functional characteristics, used building materials and house plan. This work is based on primary and secondary data. On the bases of selected parameters like density, growth, sex-ratio, literacy rate and work participation rate of rural population the study area has been divided into four regions. In the study area, it has been recorded that 51 per cent of total rural dwellings are pucca, 20 per cent are mixed and 29 per cent are kutcha. Further, it is found that the street pattern is irregular and unplanned. He is observed that architectural design and conditions of the households are good and attractive in the eastern region. This is due to prevailing prosperity of the local people. On the other hand, in the western region, households are generally kutcha and lack modern facilities and inhabited by the poorer people.

Study Region

Rohtak district of Haryana is selected as study area for research work. It is one of prosperous district of Haryana. The Rohtak district is extended between 28º 40' 30" N to 29º 55' 35" N latitude and 76º 13' 22" E to 76º 51' 20" E longitudes. It is bounded by Jind and Hisar districts in the north, Sonipat district in north-east, Jhajjar is in south, Bhiwani and Charkhi Dadri districts in western part. As per census 2011 Rohtak district have 615040 total rural populations, out of which 332034 (53.99 per cent) are male and 283006 (46.01 per cent) are female. Rohtak district is the part of Rohtak division. It has five Community Development Blocks namely Kalanaur, Lakhan Majra, Maham, Rohtak and Sampla have been set up in the district for the development of rural areas. There are 143 villages in Rohtak district out of which 136 inhabited and seven un-inhabited villages. Rohtak have well developed network of rail and road transport. Rohtak is shown in the map.

Objective

The main objective of the present research work is to identify the village-wise house types of rural areas of Rohtak district.

Database and Methodology

The research work is based on primary data of rural Rohtak. The data in respect of storey of houses, number of rooms and building materials of wall, roof and floor has been used. Primary data has been collected through well prepared scheduled on various aspects and personal interviews. Rohtak district have five blocks, 143 villages including seven un-inhabited villages. From each block two villages will be selected as sample village. The primary data has been collected from 500 sample houses from these sample villages. One respondent has been selected from each house and personally interviewed. Per cent distribution of households were calculated for different villages to describe the households based on number of rooms, number of storey and building materials like wall, roof and floor and variations in house types. Finally, the data has been tabulated. Diagrams has been prepared with the help of suitable cartographic techniques.

Results and Discussion

House Types: Size, Storey and Building Materials

Types, distribution and formation of the households are influenced by natural environment and socio-economic status of the people. In rural areas, single storey households were found which either lacks of window or if it is, its location must be in upper part of backside wall having small in size. But now the scenario has changed in rural areas. Mainly, house types are classified on the basis of size, building materials, storey and shape. Size of the households reflects upon the economic well-being of the people. The dwellings are grouped into six categories on basis of number of room in each house. The study reveals that three and four room households are larger in occurrence. 66 per cent households have three and four rooms. Only one per cent houses have one room and about five per cent houses have two rooms. Besides 17.6 per cent of the total houses are covered by five room households. The study represents that 10.2 per cent of the total households in rural Rohtak have six and more rooms. On the basis of above facts, it can be said that size of the households is larger in rural areas of Rohtak district. It is observed that maximum proportion of three rooms dwellings is found in Chiri (58 per cent) village.

The highest number of four rooms houses has been found in Khidwali (50 per cent) village while five room houses are in Kakrana and Nandal (26 per cent). It is highlighted that 32 per cent households have six and more rooms in Kehrawar village followed by Baniani (22 per cent) and Nandal (16 per cent) village. Even a 27 rooms' house has been recorded in Kehrawar village which is used for rent. The numbers of storey of houses are represents the good condition of villages in Rohtak. It is observed that 38.4 per cent households are occupied by single storey, 60.2 per cent houses are occupied by double storey and 1.4 per cent households are occupied by triple storey. It is highlighted that Bahelba have 64 per cent houses are occupied by single storey followed by Nidana (50 per cent), Nunond (44 per cent), Chiri (36 per cent), Baniani (36 per cent) etc. 74 per cent households belongs to double storey in Nandal village and it is followed by Ghilor Kalan (68 per cent), Kakrana (68 per cent), Kehrawar (64 per cent), Baniani (64 per cent). Eight per cent houses of Kehrawar village are occupied by triple storey and there are good conditions of houses. Triple storey houses have been recorded in Chiri (4 per cent) and Khidwali (2 per cent) also.

Use of Building Materials in Rural Areas of Rohtak District

Use of building materials is influenced by economic and environmental conditions. Generally, the houses in a rural area are built by using materials available locally. If the owner of a house can afford to bring materials from other areas, by bearing the cost of transportation and the materials, they may construct his house of choice, not restricted to locally available material. In the study area, the building materials of houses in villages can be analyzed separately for walls, roofs and floors. In the study area, building materials of houses are classified into three groups, namely, Materials for Walls: un-brunt bricks, brunt bricks, Materials for Roofs: thatch, wood timber, stone, brunt bricks, reinforced cement concrete, Materials for Floors: mud, brunt bricks, Cement, tiles, marbles. The walls of almost all the houses (99.8 per cent) are made of brunt bricks and only 0.2 per cent houses are made of un-brunt bricks. As is observed, 78 per cent of the houses in the study area have roofs made of stone. Reinforced cement concrete has been used in another 18.4 per cent houses, while wood timber has been used in another 2.6 per cent houses. One per cent households' roofs are made of brunt bricks and thatch. As is observed, about 40 per cent of the dwellings have floors made of cement in the study area. Of the remaining 31.6 households have floor made of marbles and 25.4 per cent households have floor made of tiles. While brunt bricks and mud have been used 1.6 and 1.2 per cent respectively. It is obvious that these households belong to economically better off section of society.

Villagewise Use of Wall Materials

It is highlighted that only 2 per cent walls of the households in Chiri village are made of un-brunt bricks. In all the remaining villages brunt bricks has been use to build the walls of the houses.

Villagewise Use of Roof Materials

98 per cent houses' roofs are built of stone in Nunond village. More than 80 per cent of the houses' roofs belonging to Nidana, Chiri, Baniani and Ghilor Kalan are made of stone. It is also noted that above 70 per cent stone roofs are observed in Khidwali, Nandal and Bahelba village. In case of Kakrana and Kehrawar village 68 and 52 per cent households respectively have roofs made of stone. It is recorded that the maximum use of R.C.C. as roofs' material is used in Kakrana village (32 per cent) followed by Bahelba, Nandal, Kehrawar, Khidwali etc. While the minimum use is shown in Nunond village that is two per cent. 24 per cent roofs of households are made of wood timber in Kehrawar village followed by Chiri village (2 per cent).

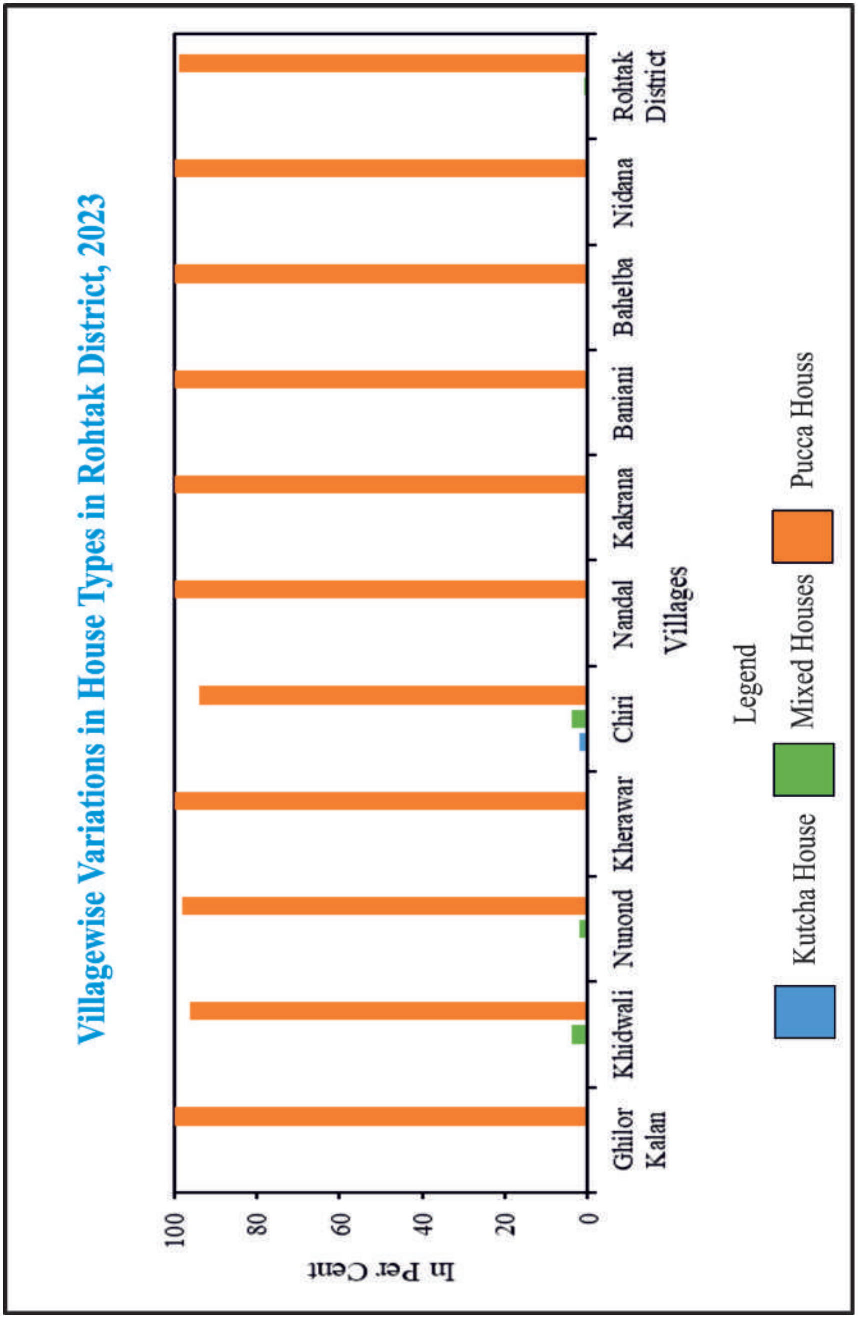
Villagewise Variations in House Types in Rohtak District, 2023
In Per Cent
100
80
60
40
20
0
Ghilor Kalan
Khidwali
Nunond
Kherawar
Chiri
Nandal
Kakrana
Baniani
Bahelba
Nidana
Rohtak District
Villages
Legend
Kutcha House
Mixed Houses
Pucca Houss

Fig. 1

Apart from this, wood timber has not been used in the roofs of any villages. On the other hand, only four per cent of the households' roofs are made of brunt bricks in Ghilor Kalan and Baniani. As a roof material thatch is used in Chiri (4 per cent) only.

Villagewise Use of Floor Materials

It is observed that maximum use of cement as a floor material is recorded in Nunond village that 54 per cent followed by Chiri (52 per cent), Baniani (50 per cent), Kakrana (48 per cent), Nidana (40 per cent) etc. Rest of the villages, cement has been used in less than 40 per cent households. 58 per cent houses' floors are made of marbles in Kehrawar followed by Kakrana and Bahelba (38 per cent), Nandal, Baniani and Nidana (34 per cent), Ghilor Kalan (30 per cent), Nunond (24 per cent), Khidwali (16 per cent) and Chiri (10 per cent). It is found that maximum use of tiles in houses' floors in Nandal (40 per cent) followed by Khidwali (38 per cent), Ghilor Kalan (32 per cent), Chiri and Bahelba (30 per cent) etc. A very small proportion of households are used mud and brunt bricks as floor's material that i.e. 1.2 and 1.6 per cent respectively in rural areas of Rohtak district. The highest use of mud is shown in Chiri (6 per cent) village. While largest proportion of brunt bricks is found in Nunond (6 per cent).

House Types Based on Building Materials

On the basis of various building material used in houses, 13 categories have been identified and broadly groups into three types of houses rural areas of Rohtak district (Table-1 and Fig. 1).

(a) Kaccha House

These types of houses have relatively very low occurrences (0.2 per cent) in the study area. Such houses are found in Chiri village of Lakhan Majra block. A common feature of kaccha house is extremely low economic groups, because its construction is simple and cheap. Most of these people depends upon the local building materials i.e. soil and vegetation etc. Reeds are commonly used for thatching. The mud wall is plastered with mud mixed with cow dung and straw to ensure safety from rains.

(b) Mixed Houses

Mixed houses are occupied by poor class people in rural India. The same is true in case of villages of Rohtak district. But their economic condition is better

Table-1: Villagewise Variations in House Types in Rural Rohtak.

Villages	Kaccha Houses	In Per Cent	Mixed Houses	In Per Cent	Pacca Houses	In Per Cent
Ghilor Kalan	0	0	0	0	50	100
Khidwali	0	0	2	4	48	96
Nunond	0	0	1	2	49	98
Kehrawar	0	0	0	0	50	100
Chiri	1	2	2	4	47	94
Nandal	0	0	0	0	50	100
Kakrana	0	0	0	0	50	100
Baniani	0	0	0	0	50	1003.
Bahelba	0	0	0	0	50	100
Nidana	0	0	0	0	50	100
Rohtak District	1	0.2	5	1	494	98.8

Source: Field Survey, 2023. Computed by Authors.

than those living in kaccha houses. The proportion of mixed house in the study area is very low. Only one per cent mixed house has been found in rural Rohtak. Village-wise scrutiny reveals that Chiri and Khidwali have four per cent houses that are classed as mixed and followed by Nunond (2 per cent) village. In this category, brunt bricks, stone and mud have been used to make the walls, roofs and floors of the houses respectively.

(c) Pacca Houses

As economically well of families live in pacca houses with better families. This type of house is more wide spread in rural areas of Rohtak district. 98.8 per cent houses are observed as pacca house. In this type of house, brunt bricks have been used to make the wall and stone, brunt bricks, R.C.C. and wood timber have been used to make the roof. Apart from this, the floor is made of cement, marbles, tiles and brunt bricks. It is highlighted that cent per cent households are pacca in Ghilor Kalan, Kehrawar, Nandal, Kakrana, Baniani, Bahelba and Nidana village. Along with this, 98 per cent houses in Nunond, 96 per cent houses in Khidwali and 94 per cent houses in Chiri fall in this category.

Conclusion

The overall wellbeing of individual in a community is closely related to the living conditions reflected in the types of houses they live in, and amenities and space available to them. The quality of houses in the study area has improved over time, be it in terms of building materials, storey or size of dwellings. Rohtak is predominated by pacca, two storey and three to four rooms house. Here the condition of the households is quite good. So we can say that people are economically prosperous in the rural areas of Rohtak district. Despite this, the government should find out the reasons behind the houses being kaccha and mixed. Along with this, appropriate steps should be taken to solve them.

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BIDADI AND ITS NEIGHBOURHOOD IN BENGALURU URBAN FRINGE AREA- A REGIONAL APPROACH TO PROMOTE SUSTAINABILITY AND GROWTH

Dr. Priyadarshini Sen

Abstract

A rural-urban fringe area of Indian cities is often known for its excellent growth of crops like cow peas, snake gourds and brinjal as grown in Bidadi. This fringe area of Bengaluru has been significantly known for its promising scope in the industrial activities of Karnataka and most importantly the southern part of India. The urban project under the name of Bidadi Smart City Local Planning Area has been expected to accommodate the growing population of Bengaluru city as new industrial units are coming up gradually on its rural inclined landscape. The paper analyses the demographic factors like population, its gender distribution, literacy status, working scenario of the study area along with the upcoming land use proposals with utmost environmental sustainability. The levels of disparity between male and female literacy, poor working status (with more dependencies) remained chief concerns. Additionally, the rising levels of pollutants in the river Vrishabhavathi, flowing at close vicinity of Bidadi due to reckless disposal of industrial effluents has been highlighted in the study. Thankfully, recent urban-planning efforts in Bidadi have been much more sustainable promoting integrated crop cultivation methods, regular cleaning of the river, regulating zones exclusive for forest activities and promoting energy generation from solar panels and effective rainwater harvesting for industrial needs. The statistical analyses and diagrammatic representation of such components of Bidadi region presents an unique kaleidoscope of concern and hope for future.

Introduction

It is important to track the risk associated with the megacities to the social background (Banzhaf E., 2011); so, for that matter quantitative and qualitative assessment are of utmost importance. For such cities, it is always important for the government, and decide how to plan, finance and manage urban areas, and those in transition (UN, 2023). In the United Kingdom, there was an increase in concern regarding the future of rural-urban fringe areas of low-density development punctuated by rugged open spaces with essential service functions enveloping towns and cities (Gallent N., 2006). For Asian countries the process of urbanization takes various forms, categorised into two parts; communities that have experienced planned urbanization vs. communities with spontaneous urbanization while creating slums. The first one is the choice and the second one is that happens sporadically. Planning for the expansion of urban areas are the co-ordination procedures between the government obviously for making of plans and governance (that means managing its execution) (Huxley M., 2020). UN in its 17 sustainable development goals have highlighted much needed support for establishing positive, economic, social and environmental links between urban, peri-urban and rural areas by strengthening national and regional development planning initiatives. There are numerous villages in areas adjacent to Bengaluru city which have been continuously taken for connecting with the city proper ways; through transport and infrastructural linkages, urban activities amidst steadily vanishing patches of agricultural lands (Balakrishnan S., 2013). Infact the concentric expansion of the city has witnessed such haphazard process of urban expansion at the cost of greeneries and open lands with excellent climate for which it was termed pensioners' paradise few years back. It was mentioned that Bidadi was a place where the then Maharaja of Mysore in is way towards Bengaluru stopped and then had his breakfast. It was initially called Bidara (meaning lodging in Kannada) in Kannada. It has been presently called Bidadi and considered a promising industrial unit and urban area in the neighbourhood of Bengaluru.

Study Region

The paper discusses some vivid characteristics of a region that is situated in the south western fringe area of the extended urban periphery of Bengaluru Urban Agglomeration. Cities in India are major growth poles of polarised functions and specialised activities. The fringe area includes one of the most significant districts of Karnataka and that is Bengaluru Rural which come under direct zone of influence of the major city of India and the software capital. The district, as the name suggests has been typically rural where the urban planners have plans to decentralize some of the congestions and functions of Bengaluru to tackle the urban infrastructural inadequacies. The region has potentials of urban expansion and serving the main city may be an opportunity for the district's overall economic situation. But what is concerning is its great stretches of forest areas and agricultural activities that may suffer from changing land use. The name Bengaluru originated from the word Bendakaluru, as during his tour the then king Kempegowda was hungry and he was served with Bendakalu (boiled beans) by an old woman. It should be noted, few years ago this area named Bidadi in the vicinity of Bengaluru was chosen as a location for developing Integrated Township programme. As, Channapatna is famous for its wooden toys, Ramanagara for its silk, Bidadi is known for its famous Bidadi Thatte Idly (a type of food made with rice flour). This has been further associated to the areas or rather the fringe part that may be considered for decentralised urban activities. This has come to be known as Bidadi Smart City Local Planning Region. This region includes 37 villages of Ramanagara district and one ward of Bidadi Municipal Council. It covers four major sub-districts or Hoblies of Ramanagara, namely Ramanagara Kasaba, Kailancha and Harohalli. The study area encompasses twenty-five villages of Bidadi sub-district followed by eight villages of Ramanagara Kasaba sub-district, three villages of Kailancha and one single village of Harohalli.

Objectives

(1) The study is a detailed analysis of Bidadi Smart City Local Planning Area based on demography, land use and the risk of environmental degradation with growing industries

(2) It incorporates comprehensive approach towards studying Bidadi it in the light of rural-urban fringe including the municipal and village boundaries

Database and Methodology

The goal of any kind of research especially, the social science based, are to explain real conditions based on secondary and primary level data which may be described according to future planning perspective. So there remains quite an urgent need of reviewing past literatures while Bidadi and its neighbourhood is studied. The past studies would initially be on a global scale; like how well (or poor) the overcrowded cities are managed with promises to maintain sustainable land use at its optimum level. Being an Asian city, Bengaluru is suffering hugely from over- population and haphazard of growth of urban functions. Due to this it is sprawling in its fringe areas and Bidadi is one of them. In the name of Bidadi Smart City and Local Planning Area, Bidadi an urban unit and its surrounding villages have been integrated to develop an urban cluster or region to be particular to share some functional and demographic loads of Bengaluru. For such analysis, great deal of past and present data have been gathered from government offices, land use departments and research papers. Additionally, the census data for Karnataka and the districts in particular of 2011, came supported the study with village and municipality-based data of the demographic components. Observations based on data on the region encompassing size of population, households, male and female literacy rates, working status (workers and non-workers) analysed the present conditions of the region. Besides, the study also throws light upon the plan for future land use to understand its potentialities and perspectives to be exemplary to the other rural urban fringe areas yet to develop. Thus, the methodology of this study may be summed up as mentioned below:

(a) The study area quantifies the demographic parameters and land use components.
(b) Its planning perspective has been highlighted with the proposed land use in Bidadi and its rural fringe areas.
(c) The study has significantly thrown light upon the risk of environmental hazards due to the growing urban functions on this area. But although the attempts of conservation (solar panels, integrated cropping systems, rainwater harvesting measures) and de-siltation of the river bed have been started recently, but have been mentioned for future reference in other studies and research for finding solution to similar urban planning.

Result and Discussion

Physiographically, the study area of Bidadi Smart City Local Planning Area is underlain by the granitic gneisses which had created captivating lands with rich mineral resources in a dry savanna type of climate. The crops grown here are mostly dry millets with some varieties of oil seeds and pulses. Also, the forested region of this particular area primarily consists of deciduous species with thorny undergrowth. Most trees are used as firewood; however, sandalwoods and bamboos are commonly found. This region is majorly drained by the river of Arkavathi, a tributary of river Kaveri. The study area of Bidadi Smart City Local Planning Area as mentioned contain around 37 villages and one ward of Bidadi City Municipal Council. It encompasses nearly 15,000 households altogether which is not very high with around 400 households on an average. Of these villages, Balaguli has been recorded uninhabited and Hejjala village of Bidadi Sub-district record nearly 900 households. However, Bidadi with an urban status records higher number of households. Table-1 denotes the categorised distribution of total households present in the study area; most villages are found to be sheltering population well below the mean; infact 24 villages show such trend where population households are calculated well below the average measured on Z-score. There are only few villages (11 only) who show a slightly higher distribution of households as measured by mean. These villages that have been chosen for planning at the regional basis are quite low in households' numbers that may be due to the reason of inadequate supply of rich agricultural products and job opportunities. This may be taken as an advantage while the planners of city often suffer from the dilemma of evacuating the indigenous population and resettling the same.

Table-1: Distribution of Towns and Villages Based on Total Households

Z Scores	Villages/Urban Areas	Count
>=1.00	Bidadi, Hejjala	2
0.50-1.00	Hagalahalli, Abbanakuppe, Baleveeranahalli, Byramangala, Gopahalli, Kenchanakuppe	6
0-(0.50)	Kethohalli, Hosuru, Ittamandu	3
0-(-0.50)	Kempayyanapalya, Kempanahalli, Madapura, Mayaganahalli, Basavahalli, Annahalli, Bennahalli, Vaderahalli, Allalasandra, Bannigiri, Ramanahalli	11
(-0.50) - (-1.00)	Dharapura, Manchegowdanahapalya, Borehalli, Ganakallu, Gollarapalya, Hulthur State Forest Region, Kanchugaranahalli, Kanchugaranahalli Kaval, Kempadyapanahalli, Kakaramanahalli, Ivagilu, Yerepalya	13

Source: Computed by Authors

$$Z\ Scores=[(xi-\mu)/\sigma]$$

where xi is the observations (here households) μ= Mean of the observations (households) and σ =Standard Deviation (of households).

Overall, it may be stated that the study area includes male dominance of distribution of population (53 %) over female population (47 %). Altogether, there are around 45,000 people residing in the study area with over 24,000 people being males and around 21,000 females. They, being the early residents of the region are to be prioritised through resettlement and employment opportunities and of course compensational drives. Majority of villages show population in less than 1000 category, followed by those belonging to 1001-2000 category. There are only two villages which record total population between 3001 to 4000 as per Census of India 2011. Bidadi being the only urban area with a single ward has a total population of over 4001 (almost 10000). Also, as far as the gender wise distribution of population is concerned, the three hoblies namely Ramanagara Kasaba, Kailancha and Harohalli show meagre gap between male and female distribution of population (1-2%), however the picture is quite different in Bidadi where maximum number of villages are included. The gap between male and female distribution of population is high as 7% owing to the fact that Bidadi urban area provide slightly better opportunities for employment, education and other infrastructures for which the male population have migrated from the nearby areas to migrate in this particular urban location. Their families have stayed back to their places of residence away from this region. The share of population belonging to backward class (SC and ST) to total population have been 19% and 1.5% respectively in the study area. The region records overall male dominance amongst these population over the females (52% and 53 % Male SC and ST population and 48% and 47% Female SC and ST population altogether). At micro-level it may be found that Bidadi records highest number of these backward class population followed by Ramanagara Kasaba, Harohalli and Kailancha sub-districts.

The male population in these categories dominate the females except for Kailancha where females in Scheduled Caste category outweighs the males in number. Infact these analyses are necessary to implement region-based approaches for development of the backward areas; proper implementation of government initiatives on educational schemes and employment opportunities should come up with the city expansion initiatives. The region as planned under Bidadi Smart City Local Planning Region should not only build infrastructures for new investments on industries that would eventually attract skilled employees from other places but also employ the local youths with training or direct recruitment drives whichever and wherever possible. There are other factors which need to be considered thoroughly; literacy is definitely a parameter which largely impact development. But it is more meaningful to consider gender level disparity in literacy scenario. Most of the villages in the study region (29 villages out of 38) have percent male literacy outweighing the females. Out of the remaining villages, 5 record higher gender disparities in the parameter of literacies. Two villages, namely, Ivagilu and Hulthur State Forest Region experience even acute gender disparity in male-female literacy; the latter village is situated amidst a forested region where such disparities may be likely but should be eradicated. The village named Muddapura Karenahalli however exhibits a different picture where female literates outweigh male literates (Fig. 1). There are other factors which need to be considered thoroughly; literacy is definitely a parameter which largely impact development. But it is more meaningful

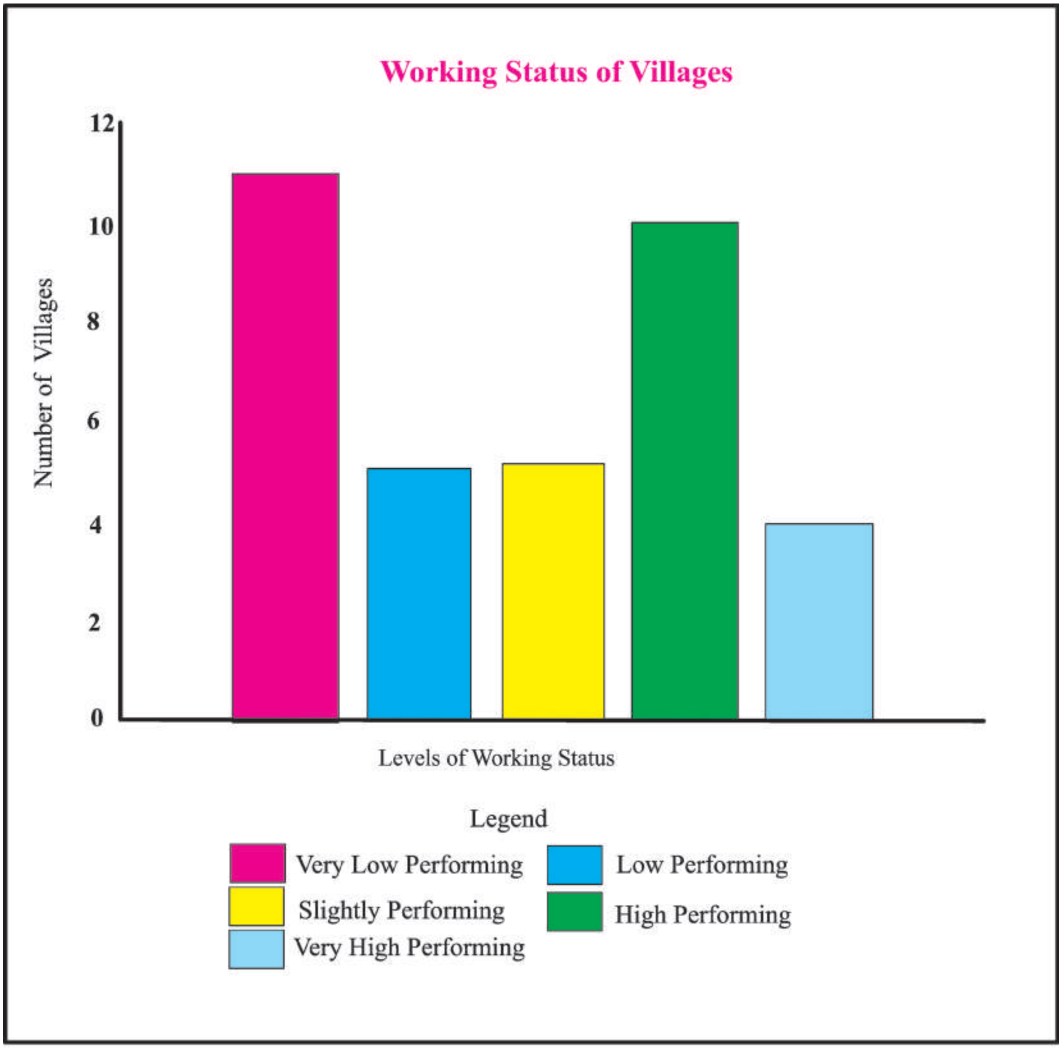
Working Status of Villages
12
10
8
6
4
2
0
Number of Villages
Levels of Working Status
Legend
Very Low Performing
Low Performing
Slightly Performing
High Performing
Very High Performing

Fig. 1

to consider gender level disparity in literacy scenario. Most of the villages in the study region (29 villages out of 38) have percent male literacy outweighing the females. Out of the remaining villages, 5 record higher gender disparities in the parameter of literacies. Two villages, namely, Ivagilu and Hulthur State Forest Region experience even acute gender disparity in male-female literacy; the latter village is situated amidst a forested region where such disparities may be likely but should be eradicated. The village named Muddapura Karenahalli however exhibits a different picture where female literates outweigh male literates. Kanchugaranahalli Kaval records 50% male literates and 40% female literates which are quite low as compared to the other villages though Bidadi being urban creates a hopeful structure for female literates (around 83%) and male literates (92%). The working status of the population in the majority of villages are very poor performing; this is given by the fact that in major number of villages the non-working population outnumber those being working. Infact there are nearly 16 villages altogether where non workers are recorded more than working people (Fig. 2). There are around 20 villages where though workers are recorded more than the non-workers but these situations as directly attributed to the region's underdevelopment. While this area is thought to be an alternative place of re-centering some of the functions of over congested city of Bengaluru, but what remains important is to give growth impetus to the already underdeveloped pockets of it in order to arrest further disparities.

Coming to the main workers it may be inferred that the share of male main workers is distinctly predominant (around 71%) over the females (29%). Interestingly, the percentage of female marginal workers (52%) dominate that of the males (48 %). The marginal workers are those who according to the Census of India, did not work for at least 183 days in the preceding 12 months uptill the Census. This situation is common in any rural areas of Asia where the females work temporarily in fields, mining, forest activities or local factories for a very short period of time. For such engagements, women need to balance their family related responsibilities like cooking, taking care of the children and relatives and many other daily chores. In most cases, they are unable to do so and thus remain only as marginal workers with irregular wages and working hours. Comparable participation of male and female population in any region in the spheres of economy, most importantly in wage earning activities remains significant in the parameter of social wellbeing. Also, as far as the gender wise distribution of population is concerned, the three hoblies namely Ramanagara Kasaba, Kailancha and Harohalli show meagre gap between male and female distribution of population (1-2%), however the picture

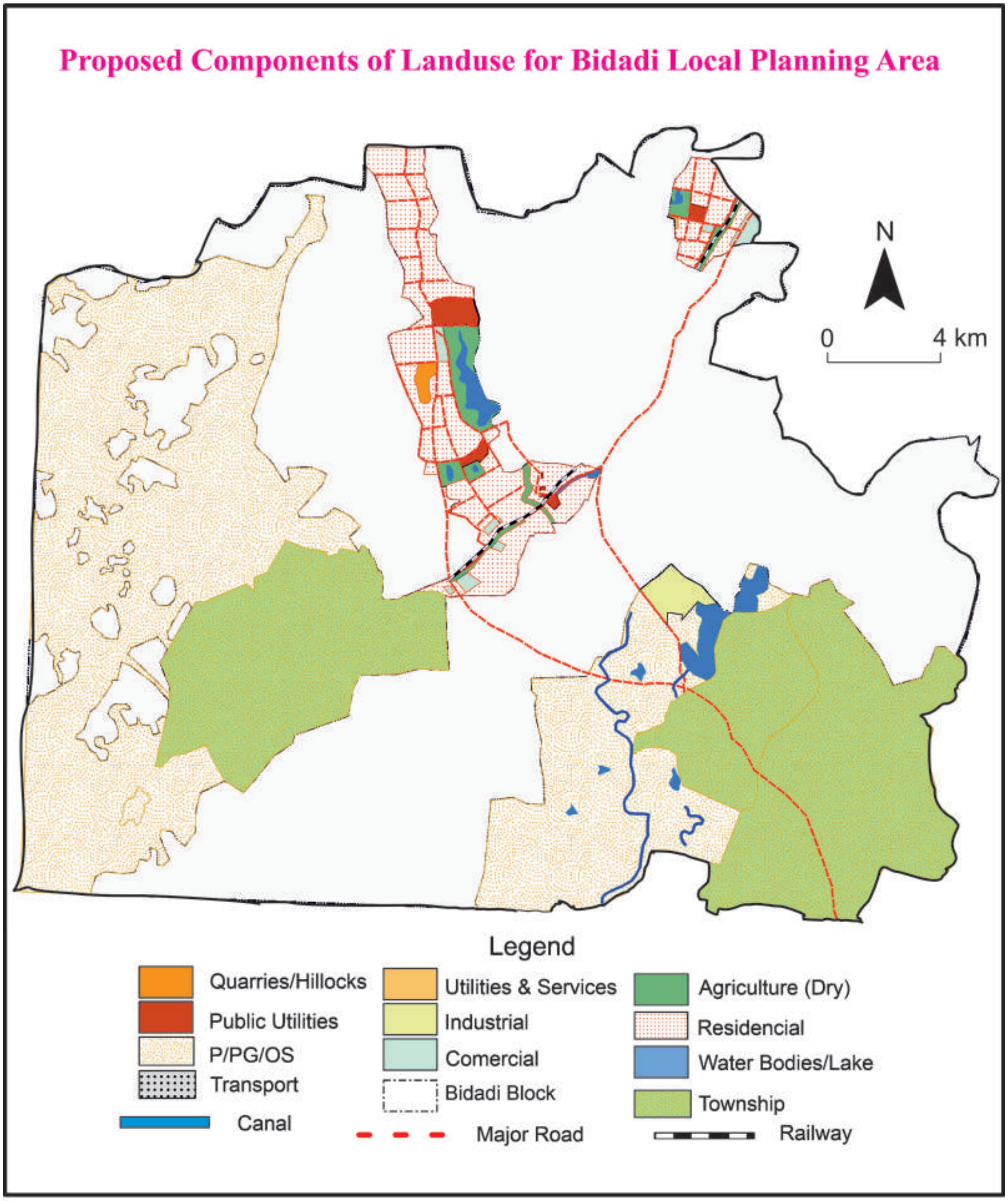
Proposed Components of Landuse for Bidadi Local Planning Area
N
0
4 km
Legend
Quarries/Hillocks
Public Utilities
P/PG/OS
Transport
Canal
Utilities & Services
Industrial
Comercial
Bidadi Block
Major Road
Agriculture (Dry)
Residencial
Water Bodies/Lake
Township
Railway

Fig. 2

is quite different in Bidadi where maximum number of villages are included. The gap between male and female distribution of population is high as 7% owing to the fact that Bidadi urban area provide slightly better opportunities for employment, education and other infrastructures for which the male population have migrated from the nearby areas to migrate in this particular urban location. Their families have stayed back to their places of residence away from this region.

Landuse Pattern

In order to ensure public health, safety and social wellbeing of the population it is always important to apply some kind of reasonable limitations on development aspects. Land use has been one of many parameters which is significantly changing with growing urbanization and cities under planning (and sometimes sporadic though). The state thus should pose some regulations which would ensure a balance between growing urbanization and conserving the environment through true demarcation of zones under residential, commercial, industrial, public and semi-public uses. It has to be mentioned here that this area chosen for planning includes Hulthur State Forest Region which has to be conserved. Since 1900 indeed the forested regions of Karnataka are heavily exploited for the supply of fuelwood, timber and bamboo which later were somewhat restricted using legal initiatives though. As far as historical accounts are available, this region presently under study came under expansive stretch of Chandanaranya (Sandal Forest), the Ganjaranya (forest of the Abrus precatorius) and Kundaranya (Jasmine Forest) which were later cleared for human settlements. So, it has to be kept in mind while planning, is that the forested regions which are existing at present should not be compromised at the cost of urban infrastructural projects. Here the motto remains conservation should go hand in hand with urban development. Keeping in view the present policies, due consideration is given to the concepts of conservation, wildlife management, eco-tourism, participatory management of forests and conservation of agricultural field growing paddy, millets and sugarcanes. The villages under the study area are less populated which may consider advantageous but they have quite a considerable stretches of vegetation patches that are needed to be conserved in situ which may appear challenging (Table-2).

It is very crucial to design a plan for this particular area with a sustainable approach for a region-based planning. The fig. 2 exhibits an overall sketch of Bidadi's future land use plan; what is striking to note is the region shows lesser settlement areas which may be advantageous from the view point of new settings of industrial units and transport corridors. The availability of area for planning

Table-2: Plant Species and Villages of the Study Area

Villages	Plant Species
Hulthur State Forest Region	Arali, Honge, Bevu, Hippe, Sissooo, Thoremathi, Nayinerale, Basari, Sandal, Bela
Kempanahalli	Acaccia, Eucalyptus
Annahalli	Acaccia
Mayaganahalli	Sissoo, Nerale
Bidadi	Honge, Rain Tree, Peltophorum.
Gopahalli	Mixed vegetation
Hejjala	Acacia, Hunase, Hale, Neelagiri
Hosuru	Ashoka, Honge, Hunase, Jakaranda, Gulmohar

Source: GOK, Bengaluru Rural Forest Division, 2003

remains always a challenge for the authorities to set up non-agricultural or industry-based activities which often brings in the not so desirable issues of displacement of early settlers and compensations. However as depicted below, the study area shows a not so crowded deserted region which have been selected for the urban planning in the name of Bidadi Smart Town Local Planning Area. The urban settlements are scanty, the remaining land use has been mostly rural in nature and a major part has remained open or under-utilised. The western part of the study area includes a vast expanse of areas under open spaces which have been demarcated for playgrounds, parks and maintained open spaces. To be precise, the region may be suitable for thoughtful planning with adequate provisions of new urban settlements, industries that may be positioned in the western part with the precondition of maintaining the share of open spaces and green areas. It shows zones demarcated for town areas in the western and eastern part for future. The ribbon like strip of urban residential areas are markedly found in the northern part of the region which passes uptill the middle part.

The north-eastern part also shows patches of few residential areas that may be considered zones of urban development which may be further upgraded with infrastructural activities. Few are the areas under water bodies; within the residential areas mentioned above in the north and that in the southern part too. These water channels may be desilted at regular intervals which may preserve the tiny aqua-ecosystem present here. Within the residential areas there are areas marked for quarrying activities where the local and migrants from the nearby villages are engaged as daily paid workers. The ribbon like settlement area has a tiny patch of dry agricultural land; which should be preserved for the sake of the associated cultivators. At a glance, the road networks and the railway line (in the eastern segment) should have provision of further expansion and extensions if Bidadi has to be viewed as a promising urbanisable block or planning area in the near future. The land use categories have been tabulated below, which shows that sustainable planning for Bidadi prioritises agriculture the most (41.5%), followed by land use for residential activities (31.30%). The lakes, existing and to be maintained, should cover almost 4 square kilometres areas. The transport activities should cover nearly 5% of proposed land area but as far as the visual interpretation goes, there should be more transportation facilities if there is a plan for urban-industrial expansion. It is satisfying to note that the areas have been marked under park, open spaces and playgrounds categories. The balance of development and conservation may be achieved this way; also, taken lakes or waterbodies and parks or playgrounds and open spaces together outweigh the area coverage of transport activities (Fig. 2).

Table-3: Land Use Proposed in Bidadi Smart City

Sl. No.	Landuse Components	Area in Square Kilometres	% Coverage
1	Agriculture	18.55	41.5
2	Residential	13.99	31.3
3	Lakes	3.99	8.9
4	Transport	2.20	4.9
5	Parks/Playgrounds/Open Spaces	2.01	4.5
6	Industrial	1.79	4.0
7	Public Areas	0.98	2.2
8	Commercial	0.79	1.8
9	Quarries	0.36	0.8
10	Utility	0.05	0.1

Source: Bidadi Smart City Local Planning Area (2021)

Note: Computed by Authors

Concerns for Planning

As per the structural planning regulations, there are few ‘A’ grade risks associated to Bidadi Smart City Local Planning Area which are considered the ‘most critical ones' as far as urban planning and expansions are concerned. The study area of Bidadi and its neighbourhood is situated in close vicinity of river Vrishabhavathi, a tributary of river Arkavathy, which has been under tremendous threat of excessive pollution due to reckless disposal of waste water from the industrial units already present and domestic sources as well (GOI, 2021). The river reportedly carries quite a huge load of industrial effluents from the industrial regions of Peenya, Yeshwanthpura, Kumbalgodu, Bidadi and Harohalli (and it is frustrating to note that many local industries dump their harmful waste products, including plastic directly and repetitively into the river). Rapid urbanization of Bidadi and its neighbourhood may limit the catchment area of the river which may lead to over-flooding of its bank and affect the region. Besides, one of the leading producers of automobiles, the Toyota factory has been lately expanding its factories in this area which has no-doubt a positive impact as far as employment is concerned. The industrial unit has also some meaningful environment friendly measures which are noteworthy; the painting of their motor cars were initiated in water-less paint (or dry booths). Infact they already shifted the fuel sources from LPG to Pipeline Natural Gases and use solar energy vigorously for lighting of streets public spaces, open areas, traffic signals, and advertisement related billboards. Also, it should be noted that Bidadi occupies the third position after Devanahalli and Bommasandra in making provision of area for automobile industries which would provide employment opportunities to the people and upgrade the infrastructures too. But it should be noted opportunities in work forces should not only be beneficial to those migrating from Bengaluru city, these opportunities should percolate to the people who are the local residents.

In such cases it is important to provide them with suitable training and educational along with skill development workshops for a broader job prospect in situ. Such urban growth and which are meant to be regional should not push the early residents at the margins of their very existences. Besides there are many other kinds of industries which may generate employment opportunities, like food and beverage-based industries (Paramount Nutrition Biscuit Company and Coco-Cola), handicrafts at Jogaradoddi, film city, golf playground and restaurants along with hotel businesses (GOK,2020). It should be also mentioned here that the Coco cola company has encouraged integrated farming systems in Bidadi providing training, seed banking and that too totally free of cost. That can be their ways of reducing the carbon foot prints but the initiative is no-doubt mention worthy. Additionally, Bidadi and its surrounding areas are also noted for its mining and quarrying activities on gneissic structure with hornblende dominances. These are used for building and infrastructure materials but the quarry workers are mostly migrants originating from the adjacent villages of Tamil Nadu. However recently such migrants and the local people record a trend of clinging to the main market area of Bidadi for better job opportunities. What is concerning in the study area is that there is quite a variety of workers as far as occupation type and economic levels are concerned which may make the process of planning for Bidadi Smart City Local Planning Area time consuming.

Conclusion

It is important to protect, sustain and expand areas with bio-diversity and ecosystem specific importance to make ways for new resilient resource effective societies. At present there have been multiple views against forceful alteration of rural areas into urban which is dominant in the present study area too; scholars also argue that process of interconnectedness between urban and rural frills are nothing but capitalistic transformation (Schwind M, Altrock U., 2023). It has been estimated that the decades between 2021-2031, would witness the dominance of cities and towns even urban settlements and even with both rural and urban characteristics (that may be termed 'Rurban' (GOK, 2022). Such changes over the decades were inclined more towards industrial and residential development, where Bidadi is no exception, which came up amidst its otherwise land dedicated to millets and mango fields (Sen P., 2014). The dilemma is still there, with urbanization vs agriculture or industries vs green fields and even in-migration of the technically sound labour force vs the marginalization of those local who every-day face the threat of evacuation and loss of indigenous occupation. In India, as economic conditions improved in many cities, like Bengaluru, with faster pace of urbanization that needs to be addressed with long term sustainable urban solutions (UN, 2003).

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MGNREGA AS A TOOL FOR EMPLOYMENT GENERATION IN ROHTAK DISTRICT OF HARYANA

Deepak Moda

Abstract

The Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA-2005) is the world's biggest employment generation programme launched in India to fill the gap in employment generation in rural parts of the nation. It aims to improve the poor's access to resources for subsistence living, create long-lasting rural assets, ensure social inclusion, and enhance Panchayati Raj Institutions. MGNREGA is, therefore, seen as a 'magic pill' for reducing rural poverty and unemployment. By offering livelihood stability through wage employment and asset development, it can brighten the lives of the locals, especially the vulnerable rural population. The key concern of this research paper is to analyze the block-wise performance of the MGNREGA in Haryana's Rohtak district which is located at a distance of 80 kms from the national capital New Delhi and 228 kms from the state capital, Chandigarh, employing secondary sources of data obtained from the official website of the MGNREGA for FY 2021-22. Are rural households in the district interested in undertaking the MGNREGA jobs? Has MGNREGA been able to provide employment to rural households in the district? This paper attempts to address some of these questions with the help of data analysis. The study's findings reveal that rural households in the district are willing to undertake unskilled MGNREGA work but the implementing agencies have not been able to meet their expectations. Undertaking more sincere and concentrated efforts is the need of the hour to make the act successful in achieving its anticipated goals. The study would be helpful to policymakers interested in overcoming the inter-block variations in the patterns of performance of MGNREGA. The future implication of the study is a vastly improved ability to derive latent information based on data analysis for the implementation of MGNREGA constructively to rejuvenate and strengthen rural areas.

Introduction

Came into existence on November 01, 1966, Haryana is one of the nation's most developed states with a per capita income of INR 2,96,685/- lakhs during FY

2022–23 (PIB, New Delhi, 2023) and is second only to Rajasthan in terms of the number of unemployed people (CMIE, Jan-April, 2021). In rural Haryana, where 24.24 per cent of the population is classified as unemployed, the situation is even worse. When it comes to women, the situation is considerably worse. Numerous households are being forced deeper into poverty as a result of unemployment. Therefore, to maintain a bare minimum level of living, rural households are in desperate need of employment possibilities. In this situation, MGNREGA, a right-based flagship scheme of the Government of India with effect from February 02, 2006, is a blessing for the communities as it legally guarantees at least 100 days wage employment every fiscal year to every household whose adult members want to perform unskilled manual labour. There is a wealth of literature to help understand the MGNREGA and how it is implemented in rural areas. Moda and Singh (2023) in their study in Nuh district of Haryana concluded that although MGNREGA achieved one of its anticipated goals of one-third of the total employment to women, it rendered nearly one-fourth eligible employment seeking households unemployed. In their assessment of MGNREGA, Meenu (2022) and Puthukkeril (2015) concluded that MGNREGA have fallen short of expectations. In his study, Patra (2021) highlighted that MGNREGA not only improved the livelihood conditions of the rural poor but also improved the local infrastructure, lowered poverty, reduced distress migration and improved the health and economic conditions of the rural poor to some extent. Mishra and Madhulika (2018) and Vattriselvan et al. (2018) highlighted that MGNREGA contributed to reducing poverty in rural areas. In their study, Paul (2016), Biswal (2017) and Sharma et al. (2017) highlighted that MGNREGA brought a series of positive changes in the lives of rural households as it not only freed them from the local unorganized employers for their livelihoods but also benefitted them in the off-season when they are not in their self-economic engagements.

Study Region

Rohtak, occupying a total area of 1745 sq. kms., is one of the 22 districts in Haryana and is located at a distance of 80 kms from the national capital New Delhi and 228 kms from the state capital, Chandigarh. It is bordered on the north by the Jind and Sonipat districts, on the south by the Jhajjar district, on the east by the Jhajjar and Sonipat districts, and on the west by the Hisar and Bhiwani districts. The Rohtak district consists of 146 villages, 151 Panchayats, 2 sub-divisions/tehsils (Rohtak and Maham), 1 sub-tehsil (Sampla), and 5 community development blocks (hereafter, CD blocks) viz., Kalanaur, Lakhan Majra, Maham, Rohtak, and Sampla.

According to 2011 Census, Rohtak is home to 10,61,204 people of which 5,68,479 (53.56 per cent) are men and 4,92,725 (46.43 per cent) are women. The district has a 70.45 per cent documented literacy rate. Compared to the state average of 75.6 per cent, it is marginally lower. Women's literacy rate is 41.68 per cent and men's literacy rate is 58.32 per cent. The sex ratio in Rohtak district is 867 females for every 1,000 males, which is significantly lower than the national average of 927. Of the total population, 27.23 per cent and 5.37 per cent constitute the main workers and marginal workers respectively while 67.40 per cent are non-workers (Census, 2011). Despite being a politically vibrant district and located in close spatial proximity to the national capital New Delhi, 13.72 per cent population of the district is multi-dimensionally poor (Niti Aayog, 2021). By region, rural residents (16.83 per cent) are far more poor than urban (9.18 per cent) residents.

Research Objectives

(1) To analyse the extent of households issued job cards, demanded employment, and provided employment under MGNREGA; and
(2) To analyses the extent of unskilled wages paid to labourers.

Database and Methodology

To develop this paper, secondary data sources have been used and the same were gathered from the official website of MGNREGA, Ministry of Rural Development, Government of India with particular reference to households issued job cards, demanded employment and provided employment, women’s share in total employment, average days employment provided per household and amount of unskilled wages paid to labourers. Latest financial year, i.e., 2021-22 has been taken as the reference year for the data analysis while the Community Development Block has been taken as the basic unit of analysis to examine MGNREGA as a tool for employment generation. Tables and pie diagrams have been prepared for better visual representation and interpretation of the data. Tabulation, average, percentage, and graphical tools have been employed to explore the research questions.

Results and Discussions

MGNREGA has been in operation in Rohtak district since April 01, 2008. Table-1 sheds light on the performance of MGNREGA in Rohtak district vis-à-vis Haryana during the FY 2021-22.

Table-1: Performance of MGNREGA in Rohtak District (2021-22)

Particulars	CD Blocks					Rohtak District	Haryana
	Kalanaur	Lakhan Majra	Maham	Rohtak	Sampla		
Cumulative households issued job cards	7,503	4,494	8,950	10,169	5,808	36,924	11,55,331
New households issued job cards	1,060	445	957	1,169	393	4,024	1,71,907
Households demanded employment	3,393	2,447	3,781	4,882	1,616	16,119	5,22,630
Households provided employment	3,245	1,867	3,403	4,467	1,470	14,452	4,56,989
Average days employment provided per household	14.11	12.37	17.17	19.81	19.66	17.15	39.31
Households completed 100 days of employment	180	57	94	581	118	1,030	14,078
Women provided employment	2,746	1,383	2,779	3,144	806	10,858	3,26,880
Total fund available (Rs. Lakhs)	615.6	309.76	417.45	1358.4	322.12	3,023.33	70,709.77
Total expenditure (Rs. Lakhs)	617.06	316.72	419.79	1372.95	322.36	3,048.88	70,692.89
Total Expenditure on wages (Rs. Lakhs)	457.9	228.07	309.53	755.99	205.84	1,957.33	45,423.06

Source: https://mnregaweb2.nic.in, June 2022

Households Issued Job Cards, Demanded Employment and Provided Employment

To be employed under the MGNREGA, individuals or households are required to have a valid job card issued by Gram Panchayat. In the district, there are a total of 6,15,040 rural households, of which 36,924 households or 6 per cent have been issued MGNREGA job cards. However, this percentage varies from as high as 15.50 per cent in Nuh district to as low as 1.89 per cent in Faridabad district. Among the blocks, Rohtak (27.54 per cent), Maham (24.24 per cent) and Kalanaur (20.3 per cent) collectively accounted for a little over 72 per cent of all the job cards issued in the district. On the other hand, Lakhan Majra (12.17 per cent) and Sampla (15.73 per cent) blocks accounted for the district's lowest percentage of households issued job cards (Table-1). After receiving job cards, registered households and individuals can submit a request for work to the Gram Panchayat. Post verification, a letter containing information about the work is issued to the job card holder and the employment is made available within a 15-day window. Of the total households having valid MGNREGA job cards, less than half of them (16,119 households or 43.65 per cent) demanded jobs. The proportion of households demanded employment constituted 3.08 per cent of all households seeking jobs in the state. Among the blocks, Rohtak saw the largest demand for employment (30.28 per cent), followed by Maham (23.45 per cent), Kalanaur (21.05 per cent), and Lakhan Majra (15.18 per cent) (Table-1). It is essential to mention here that these three blocks also accounted for the districts's lion share of households issued job cards (Fig. 1).

On the other hand, if we see the households provided employment scenario, we see that slightly less than 90 per cent (4,452 households, 89.66 per cent) households were provided employment while 10.34 per cent eligible employment-seeking households rendered without employment indicating that MGNREGA has fallen short of expectations. The proportion of households who remained unemployed varied from as high as 23.83 per cent in Nuh district to as low as 2.31 per cent in Faridabad district. Factors such as delay in approval of work from higher authorities, insufficiency of adequate budget and staff, among many others may be held responsible for inadequate employment generation. Among the blocks, Rohtak (30.9 per cent), Maham (23.54 per cent), and Kalanaur (22.45 per cent) saw the largest number of households provided employment (fig. 2). It is pertinent to mention here that these blocks also saw the highest proportions of households issued job cards and demanded employment (Fig. 1).

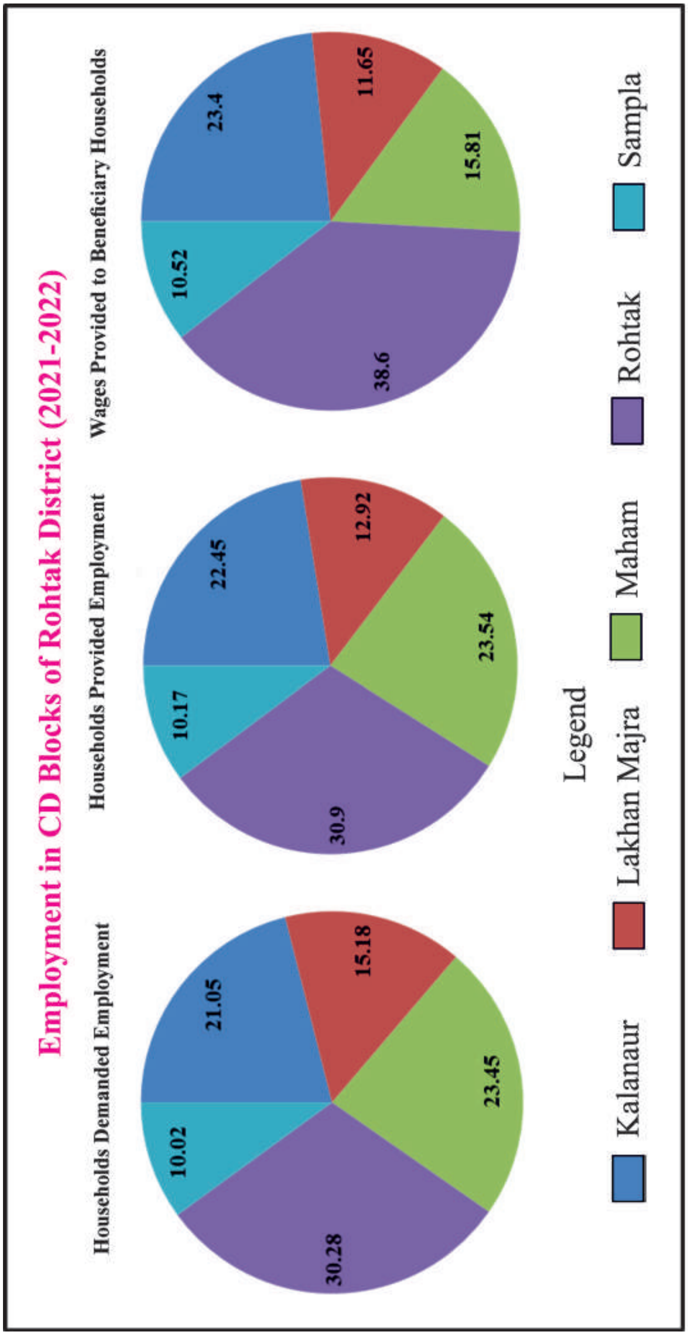
Employment in CD Blocks of Rohtak District (2021-2022)
Households Demanded Employment
21.05
15.18
23.45
30.28
10.02
Households Provided Employment
22.45
12.92
23.54
30.9
10.17
Wages Provided to Beneficiary Households
23.4
11.65
15.81
38.6
10.52
Legend
Kalanaur
Lakhan Majra
Maham
Rohtak
Sampla

Fig. 1

In terms of social category SC made up 53.13 per cent of all employed households, while ‘others’ made up 46.87 per cent of it. Further, it is interesting to note that women made 52.22 per cent in the total beneficiaries, thereby, successfully meeting the MGNREGA’s anticipated goal of at least one-third of women being progamme’s beneficiaries. Among the blocks, Rohtak (28.96 per cent) saw the highest percentage of women participants, followed by Maham (25.59 per cent) and Kalanaur (25.29 per cent). As far as average days employment provided per household is concerned, MGNREGA supplied a pitiful 17 days employment, far less than the state average of 36.26 days indicating that legal guarantee of 100 days of paid work has not been fully met by MGNREGA in Rohtak. Among the blocks, Rohtak (19.81 days) supplied the highest employment days followed by Sampla (19.66 days), and Maham (17.17 days). Although, the act guarantees at least 100 days of employment, merely a handful of households i.e., 1,030 families (7.13 per cent) completed it in the district which is very discouraging as far as employability under the MGNREGA is concerned. It is important to mention here that the proportion of households completed 100 days employment ranges from as high as 12.08 per cent in Faridabad district to as low as 0.31 per cent in Kaithal district. Factors such as lack of work-site facilities, incomplete and delayed wage payments among others discourage people to participate in MGNREGA jobs (Moda et al., 2023).

Wages Paid to Labourers

The most significant component of the MGNREGA is the wages paid to workers which helps them to sustain their day-to-day livelihoods. As per the norms, of the total expenditure, expenditure on unskilled wages shall be at least 60 per cent while expenditure on material purchase should not exceed 40 per cent. According to official figures, beneficiaries in the district received Rs. 1957.33 lakhs as unskilled wages which constituted 63.52 per cent of the total expenditure of Rs. 3023.33 lakhs in the district (FY 2021-22), which is highly appreciable. It is significant to mention here that this percentage varies from as high as 89.17 per cent in Charkhi Dadri district to as low as 41.39 per cent in Nuh district.

Wages Provided to Beneficiary Households by CD Blocks (2021-22)

Among the blocks, Rohtak (38.6 per cent) received the highest unskilled wage’s share, followed by Kalanaur (23.4 per cent) and Maham (15.81 per cent). Together, these three blocks accounted for more than 3/4th of the total pay for unskilled labourers in the district. Sampla block stood at last for the percentage of wages paid to workers (10.52 per cent) followed by Lakhan Majra (11.65 per cent) block.

Conclusion

Analysis of the statistics presented in this paper highlighted that, although, MGNREGA generated ample employment in Rohtak district but it has fallen short of its expectations as 10.44 per cent employment seeking eligible households remained employed and those who were employed hardly stayed in them for 17 days with wide inter-block variations. Further, a handful of households (7.13 per cent) availed full 100 days employment. At the same time, the local administration has successfully achieved one of the MGNREGA's anticipated goals of one-third of the total beneficiaries being female. In light of the above, it is suggested that the blocks with several gaps and weak links in MGNREGA implementation should be given top priority in the budget allocation and speedy approval of the development works. Concentrated efforts should be made to employ those who demand it within the given time frame. Local administration and civil society organisations have to work in synergy to make MGNREGA successful in achieving its goal of providing poor rural households with alternative means of livelihood, reducing poverty and distress migration, promoting gender equality and social inclusion, and generating sustainable community assets. If any of them is found lacking, MGNREGA would never achieve its objectives given the extremely low ability of the poor to realize their entitlements.

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MUNICIPAL SOLID WASTE MANAGEMENT AND ITS IMPROVEMENTS ALONG WITH THE SWACHH BHARAT MISSION- ANALYSIS OF JAIPUR CITY

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Abstract

In urban areas, managing municipal solid waste scientifically is a major challenge in India. Municipal Solid Waste Management (MSWM) practices are used in the city to improve sanitation and environmental standards while keeping up with the city's rapid urbanization and expanding population. The primary goals are to protect public health, improve environmental quality, create sustainability, and enhance economic productivity. With the beginning of the Government of India's flagship program, Swachh Bharat Mission, in 2014, it is now possible to collect, transport, process, and dispose of municipal solid waste by applying scientific methods while still delivering basic infrastructure and services. The quantity of solid waste generated in India today—1,60,038 Tons per Day (TPD) creates major challenges for sustainable and efficient solid waste management. In India, in addition to this volume of garbage, there are difficulties with service quality, such as mandated door-to-door pickup and waste segregation, as outlined in the Solid Waste Management (SWM) Rules 2016. According to Swachh Bharat Abhiyaan, there are 196 Urban Local Bodies (ULBs) for the management of solid waste in Rajasthan, of which 196 ULBs are collected as door-to-door waste, 81 ULBs (41.3%) are segregating waste, and 121 ULBs provide covered transportation. With the cooperation of Jaipur Nagar Nigam Heritage and Greater, Jaipur Municipal Corporation (JMC) collects 1628 TPD Municipal Solid Waste. Because the garbage was not segregated at the initial phase of generation, there is mixed waste that is challenging to manage. Unscientific methods of trash disposal at an open landfill. In compliance with SWM 2016 rules, the work of disposal of municipal waste coming out of the urban area is being done by the processing plant. Urban municipal governments are continually seeking to address this problem despite limited financial resources, technological capabilities, and land availability.

Introduction

Municipal solid waste includes any kind of solid and semi-solid waste produced in both commercial and residential areas. This is released by our houses, schools, hospitals, public spaces, and other institutions. Solid waste is classified into three types: (I) biodegradable or organic waste (ii) non-biodegradable garbage (iii) recyclable garbage. Solid waste management refers to garbage collection, transportation, resource recovery, recycling, and treatment. The goal of Solid Waste Management (SWM) is to reduce the amount of waste disposed of in landfills by providing appropriate treatment alternatives such as reuse, recycling, thermal treatment, and biological treatment, thereby reducing the amount of land required for landfilling. The use and reuse of materials in the most productive and sustainable manner over their entire life cycle is referred to as sustainable material management. According to the Central Pollution Control Board(CPCB), 34 states and union territories generated 1,43,449 TPD of Municipal Solid Waste in 2013–2014. Approximately 1,17,644 TPD (82%) of total garbage generated was collected, and 32,871 TPD (22.9%) was processed or treated. With an annual urban growth rate of 3.0%–3.5%, the yearly increase in waste volumes may be estimated at 5%. Numerous studies reveal that improper disposal of waste produces hazardous gases, as well as refuse characteristics and land-filling activities.

The Government of India launched the flagship program Swachh Bharat Mission in 2014, which aims to provide basic infrastructural and service delivery with respect to sanitation facilities to every family, including toilets, and to adopt scientific methods to collect, transport, process, and dispose of municipal solid waste. The mission emphasizes the dedication of all stakeholders to bring about tangible change in society, as well as the quality and sustainability of service provision. MSWM is an essential component of municipal services provided by ULBs, which are responsible for a city's safe and healthy environment. All municipal authorities are required to perform this service efficiently in order to keep cities and towns clean and to dispose of MSW in an ecologically appropriate way in accordance with the SWM Rules, 2016. Integrated Solid Waste Management (ISWM) presents a waste management hierarchy with the ultimate objective of reducing waste disposal while maximizing resource conservation and efficiency. According to the ISWM hierarchy, waste management alternatives are ranked based on their environmental advantages.

Study Region

The study area, Jaipur metropolis, the state capital of Rajasthan has emerged as one of the largest and most developed city of Northwestern India. Jaipur is situated

1417 feet above the sea level and is located at 26.9º North latitude and 75.8º East longitude. Jaipur city is located and situated east central part of the state over an area of 467sq. km with total population of 34.73 lacks whereas density is 6285/km (Census 2011). It is the 10th most populous city in the country. Jaipur is one of the earliest planned cities of modern India (Census 2011). Jaipur City is divided into 2 Nigam and 250 wards. It was founded on 25 November 1727 by the Jai Singh 2nd. The city is known for its town planning; Shri Vidhyadhar Bhattacharya planned it according to Hindu craftsmanship. Jaipur city is rectangular in shape and the roads cut each other in right angle and it is also known pink city due to the dominant color scheme of its building. Jaipur is a popular tourist destination in India and forms a part of the west Golden triangle tourist circuit along with Delhi-Agra. City has a monsoon inflected hot semi-arid climate with long extremely hot summers and short mild to warm winters. The rainy season is from mid-June to mid- September when Jaipur gets average annual rainfall of 630 mm. Jaipur walled city has added a new title in its royal cap by making it to the exclusive league of UNESCO world heritage site. Its monuments, Bazaars and festivals which have evolved over the past 400 years, makes it different from other historical and cultural sites. On 6 July 2019 UNESCO World Heritage committee declared Jaipur City as a World Heritage site. Jaipur has become second city of India after Ahmadabad to get the recognition. The pink city was nominated for its value of being an exemplary development in town planning and architecture... Its urban planning shows an exchange of ideas from ancient Hindu and modern Mughals as well as western culture.

Objectives

(1) The present study's aims are to analyze the main trends of municipal solid waste, along with the Swachh Bharat Mission, its generation, collection, and treatment of municipal solid waste in Jaipur based on recent data and annual reports.

(2) The study also aims to provide potential solutions to enhance the existing state of solid waste management in Jaipur.

Database and Methodology

The process of segregation, collection, storage, transportation, and disposal of solid wastes was interpreted by going into the fields and observing the trends and techniques followed by Jaipur Municipal Corporation (JMC). The major techniques for analysis included both primary and secondary data. Secondary data included district census data, JMC annual reports, and published articles on Jaipur City's SWM.

Data on current urban solid waste processing and management will be acquired through both quantitative and qualitative. Information was gathered from various JMC workers concerning garbage collecting processes, segregation, storage and bins, transportation, disposal vehicles for transportation, storage bins, and so on. Jaipur Municipal Corporation reports on waste handling and management statistics, including street sweeping, garbage collection, staff deployed, resource allocation, and waste handling strategies.

Results and Discussion

Trends of Municipal Solid Waste Management in Jaipur City

Increased solid waste is also influenced by urbanization, industry, and changing lifestyles. Currently, 700 to 800 TPD of waste is generated in Jaipur Nagar Nigam heritage. Municipal Corporation Jaipur collects MSW generated in Jaipur door-to-door by auto tippers and transports it to transfer stations at Lal Doongri and Jhalana. Other ULBs are engaging in the same practices (Table-1 and Fig. 1). All local governments are segregating and transporting solid waste to designated dumping sites. JMC has given 5145 green and blue dustbins for solid waste collection. JMC has finished the construction of the MRF facility center at the Mathuradaspura dump site, and work is underway at Sewapura.

Table-1: Waste Generated According to Wards in Jaipur City

Sl. No	Zones	No. of Wards	Waste Collected Daily (MTD)2014	Waste collected daily (MTD)2019
1	Hawa Mahal East Zone	11	170	174
2	Vidhyadhar Nagar Zone	21	240	354
3	Civil Lines Zones	16	230	260
4	Mansarovar Zone	11	120	177
5	Sanganer Zone	12	140	205
6	Moti Dungri Zone	9	130	141
7	Hawa Mahal West Zone	6	80	86
8	Amer Zone	5	70	79
	Total	91	1180	1477

Source: Jaipur Municipal Corporation, Jaipur

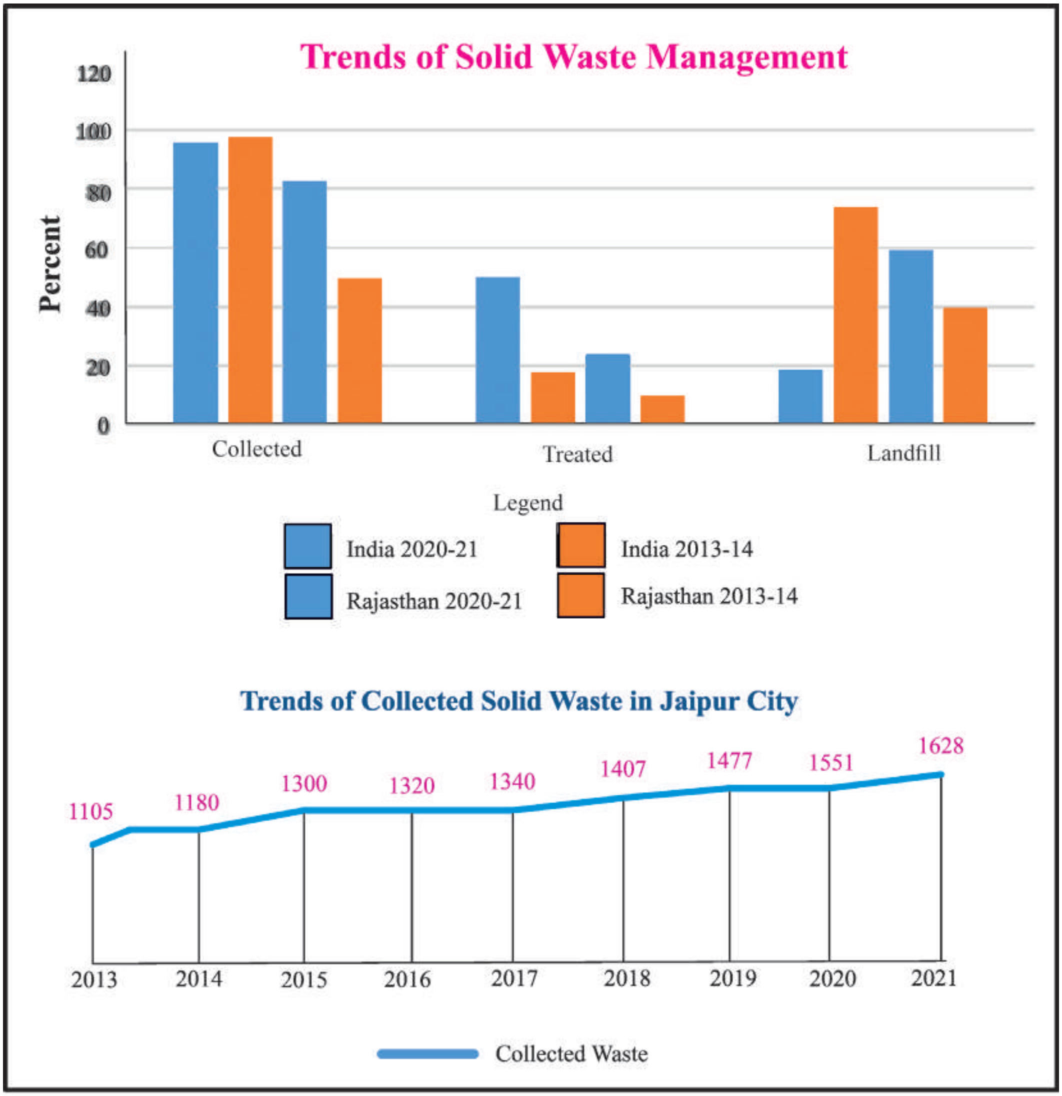
Trends of Solid Waste Management
Percent
120
100
80
60
40
20
0
Collected
Treated
Landfill
Legend
India 2020-21
India 2013-14
Rajasthan 2020-21
Rajasthan 2013-14
Trends of Collected Solid Waste in Jaipur City
1105
1180
1300
1320
1340
1407
1477
1551
1628
2013
2014
2015
2016
2017
2018
2019
2020
2021
Collected Waste

Fig. 1

Other municipal boards have also designated dumpsites (Jobner, Kotputali, Virat Nagar, Shahpura, Kishangarh Renwal, Sambhar Lake, and Chomu), and solid waste is being deposited at those sites. The generation of waste is greatly affected by the local economy, lifestyle, and infrastructure. It is commonly known that garbage generation in a certain location is related to the average income of the people who live there. It has also been found that organic, plastic, and paper trash output is significant in high-income communities.

Waste Segregation and Transportation

Duties of waste generators include segregation of generated waste into bio-degradable, non- biodegradable, and domestic hazardous waste, but there is no procedure of waste segregation that takes place at the source (either by public or by JMC) in the whole city because it is very difficult to separate them later. Waste is transported from the transfer station to the landfill site by different types of vehicles such as Dumper placers, tractors, bullock carts, etc. Most of the vehicles are aged and not covered so the spreading of waste pollutes the environment. In most places, loading is done manually. The conventional transportation system does not harmonize with the primary collection system and facilities of secondary waste storage which results in multiple manual handling of waste. JMC has provided 275 vehicles for the transportation of waste from bins to landfill sites.

Treatment and Disposal of Solid Waste

In India, a decreasing trend in solid waste landfilled has been observed during the last six years wherein solid waste landfilled has decreased from 54% in 2014-2015 to 18.4% in 2020-2021. Although in Rajasthan, an increasing trend in solid waste landfilled has been observed during the last 6 years from 39.73% in 2013-14 to 73.68% in 2020-21. Garbage is dumped at the garbage transfer station, where the garbage is temporarily dumped at the transfer station located under Hasanpura Pulia, Laldungri, Gol Market, RPA Road, Sultan Nagar, Gurjar Ki Thadi, Vidhya Dhar Nagar, and Jhalana. The waste from transfer stations is transported through secondary vehicles, at the processing plants and dumpsites (Table-2 and Fig. 1).

The waste generated in the city is being deposited at these landfill sites. The total number of dumpsites in Rajasthan is 197. In India, increasing trend in percentage of solid waste processed has increased from 19% in 2015- 2016 to 49.96% in 2020-2021. In Rajasthan, increasing trend of solid waste processed has increased from 9.72% in 2015-2016 to 17.55% in 2020-2021.

Table-2: Transfer Station in Jaipur City

S. No.	Transfer Stations in Jaipur		Landfill Sites in Jaipur		Processing Plants in Jaipur	
	Transfer Stations	Capacity	Landfill Sites	Area	Processing Plants	capacity
1.	Lal Dungri	400TPD	Mathuradaspura	28.76 hq	Waste to energy plant (Power generation capacity 12MW) Langadiyawas (Jamwaramgarh)	600TPD
2.	Vidhyadhar Nagar	250TPD	Sewapura	32.11 hq	Construction & Demolition Processing plant Langadiyawas (Jamwaramgarh)	300TPD
3.	Jhalana	150TPD	Langadiyawas	77.55 hq	Centralized RDF (Refused Derived Fuels) plant Langadiyawas (Jamwaramgarh)	350TPD
4.	-------	----	--------	-----	Centralized Compost (Sewapura)	250TPD

Source: Jaipur Municipal Corporation.

Implementation Status and Performance under the Swachh Bharat Mission

(1) The municipal corporation of Jaipur Heritage has 4 zones or 100 wards, whereas the municipal corporation of Jaipur Greater has 6 zones or 150 wards. Generated waste is carried out by 327 hoopers and 28 corporation and firm units through door-to-door garbage collection work and commercial area cleaning from 7:00 AM to 4:00 PM. Garbage collection is performed in commercial and market districts during the evening shift.

(2) The garbage is dumped after door-to-door pickup at specific locations in the wards, known as the Depo. Which is cleaned in three shifts, with the task of lifting waste located on the main roads and the ward done.

(3) Under the supervision of SBM, dustbins were installed in the business area. The company acquired two road sweeper machines for municipal road cleaning duties, which are cleaning the city's main roads on a regular basis.

(4) For the convenience of the general public for door to door garbage collection and disposal of garbage collection and disposal of garbage lying on public roads, a call center has been set up at the corporation headquarters, which remains operational 24*7. Along with this, a command center has been set up at the headquarters level to monitor all the resources engaged in door-to-door garbage collection work, through which all the vehicles are being monitored.

(5) JMC is currently working in the direction of integrated plastic waste management 2016 in compliance with the orders of NGT in Jaipur city. For this, the construction work of the Material Recovery Facility center establishment has been completed by the municipal corporation, Jaipur at the garbage dump located in the village of Sewapura.

(6) Apart from this, the feedback on cleanliness work is being taken from common citizens by the officers and employees from all the wards daily, in which cleaning work is being done as per the suggestions received.

(7) Establishment of a common bio medical waste treatment facility in Jaipur rural and Dausa district on a "DBOOT" (Design, Build, Own, Operate & Transfer) basis. In compliance with the biomedical waste management rules, the work of disposal of bio-medical waste coming out of the urban area is being done by messers Intrometic India Private Limited. For the disposal of biomedical waste coming out of Jaipur's rural and Dausa areas, the work of setting up a plant has been done in the village of Khori Ropada.

The present analysis focuses on an overview of the existing MSWM system in Jaipur City. The major challenges and potential solutions for sustainable MSW management have also been identified. Understanding waste creation, processing, resource availability, and scientific disposal is critical for building an effective solid waste management system. Adoption of best practices and technology for solid waste management is required. The following key MSWM concerns have been identified as a result of the preceding discussions: (a) collection & transportation designing, construction, operating & maintenance of processing & recycling facility of construction and demolition waste under the guidance of Swachh Bharat Mission (Urban) for Nagar Nigam Jaipur, (b) as a result of the installation of GPS devices on all dumpers engaged in door-to-door garbage collection, work is completed according to the route assigned to them, and it is monitored at the digital zone office and headquarters, (c) to prevent common people from throwing garbage on roads, streets, etc. watch riders have been deployed in each zone who are taking challan action, (d) there is no segregation at the source. The waste is not separated at the point of generation that is why mixed waste is there, which is difficult to handle, € MSW (Management and Handling) Rules 2016 Negligence and Inconsistency in data administration and record keeping, (f) Open garbage cans for the community (g) Transport vehicles that are open to the public and Transportation costs are high due to long distances and expensive fuel costs. There is a need for decentralized and cost-effective Solid Waste Management, (h) Lack of community involvement and lack of awareness among solid waste generators. Citizens have not been taught to keep separate bins for different types of waste such as domestic, recyclable, and inert waste, so they only throw mixed waste on the streets and (i) unscientific waste disposal practices at an open landfill. No scientific method of waste disposal has been adopted at the Sewapura site. Entire waste is disposed of at the landfill site by just dumping it.

Conclusion

The Swachh Bharat Mission has provided significant learning over the previous years, reinforcing the requirement for cities to have efficient collection and transportation infrastructure for successful MSWM. With door-to-door collection occurring in 96% of urban wards, a good number of best practices in efficient Collection and Transportation systems from around the country are accessible, spanning a wide variety of demographic and geographic contexts. With rising levels of environmental degradation and greenhouse gas emissions, municipal solid waste presents a possibility for a substantial source of renewable energy in the international climate agenda. The government and the public should take strong initiatives to manage these wastes for our healthy livelihood. People who are more competent and educated should pay greater attention to solid waste management and environmental improvement. In 2016, solid waste management produced an estimated 1.6 billion tonnes of carbon dioxide-equivalent (CO2-equivalent) greenhouse gas emissions. This accounts for around 5% of world emissions. Without SWM improvements, solid waste-related emissions are expected to rise to 2.6 billion tonnes of CO2 equivalent by 2050. All ULBs are expected to thoroughly develop, execute, and monitor all urban service delivery systems, including municipal solid waste. The common thread for the cleanest city has been a highly effective segregation of garbage at the source by all waste producers, followed by segregated collection and transportation of the separated portions. To adopt new waste-collection systems, zero waste wards and colonies develop and wet garbage was composted in the community.

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WASTE TO WORTH: EXAMINING THE ENVIRONMENTAL AND SOCIO-ECONOMIC DIMENSIONS OF MUNICIPAL SOLID WASTE MANAGEMENT

Kirti and Surender

Abstract

Municipal Solid Waste (MSW) management is a significant challenge of the urban environments across the world. The problem is greatly aggravated in the developing countries. The approach of each country is dependent upon the type and volume of waste generated. The management of Municipal Solid Waste has grown into a problem of sizable dimensions taking in its grasp the fields of public health, environmental degradation, and the complete and efficient use of resources. The rapid urbanization over the past five decades has brought about changes in the urban landscapes that have tended to threatened the safety and hygienic existence of human and animal life in various spatiotemporal levels of their currently modified existence. This paper aims at highlighting the major issues concerning the strategists of MSW. These can range from inadequate infrastructure, lack of funding and limited awareness among the general public to total ignorance and inappropriate handling of waste. The unchecked and uncontrolled accumulation of solid waste in urban areas can lead to various health and environmental problems, including air and water pollution, disease transmission, and greenhouse gas emissions. It will present insights into the different mechanisms put into play to deal with the everyday accumulation of human generated wate and its gradual disposal in urban areas of the developed and the developing world. Governments, organizations, and communities are implementing various waste management strategies to address these challenges, including waste reduction, recycling, composting, and waste-to-energy technologies. These strategies aim to reduce the amount of waste generated, recover valuable resources from waste, and minimize the negative impacts of waste on public health and the environment. Effective solid waste management requires a comprehensive and united approach that involves all stakeholders, including government, industry, civil society and the public.

Introduction

The increasing amount of MSW generated all over the world has become a challenge for the emerging economies. Improper disposal of MSW occupies urban land, emits pollutants into the environment, and results in air, water and soil pollution. MSW management has become inter twined with the standards of human living and the socio-economic structure of any geographic area. The selection of MSW disposal technologies should logically consider the human living standards and the relevant socioeconomic factors before working out the strategies of disposal. With rapid expansion of MSW generation, the maturity of disposal technologies and future improvement of these methods are key factors in building MSW treatment plants, planning for their extension as also creating newer by-products. Solid waste has become a tenacious issue worldwide. It has been increasing exponentially due to urbanization and the increase in the population. Since the twentieth-century technological revolution, there have been significant changes in the composition of solid waste. It poses significant challenges for waste management systems worldwide. Waste management is the process of handling waste right from its creation to its final disposal, including transport, collection, treatment, and monitoring.

The present solid waste management (SWM) system is affected by unfavourable institutional, economic, technical, legislative, and operational constraints. Poor waste management is affecting ecosystems and human health, damaging our finite natural resources, impeding human economic progress, and harming people's quality of life. Now, researchers are concerned about the environment's degradation, a decline in quality of life, and risks related to waste management grow as the volume of solid waste. The selection of an efficient MSW management system requires the detailed screening of MSW disposal technologies in the desired direction of the development of MSW disposal methods which vary based on the cost and socio-economic aspects. Sometimes, the technologies chosen for MSW management have conflicting objectives especially when considered from a different viewpoint. Landfilling is among the most popular, and cheapest methods from a cost perspective because it uses the non-developed land for land disposal of waste or landfilling (Assamoi & Lawryshyn, 2012). However, landfilling emits pollutants to the water environment because of the possibility of discharging landfill leachates to the surface and groundwater (Ghosh et al., 2017). Solid waste refers to the garbage or accumulated materials arising from animal and human activities.

These are often originating from various domestic, commercial, institutional, industrial or construction and demolition processes. The basic elements of solid waste management include its generation, segregation, collection, transportation and disposal. Effective solid, waste management tends to reduce the sustained effect of waste on the environment as well as human and animal health on the environment while also supporting economics developing and a superior quality of life.

Study Region

Entire India has been taken to be the study area. All the states have been observed to have different ways of considering and generating Municipal Solid Waste. The composition and disposal methods of all the States are different. This information has been culled from the central government and State government records, reports, documents. The reuse and recycling practices were also studied in depth.

Objectives

The main objectives are to estimate the status of municipal solid waste management in India (MSWM) and to ascertain the strategies for collection and disposal of MSW.

Database and Methodology

The secondary data approach has been used. The documents, reports and physical records that were available were examined and analysed to understand the trends of MSW generation the practices of MSW collection as also the final disposal of the MSW in various States. An analysis was also made to determine how the States were segregating the MSW if at all they were. Notes of meetings of the Pollution Control Board were also studied.

Results and Discussion

Growing Urban: Waste Continuum Problem for Municipal Body

According to the latest Urban and regional development plan formulation and implementation (URDPFI) guidelines the estimated waste generation is depicted in Table-1 and Fig. 1, 2 and 3.

These guidelines have been formulated for facilitating SWM strategies along with the mandatory benchmark for solid waste management from accumulation

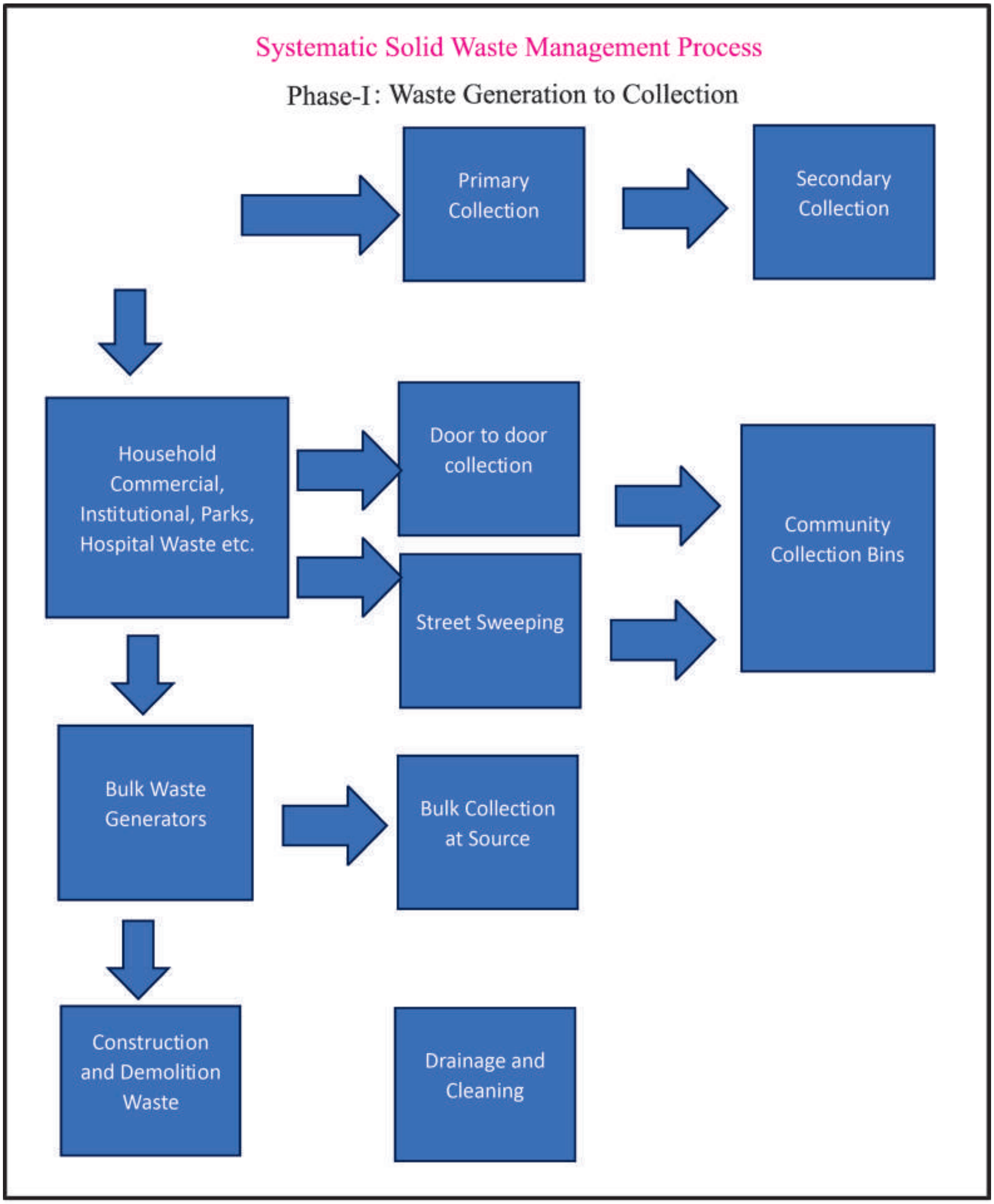
Systematic Solid Waste Management Process
Phase-I : Waste Generation to Collection
Primary Collection
Secondary Collection
Household Commercial, Institutional, Parks, Hospital Waste etc.
Door to door collection
Street Sweeping
Community Collection Bins
Bulk Waste Generators
Bulk Collection at Source
Construction and Demolition Waste
Drainage and Cleaning

Fig. 1

Table-1: URDPFI Guidelines for Estimated Waste Generation

S. No	Landuse	Waste Generation
1.	Residential	0.3 to 0.6 kg/ cap /day
2.	Commercial	0.1 to 0.2 kg / cap/day
3.	Street sweepings	0.05 to 0.2 kg /cap/day
4.	Institutional	0.05 to 0.2 kg/ cap/day

Source: URDPFI Guidelines (2019:341)

and collection to disposal. The systematic solid waste management process has been depicted in the following flow chart presented as Fig 1. The flowchart traces the essential elements of the MSW processes necessary to every municipality. The current work is a comprehensive assessment that highlights the current state of ongoing practices of SWM in India. It identifies the associated obstacles, and derives prospective MSW management solutions. MSWM is a more serious task in metropolitan regions, where quickly growing populations, infrastructure, and people's lifestyles generate increasingly larger volumes of solid garbage that urban local bodies are unable to efficiently manage. Issues that affect the MSWM system include proper waste segregation at the source citizen attitudes, insufficient potential strategies, societal taboo, poor evaluation, unexpected fiscal waste and poor government policy implementation. The exponential population expansion, high urban density, diversified culture, changing dietary habits and lifestyles have been instrumental in the generation of huge volumes of solid waste all over the world in the current century. Communities have had to deal with a slew of other difficulties relating to solid waste collection, treatment, and management. Municipal solid waste management (MSWM) is a signature component of sustainable urban development that is becoming a growing feature of the emerging Indian economy.

Composition of Municipal Solid Waste

Waste management has a long and varied history, dating back to ancient times. The earliest forms of waste management were simple methods like collecting garbage and burying it in open pits on the outskirt of towns and villages and dumping it in water bodies. MSW in India primarily consists of degradable waste including paper, textiles, food waste, straw, and yard trash, partially degradable waste wood including disposable napkins and sludge, sanitary residues and non-degradable products such as leather, plastics, rubbers, metals, glass, ash from fuel burning (coal, briquettes, or woods), dust, and electronic waste (Table-2).

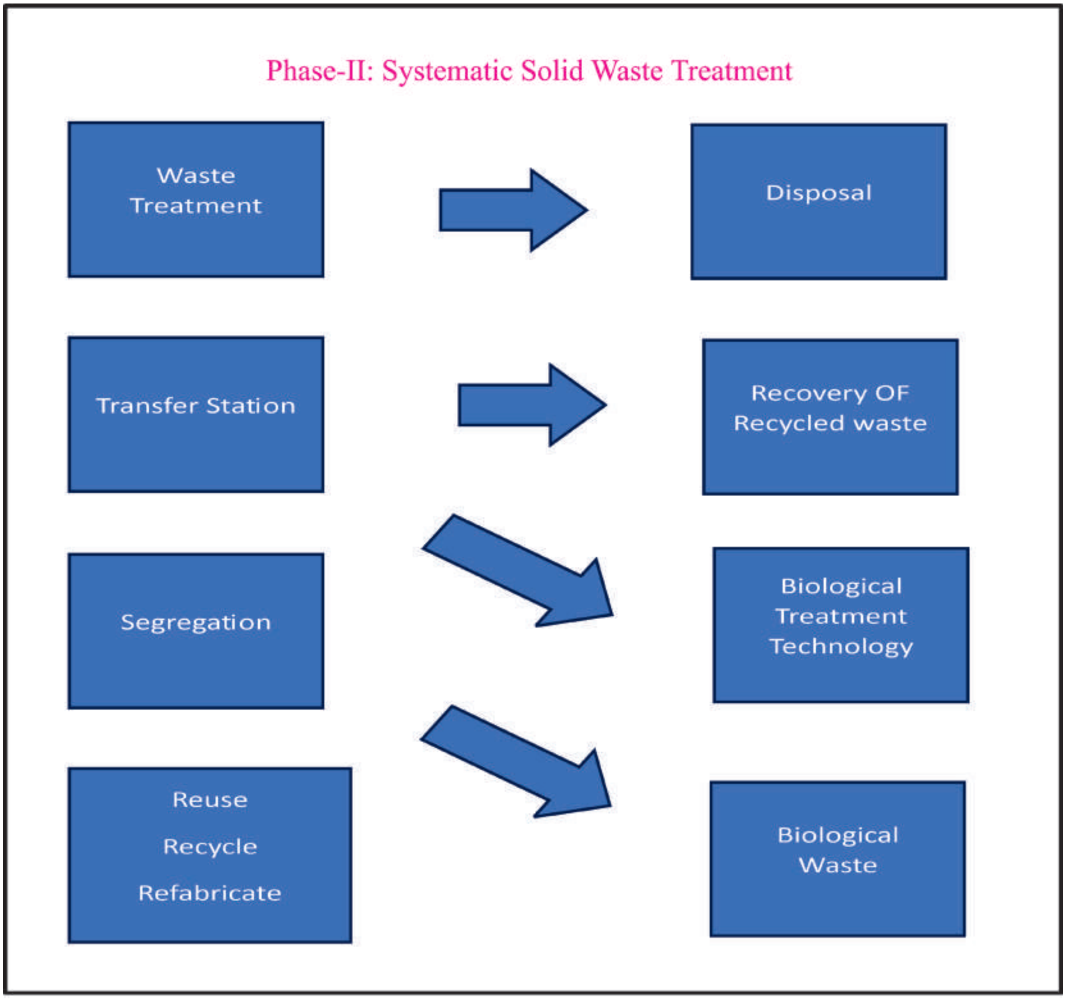
Phase-II: Systematic Solid Waste Treatment
Waste Treatment
Disposal
Transfer Station
Recovery OF Recycled waste
Segregation
Biological Treatment Technology
Reuse
Recycle
Refabricate
Biological Waste

Fig. 2

Table-2: Status of Waste Generation in Different States of India (CPCB, 2020-21)

S. No.	States	No. of ULBS	Waste generation rate (TPD)	House to house collection and segregation (%)	Collected (TPD)	Treated (TPD)	Landfilled (TPD)
1.	Andaman and Nicobar	01	89	100	82	75	7
2.	Andhra Pradesh	124	6898	99	6829	1133	205
3.	Arunachal Pradesh	02	236.51	100	202.11	-	27.5
4.	Assam	96	1199	88.5	1091	41.4	0
5.	Bihar	142	4281	100	-	-	-
6.	Chandigarh	1	450	100	450	61.15	410.8
7.	Chhattisgarh	166	1650	10	1650	1650	0
8.	Daman and Diu	3	267	100	267	237	14.5
9.	Delhi	5	10990	100	10990	5193.57	5533
10.	Goa	14	226.87	100	218.8	197.47	22.05
11.	Gujarat	164	10373.7	100	10332	6946	3385.8
12.	Haryana	88	5352.1	95	291.41	3123.9	2167.51
13.	Himachal Pradesh	61	346	80	332	221	111
14.	Jammu and Kashmir	80	1463.2	100	1437.2	547.5	376
15.	Jharkhand	42	2226.39	100	1851.65	758.26	1086.33
16.	Karnataka	316	11085	98	10198	6817	1250
17.	Kerala	93	3543	-	964.76	2550	-
18.	Nagaland	39	330.49	100	285.49	122	7.5

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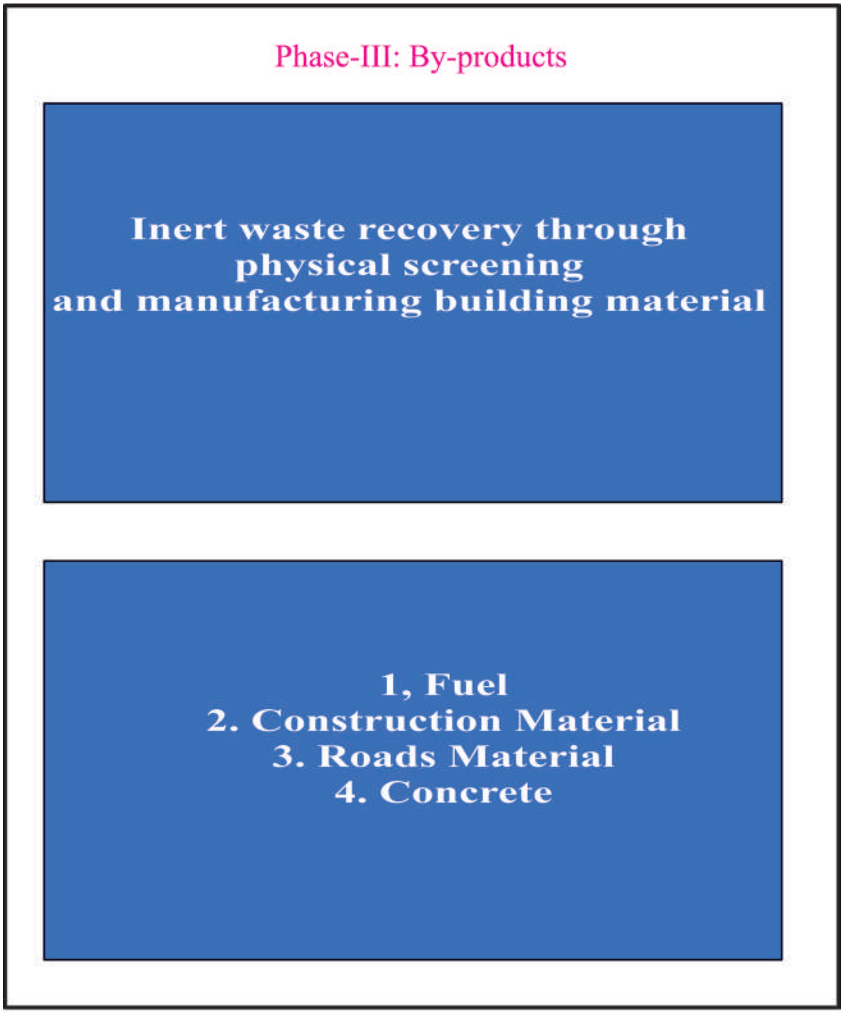
Phase-III: By-products
Inert waste recovery through
physical screening
and manufacturing building material
1, Fuel
2. Construction Material
3. Roads Material
4. Concrete

Fig. 3

19.	Lakshadweep	10	35	-	17.13	17.13	-
20.	Madhya Pradesh	383	8022.5	Partially	7235.5	6472	763.5
21.	Maharashtra	403	22632.71	262	22584.4	15056.1	1355.36
22.	Manipur	27	283.3	-	190.3	108.6	81.7
23.	Mizoram	1	345.47	100	275.92	269.71	0
24.	Meghalaya	07	107.01	100	93.92	9.64	83.4
25.	Orissa	114	2132.95	95.5	2097.14	1038.31	1034.33
26.	Punjab	167	4338.37	60	4278.86	1894.04	2384.82
27.	Pondicherry	5	504.5	-	482	36	446
28.	Rajasthan	196	6897.16	100	6720.476	1210.46	5082.16
29.	Sikkim	07	71.9	100	71.9	20.25	51.55
30.	Tamil Nadu	664	13422	100	12844	9430.35	2301.04
31.	Telangana	142	9965	100	9965	7530	991
32.	Tripura	20	333.9	Partially	317.69	214.06	12.9
33.	Uttarakhand	91	1458.46	100	1378.99	779.85	0
34.	Uttar Pradesh	651	14710	99	14292	5520	0
35.	West Bengal	125	13709	97	13356	667.6	202.23
36.	Total	4440	160038.9		152749.5	79956.3	39427.2

Source: Kumar et al (2022) *TDP – Tonnes per Day

Available statistics have shown that although the municipal solid waste generation in the developing countries is still quite low per capita as compared to that in the developed countries it is growing steadily. The collection of waste is the first step to effective solid waste management. This includes collecting waste from the source and transporting it to be treated and/or disposed of. The waste collection process starts with generating, source segregation, storage, and transportation. Collection and transporting of waste is the most critical and cost-effective part of solid waste management because it is laborious and requires the use of vehicles. Factors ranging from the route to transporting waste and the availability of storage for waste are all to be considered. The type and quantity of waste produced will determine the scale and nature of the collection process. The collection of recyclable wastes has become very essential to most societies looking toward sustainable waste management. In most urban areas the collection of waste is the responsibility of local authorities and in some areas, there are no formal methods of waste collection. Optimal locations for waste collection are a fundamental aspect of the cost-effectiveness and convenience of solid waste management. Evidence from literature shows that provision of waste management services in urban large settlements makes huge demands on the finances of the government. Many scholars have argued that to make waste management efficient, local governments and other service provides should have a reliable and sustainable means of obtaining funds to cover the costs of the services. Numerous valuable components extracted from processed production and consumption wastes can be an important source of reserves and revenue for the development of industries and sectors of the economy, entrepreneurial activities in the use of secondary resources for production, services, works and energy. It is necessary, however, to ensure that all primary, secondary and tertiary segments of the MSW strategy are maintained and monitored efficiently. The current work is a comprehensive assessment that highlights the current state of ongoing practices of SWM in India. It identifies the associated obstacles, and derives prospective MSW management solutions. MSWM is a more serious task in metropolitan regions, where quickly growing populations, infrastructure, and people's lifestyles generate increasingly larger volumes of solid garbage that urban local bodies are unable to efficiently manage. Issues that affect the MSWM system include proper waste segregation at the source citizen attitudes, insufficient potential strategies, societal taboo, poor evaluation, unexpected fiscal waste and poor government policy implementation.

MSW Strategies Phase-1: Waste Collection from Source Segregation

Source segregation is defined as separating 'useful' waste materials from the waste stream right after the waste has been generated. Waste is segregated either by recyclability or degradability. Ideally, waste should be segregated based on whether the material is paper, glass, organic, or plastic. In doing this, the amount of waste that goes to landfills is reduced. Source segregation of waste increases the amount of recycling, reuse, and recovery. When recyclable waste is not segregated at the source and is mixed with organic matter it makes sorting and recycling very difficult. In addition, the moisture content in waste is less when it is segregated at the source, this makes it easy for disposal by incinerating. Burning of recyclable wastes like plastics produces harmful gasses that harm the environment and its inhabitants. Waste segregation begins at the household level, schools, offices, commercial buildings like hospitals, hotels and restaurants besides government and administrative buildings etc. The common method of segregating waste is to get different bins for the different waste types. These bins are labelled and placed conveniently so that after primary use, waste materials are stored in their appropriate bin. The quality of raw materials for recycling is much higher in source-segregated waste than it is in materials sorted from a mixed waste stream. It is important that all solid wastes generated must be stored properly while waiting to be transported. Plastic dustbins are the most commonly used waste storage devices in this part of the world. The bin must have a tight lid to prevent fumes from polluting the environment and also diseases from breeding from it. These bins should also be conveniently placed and accessible to waste generators and collectors. Any material that is discarded after primary use is considered waste material. The increasing quantity and complexity of modern waste pose a serious risk to human health and the environment. The increase in municipal solid waste in the modern world is a result of the world gearing toward urbanization. Waste generation is a burden that comes with development. Currently, municipal waste generated globally is estimated to be about two billion tons, and only 33% of that is managed properly. The remaining 67% ends up in landfills, dumpsites, and the oceans then contributes to polluting our environment. Reported that, by 2025, there will be about 4.5 billion urban residents generating 1.4 kg/capita/day of municipal waste.

Waste Disposal of SWM

Transporting waste is the next step in solid waste management after storage. Waste materials are either transported to a treatment facility or a landfill to be disposed of. Transporting waste is a very complex and cost-inducive process. It requires a collection crew, vehicles, pick-up points, and intricate logistics. In most urban and residential homes, the storage of waste is done by individuals and residents whereas the transportation is outsourced to private collectors by municipal authorities. In some instances, the waste is collected from bins placed in front of the respective residence for collection. Other situations require that the waste be sent to designated pick-up spots for collection. After waste is collected, it is transported to treatment sites to be sorted and treated before disposal. The main thing that must be looked at when analysing waste transportation is economics. It ranges from the cost of fuel for transporting to the cost of crew members collecting waste materials. The distance of transportation routes and the size of the axle of waste trucks contribute to the total cost of collecting and transporting waste. If the distance between the collection sites and the treatment site is too far, the vehicles use up more fuel to make the trip. The capacity of the axle of the waste truck also contributes to the cost of transportation. If the waste truck has a smaller axle then it must make multiple trips within a given week or month. A model adopted by some developed countries is that waste is moved by smaller vehicles to a temporary dumpsite, then large garbage trucks collect the solid waste from the temporary site to their preferred destination. Management of urban solid waste and the knowledge of solid waste composition requires, most significantly a dynamic approach with an eye on innovating over time. There are many ways of the dealing with the solid waste generated by human activities in cosmopolitan areas of developing and developed countries all over the world. MSW production is strongly influenced by geographical conditions, rapid urbanization and pattern of consumption. Those responsible for the design and operation of MSW management systems must know the sources and composition of MSW generated. Some of the scholars across the world have given their thoughts on MSW and SWM. Some of the recent eminent ones are detailed. Safe handling of waste till final disposal is essential for any modern community or municipality. Proper handling of municipal waste could be an economic resource with great potential in the energy and manufacturing fields. Effective waste management is a hands-on situation and requires participation from everyone, from the authorities to the individual waste generators. In most developed countries, wastes are carefully regulated through well-established record-keeping systems.

These countries have legislations in place to prevent improper disposal of waste that may cause pollution and outbreak of diseases. In developing countries, insufficient resources, and a lack of clear definitions, roles, responsibilities, and quality data have made waste management difficult. Some of these developing countries have legislations to regulate solid waste management but have struggled to enforce these regulations. As the realization that most of our resources are limited, it is necessary that we derive economic value from waste materials. The process of finding value out of waste is known as recycling. There are various ways in which waste materials can be recycled; the raw materials could be processed and used for another product or the waste material can be repurposed to generate energy. In order to extract value from waste, we must first start by properly managing solid waste right from the source. Solid waste management includes; the generation, collection, treatment, disposal, and monitoring of waste. There are several factors such as environmental, political, economic, technical, and legislation that are taken into consideration during waste management. Sustainable waste management looks to promote reducing the amount of waste generated and recycling the majority of the waste. Minimizing waste produced heavily relies on the actions of the waste generator. It is important that education and awareness in the area of waste management be prioritized. We shed light on the process of solid waste management, its importance, and its challenges.

Advantages of Solid Waste Management

Solid waste management is an essential part of the development of any town, city, or urban area. Some of the key benefits of an effective solid waste management practice are: Improved public health, environmental protection, resource conservation, economic benefits, reduced greenhouse gas emissions, and improved aesthetics. Proper waste management practices help prevent the spread of diseases, reduce the risk of contamination, and minimize exposure to harmful toxins and pollutants. Poor solid waste management is linked with poor public health and affects the sustainable development of most cities. Proper disposal of waste reduces the risk of soil, air, and water pollution, preserving the environment and protecting wildlife. Solid waste management involves the recovery and recycling of valuable resources, such as metals, plastics, and paper. This reduces the amount of waste sent to landfills and deductively conserve natural resources. Proper waste management practices can create jobs and generate income by collecting, transporting, and processing waste materials. Landfills are a significant source of greenhouse gas emissions, particularly methane. Proper solid waste management, including waste reduction, recycling, and composting, can help lower these emissions and mitigate the effects of climate change. Properly managed solid waste helps maintain a clean and tidy appearance in public spaces, reducing litter and improving the overall quality of life in a community. According to Seberinic (2020) waste generation is gaining momentum in the 21st century.

It is not a small measure of spoiled and often unused food. Food waste and the problems of waste of food is a sub-area of action of food law. The waste that occurs at all levels of the food chain has enormous implications for many sectors of life. Also Turyahabwe et al, (2022) in this study have assessed the environmental and socio-economic impact of waste management practices in Mbale city. Their socio-economic analysis indicated that costs of waste management practices outweigh the benefits. Thus management practices have been associated with severe health issues to the households living near dumpsites and waste management employees, although revenue and employment opportunities were also created in some instances in remote areas of the city there is limited sorting of hazardous from ordinary wastes that have come with associated effects on the environment.

High Socio-economic Dividends for MSW

For the sustainable development of our cities and urban areas, solid waste management must be practiced effectively. Best solid waste management programs improve the health and environmental conditions of residents and animals. This creates an opportunity for waste materials to be used as a resource which in turn, generates significant economic benefits. Recycling provides job opportunities for several people and enhances the economic quota of a particular region and/or country. The extraction of energy from waste material is an important addition to the solutions for the global depletion of non-renewable resources. Proper management of waste reduces the volume of waste on landfills and subsequently minimizes the emissions of greenhouse gasses. A significant reduction in waste generation from successful solid waste management practices is a huge step toward achieving sustainable development goals. Despite the many challenges that are faced with the implementation of solid waste management, it is necessary that municipalities and governments provide the right infrastructure and systems that will minimize waste, channel generated waste to recycling, and minimize landfilling to protect the people and the environment.

Conclusion

In rising economies like India, where SWM is a major concern, it is critical to establish and implement cost-effective SWM projects. Expansion and application of emerging technologies, etc., must be considered to define real time lines to achieve proper MSWM in India. There are a number of factors that impact upon the management of solid waste in any geographical location. These factors determine the success and failure of the solid waste management system being adopted and adapted by them are, namely, Public attitudes and beliefs about waste management, Factors that influence public engagement in waste management.

The role of social media and other communication technologies in engaging the public, Community based waste management initiatives. The impact of public participation on waste management performance, the role of public education and awareness in promoting sustainable waste management practices.

There are a number of streams and a number of by-products that can be generated from their management. These are included in the list which is by no means complete but it is definitely indicative of the wealth of secondary by-products that emerge from the processing of MSW are compost, fertilizers, biofuels, bioenergy, syngas, biochar, activated carbon, adsorbents, construction materials, paving materials, road aggregates, Infill materials, landfill gas. These by-products can have useful application like, agriculture, horticulture, energy production, manufacturing, and construction. The overall environment impact of solid waste management and create new economic opportunities. Some of the proactive international agencies working on and constantly monitoring the solid waste management are (1) United States Environmental Protection Agency (USEPA) waste management Hierarchy. This Hierarchy provides a framework for prioritizing waste management options, with waste reduction and reuse at the top and landfilling at the bottom. (2) World Bank Global Waste Management outlook: this report provides a global overview of waste generation and management, including information on the types of by-products that can be generated and (3) United Nations Environment Programme (UNEP) Waste and Climate Change: This website provides information on the role of waste management in climate change mitigation and adaption, as well as the potential to reduce Green House Gas (GHG) emissions. Mismanaged municipal solid waste (MSW) is a major source of plastics pollution and a key contributor to climate forcing, in Global South cities poses public health and environmental problems. This study has analysed the first consistent and quality assured dataset available for cities distributed worldwide, featuring a comprehensive set of solid waste management performance indicators also called the (Waste Aware Cities Benchmark Indicators or WABI) are consistent and quality assured.

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GENDER DYNAMICS IN TRANSFORMING LANDSCAPE IN ASSAM

Daisy Rani Hazarika and Dr. Minakshi Phookan Hazarika

Abstract

Developmental activities play a crucial role in the growth and development of the nation. Such activities initiated by the government aims at fostering economic growth, infrastructural expansion and poverty alleviation, in addition to boosting regional balance. Although such initiatives are indispensable for the progress of a nation, yet they can often bring many challenges to the local communities involved. Due to the prevailing inequalities in the society, the benefits of these developmental activities are also unevenly distributed. As such, developmental activities can pose challenges to the principles of social inclusion and equity. In the discourse of social inclusion and equity, it is important to recognize that gender is a key component. Recognizing the importance of gender in the context of developmental studies, this paper aims to study the gender dynamics in a tribal village of Assam that has recently experienced a massive developmental activity. It is based on a village named "Lepetkata Kachari Gaon" located in the upper Assam district Dibrugarh and inhabited by the Sonowal Kachari tribe, which is one of the major tribes of the state. The construction of the Brahmaputra Cracker and Polymer Limited (BCPL), a public sector petro-chemical industry, in the study area, has led to a drastic transformation of the village's physical landscape owing to significant land acquisition and subsequent displacement. Using a blend of quantitative and qualitative methodologies and drawing from both primary and secondary data sources, this empirical study aims to explore the changing gender dynamics of the Sonowal Kachari tribe in Lepetkata Kachari gaon after the construction of the BCPL.

Introduction

Often termed as affirmative actions, developmental activities initiated by the government like the construction of dams, industries, transport networks and other infrastructural expansion projects, undeniably aim at the progress of the nation (Gupta, P. K. D., 1991). Such activities foster economic growth through employment generation and thereby alleviate poverty by raising the per capita income. Most importantly, developmental activities remove regional imbalances which consequently leads to a more balanced development across the nation. Although such initiatives are indispensable for the progress of a nation, yet they can often bring many challenges to the local communities involved (Meher, R., 2003). As a result of the existing social inequalities, the benefits of these developmental activities are also unevenly distributed (Thakur, D. T. D., 2009). As such, developmental activities can subsequently pose challenges to the principles of social inclusion and equity (Enache, C. & Craciun, C., 2013). In the context of social inclusion and equity, it is pertinent to recognize that gender is a key component. Recognizing the importance of gender is crucial for ensuring that these developmental initiatives are inclusive and equitable. Amid this backdrop, the present study attempts to explore the evolving gender dynamics of the Sonowal Kachari tribe of Assam inhabiting Lepetkata Kachari Gaon, following the establishment of the Brahmaputra Cracker and Polymer Limited (BCPL). This public sector petro-chemical industry has significantly transformed the physical, as well as the socio-economic landscape of the village through extensive tribal land acquisition.

Land and the People

Lepetkata Kachari Gaon is located in Dibrugarh district of upper Assam, in the North Eastern region of India. It is located in Dibrugarh West subdivision and is classified under the Barabarua Development Block of Dibrugarh district. Situated approximately 15 kms from the district headquarter of Dibrugarh, the village has a total area of 3.21 sq kms. With a total household of 320, the total population of the village is 1680 as of 2011. Of this, the total male population of the village is 720 and the total female population is 960. The village has a flat terrain and experiences a humid sub-tropical climate. Lepetkata Kachari gaon is a tribal village inhabited by the Sonowal Kachari tribe which belongs to the Mongoloid race. It is a major tribal group of Assam and is a part of the Tibeto-Burman linguistic family. The Sonowal Kacharis are mostly inhabitants of the upper Assam and are predominantly found in the seven districts of Tinsukia, Dibrugarh, Sigsagar, Jorhat, Golaghat, Dhemaji and North Lakhimpur (Barooah, 1998). Originally a branch of the larger Bodo Kachari tribe of the state (ibid). Sonowal Kachari tribe also inhabit parts of Arunachal Pradesh and Nagaland (Saikia, 2018). Originally, the Sonowal Kachari tribe has been practicing paddy cultivation as their primary economic activity (Barooah, 1998). One of the unique characteristics of the Sonowal Kachari tribal community is that their societies are primarily egalitarian where co-operation and co-existence are the prime principles of social life and where class and gender disparities are non-existent (ibid).

Objectives

This study aims to explore how the establishment of the BCPL in Lepetkata Kachari Gaon has altered the gender roles and relations of the Sonowal Kachari tribe inhabiting the village due to the transformation of the physical landscape.

Database and Methodology:

Integrating both quantitative and qualitative research methodologies, this study employs a comprehensive approach so as to thoroughly investigate the subject matter. Although primarily based on primary data, secondary data sources were also referred to in order to enrich the analysis. Books, journals, research work both published and unpublished, government documents and official websites of ministries formed the secondary data sources of this study. On the other hand, primary data was also gathered from multiple sources which included the Lot Mandal Office Dibrugarh, village headman and respondents. In order to investigate the changes in the physical landscape brought by the construction of the BCPL, and to assess the changes in the land use and land cover of the study area, content analysis of the village map was done. In addition to this, extensive field research involving direct observation method was conducted to gain in-depth insights of the various changes in the physical landscape. Based on the relevance and need, purposive sampling was employed to meet the specific objective of this study. To delve into the experiences, attitudes and perspectives of the participants, different data collection methods were employed. These are focus group discussions, in-depth personal interviews and open-ended interviews. In addition to the above, household survey was also conducted using both structured and semi-structured questionnaires.

The Transforming Landscape

The Brahmaputra Cracker and Polymer Limited (BCPL) is a petrochemical complex located at Lepetkata, Dibrugarh. The BCPL plant is a part of the Assam Accord (1985) signed to conclude the Assam agitation on the foreigner issue. It was primarily established for the socio-economic development of the region. The foundation stone of this project was laid in 2007 by the then Prime Minister of India, Dr. Manmohan Singh. Initially, the plant was attached under the Ministry of Chemicals and Fertilizers, Government of India. In 2019, the Cabinet Committee on Economic Affairs transferred the administrative control of BCPL from the Ministry of Chemicals and Fertilizers to the Ministry of Petroleum & Natural Gas, Government of India. Finally, the plant was commissioned in 2016 by the Honourable Prime Minister of India, Narendra Modi.

The BCPL is spread over 4.01487 sq. kilometers of land in Lepetkata, Dibrugarh. Of the total land acquired by the BCPl, 13% of the land has been acquired from Lepetkata Kachari Gaon alone. Data collected from the filed shows that of the total 320 households of the village, more than 40% of the households had to alienate their agricultural as well as homestead land to the construction of the BCPL plant. On the other hand, of the 40% of the households who lost their land to BCPL, more than 42% of the households were completely displaced from the village. These households were given land for resettlement in the nearby villages of Lepetkata Kachari gaon.

Changes in Landuse Pattern

Due to the massive land acquisition by the government for the establishment of the BCPL plant in Lepetkata Kachari gaon, the village has undergone extensive transformations in the land use pattern. The following table shows the change in the land use pattern of the study area over a period of time. Land acquisition for construction of the BCPL was completed in the year 2006. Therefore, in order to show the change in the land use pattern of the village, two years have been selected. The reference year of 2001 was selected since land acquisition for the plant did not start during that year. To assess the changes in the land use of the village after the completion of land acquisition, data for the year 2011 was collected. As such the above table shows the decadal change in land use of pattern of the village. From the above table it can be seen that during the year 2001, 44% of the land was utilized for paddy cultivation. However, in 2011, this land under paddy cultivation was reduced to 33%. In addition to this, it can also be assessed that land under vegetation cover also reduced from 17% in 2001 to only 10% in 2011. Interestingly, a major change in settlement size can be discerned from table 1. In 2001, only1% of the land comprised of settlement. However, this drastically increased to 9% in 2011. Such a drastic change can also be seen in the size of land for small tea gardens. In 2001 the size of land devoted to small tea gardens was only 3% while in the year 2011 this percentage rose to 29%. This substantial increase in small tea gardens is due to the growing economic benefits accrued from it. From the above table it can also be noted that while the percentage of un-metalled roads remained the same in both the years, new metalled roads (3%) were constructed in 2011 but were completely absent in the village in 2001. During the year 2001, various water bodies like natural ponds and fisheries were found in the village which amounted to 2% of the total land area of the village. However, in 2011, waterbodies have reduced in the village to only 1%. Originally 31% of the total village land was occupied by the Lepetkata Tea Estate. However, it can be seen that in 2011, this entire tea estate area has been transformed to other land uses. On the contrary, it can be seen that during the year 2001 no land of the village was under the BCPL. However, in 2011, which is after the construction of the BCPL, it is evident from the above table that 13% of the land of the village has been acquired by the plant (Table-1).

Table-1: Landuse Pattern of Lepetkata Kachari in 2001 and 2011

Sl. No.	Landuse Classification	2001 (%)	2011 (%)
1	Paddy Fields	44	33
2	Vegetation	17	10
3	Settlement	1	9
4	Small Tea garden	3	29
5	Un-metalled roads	2	2
6	Metalled roads	nil	3
7	Water Bodies	2	1
8	Lepetkata Tea Estate	31	Nil
9	BCPL Complex	Nil	13
	Total	100	100

Source: Authors Note: Figures are in percent.

Gender Dynamics

Unlike sex which is a biological construct, gender on the other hand is a social construct, purely created and maintained by the society and its norms (Jardine, S. A. & Dallalfar, A. 2012); (Thomas & Phillips, 2004). It refers to the various societal roles, responsibilities and behaviours that are often guided by different cultures (Bhattacharya, S. & Pal, S., 2022). It is primarily the distinctions of work to be performed by virtue of being a male or a female (Oláh, L. S., Vignoli, D. & Kotowska, I. E., 2020). Since gender is a social construct, it is a multifaceted concept that differs from culture to culture (Ghannam, F., 2013). Further, it encompasses a wide variety of identities that flow beyond the traditional binaries of male and female identities. Gender dynamics refer to the dynamics power relationships between women and men within a given society. Such power dynamics and power relationships are the outcome of complex interplay of various socio-cultural and institutional forces (Xaxa, V., 2004). It can manifest in various aspects of life and can influence the roles, opportunities, interpersonal relationships and status attributed to individuals based on their gender, both at the levels of family and society. While gender dynamics is universal, it is not static as they vary over time, space and culture (Dhal, S., 2018).

Gendered Division of Labour

Due to the change in the land use pattern of the village it can be seen that the division of labour has also altered based on gender differences. As mentioned earlier, the Sonowal Kachari tribe mostly is an egalitarian society. While co-existence and co-operation has been the norm of this society, gender discrimination is mostly non prevalent (Barooah, 1998). Data retrieved from folklores and older generation of the village also echo the above-mentioned fact. However, due to the change in the land use pattern of the village, the economic participation of the community has also been altered (Table-2). The following table shows the change in economic participation of the Sonowal Kachari women in the study are.

Table-2: Participation of Women in Lepetkata Kachari in 2001 and 2011

Sl. No.	Economic Activities	% of economic participation of women	
		2001	2011
1.	Paddy Cultivation	100	66
2.	Horticulture	87	62
3.	Tea Cultivation	nil	nil
4.	Non-farm poultry keeping	100	100
5.	Non-farm economic participation	2	9
6.	Daily Wage	10	4

Source: Authors Note: Figures are in percent

From table 2 it can be seen that 100% of the women respondents of the study area practiced paddy cultivation prior to the construction of the BCPL in 2001. However, post construction of the BCPL in 2011, due to the alienation of agricultural land, only 66% of the women have been engaged in paddy cultivation. On the other hand, during the year 2001, while 87% of the women in the village were engaged in horticulture, in 2011, only 62 % of the women are engaged with it.

In addition to the above, it can also be seen that while only 2% women of the village participated in other non-farm economic activities, this percentage increased to 9 % in the year 2011. Contrary to this, while 10% of the women were engaged as daily wage earners in 2001, such women daily wage earners in the village reduced to only 4% in 2011. One of the interesting facts that can be noticed from the above figure is that both prior to the construction of BCPL and post the construction of the BCPL, no women of the village have ever been engaged in tea cultivation. Hence in both the years of 2001 and 2011, we can see that the data is absent. Conversely, it is also evident from table 2 that non-farm poultry keeping has been practiced by the women of the study area both before and after the establishment of the BCPL. Therefore, it can be seen that in both the years of 2001 and 2011, 100% women are practicing this economic activity.

Changing Gender Roles

Gender roles can be defined as an individual's participation in social activities that involves interaction with other members of the society or community (Levasseur et.al. 2010). Sonowal Kachari is not confined to traditional gender roles of household management only. Instead, they have been traditionally been involved with different social activities thus extending their responsibilities beyond the domestic sphere. Sonowal Kachari women have had held a prestigious position in the society since the very beginning (Das, P., 2015). It is due to the many religious roles they have to perform in the society. Some of the many religious rituals that are to be performed only by women are as follows: Aai Sabah, Apeswari Sabah, Ayushtula Sabah, Batar Sabha, Lakhimi Tolā Sabhā, Batoruwā Sakām and Nuoi tuloni biya (Duwarah, S. G., 2020). Women's pivotal role in the performance of these sacred rituals reflects the high-status Sonowal Kachari women possess within the community (Sonowal, C. J., 2010). However, after the massive land alienation of the Sonowal Kacharis in the village, many a sacred grooves, forests and community spaces have been transformed in the village's landscape. This has adversely affected the social functioning of the community. The loss of these social spaces has subsequently led to the loss of practice of the above-mentioned religious activities leading to the disappearance of women's participation in the social sphere. As a result of the transformation of the physical landscape, women of this village are now mostly confined to the management of household activities thereby reducing their social participation in the community. This phenomenon has today altered the traditionally egalitarian gender dynamics of the society to a more gendered division of roles both in the family and in the society.

Changing Gender Relations

The Sonowal Kachari community is distinctively marked by their rich cultural traditions and egalitarian societal structures. Women holds important position in the community due to the significant role they play both in the society and the family. Sonowal Kachari women have been actively participating in various economic actives alongside men in the society and have been contributing actively in the development and well being of not only the family but also the society (Endle, 2011). Therefore, it can be seen that the Sonowal Kachari women have had traditionally been enjoying an empowered position in the society. And due to their empowered social status, gender relations in the community have had always been one of equality. The construction of the BCPL has altered the land use pattern of the village. With a reduction of 10% paddy fields in the village, women's economic participation has also decreased. Although women were previously actively involved in paddy cultivation, their participation significantly declined following the construction of the BCPL.

With the decline of women's participation in the paddy fields, gender relations have also shifted within the community. In addition to this, small tea gardens have significantly increased from just 3% in 2001 to 29% in 2011. Coupled with this data, it can also be seen that women's participation in tea cultivation have been traditionally non-existent in the village. Tea cultivation has had traditionally been practiced by the men of the community. Tea being a cash crop, improved technology and advanced scientific knowledge is required for its production. Additionally, knowledge of complex industrial setups and networks is also crucial in optimizing tea production. Due to the complex nature of tea cultivation, more men have been engaged with it. After the construction of the BCPL, the percentage of land under tea cultivation has notably increased. More land has now been converted to tea cultivation. Such increase has been attributed to the increased economic advantages associated with tea cultivation. With no women engaged in tea cultivation in addition to the increased cultivation, a widened gap has been generated in gender relations. While in traditional rice cultivation men and women equally shared labour and responsibilities, alternatively, tea cultivation has only increased men's participation thereby drastically reducing women's economic participation. This unequal economic participation of women has resulted in a skewed gender relation in the village which was traditionally not experienced prior to the establishment of the BCPL. Furthermore, as compensation to the villagers who lost their land to BCPL, one male member of such a household was given an employment on contractual basis.

This has further implications in that while 13% of the village land have been allotted to the BCPL construction, which was traditionally used by both men and women of the village, post construction, the institutional framework have been designed to give economic opportunities to only men of the village. This clearly demonstrates the perpetuation of gender discrimination in a tribal village that has never experienced such biases before. Consequently, with the reduction of vegetation, waterbodies and agricultural fields, women's economic participation has significantly been affected. These spaces not only acted as spaces for economic production, but also as spaces of social and cultural production. In addition to the above, it is these spaces that aided the community to create interpersonal relationships and hence construct strong social bonds. A loss of these spaces means not only loss of economic opportunities but also loss of the traditional social support system.

Production of Gendered Landscape

From the above discussion it can be seen that the transforming landscape of Lepetkata Kachari Gaon is also altering the economic practices of the Sonowal Kacharis of the village. These changes in economic practices have also ushered a change in the economic participation of women and men in the village. The resultant land use pattern of the village after the construction of the BCPL, has produced a landscape where women are predominantly engaged in activities that require limited mobility. In this landscape women are often confined to their immediate surroundings or homestead lands. As such, their presence is higher in private spheres unlike previously where women enjoyed greater mobility. On the other hand, men have been seen to be actively engaged in activities demanding greater mobility like working in the tea gardens, BCPL, as daily wage earners in the nearby towns and in various other market-based activities like working in shops and garages. While traditionally no such gender divisions were experienced in the village among the Sonowal Kacharis, the recent change in the physical landscape and due to land alienation for BCPL, clear divisions can be noticed. The indigenous landscape of the village promoted indigenous economic practices like paddy cultivation and horticulture where both men and women worked equally. However, the changing landscape of the village today has been responsible for the production of a more gendered landscape where women seem to occupy the private spaces and men on the other hand dominates the public spaces. As such, the construction of the BCPL in the village has been responsible for the production and promotion of a clear dichotomy of spaces – the public-private dichotomy. This public-private dichotomy often gives birth to hierarchical societal patterns, where women are often assigned lower status due to their lesser economic participation both in the family and in the society. Therefore, such a dichotomy is responsible for dismantling of the egalitarian society of the Sonowal Kacharis where both men and women had equal access to resources and where both the genders enjoyed equal position in the society.

Conclusion

From the above discussions it becomes evident that developmental activities not only transform the physical landscape of the concerned place, but also change the socio-economic characteristics of the local communities involved. Recognizing that gender plays a pivotal role in any development discourse, the above discussions also illustrate that such development initiatives can effectively alter gender dynamics. Therefore, developmental activities must prioritize gender equality to ensure social inclusiveness and equity, especially while working on tribal landscapes. Measures must be taken by policy makers and practitioners to not adversely affect the egalitarian and gender-neutral tribal societies while implementing developmental projects. Policies must be designed in such a way so as to prevent any unintended harm or disruption of values of these communities. Through such considerations it will be possible to safeguard the integrity and well-being of such societies and thus foster sustainable development.

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SPATIAL ANALYSIS ON DISTRIBUTION OF SCHEDULED CASTES AND SCHEDULED TRIBES POPULATION IN UPPER ASSAM OF NORTHEAST INDIA

Diram Bori, Shukla Acharjee and Runa Hazarika

Abstract

This paper presents a spatial analysis of the distribution of Scheduled Castes and Scheduled Tribes population in the districts of Upper Assam according to Census of India, 2011, examining the spatial patterns. Methodologically, the study employs sophisticated analytical tools including Location Quotients, Lorenz's Curve, and Gini's Coefficient. The results reveal that the SC and ST population in Upper Assam are predominantly concentrated in Dhemaji, Lakhimpur and Jorhat districts. By elucidating the spatial dynamics of these marginalized communities, this study seeks to enrich the academic literature on demographic studies and contribute to evidence-based policymaking aimed at promoting inclusive growth and equitable development in the region.

Introduction

Scheduled Castes (SCs) and Scheduled Tribes (STs), historically marginalized communities in India, have been subjected to social and economic discrimination for centuries (Biswas, S., Pramanik, K.R. & Sonowal, C.J. 2023). Note, India, and especially rural India is considered to be one of the most rigidly hierarchical societies in the world (Bango, M., Ghosh, S. 2023). Nearly one third of Indian population constitutes SC and ST. Almost all belong to poor family, and in re-mote area so they are unable to participate in development program (Athawar, V & Ubale, Pv. 2015). The Indian government has envisioned the upliftment and empowerment of SCs and STs and has implemented various policies and programs for their socio-economic developments. The outcomes of these policies and programs depend on the spatial and demographic spread of these communities. Upper Assam is an important geographic area in the state of Assam and is known for its unique socio-cultural entity. The various ethnic and indigenous communities in Upper Assam have also witnessed demographic transformation and socio-economic change over the years.

From time immemorial different tribes and ethnic groups have lived in the Brahmaputra Valley and the hills surrounding it (Bharali, A., 2009). Proper mapping of spatial spread of the SCs and STs in the districts of Upper Assam is essential to focus on policy issues and interventions. Traditionally, population distribution was examined, as static phenomena, relating them particularly to the pattern of the physical environment (Clarke J.I., 1971). But history and economic events play an important role in distribution of mankind on the globe (Kumar, R., 2017). Spatial analysis methods provide an efficient toolset for studying the geography of population groups, allowing the characteristic of spatial patterns and distinctions. Spatial analytical tools and spatial statistics used in this study help determine the spatial character of distribution of SCs and STs in the districts of Upper Assam. This approach allows the identification of spatial clusters and hotspots occupied by these groups and distinguish the areas of their largest concentration to gain a comprehensive understanding of the socio-demographic geography of the region.

Study Region

Upper Assam constitutes an administrative division within the state of Assam, encompassing the former undivided Lakhimpur and Sivasagar (previously known as Sibsagar) districts, situated in the upper reaches of the Brahmaputra valley. It is delineated as one of the five regional divisions of Assam, alongside Lower Assam, North Assam, Central Assam, and Barak Valley. The districts comprising Upper Assam include Charaideo, Dhemaji, Dibrugarh, Golaghat, Lakhimpur, Majuli, Sivasagar, Tinsukia, Jorhat. Renowned for its productivity, Upper Assam boasts abundant natural resources such as coal, oil, natural gas, and extensive tea plantations. Initially constituted with seven districts, the Upper Assam division has since expanded to encompass ten districts, including Jorhat, Dibrugarh, Dhemaji, Golaghat, Charaideo, Lakhimpur, Majuli, Sivasagar, and Tinsukia. Notably, Charaideo and Majuli attained district status in 2016, whereas Golaghat and Tinsukia were elevated to district status in 1987 and 1989, respectively. Dibrugarh, Golaghat, and Jorhat emerge as the oldest recognized and continuously inhabited urban centres within the region, with municipal bodies established prior to India's independence in 1947.

Objectives

The principal objective of this study encompass a comprehensive examination of several key aspects: firstly, to scrutinize the distribution trends of scheduled castes and tribes within the Upper Assam region; secondly, to explore the spatial distribution patterns of SC and ST populations across the various districts of Upper Assam; and thirdly, to ascertain pertinent statistical measures such as Location Quotients, Gini's Coefficient, and Lorenz's Curve specifically for these populations at the district level.

Database and Methodology

The data utilized in the current spatial analysis has been sourced from secondary repositories, notably the Census of India, recognized for its comprehensive coverage and reliability. This dataset serves as a robust foundation for investigating the demographic landscape of Upper Assam. Methodologically, the study employs sophisticated analytical tools including Location Quotients, Lorenz's Curve, and Gini's Coefficient. These statistical measures are instrumental in discerning the relative concentration and dispersion patterns of the scheduled caste and tribe populations at the district level, thereby facilitating a nuanced understanding of their spatial dynamics. By leveraging these analytical techniques, the study endeavours to provide empirical insights into the socio-demographic fabric of Upper Assam, contributing to the scholarly discourse on regional development and inclusive policymaking. Furthermore, the utilization of established methodologies ensures the rigor and reliability of the findings, enhancing the credibility and applicability of the research outcomes for informing evidence-based interventions and strategic planning initiatives aimed at fostering equitable development and social cohesion within the region.

Results and Discussion

Distribution of Scheduled Castes Population

Table-1 presents a comprehensive overview of scheduled castes populations within various districts of Upper Assam, accompanied by their respective total populations and Location Quotients (LQ). The Location Quotient serves as a crucial metric for assessing the relative concentration of scheduled castes in each district relative to the overall population of Upper Assam. A Location Quotient of 1.000 signifies parity with the regional average. Districts such as Jorhat exhibit notably elevated LQ values (0.882), indicative of a heightened concentration of scheduled castes compared to the regional mean. Conversely, Sibsagar displays a lower LQ (0.382), suggesting a relatively diminished presence (Fig. 1). This nuanced analysis underscores spatial differentials in scheduled castes distributions across Upper Assam districts, thereby enriching our understanding of regional demographic dynamics (Table-1).

Table-1: Upper Assam: Scheduled Castes Population and Location Quotient, 2011

Districts	Total Population	Scheduled Castes Population	Location Quotient
Dhemaji	6,86,133	44,225	0.508
Lakhimpur	10,42,137	81,840	0.789
Golaghat	10,66,888	62,298	0.580
Jorhat	10,92,256	88,665	0.882
Sibsagar	11,51,050	42,347	0.382
Dibrugarh	13,26,335	58,876	0.442
Tinsukia	13,27,929	37,688	0.337
Upper Assam	76,92,728	4,15,939	1.000

Source: Authors

Table-2 provides a detailed analysis of district-wise total population and scheduled caste (SC) demographics within Upper Assam. It delineates the percentage distribution of both total population and SC population across districts, along with cumulative percentages. Key observations include varying degrees of SC population concentration across districts. For instance, districts like Tinsukia and Sibsagar exhibit relatively lower SC population percentages compared to Dibrugarh and Lakhimpur, where SC populations represent a more substantial proportion of the total population. The cumulative distribution of SC populations highlights disparities, with certain districts contributing more significantly to the overall SC population than others. Additionally, the calculated Gini coefficient of 0.21 underscores moderate inequality in SC population distribution across Upper Assam districts. The Gini coefficient is a measure of variation among different populations or groups, either of a positive resource or of an undesired burden that is derived from the Lorenz curve of inequality (Moskowitz CS., Seshan VE., Riedel ER, Begg CB., 2008). These findings underscore the nuanced demographic dynamics within the region and emphasize the importance of tailored policy interventions to address disparities and promote equitable development initiatives, particularly in districts with higher concentrations of SC populations.

The Lorenz curve was devised by an American economist named Max O. Lorenz in 1905 as a method for measuring the concentration of wealth (Sitthiyot, T., Holasut, K., 2021) The Lorenz Curve for Distribution of SC Population in Upper Assam, 2011 (Fig 01) shows that the distribution of the Scheduled Caste (SC)

Table-2: Upper Assam- CalcLorenz Curve and Gini's Coefficient for Scheduled Castes, 2011

District	District-wise Total Population			Scheduled Castes					
	Total Population	% Distribution of Total Population	Cumulative % Distribution of Total Population (Xi)	SC Population	% of SC Population in the District	% Distribution of SC Population	Cumulative % Distribution of SC Population (Yi)	Xi×Yi+1	Xi+1×Yi
Tinsukia	13,27,929	17.26	17.26	37,688	2.84	9.06	9.06	332.08	291.91
Sibsagar	11,51,050	14.96	32.22	42,347	3.68	10.18	19.24	1075.83	951.61
Dibrugarh	13,26,335	17.24	49.46	58,876	4.44	14.15	33.39	2392.38	2114.59
Golaghat	10,66,888	13.87	63.33	62,298	5.84	14.98	48.37	3736.47	3494.73
Dhemaji	6,86,133	8.92	72.25	44,225	6.44	10.63	59.00	5684.63	5062.20
Lakhimpur	10,42,137	13.55	85.80	81,840	7.85	19.68	78.68	8580	7868
Jorhat	10,92,256	14.20	100	88,665	8.12	21.32	100		
Upper Assam	Total= 76,92,728			Total= 4,15,939		Gini= 0.21		21801.39	19783.04

population in Upper Assam in 2011 is relatively equal. A perfectly equal distribution would be represented by a diagonal line, where the cumulative percentage of the SC population (y-axis) is exactly equal to the cumulative percentage of the total population (x-axis). The curve in the image deviates from this diagonal line, which indicates that the distribution is not perfectly equal. However, the curve is relatively close to the diagonal, which suggests that the distribution is more equal than it would be in other parts of the country. It is important to note that the Lorenz Curve only shows the relative distribution of a population. It does not provide any information about the absolute numbers of people. For example, the Lorenz Curve could represent a situation in which a small number of people hold a large share of the wealth, or a situation in which a large number of people hold a small share of the wealth. The area between the Lorenz Curve and the line of perfect equality quantifies inequality known as Gini Coefficient (calculated in Table-2). A smaller area indicates less inequality, while a larger area suggests greater disparities. In short, the Lorenz Curve for Distribution of SC Population in Upper Assam, 2011, suggests that the distribution of the SC population in Upper Assam in 2011 was relatively equal, but not perfectly equal.

Distribution of Scheduled Tribes Population

Table-3 presents a comprehensive analysis of scheduled tribes (ST) populations across various districts within Upper Assam, alongside their respective total populations and Location Quotients (LQ). Notably, districts like Dhemaji and Lakhimpur exhibit LQ values exceeding 1, indicating a higher concentration of ST populations compared to the regional average. Dhemaji, with a Location Quotient of 1.379, boasts the highest relative concentration of ST populations among the districts, followed closely by Lakhimpur with an LQ of 1.989 (Fig. 1).

Conversely, districts like Sibsagar, Dibrugarh, and Tinsukia demonstrate LQ values significantly below 1, suggesting a comparatively lower concentration of ST populations relative to the regional average. Golaghat and Jorhat districts, although with LQ values slightly above 1, indicate a relatively modest deviation from the regional average in terms of ST population concentration. The cumulative LQ of 1.000 for Upper Assam underscores the regional average concentration of ST population across all districts. This nuanced analysis provides valuable insights into the spatial distribution and demographic dynamics of ST populations within the Upper Assam region. By comparing the LQ values across districts, the analysis provides a comparative understanding of the spatial distribution of ST population within the study area.

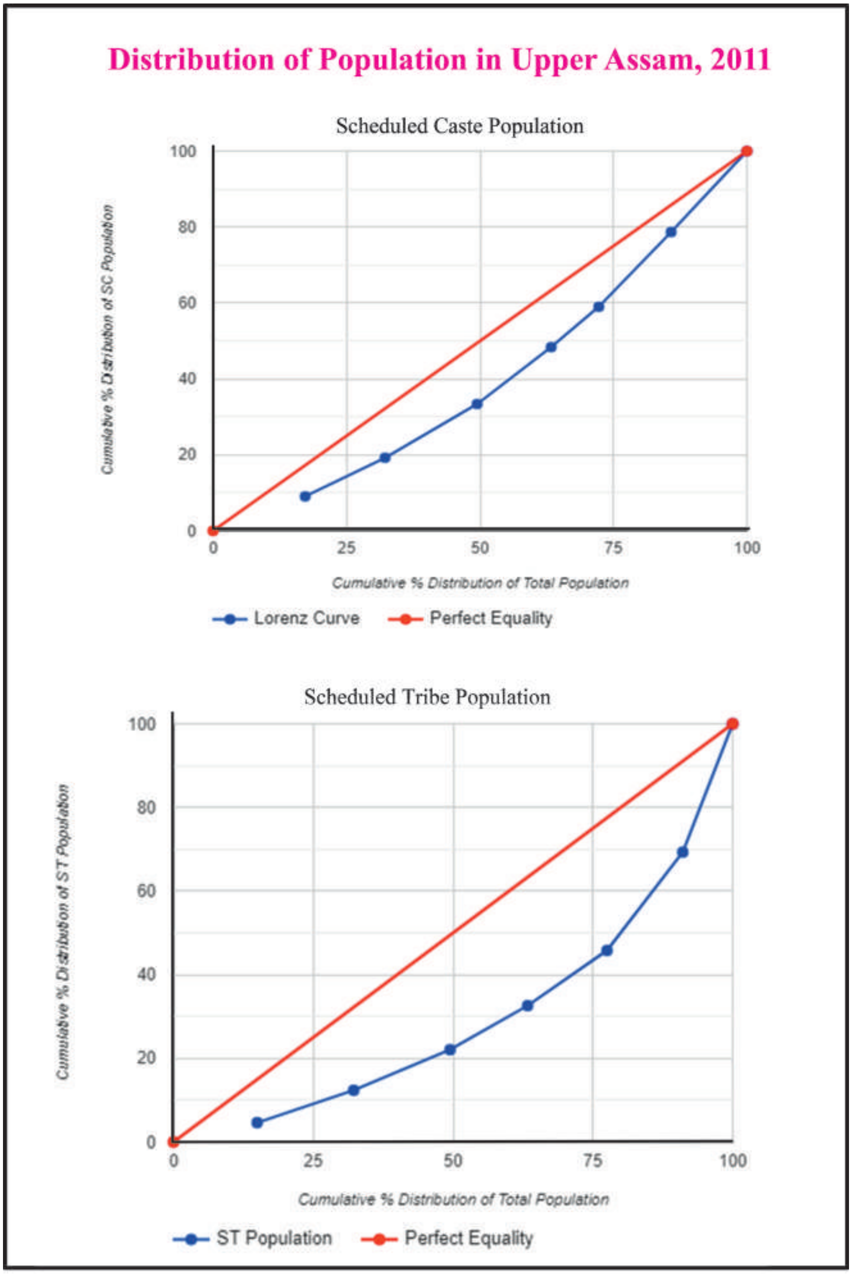
Distribution of Population in Upper Assam, 2011
Scheduled Caste Population
Cumulative % Distribution of SC Population
Cumulative % Distribution of Total Population
Lorenz Curve
Perfect Equality
Scheduled Tribe Population
Cumulative % Distribution of ST Population
Cumulative % Distribution of Total Population
ST Population
Perfect Equality

Fig. 1

Table-3: Upper Assam: Scheduled Tribes Population and Location Quotient: 2011

District	Total Population	Scheduled Tribes Population	Location Quotient
Dhemaji	6,86,133	3,25,560	1.379
Lakhimpur	10,42,137	2,49,426	1.989
Golaghat	10,66,888	1,11,765	0.774
Jorhat	10,92,256	1,39,971	1.003
Sibsagar	11,51,050	49,039	0.120
Dibrugarh	13,26,335	1,02,871	0.685
Tinsukia	13,27,929	82,066	0.627
Upper Assam	76,92,728	10,60,698	1.000

Table-4 reveals significant disparities in the distribution of scheduled tribe (ST) populations across districts within Upper Assam. For instance, while Sibsagar and Tinsukia exhibit relatively lower percentages of ST populations, districts like Lakhimpur and Dhemaji demonstrate substantially higher percentages, with Dhemaji boasting the highest concentration at 47.45%. By assessing cumulative percentage distributions, it becomes evident that certain districts, particularly Lakhimpur and Dhemaji, significantly contribute to the overall ST population of Upper Assam. Lakhimpur, for instance, accounts for 23.51% of the total ST population, reflecting its considerable demographic weight within the region. The calculated Gini coefficient of 0.41 indicates a relatively high level of inequality in the distribution of ST populations across districts within Upper Assam. This suggests that ST populations are unevenly distributed, with certain districts exhibiting much higher concentrations than others. The analysis underscores the complex spatial dynamics influencing ST population distribution within Upper Assam.

Factors such as historical settlement patterns, geographical features and socio-economic conditions likely contribute to these disparities, highlighting the need for targeted policy interventions to address socio-economic inequalities and promote inclusive development within the region. The Lorenz Curve for ST Population in Upper Assam, 2011 (Fig 02), reveals a clear trend of inequality in the distribution. The curve dips considerably below the perfect equality line (diagonal). This significant gap indicates a substantial imbalance in how the ST population is spread across Upper Assam.

Table-4: Upper Assam- Lorenz Curve and Gini's Coefficient for Scheduled Tribes, 2011

District-wise Total Population				ST					
District	Total Population	% Distribution of Total Population	Cumulative % Distribution of Total Population (X1)	ST Population	% of ST Population in the District	% Distribution of ST Population	Cumulative % Distribution of ST Population (Y1)	$X_i \times Y_{i+1}$	$X_{i+1} \times Y_i$
Sibsagar	11,51,050	14.96	14.96	49,039	4.26	4.62	4.62	184.90	148.86
Tinsukia	13,27,929	17.26	32.22	82,066	6.18	7.74	12.36	710.77	611.32
Dibrugarh	13,26,335	17.24	49.46	1,02,871	7.76	9.70	22.06	1612.40	1397.06
Golaghat	10,66,888	13.87	63.33	1,11,765	10.47	10.54	32.60	2900.51	2527.48
Jorhat	10,92,256	14.20	77.53	1,39,971	12.81	13.20	45.80	5373.60	4171.46
Lakhimpur	10,42,137	13.55	91.08	2,49,426	23.94	23.51	69.31	9108	6931
Dhemaji	6,86,133	8.92	100	3,25,560	47.45	30.69	100		
Upper Assam	Total= 76,92,728			Total= 10,60,698		Gini= 0.41		19890.18	15787.18

Conclusion

The present paper attempted a spatial analysis on distribution of SC and ST population in Upper Assam. The results revealed that SC population is mainly concentrated in Jorhat, Lakhimpur and Dhemaji districts. Similarly, higher concentration of ST population is seen in Dhemaji, Lakhimpur and Jorhat districts. On the other hand, Tinsukia, Sibsagar and Dibrugarh districts have lower concentration of SC as well as ST population. Hence, one may conclude that SC and ST population in Upper Assam are prominently concentrated in three districts, namely, Dhemaji, Lakhimpur and Jorhat. The results also show that distribution of ST population is relatively more inequal than SC population.

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ASSESSMENT OF LIVING CONDITIONS OF DIFFERENT SOCIAL GROUPS IN HARYANA

Parul and Dr. Renu Arya

Abstract

This study aimed to examine multifaceted aspects of living conditions among diverse social groups in Haryana, a state located in northern India. Despite significant economic growth and development in recent years, Haryana grapples with persistent inequalities that manifest in varying living standards among its population. The implications of disparate living conditions extend beyond mere material deprivation, impacting overall well-being, social mobility, and human development indices. By shedding light on the lived realities of different social groups in Haryana, this study provides valuable insights for policymakers, development practitioners, and social organisations striving towards a more equitable and just society. There are two main objectives of the present study, i.e., to analyse the socio-economic factors contributing to disparities in living conditions among various social groups in Haryana and to examine the role of discrimination and unequal resource distribution in perpetuating inequalities in living standards among different social groups. Primary data for this study has been collected in a well-organized manner by utilising a qualitative research approach. It is crucial that household-level data be collected for the present study in order to comprehend the changes at the micro- or household level. A stratified random sample has been used as the foundation for selecting these households. Nine villages from six different districts of Haryana have been surveyed. Depending on the size of the houses, 1–10% of all households have been chosen for the primary survey in this study. A total of 390 houses have been surveyed throughout the fieldwork. According to the study, higher castes in Haryana have better living standards than other castes.

Introduction

A concept linked to condition of living, which is based on the argument that the human condition should be evaluated on a wider range of indicators than just income, whether at the individual level or through national aggregates, is what the Dictionary of Human Geography (2009) defines as quality of life. Governments frequently conflate “condition of living” and “quality of life” (Jackson, 2002). Condition of living is an all-encompassing concept that encompasses more transcendent aspects of life, such personal development, self-realization, and a healthy environment, in addition to the material fulfilment of basic needs (Dube, 1983). An early concept of the condition of living may be found in Aristotle's phrase “Eudaimonia” (382–322 B.C.), which indicated a good and prosperous lifestyle, both for the individual and for society as a whole. According to Immanuel Kant, a decent society is built on the moral behavior of its members, which may eventually lead to the creation of universal laws. Seth (1889) used the term “quality of life” for the first time in an article titled “Evolution of Morality” in 1889. Particularly in the latter half of the 20th century, the term “condition of living” became increasingly common. The term "rural development" refers to the process of enhancing the standard of living and economic well-being of those who reside in places that are generally remote and have a low population density. The exploitation of land-intensive natural resources, such as agriculture and forestry, has historically been the primary focus of rural development. The nature of rural regions has been altered, however, as a result of changes in global industrial networks and rising urbanization.

The term "rural development" refers to the process of enhancing the overall quality of life for individuals living in rural regions so that they may continue to improve their standard of living. The end result is the creation of an atmosphere that is favourable to the enhancement of people's capabilities and the use of those capabilities to their fullest extent, without exploitation, and on a sustainable basis. When it comes to the economic growth of a nation like India, it is both the means and the end of the job. Housing conditions that are improved have the potential to save lives, prevent illness, improve quality of life, lead to a reduction in poverty, and contribute to the mitigation of climate change. In view of the increase of rural areas, the aging of populations, and the effects of climate change, the state of housing is becoming an increasingly significant factor in health (WHO, 2018). Global attention has focused on its importance for human development ever since it was included in the Millennium Progress Goals. The goals are ambitious but doable, and they lay the groundwork for the worldwide endeavor to achieve them by 2015 in tandem with the larger UN development agenda. A primary objective of the Millennium Development Goals was to ensure that everyone has access to the needs of life. Still, most developing nations including India face obstacles in reaching the Goals.

Despite its progress in the economy and technology in the 21st century, a portion of the Indian population still lacks access to essential home supplies. Having access to needs like power, water for drinking, sanitary conditions, drainage, housing, and other things is essential to a community's overall health. (MDGs, 2015).

Study Region

Haryana is a state in northwest India between 27°37' to 30°35' N latitudes and between 74°28' to 77°36' E longitudes. It was carved out of the Indian state of Punjab on 1st Nov. 1966. It is bounded by Uttar Pradesh in east, Punjab in west, Himachal Pradesh in north and Rajasthan in south with 1.37 percent of total geographical area of India. There are 21 districts, 74 tahsils and 6841 villages as per Census 2011. According to Census of India 2011, the total population of Haryana is 2,53,51,462 persons (1,34,94,734 males and 1,18,56,728 females) 1,65,09,359 persons belong to rural areas and 88,42,103 persons belong to urban areas. Haryana ranked 3rd among all states in terms of per capita income but as far as social aspects are considered its ranked went down to lowest. Haryana sex ratio is 879/1000 males which is worst in India.

Objectives

(1) To study the Living Conditions of Women in Different Social Groups in Haryana.

(2) To study the Household Amenities in Different Social Groups in Haryana.

Database and Methodology

The study is mainly based on primary data collected on the basis of a well-structured, scheduled, and personal interview conducted with the households. To understand the changes at the micro- or household level, it is important for the present study to collect household-level data. The selection of these households has been done on the basis of stratified random sampling. However, their interactions during the field survey have been considered. The total villages of six different districts have been selected. A stratified random sample has been used as the foundation for selecting these households. Nine villages from six different districts of Haryana have been surveyed. Depending on the size of the houses, 1–10% of all households have been chosen for the primary survey in this study. A total of 390 houses have been surveyed throughout the fieldwork. To identify the levels of living condition in different social groups in Rural Haryana 17 indictors have been taken up in this study.

They are , namely, Households having Kachha house (X1), Households having Pacca houses (X2), Households having Mixed houses (X3), Households having cooking fuel as Firewood (X4), Households having cooking fuel as LPG (X5), Households having cooking fuel as Combined (Firewood & LPG) (X6), Households having T.V/LED (X7), Households having Washing Machine (X8), Households having Refrigerators (X9), Households having Fan (X10), Households having Cooler (X11), Households having A.C. (X12), Households having R.O facilities (X13), Households having source of water as Govt. (X14), Households having availability of Tap water for drinking (X15), Households having treated water (X16), Households having Sanitation facilities (X17). To find out the levels of Living condition among general castes in Rural Haryana 'Z score' in respect to each of the indicator in a district has been calculated as under:

$$Z \text{ Score} = X - X / \sigma$$

Whereas:

X =Percentage value of the indicator in a district

X = Mean value of the indicator in the study area

σ= Standard deviation

For the purpose of calculating the "composite Z score," the "Z scores" of all 17 of the indicators that were chosen were combined together. The degrees of living conditions in different social groups in rural Haryana have been established via the use of a numerical metric known as "composite Z scores." Following this, the value of the "composite Z score" that was acquired was divided into three distinct groups. The value that falls between minus 0.50 and plus 0.50 is considered to be of medium level, while the value that falls between minus 0.50 and plus 0.50 is considered to be of high level. The values that fall below 0.50 are considered to be of low level, while the values that fall between minus 0.50 and plus 0.50 are considered to be of low level. Finally, in order to comprehend and evaluate the data, diagrams were created with the assistance of Microsoft Excel, and tables were generated.

Result and Discussion

(a) Living Condition of General Castes

Three categories are considered: Kachha, Pacca, and Mixed. Kachha houses typically refer to those made of less durable materials like mud, thatch, or bamboo, while Pacca houses are constructed using more permanent materials like brick,

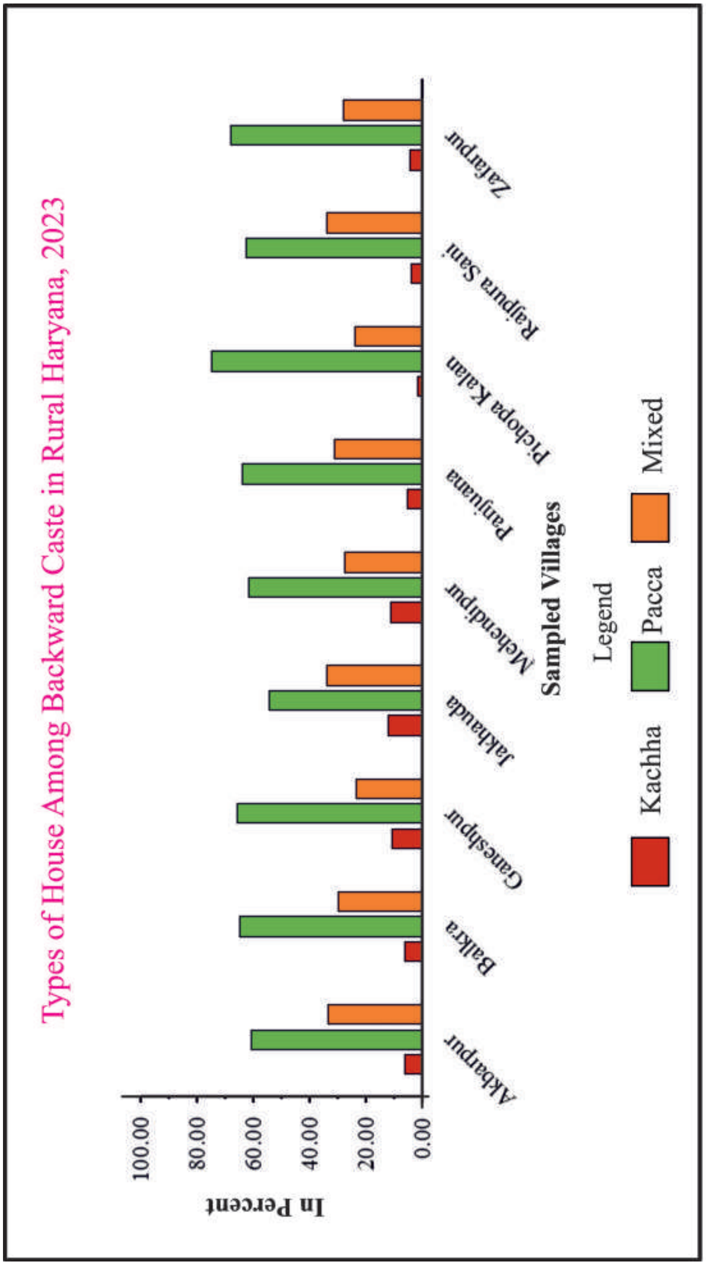
Types of House Among Backward Caste in Rural Haryana, 2023
In Percent
100.00
80.00
60.00
40.00
20.00
0.00
Akbarpur
Balkra
Ganeshpur
Jakhauda
Mehendipur
Panjuana
Pichopa Kalan
Rajpura Sani
Zafarpur
Sampled Villages
Legend
Kachha
Pacca
Mixed

Fig. 1

concrete, or stone. Mixed houses indicate a combination of both types within a single household. The sampled villages have not reported any Kachha houses. Instead, the predominant types of houses are Pacca and Mixed. For instance, in Akbarpur, 63.61% of households have Pacca houses, while 36.39% have mixed houses. This pattern repeats across the various villages, with varying degrees of Pacca and Mixed house prevalence. Overall, the data suggests a consistent trend toward more durable housing materials, with Pacca houses being the most common, and Mixed houses also contributing significantly in some areas. The majority of households use LPG as their main cooking fuel; the percentages vary from about 23.17% to 55.48% in different areas. This implies a heavy dependence on easier and cleaner cooking solutions, like LPG. The **Diagram 3** shows the percentage of general caste households having TV/ LED sets in sampled villages. The highest utilisation percentage is observed in Zafarpur at 97.48%, followed by Mehendipur at 96.52%, indicating widespread access to TV/LED among general caste households in these villages. Balkra and Panjuana also show high utilisation rates, with 93.08% and 92.52% respectively. Ganeshpur has the lowest utilisation percentage among the listed villages at 85.74%, still representing a significant portion of households having access to TV/LED. Diagram 3 shows that washing machine ownership varies across villages, with Akbarpur and Balkra having the high percentages 73.02% and 74.04% respectively, followed by Zafarpur (61.52%). This suggests that socio-economic factors or access to modern amenities may influence the distribution of utilisation among general castes in Rural Haryana.

The high utilization rates of 87.3% and 88.32% in Akbarpur and Balkra show refrigerators, respectively. Zafarpur village noticed a noteworthy rate of refrigerators, standing at 68.24%. On the other hand, Rajpura Sani has the lowest utilization (54.26% of the villages that are included), closely followed by Panjuana and Pichopa Kalan. The data indicates high ownership rates across all villages, with the highest percentages observed in Balkra (97.21%) and Zafarpur (98.35%). Akbarpur, Mehendipur, and Jakhauda also demonstrate high ownership rates, ranging from 93.64% to 96.19%. Rajpura Sani has the lowest ownership percentage among the listed villages at 86.15%. Overall, the data suggests widespread access to electric fans among general caste households in the surveyed villages, with only slight variation in ownership rates across different locations. Among the listed villages, Akbarpur and Balkra have relatively high ownership percentages at 90.48% and 91.5% respectively. Zafarpur also shows a considerable ownership rate at 85.06%. Conversely, Rajpura Sani has the lowest ownership

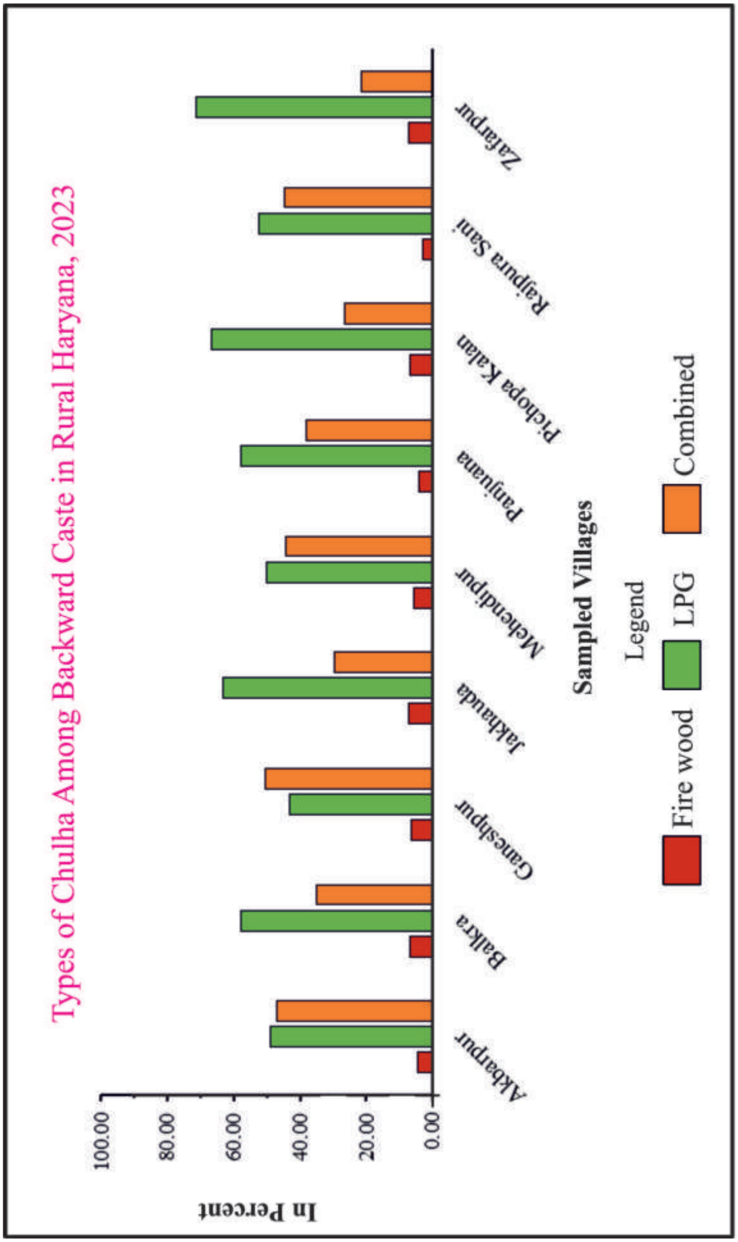
Types of Chulha Among Backward Caste in Rural Haryana, 2023
In Percent
100.00
80.00
60.00
40.00
20.00
0.00
Akbarpur
Bakra
Ganeshpur
Jakhauda
Mehendipur
Panjuana
Pichopa Kalan
Rajpura Sani
Zafarpur
Sampled Villages
Legend
Fire wood
LPG
Combined

Fig. 2

percentage among the listed villages at 69.44%, with Panjuana and Pichopa Kalan following closely behind. This data suggests that while electric cooler ownership is prevalent in some villages, there is variation across different locations, likely influenced by socioeconomic factors or climatic conditions. Across the villages, AC ownership is relatively low, with the highest percentage observed in Mehendipur at 7.91%. Other villages show ownership percentages ranging from 0.91% in Pichopa Kalan to 4.13% in Ganeshpur. Akbarpur, Balkra, Jakhauda, Panjuana, Rajpura Sani, and Zafarpur all have AC ownership percentages below 4%. The percentage of general caste households owning Reverse Osmosis (RO) systems in various sampled villages. Mehendipur has the highest ownership percentage at 9.51%, followed by Akbarpur at 8.63%. Balkra, Jakhauda, and Panjuana have ownership percentages ranging from 5.51% to 7.65%. Conversely, Rajpura Sani and Pichopa Kalan have the lowest ownership percentages among the listed villages at 2.23% and 2.51% respectively, with Ganeshpur and Zafarpur also having relatively low ownership percentages below 7%. Diagram 3 shows tap water is the predominant source of drinking water in several villages, with 82.79% to 87.82% of the population using it, indicating significant investment in water infrastructure.

(b) Living Condition of Backward Castes

Kachha houses, constructed from less durable materials, are present to varying degrees across the villages, ranging from 1.57% in Pichopa Kalan to 12.05% in Jakhauda. In contrast, Pacca houses, characterized by more permanent materials, dominate the housing landscape, with percentages ranging from 54.07% in Jakhauda to 74.68% in Pichopa Kalan. Pacca houses dominate villages due to infrastructure investments and economic development. These housing types reflect diverse socio-economic and cultural contexts, balancing tradition, modernity, and practicality shows that LPG is the most popular cooking fuel among households in sampled villages, with 43.22% in Ganeshpur and 71.31% in Zafarpur, largely due to its convenience and cleanliness, and government initiatives. Firewood usage in Rajasthan varies, with 2.88% in Rajpura Sani and 7.32% in Jakhauda, despite environmental concerns and indoor air pollution. (Fig 2). The high usage of electrical appliances in rural communities, such as TV/LED and fans, indicates a significant emphasis on entertainment and ventilation, enhancing overall well-being and quality of life. Similarly, the widespread usage of Refrigerators, ranging from approximately 49.80% to 83.33%, reflects an increasing reliance on modern conveniences for food preservation and storage, enhancing food security and dietary options. In terms of govt. supply of water, all villages exhibit a high category with 100% access, ensuring universal provision of water supply by the government. Regarding tap water access, the majority of villages, including Akbarpur, Balkra, Ganeshpur, Jakhauda, Panjuana, Pichopa Kalan, Rajpura Sani, and Zafarpur, fall into the high category, with percentages ranging from 81.18% to 83.67%. However, Mehendipur stands out in the moderate category with 76.92% access. In contrast, for tube well water access, most villages fall into the moderate category, with percentages ranging from 16.33% to 23.08%, except for Ganeshpur, which falls into the low category with 16.33% access. Lastly, all villages score high in flush toilet access, indicating universal access to this sanitation facility. This analysis provides insights into the varying levels of water supply and sanitation infrastructure across the villages, highlighting areas of strength and potential areas for improvement in ensuring equitable access to essential amenities.

(c) Living Condition of Scheduled Castes

This reveals the housing composition among scheduled caste households in sampled villages, delineating between Kachha, Pacca, and mixed housing types. Villages show Pacca houses dominate (54.73%-61.55%) in Akbarpur, Balkra, Jakhauda, Panjuana, with Kachha houses at 20% in Ganeshpur, indicating lower infrastructure development or economic conditions. Conversely, Mehendipur exhibits a notably high percentage of Pacca houses at 69.64%, suggesting better-built infrastructure. Mixed housing types, incorporating elements of both Kachha and Pacca structures, are present in varying degrees across villages, with Rajpura Sani and Panjuana showing higher percentages at 38.83% and 33.99%, respectively. Diagram 8 provides a comprehensive overview of cooking fuel preferences among scheduled caste households in various sampled villages, offering insights into the distribution of Firewood, LPG, and combined fuel usage. In Akbarpur, Balkra, and Zafarpur, a significant portion of households primarily rely on combined fuels, with percentages ranging from 66.63% to 78.43%, indicating a trend of using a mix of traditional and modern fuel sources. Meanwhile, villages like Jakhauda show low percentage of households using Firewood (1.14%), indicating a substantial shift towards modern cooking fuels. However, in Ganeshpur and Mehendipur, a notable percentage of households still use Firewood 5.98% and 6.07% respectively. Conversely, LPG usage varies across villages, with Panjuana and Pichopa Kalan showing relatively higher percentages 30% and 34.2% respectively. **Diagram 9** shows significant variations in TV/LED usage among Scheduled Caste households in various villages. Zafarpur has the highest adoption rate, with 93.5%, followed by Mehendipur and Rajpura Sani with 86.12% and 85.85% respectively.

Jakhauda has the lowest usage, indicating disparities in access to modern amenities and technological advancements. Addressing socio-economic factors is crucial for enhancing technology adoption. The levels of washing machine adoption among Scheduled Caste households in various villages. Zafarpur has the highest adoption rate (57.54%), followed by Balkra, Jakhauda, and Panjuana (54.87%-62.48%). Rajpura Sani has the lowest (41.81%). This highlights disparities in access to modern amenities and the need for targeted interventions to promote equitable access. The study reveals that refrigerator usage among scheduled caste households in various villages varies. Balkra and Akbarpur have high adoption rates, with over 70% of households using them, while Mehendipur and Rajpura Sani have lower rates, indicating disparities in access to modern amenities and economic conditions. In Zafarpur, the highest adoption rate, where 94.37% of households utilize electric fans, indicates widespread access to this essential cooling appliance. Conversely, villages like Pichopa Kalan and Panjuana exhibit slightly lower adoption rates, with around 76-79% of households using electric fans. Overall, the data underscores the importance of electric fans as a common household appliance, essential for providing comfort and relief from heat, particularly in regions with warmer climates.

The data provides insights into the usage of coolers among scheduled caste households in various sampled villages. Across the villages, there are noticeable differences in the percentage of households utilizing coolers as electrical appliances. Zafarpur has the highest adoption rate of coolers (62.32%), indicating a need for cooling solutions due to warmer climates. Rajpura Sani has the lowest adoption rate (49.47%), highlighting the importance of access to cooling appliances in improving living standards in marginalized communities. All sampled villages report 100% of Scheduled Caste households having access to government supply of water, indicating widespread provision of this essential service by the government. Similarly, all villages report 100% of Scheduled Caste households having access to tap water, highlighting universal access to piped water sources in these communities. The percentage of households having access to tube wells varies across the villages, ranging from 18.29% in Ganeshpur to 25.85% in Mehendipur. This suggests that while a majority of households rely on government or tap water supply, a significant portion also utilizes tube wells for water access, particularly in areas where piped water infrastructure may be limited. Access to flush toilets also varies across the villages, with percentages ranging from 69.2% in Ganeshpur to 87.83% in Panjuana. This indicates disparities in sanitation infrastructure, with some villages having higher rates of flush toilet usage compared to others.

(d) Level of Living Conditions of Different Social Groups in Haryana

Among the sampled villages, there is considerable variation in the composite index reflecting living conditions among social groups. Akbarpur and Balkra stand out with positive index scores of 0.33 and 0.39, respectively, indicating relatively favorable living conditions. These villages likely better access to education, healthcare, and infrastructure, along with higher income levels among the general caste population. Mehendipur follows closely with a score of 0.26, suggesting decent living standards as well. Conversely, Pichopa Kalan and Rajpura Sani present markedly lower scores of -0.44 and -0.54, respectively, indicating significantly poorer living conditions. These villages may face challenges such as inadequate infrastructure, limited access to essential services, and lower income levels among the general caste residents. Ganeshpur, Jakhauda, Panjuana, and Zafarpur fall within the mid-range of the index, implying mixed living conditions where certain aspects may be better or worse compared to the extremes. Overall, this data highlights the disparities in living standards among the sampled villages, reflecting the importance of targeted interventions to improve the quality of life for all residents, particularly those in disadvantaged communities (Table-1).

Table-1: Rural Haryana: Living Conditions of Different Social Groups, 2023

Sr. No.	Villages	General Castes	Backward Castes	Scheduled Castes
1	Akbarpur	0.33	0.24	0.11
2	Balkra	0.39	0.37	0.15
3	Ganeshpur	-0.03	0.01	-0.02
4	Jakhauda	-0.01	0.07	0.00
5	Mehendipur	0.26	0.28	-0.15
6	Panjuana	-0.14	-0.17	0.11
7	Pichopa Kalan	-0.44	-0.46	-0.32
8	Rajpura Sani	-0.54	-0.48	-0.36
9	Zafarpur	0.18	0.14	0.47

Source: Primary Survey, 2023

Pichopa Kalan and Rajpura Sani show poorer living conditions, while Ganeshpur, Jakhauda, Panjuana, and Zafarpur have mixed conditions, with Panjuana having significant challenges. In the sampled villages, the composite index representing living conditions among scheduled castes reveal a diverse landscape.

Zafarpur emerges as a notably higher index score of 0.47, indicating comparatively better living conditions for scheduled caste. While Zafarpur village likely offers improved access to essential services, education, and opportunities for scheduled caste residents. Akbarpur and Balkra also present moderate index scores of 0.11 and 0.15, respectively. On the other hand, Pichopa Kalan and Rajpura Sani shows significantly lower scores of -0.32 and -0.36, respectively, indicating considerable challenges and poorer living conditions for scheduled caste communities. Mehendipur, despite its general caste and backward caste scores, shows a negative index score of -0.15 for scheduled castes, indicating relatively poorer conditions for this specific group. Ganeshpur, Jakhauda, and Panjuana fall within the mid-range of the index, suggesting mixed living conditions for scheduled castes in these villages.

Conclusion

After analyzing the data from the sampled villages, several trends and disparities in living conditions and access to amenities among Scheduled Caste households become evident. Villages with better housing infrastructure, such as Balkra and Ganeshpur, have higher proportions of pucca houses; conversely, villages with worse housing quality, such as Pichopa Kalan and Rajpura Sani, have higher percentages of kachha dwellings. The majority of homes in most villages utilize LPG as their primary cooking fuel, which suggests a shift toward more contemporary cooking methods. Villages like Mehendipur and Panjuana, meanwhile, continue to rely heavily on firewood, indicating possible difficulties in obtaining clean energy sources. Every hamlet has access to a government-supplied water supply, and every home has tap water available. The use of tube wells varies, though; compared to other villages, Panjuana and Mehendipur use them more frequently. There is variation in the availability of sanitation facilities as well; certain villages, like Panjuana, have a higher proportion of families with flush toilets, while other villages, like Ganeshpur, have lower usage rates. Villages like Pichopa Kalan and Rajpura Sani exhibit lower adoption rates of electrical appliances, whereas villages like Zafarpur and Balkra exhibit high adoption rates of TVs/LEDs and refrigerators, showing improved access to contemporary facilities. The ubiquitous availability of water and the increasing use of modern conveniences like LPG cooking and electrical equipment, despite the disparities between the settlements, show overall growth. To improve the overall welfare and standard of life of Scheduled Caste households in all villages, it is critical to address the disparities in housing quality, sanitary facilities, and modern utilities.

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ASSESSMENT OF SPATIAL AND TEMPORAL DYNAMICS OF GROUNDWATER IN BHIWANI DISTRICT, HARYANA -A DECADAL ANALYSIS

Dr. Surbhi Gaur, Dr. Pawan Kumar and Mr. Vikas Sangwan

Abstract

Groundwater depletion is a persistent issue in India, especially in semi-arid regions like Haryana. This study focuses on the spatiotemporal variability of groundwater table depth in Bhiwani district, Haryana, aiming to understand its dynamics and implications for sustainable water management. Utilizing data from the Haryana Water Resource Authority (2010-2020), the study maps groundwater dynamics at the village level. Results show that 26.26% of Haryana's villages are severely groundwater stressed, with 30.67% of Bhiwani's villages falling into this category. Additionally, while 18.60% of Haryana's villages have good groundwater potential, only 14.06% of Bhiwani's villages fall into this category. Spatial heterogeneity in groundwater depletion is evident, with Behal and Loharu blocks experiencing the highest depletion rates. Further analysis reveals that 196 villages in Bhiwani reported depletion in groundwater table depth, mainly in western and southern blocks, while 107 villages reported gains, primarily in the eastern and northern parts. Significant declines in groundwater table depth was observed in villages like Hasan and Chehar Khurd, emphasising the urgency of addressing groundwater depletion. Spatial patterns show increasing groundwater depth from east to west, signalling a growing waterlogging issue in eastern areas. Groundwater depletion poses a significant threat to water resource sustainability in study area, necessitating integrated water management strategies to mitigate adverse effects on agriculture, livelihoods, and the environment. Collaboration among stakeholders is crucial to ensure sustainable groundwater use and safeguard water resources for future generations.

Introduction

Water is an important natural resource, fundamental to life, agriculture, and sustainable development (Dangar et al., 2021; Kumar Joshi et al., 2021; Sayre

& Taraz, 2019; Sidhu et al., 2021). Surface water availability in India is year-round restricted due to diverse climatic conditions and a range of geological, physiographical, and hydrological variety. As a result, groundwater has become a valuable resource for drinking, farming, and other uses, particularly in India's semi-arid areas (Siebert et al., 2010). Northwestern India is a hotspot for groundwater depletion (Bhattarai et al., 2021; Dangar et al., 2021; Lal, 2017; Pal et al., 2022) and has observed a rapid decline after 2010, with spatial heterogeneity largely determined by localized factors (Kumar Joshi et al., 2021). Owing to the rice-wheat cropping system, Punjab was able to meet 73% of its water demands from groundwater. Consequently, the area with a water table below 10 meters increased from 30% to 75% between 2000 and 2019 (Sidhu et al., 2021). Groundwater depletion is the biggest threat to national food security in India, reducing cropping intensity by 20% overall and 68% in groundwater-depleted areas (Jain et al., 2021). In Haryana, addressing water scarcity has been a challenge whose magnitude has increased manifold over the past years due to a variety of reasons such as rapid population growth, changing cropping patterns, the Green Revolution, and electrification (Pal et al., 2022; Rodell et al., 2009; Singh, 2015).

According to an estimate by the Central Ground Water Board (CGWB), Haryana has an annual capacity of replenishable groundwater resources of 9.31 BCM; however, the annual draft of groundwater resources has exceeded 9.45 BCM, resulting in the depletion of groundwater resources. According to CPCB, out of 108 blocks demarcated for groundwater development and management in Haryana, 55 blocks are overexploited, 11 blocks are critical, and 05 blocks are semi-critical. In Haryana, the average depth of groundwater has decreased from 12.5 meters to 17.5 meters between 2004 and 2013 (Singh & Amrita, 2015). Management of water resources in Haryana has been a significant challenge whose magnitude has increased manifold over the past years due to various factors such as rapid population growth, changing cropping patterns, the Green Revolution, and electrification (Dangar et al., 2021). Bhargava, 2018, explores the relationship between climate variability, rice production, and groundwater depletion, highlighting the adverse effects of changing climate patterns on agricultural water demand and groundwater recharge rates. Similarly, (Fishman, 2018) emphasizes how groundwater depletion limits adaptation to increased rainfall variability, underscoring the need for resilient water management strategies in the face of climate change. Consequently, there is an urgent need to investigate the spatiotemporal variability of groundwater table depth in Haryana to focus on its judicious use for agricultural sustainability in the future.

Study Region

Southwest Haryana is situated in a semi-arid climatic region, leading to acute scarcity of surface water resources and heavy reliance on groundwater. Bhiwani, located in the southwest part of Haryana, spans an area of 3404 km2. Administratively, the Bhiwani district has five tehsils (Bhiwani, Bawani Khera, Loharu, Tosham, and Siwani) and seven development blocks (Bhiwani, Bawani Khera, Tosham, Kairu, Siwani, Loharu, and Behal), comprising a total of 313 villages. The study region primarily consists of level plains with isolated sections of the Aravalli hills and sand dunes, predominantly in the west. According to the Digital Elevation Model (DEM), the elevation of the study area ranges from 135 to 339 meters above sea level (m.a.s.l.). In the Bhiwani district, no perennial river exists; however, traces of palaeo-channels are present in the study region. The Indian Meteorological Department (IMD) records indicate an annual rainfall of 420 mm in the study area. The soil in the area ranges from sandy loam to loamy sands in texture (Sierozem soil). The local population largely depends on subsurface water resources and external sources for drinking and irrigating agricultural land. Rapid population growth, changes in cropping patterns, the Green Revolution, and electrification have led to an over-extraction of groundwater resources, surpassing their maximum safe yield potential. Consequently, this has resulted in the depletion of water levels at a rate exceeding one meter per year.

Objectives

(1) To map the spatial and temporal dynamics of groundwater resources in the Bhiwani district of Haryana.

(2) To identify and map the village-level dynamics of the groundwater table in the study area.

Database and Methodology

The present study primarily relies on secondary data regarding the groundwater table collected from the Haryana Water Resource Authority, Government of Haryana, for the period 2010–2020 (https://hwra.org.in/). This data source is considered one of the most reliable and consistent, available at the village level. The spatial and temporal variations in groundwater table fluctuations have been presented on a block-by-block basis at the village level, utilizing tables and diagrams created using Microsoft Excel. Villages have been categorized into seven groups, with details provided in table 1. Spatial-temporal mapping of groundwater table depth has been conducted using ArcGIS Desktop software.

Result and Discussion

Out of a total of 6778 villages in Haryana, 1780 villages (26.26 percent) are classified as severely groundwater stressed, with groundwater depths greater than 30 meters (table 1). However, within the Bhiwani district, 96 out of 313 villages fall into this category. Additionally, in Bhiwani, 30.46 percent of villages have groundwater depths exceeding 30 meters, which is nearly 4 percent higher than the state average (table 1). Only 1261 villages (18.60 percent) have been classified as having good groundwater potential, with groundwater depths ranging from 5.01 to 10.0 meters. Out of the 313 villages in Bhiwani, only 44 are categorized as having good groundwater potential. In Bhiwani, 14.06 percent of villages fall into this category, which is nearly 4 percent lower than the state average (table 1). Conversely, 16.61 percent of Bhiwani villages are classified as buffer zones for waterlogging, nearly double the state average for Haryana. Even within potentially waterlogged villages, Bhiwani comprises 8.63 percent of villages, nearly double the state average of 4.71 percent (Table-1 and 2). On one hand, the Bhiwani district has a higher proportion of severely groundwater-stressed villages, while on the other hand, it also has a greater percentage of buffer zones or potentially waterlogged villages. This highlights the complexity of the aquifer in the region and its spatial variability. The groundwater table depth in Bhiwani district ranges from 1.7 to 95 meters, with the minimum depth observed in Dang Kalan village of Tosham block and the maximum depth in Chehar Khurd village of Behal block.

Table-1: Village Level Groundwater Table Depth of Haryana and Bhiwani

Depth to Water Table (Meters)	Categories	Haryana		Bhiwani	
		No of Village	Percentage	No of Village	Percentage
30.01 & more	Severely groundwater stressed	1780	26.26	96	30.67
20.01 to 30.0	Low groundwater stressed	1011	14.92	35	11.18
10.01 to 20.0	Potential groundwater stressed	1807	26.66	59	18.85
5.01 to 10.0	Good groundwater potential	1261	18.60	44	14.06

Contd...

3.01 to 5.0	Buffer zone for waterlogging	592	8.73	52	16.61
1.5-3.0	Potential waterlogged	319	4.71	27	8.63
Less than 1.5	Severely waterlogged	8	0.12	0	0.00
Total		6778	100	313	100

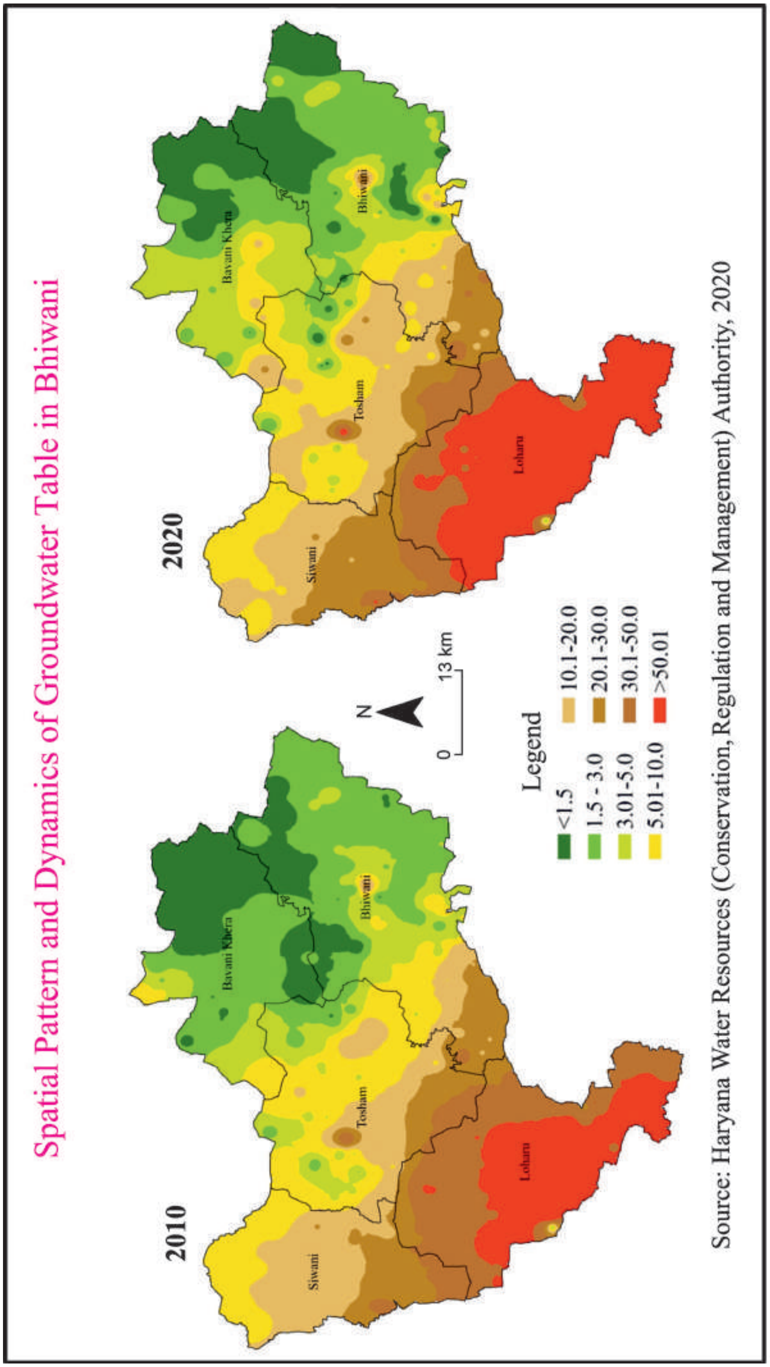
Source: Haryana Water Resources (Conservation, Regulation and Management) Authority, 2020

Table-2: Block wise Categorisation of Villages based on Groundwater Table Depth of Bhiwani

Depth to Water Table (Meters)	Bawani Khera	Behal	Bhiwani	Kairu	Loharu	Siwani	Tosham	Total
30.01 & more	-	29	3	11	45	7	1	96
20.01 to 30.0	-	-	6	5	-	19	5	35
10.01 to 20.0	4	-	3	16	-	11	25	59
5.01 to 10.0	6	-	19	4	-	-	15	44
3.01 to 5.0	12	-	33	-	-	-	7	52
1.5-3.0	11	-	14	-	-	-	2	27
Less than 1.5	-	-	-	-	-	-	-	0
Total	33	29	78	36	45	37	55	313

Source: Haryana Water Resources (Conservation, Regulation and Management) Authority, 2020

In the study area, 96 villages have groundwater table depths greater than 30 meters, while 17 villages have depths between 30 and 40 meters, 15 villages between 40 and 50 meters, and 18 villages between 50 and 60 meters. Additionally,



Source: Haryana Water Resources (Conservation, Regulation and Management) Authority, 2020

Fig. 1

46 villages in the Bhiwani district have groundwater table depths exceeding 60 meters; among these, 29 villages have depths ranging from 60 to 70 meters. Within this group of 46 villages, 14 have depths between 70 and 80 meters, while three villages i.e., Chehar Kalan (85 meters), Paju (85.26 meters), and Chehar Khurd (95 meters) in Behal block; have depths below 85 meters. The average depletion rate of the groundwater table in the Bhiwani district was -2.38 meters over the last decade, from 2010 to 2020. Both the average depth of the groundwater table and the depletion rate are higher on the western and southwestern sides and lower on the eastern side of the Bhiwani district. Both Behal and Loharu blocks, situated on the western and southwestern sides of the Bhiwani district, have 100 percent of their villages classified as severely groundwater stressed (table 2). Behal block recorded the highest average depletion rate of -7.57 meters in the last decade, followed by Loharu (-7.26 meters), Siwani (-2.79 meters), Kairu (-2.75 meters), Tosham (-0.55 meters), and Bhiwani (0.44 meters). Conversely, the Bawani Khera block observed an average increase of 1.25 meters in the last decade.

Of the total 313 villages in the Bhiwani district, 196 villages reported depletion in the groundwater table, primarily in the western and southern blocks, from 2010 to 2020. Conversely, 107 villages reported gains in the groundwater table, mainly in the eastern and northern parts of Bhiwani, while 10 villages did not report any change (Fig. 1). Among the 196 villages experiencing depletion, 21 reported a decline of more than 10 meters in the groundwater table, 56 villages observed a depletion of 5 to 10 meters, 38 villages observed a depletion between 1 and 3 meters, and 26 villages reported a decline of less than 10 meters in the last ten years (Fig. 1). The village of Hasan in Tosham block experienced a significant decline; in 2010, the groundwater table was at a depth of 13.5 meters, but by 2020, it had dropped to 37.1 meters. Interestingly, over the past 10 years, the groundwater table in Hasan has declined at an annual rate of -2.36 meters. Similarly, Chehar Khurd village in Behal Block witnessed a depletion of -22.5 meters over the last decade, with an annual rate of -2.25 meters. Currently, the water table in Chehar Khurd stands at a depth of 95 meters. Out of 313 villages, 107 reported an increase in the water table. For instance, Sumra Khera village in Bawani Khera block recorded a gain of 10.54 meters in the groundwater table. In the Bhiwani district, 7 villages saw an increase of 5 to 10 meters, 18 villages observed gains between 3 and 5 meters, 47 villages observed gains between 1 and 3 meters, and 34 villages reported gains of less than a meter over the last decade (Fig. 1). Spatially, the depth of the groundwater table is increasing from east to west. In comparison to 2010, the groundwater depth is rapidly increasing, especially on the western side. Additionally, significant changes are observed in the central area of the Bhiwani district in 2020 (Fig.2). The groundwater depletion poses a significant challenge to water resource sustainability in region, with far-reaching implications for agriculture, livelihoods, and the environment. Efforts to mitigate groundwater depletion require a multi-faceted approach that integrates policy, technology, and community engagement. The study region requires a holistic approach that considers the complex interplay of climate, hydrology, agriculture, and socio-economic factors. Only through implementing integrated water management strategies and fostering collaboration among stakeholders, India need work towards ensuring sustainable groundwater use and safeguarding water resources for future generations.

Conclusion

The groundwater table in the Bhiwani district has declined at a rate of 23.8 cm per year over the last decade, from 2010 to 2020. The depletion rates of groundwater tables in Behal and Loharu are notably high at 75.7 and 72.7 cm per year, respectively, which is nearly three times higher than the average rate in the Bhiwani district. During the last decade, the blocks most severely affected by groundwater depletion were Behal, Loharu, Siwani, and Kairu, primarily situated on the western and southwestern sides of Bhiwani. Furthermore, the Tosham and Bhiwani blocks experienced fluctuations in the groundwater table, with both delineation and rise observed at selected pockets. These variations are location-specific and influenced by a variety of factors, including natural and anthropogenic causes. Conversely, most villages in the Bawani Khera block of the Bhiwani district are exhibiting an increase in the water table, with only a few exceptions. His groundwater depletion have potential to hamper the agricultural productivity, adverse effects on food security and rural livelihoods. Groundwater depletion may resulted into economic and social implications of for rural communities in future. Comprehensive strategies and well-defined framework is required to solve groundwater depletion with coordinated action at the local and regional levels for achieving sustainability and food security. At this stage immediate policy interventions and regulatory frameworks to promote sustainable groundwater use in the study region.

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ASSESSMENT OF PHYSICAL AND CHEMICAL CHARACTERISTICS OF AGRICULTURAL SOIL IN THOUBAL DISTRICT, MANIPUR

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Abstract

Thoubal district in Manipur is predominantly agrarian society and 50.45% of the total working population engage in agriculture. Soil health has an intricate relationship with the crop productivity. This study explores the agricultural soil quality for better crop production in the district. Various parameters like macronutrient content, pH, electrical conductivity, organic carbon, soil moisture, and bulk density are assessed for sustainable crop production to identify the deficiencies and excess conditions of the soil's nutrients. Thus it can provide recommendations for the efficient use of fertilizers to optimize crop yields. According to NBSSLUP, Nagpur Thoubal district has 11 soil types, and 50 soil samples are collected by using the suitable sampling technique. The samples are analysed at the soil testing laboratory. The assessment of soil fertility reveals both strengths and vulnerabilities. The range value of each parameter are bulk density (1.09 to1.94), soil moisture (6.74 to 35.86%), pH (4.9 to 6.9), electrical conductivity (0.043 to 0.951) mhos, organic carbon (0.752-2.178%), nitrogen (125.44- 501.76) kg/ha, phosphorus (6.86 to 43.04) kg/ha, potassium (44.8 to 347.2) kg/ha. Maps are prepared for each parameter by using ArcGIS V 10.4. It helps the farmer in decision-making, crop selection, and sustainable agriculture practices.

Introduction

Soil is an important natural resource providing water, nutrient, and mechanical support for plant growth. Soil formed as a result of pedogenic processes such as rock weathering is composed of inorganic and organic constituents, has distinct chemical, physical, and biological properties, and it varies from region to region of the earth's surface, and serves as a medium for plant growth (Thakre et al., 2012). In agro ecosystem, continuous manipulation of soil is going on due to addition of input, removal of nutrients, changing water balance, and microbial life (Shahane A. A., and Shivay Y S., 2021). Various soil parameters like pH, Electrical conductivity, Organic Carbon, Available Nitrogen (N), Phosphorus (P2O5), Potassium (K2O), bulk density, and moisture content are analysed to know the soil quality. The fertility of the soil depends on the concentration of N, P, K, organic and inorganic materials, and conductivity (Iram and Khan, 2018). Physio-chemical properties like available nutrients of soil can determine through soil testing. Commercial fertilizers are used based on their results about the requirement of nutrients of the crops. Use of any fertilizer, both inorganic and organic form, can pose a threat to the environment if misused (Sharma and Bali, 2018). Thus ideal needs of fertilizers should be adjusted based on requirements for the selected agricultural field conditions for optimum production. Soil nutrient testing is a management tool that can help accurately determine the available nutrient status of soils and guide the efficient use of fertilizers. With the increasing awareness of fertilizer effects on environmental and soil quality, soil tests have been instrumental in determining where insufficient or excess nutrient levels occur (Kim et al., 2009). Soils are indispensable resources that have been exploited for thousands of years for several purposes resulting in their degradation (Eswaran et al., 2001; Junge and Skowronek, 2007). Anthropogenic reduction in soil health and of individual components of soil quality, are a pressing ecological concerned (Doran and Zeiss, 2000).

In Manipur, farmers use chemical fertilizers and pesticides without proper consultation with the expert, which further leads to soil degradation. Knowledge of soil's physical and chemical properties is an integral part of soil quality studies and sustainable land use management strategies to conserve soil resources. The increase in human population increases the intensities of soil cultivation to meet the challenges of food security; besides, the agricultural fields are converted into a built-up area and construction site for other economic activities, which further leads to a change in the environment of the surrounding agriculture land. There is a lack of information and data regarding the soil analysis and its physical and chemical characteristics to the farmer and they are using the same method and technique they have been using before as before, like using fertilizer without testing the soil condition as they are not well aware of the required soil conditions of the different crops. Only few farmers conduct the soil test as we collect data and information from the district agricultural office. Therefore, this study is to assess the physical properties and macronutrients of the soils in the Thoubal district of Manipur.

Study Region

The Thoubal district covers an area of about 324 sq. km and lies extending between Latitude 24°30'13.002"N to 24°41'29.769"N Longitude: - 93°54'42.084"E to 94°7'50.764"E. It lies in the eastern part of the Manipur valley and it is 795 m above the mean sea level. It is characterized by its diverse topography, which includes hills, plains, and rivers. The southwestern part is part of Loktak Lake. Besides, there are many small wetlands: Waithou pat, Yaithibi, Phulou pat, kharung pat, and Ikop pat. The Imphal River and Thoubal River are the major rivers that flow in the district. Other important rivers include the Arong River, which flows through Charangpat and Khangabok and falls to Ikop pat and the Wangjing River, which flows through Heirosk and Wangjing and falls to Kharung pat. The fertile land with a good drainage system provides the area with suitable agricultural activities.

Objectives

(1) Evaluate soil health status by analysing soil's physical and chemical properties.

(2) Make recommendations for better sustainable agricultural production to the farmer.

Database and Methodology

According to NBSSLUP Nagpur, Thoubal district consists of 11 soil types. Using sentinel 2 imagery for February 2021, land use land cover map is prepared in the ARC GIS 10.4 software to find out the total agricultural land area in the Thoubal District. The total agricultural area of 15029.67 hectares which is 45.94% of the whole land in 2021, then 50 samples are collected from this agricultural land in the month of February 2023, when the crops are already harvested and the soils are free from fertilizers to get the better results of the actual soil physical and chemical properties. To collect the soil samples, the study area are stratified into 11 units as there are 11 distinct soil types. By applying the random judgmental techniques we identified 50 samples which is proportional to the total area of each soil types and recorded the exact location in using GPS. Using, soil corer we collect the soil samples from 0 to 20cm deep and it is maintained in a plastic bag and labeled accordingly. The soils are then air dried at ambient temperature before being crushed and sieved through a 2mm sieve to ensure the homogeneity of the sample. Using conventional procedures, the collected soil samples are analyzed and tested for physical and chemical parameters-soil moisture using oven drying method, bulk density(BD) using core sampling method, pH using pH meter, electrical conductivity (EC) using Digital portable water analyzer kit (Model 161 E) in m mhos, organic carbon (OC) using Titrimetric method, available Nitrogen(N) using Micro Kjeldhal Method, available Phosphorus(P) using Spectrophotometric method, available potassium (K) using Flame photometer method (Iram and Khan, 2018).

Result and Discussion

Different soil types with the sample sites and the agricultural land area from LULC classification of the district are shown in Fig.1. Soil testing provides information regarding nutrient availability in soils which forms the basis for the fertilizer recommendations for maximizing crop yields. Soil fertility maps are meant for highlighting the nutrient needs, based on fertility status of soils and adverse soil conditions which need improvement for good crop yields (Verma V.K., et al., 2005). Table-1 shows the general standard classification of the soil properties (Iram and Khan, 2018).

Table-1: Standard Classification of Soil

Soil Parameters	Range	Classification
pH	<5.50	Strongly acidic
	5.51-6.00	Moderately acidic
	6.01-6.50	Slightly acidic
	6.51-7.30	neutral
	7.31-8.50	Moderately alkaline
	8.51-9.00	Alkaline
	>9.01	Strong alkaline
Electrical conductivity EC in mmhos	Upto 1	average
	1.01-2.00	Harmful to germination
	2.01-3.00	Harmful to crops
Organic carbon in %	< 0.5	low
	0.5-0.75	Medium
	>0.75	High
Nitrogen(kg/ha)	<250	Low
	250-480	Medium
	>480	High
Phosphorus (kg/ha)	<11	Low
	11-22	Medium
	>22	High
Potassium (kg/ha)	<110	Low
	110-280	Medium
	>280	High

Source: Computed by Authors

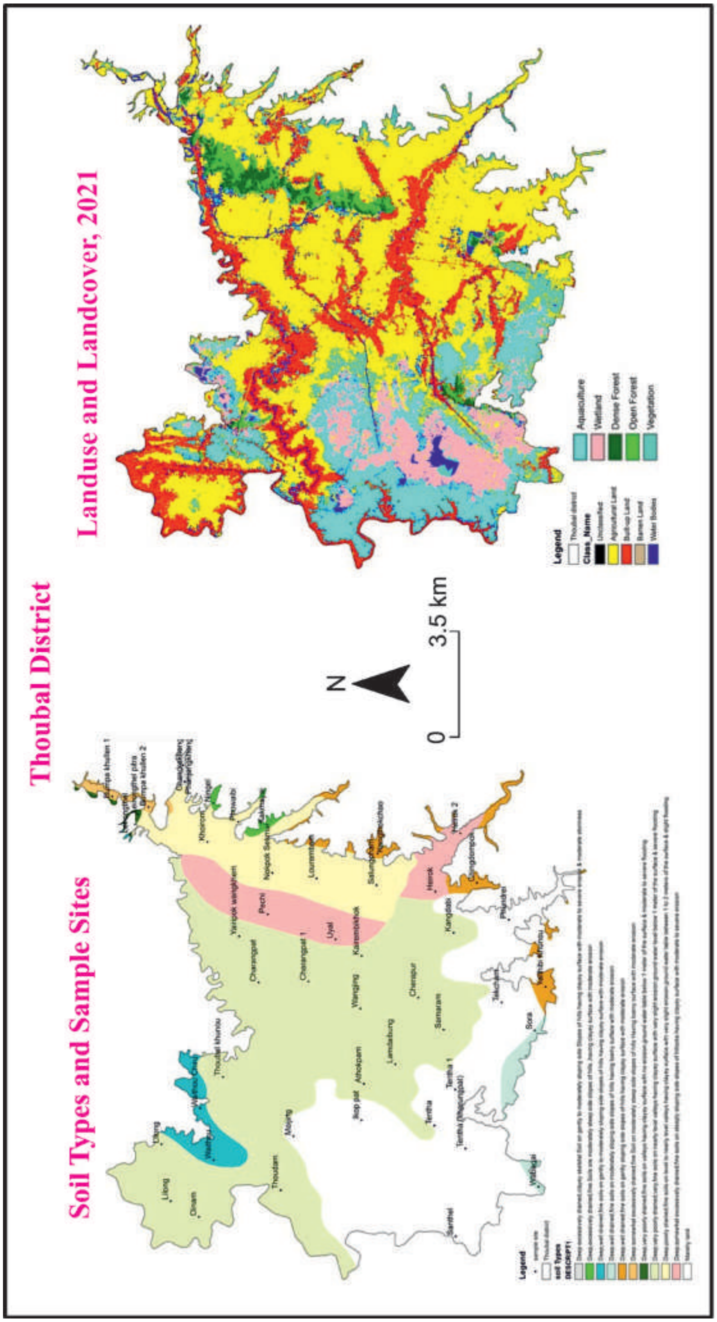
Thoubal District
Soil Types and Sample Sites
Landuse and Landcover, 2021
N
0
3.5 km
Aquaculture
Wetland
Dense Forest
Open Forest
Vegetation

Fig. 1

The statistical analysis i.e. range, average, standard deviation, and coefficient of variation of the soil testing results are displayed below in table no. 2. Maps are generated using Arc GIS V 10.4 for better visualization of the distribution value of various soil parameters for each sample site using the IDW interpolation technique which is shown in Fig. 1. Geographic information system (GIS) is a powerful tool that helps to integrate many types of spatial information, such as agro-climatic zone, land use, soil management, etc. to derive useful information (Adornado & Yoshida, 2008).

Table-2: Statistical Analysis of Soil Parameters

Parameters	PH	EC	OC	N	P	K	BD	S.M
Range	4.9- 6.59	0.043- 0.951	0.752- 2.178-	125.44- 501.76	6.86- 43.04	44.8- 347.2	1.09- 1.94	6.74- 35.86
Average	5.76	0.29	1.45	276.22	20.10	122.55	1.64	21.32
SD	0.34	0.45	0.46	85.40	8.36	58.33	0.18	6.56
CV	5.94	91.56	31.56	30.92	41.61	47.59	11.8	30.76

Source: Computed by Authors

The different crops have specific preferences for soil pH, EC, and OC. Understanding these requirements is crucial for tailoring soil management practices to maximize crop productivity (Hinsinger, P. et al., 2009). pH is a measure of the acidity or alkalinity of soil; thus, it plays a vital role in agricultural production. Soil pH is, therefore, described as the "master soil variable" that influences myriads of soil biological, chemical, and physical properties and processes that affect plant growth and biomass yield (Brady and Weil, 1999, Minasny et al., 2016). Thus, maintaining the right pH range is crucial for optimal nutrient uptake (Brady, N. C. and Weil, R.R., 2008) (Fig. 1). Most plants prefer a pH range between 6.0 and 7.5, as essential nutrients such as nitrogen, phosphorus, and potassium are readily available. The average pH value of the study area is 5.76. The lowest value is 4.9 in the Sora area and the highest in Tentha area, with 6.59. All the samples are found below 7 i.e. neutral, which is slightly acidic to slightly neutral, which is acceptable for most crops. The low CV value of 5.94% in pH value indicates the low variability that it is relatively stable within the research region. Thus, the actual pH range in the district is within the ideal range for most crops except for the small region in southern side and small patches in the eastern side of the district with the lowest value which is below the recommended pH for the main crops of the district. In order to maximize yields and reduce plant stress, it is crucial to maintain the proper soil pH range for the crops we are cultivating. Adding lime (to raise pH)

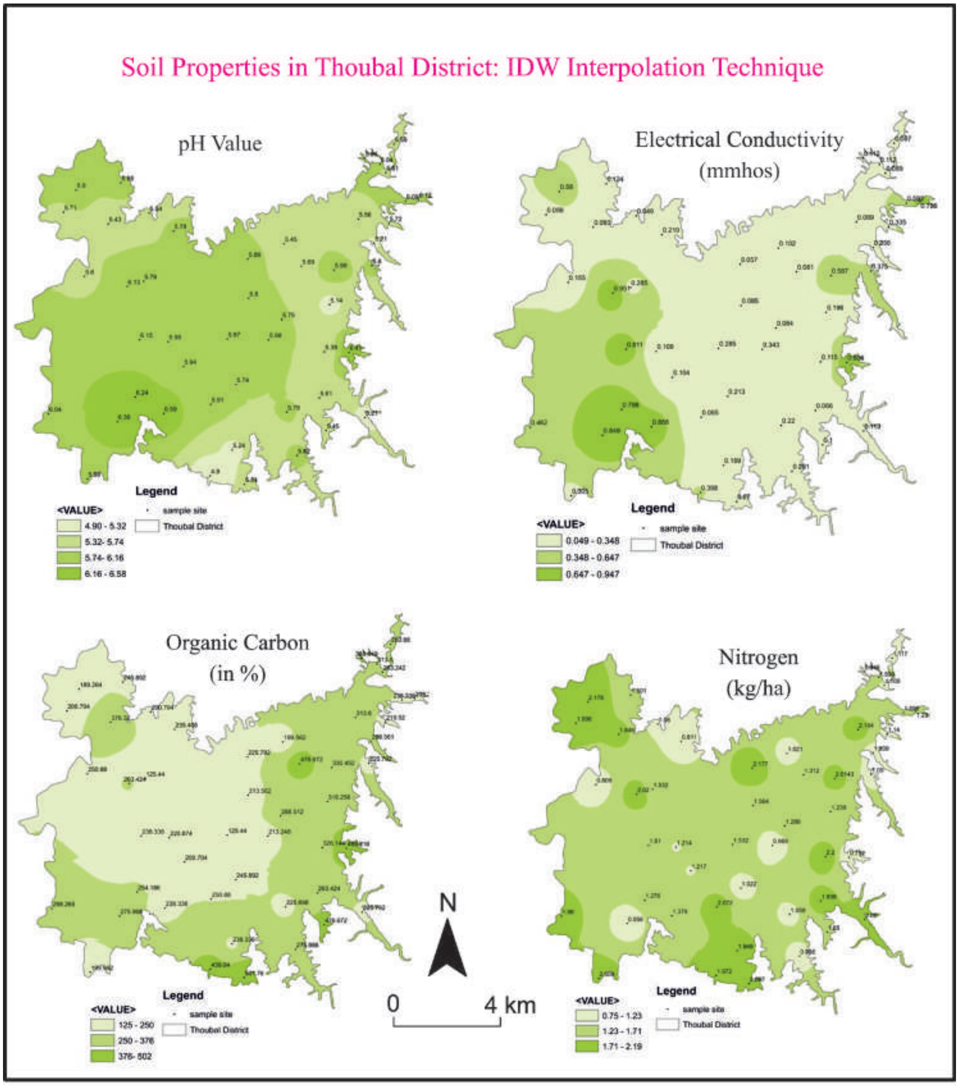
Soil Properties in Thoubal District: IDW Interpolation Technique
pH Value
Legend
<VALUE>
4.90 - 5.32
5.32- 5.74
5.74- 6.16
6.16 - 6.58
sample site
Thoubal District
Electrical Conductivity (mmhos)
Legend
<VALUE>
0.049 - 0.348
0.348 - 0.647
0.647 - 0.947
sample site
Thoubal District
Organic Carbon (in %)
Legend
<VALUE>
125 - 250
250 - 376
376- 502
sample site
Thoubal District
Nitrogen (kg/ha)
Legend
<VALUE>
0.75 - 1.23
1.23 - 1.71
1.71 - 2.19
sample site
Thoubal District
N
0
4 km

Fig. 2

or Sulphur (to drop pH) can change soil pH. Liming of the soils is however not recommended because of poor buffering ability of phosphorus and micronutrients (Havlin et al., 2014). Soil Electrical conductivity (EC) is a measure of the soil's ability to conduct electricity, which is related to the concentration of dissolved salts. EC provides information about soil salinity, nutrient availability, and water content. Monitoring EC is important for managing irrigation and nutrient levels. (Rhoades, J. D., et al., 1992). Excess salts in the soil can damage the crops, and low EC may lead to a deficiency in vital nutrients affecting the crop growth and yields. The range of EC is 0.043mmhos to 0.951 mmhos with the average of 0.29 mmhos which is low according to standard soil classification. The high CV of 91.56% suggests that EC varies significantly across the different sites, indicating spatial variability. The highest EC are distributed in patches in south western region near Ikop Pat and Kharung Pat. More than half of the total land area has low EC; thus, micronutrients like Ca, Mg, Cl, Na, SO4 are required in this region to maintain the EC for higher crop production. Soil pH impacts the solubility of minerals and nutrients, and the availability of these nutrients can be limited when the pH of the soil is either low or too high. Organic carbon (OC) is a key component of soil organic matter and Lal (2015) highlighted the critical role of soil organic matter in enhancing soil structure, water retention, nutrient availability and also supports microbial activity, which is essential for nutrient cycling. The Organic carbon content in the agricultural field in Thoubal district range from 0.752% to 2.178%, and the mean value is 1.45% which is sufficient for most crops.

The coefficient of variation of organic carbon with 31.56% indicates the moderate spatial variability. The low OC is distributed in patches while the highest OC at the district's northern and southern boundary. The organic matter of most soils ranges from 1-5% mostly in the top 25cm of soil (Agbede, 2009). Nitrogen, phosphorus, and potassium are essential macronutrients for the healthy growth of plants. Nitrogen (N) plays a vital role in photosynthesis. Adequate nitrogen is crucial for plant growth, as it is a key component of chlorophyll and essential for various metabolic processes (Havlin et al., 2014) (Fig. 2 and 3). The average nitrogen content stands at 276.22 kg/ha; notably, Yaithibi exhibits the highest nitrogen content at 501.76 kg/ha, while Thoubal region records the lowest at 125.44 kg/ha. High nitrogen content is found in the district's eastern side, mainly in the adjoining district's foothill The SD is 85.48, and the CV value of 30.92% shows the low variability in its distribution. Phosphorus is vital for energy transfer in plants and is essential for root development and flowering (Marschner, 2012).

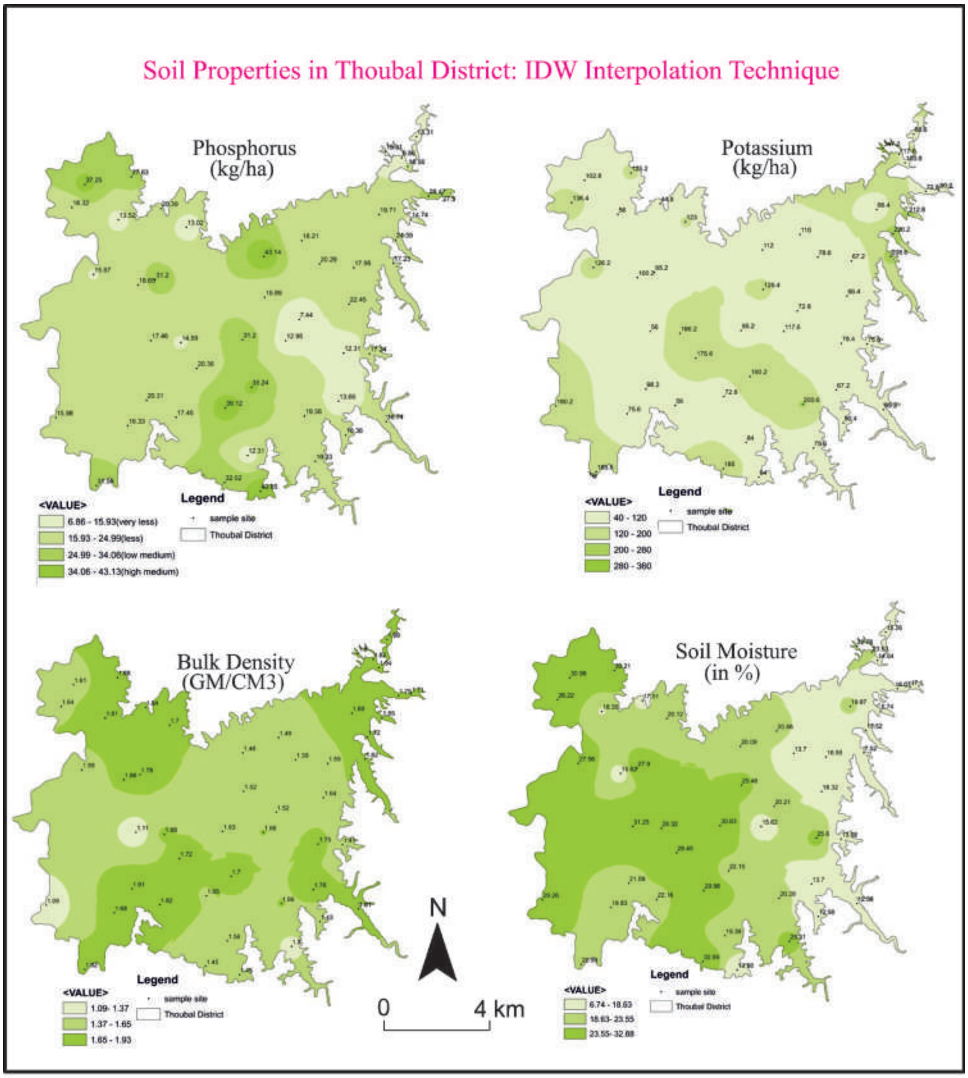
Soil Properties in Thoubal District: IDW Interpolation Technique
Phosphorus (kg/ha)
Legend
sample site
Thoubal District
<VALUE>
6.86 - 15.93(very less)
15.93 - 24.99(less)
24.99 - 34.06(low medium)
34.06 - 43.13(high medium)
Potassium (kg/ha)
Legend
sample site
Thoubal District
<VALUE>
40 - 120
120 - 200
200 - 280
280 - 360
Bulk Density (GM/CM3)
Legend
sample site
Thoubal District
<VALUE>
1.09- 1.37
1.37 - 1.65
1.65 - 1.93
N
0
4 km
Soil Moisture (in %)
Legend
sample site
Thoubal District
<VALUE>
6.74 - 18.63
18.63- 23.55
23.55- 32.88

Fig. 3

The appropriate concentration of phosphorus (P) is necessary for maintaining a balance between the other plant nutrients and ensuring the normal growth of the crop. The mean phosphorus content is 20.10 kg/ha. Leirongthel Pitra shows the lowest phosphorus content at 6.86 kg/ha, indicating a deficiency, while Charangpat records the highest at 43.04 kg/ha. The CV value of 41.61 kg/ha indicates the medium variability in its distribution. Potassium is necessary for enzyme activation and plays a role in water uptake, photosynthesis, and disease resistance (Brady and Weil, 2008). The average potassium content in Thoubal district is 122.56kg/ha; Notably, the Leirongthel area at the foothill exhibits the highest potassium level at 347.2kg/ha, while the Waithou area has a significantly low value of 44.8 kg/ha. Overall more than 90 percent of the district has potassium deficiency. Application of fertilizer -potassium is required for plant survival, carbohydrate and proteins syntheses, cell evolution which helps in maintaining the ionic cell balance and acts as an enzyme activator besides activating the photosynthetic enzymes, assimilates translocation (Marschner P. 2012, Erel R., et al., 2015, S. Sharma et al., 2022). The CV value of 47.59% indicates spatial variability in potassium distribution across the region. The NPK ratio is a common name for the interaction between these nutrients in the soil.

This ratio is significant because it establishes how much each nutrient the plants need. Farmers must ensure the soil has the proper NPK ratio for the crops they wish to cultivate because different crops have varying NPK ratio requirements. The risk of contamination of environmental resources, especially groundwater, is greatly increased if excessive amounts of phosphorus and nitrogen accumulate in the soil, due to they are limiting factors in terrestrial and aquatic ecosystems (J.M. Telesford-Checkley, 2017). Bulk density indicates how well plant roots can extend into the soil. The bulk density range is 1.09% to 1.94%, with an average of 1.64%. The CV value of 11.8 shows less variation in its distribution. Soil moisture is one of the most important factors for plant growth and agriculture. It helps in plant growth and is essential for seed germination and absorbing soil nutrients. It also affects crop yields and nutrient availability; like dry soil leads to more concentrations of nutrients which is toxic and excess moisture leads to leaching; thus, adequate moisture content is necessary for maintaining healthy soil. The soil moisture content in the dry month of February is highest in southern side with 32.89% side of the district and the areas around the wetland have high moisture content lowest at Ningel area and the eastern side of the district has low moisture content.

Conclusion

In conclusion, the soil analysis conducted in the Thoubal district of Manipur provides valuable insights into the physical and chemical properties of soils for crop productivity. The study highlights the importance of understanding soil pH, electrical conductivity (EC), and organic carbon (OC) for effective soil management. The pH values in the district generally fall within a slightly acidic to neutral range, favorable for most crops, but localized areas with lower pH require interventions such as lime application. EC measurements reveal significant variability across the region, indicating the need for nutrient management practices. Organic carbon content, influencing soil fertility and structure, exhibits moderate variability. To enhance organic carbon levels, sustainable practices such as regular use of manure, compost, and avoiding overgrazing are recommended. The assessment of essential macronutrients—nitrogen, phosphorus, and potassium—demonstrates variations in nutrient availability across different crops. While some areas show deficiencies, others show excesses, featuring the importance of targeted fertilizer applications based on specific crop needs. Considering the spatial variability in soil properties the study highlights the necessity for farmers to adopt appropriate agriculture practices. Recommendations include adjusting soil pH, addressing nutrient deficiencies, and implementing sustainable practices to maintain or enhance soil fertility. Thus site-specific approach to soil management, incorporating amendments to the unique characteristics of each area, is essential for sustaining agricultural productivity in the Thoubal district of Manipur. Thus, from this study, the farmers can get an idea about the number of fertilizers required for their fields for higher production.

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NAXALISM IN CENTRAL TRIBAL BELT OF INDIA- CURRENT SITUATION, IMPROVEMENTS AND CHALLENGES

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Abstract

Naxalites and the Indian government have been in continuous conflict since the Naxalite-Maoist a group of communists who identify themselves with Mao's political ideology. It is located primarily in India’s Tribal belt, the Red Corridor. To these native youth engaging in the Naxalite movement, it is about the struggle for land rights, resources, and dignity. This research aims to examine the issue of naxals in the central tribal belt of India and also to study recent improvements made by this problem, its impacts, challenges faced, and what its prospects will be like. Secondary data, which was sourced from various official sources including the South Asian Terrorism Portal (S.A.T.P), and the Ministry of Home Affairs, were used for this study. There was a significant decline in Naxal-affected districts from close to 200 in 2000 to around 70 regions during 2023, yet this problem has not been completely solved. Without solving the problem these states cannot develop like other states.

Introduction

Naxalism is also known as the Naxalite-Maoist insurgency, is a socio-political movement that originated in the late 1960s in the Naxalbari village of West Bengal, India (Roy, 2009). Inspired by Mao Zedong's revolutionary ideology, the movement seeks to address land distribution, social inequality, and exploitation of the rural poor. Naxalism has its roots in the discontentment of marginalized and impoverished communities, primarily tribal groups and peasants, who feel marginalized and excluded from the benefits of economic development. The term "Naxalism" derives from the Naxalbari incident in 1967, where a peasant uprising led by radical communist factions demanded land reform and equality (Roy, 2009). Over the years, the movement has evolved and spread to various states in India, particularly in the so-called "Red Corridor," encompassing regions with a significant Naxalite presence. The Naxalites led these movements under the leadership of Charu Majumdar, Kanu Sanyal, and Jangal Santhal (Shah, 2019). As a result, the people of nearby villages supported this movement, and even the Chinese started to support the movement. The Naxalist movement was called the Spring Thunder by the Chinese media during the spring of 1989 (Fung, 1991). With time, the rebels have enhanced themselves with modern weapons, firepower, and most importantly support from a certain group of India like the Communist Party of India (Maoist) and its different wings like the People`s Liberation Guerrilla Army (P.L.G.A.) (Jal, 2020). The underdeveloped regions significantly influence the emergence and spread of Naxalism (Kumar, 2015). Economic factors are a major factor in the rise of Naxalism. In actuality, the places where the advantages of government programs are not received are backward. These regions are essential to the growth of Naxalism (Kumar, 2015).

Study Region

Madhya Pradesh, Chhattisgarh, and Jharkhand are the three most important states of the Central Tribal Belt of India where 21.09%, 30.62%, and 26.21% of the total Scheduled Tribe population respectively reside. This entire area is rich in dense forests, plateaus, and hilly areas and for this reason, a lot of Naxalite activities are seen in these areas. According to the data of the Home Ministry of India, there are Naxal-affected districts in all three states, in which 16 and 14 districts in Jharkhand and Chhattisgarh respectively are suffering from this problem. Although the situation in Madhya Pradesh has improved a lot, still 3 districts here are Naxal affected.

Objectives

(1) To explain the Historical perspective of Naxalism through its different stages.

(2) To find out the current situation of the Naxal problem in India and its 2 states of Central Tribal Belt (Chhattisgarh, Jharkhand) and improvements throughout the years.

(3) To describe major schemes started by the government of India to counter this issue.

Database and Methodology

The methodology used in this study is primarily based on secondary data obtained from various official sources, including the Ministry of Home Affairs and the South Asian Terrorism Portal (S.A.T.P.). The research also involved the study of various research papers related to the subject. The data collected has been represented through tables, graphs, and maps, and ArcGIS 10.8 has been utilized to create the map. This approach allowed for a comprehensive analysis of the current situation of Naxalism in India and its Central Tribal Belt, as well as the improvements and challenges throughout the years.

Results and Discussion

Historical Perspective of Naxalism

(a) First Stage (1960s-1977): The early phase of Naxalism shows the rise of great thinkers and the ideology of the leaders. During this time, they laid the foundation of the movement (Sarkar & Manna, 2018). While the farmers' revolt in Naxalbari was quickly suppressed by the government, it also received support from students, workers, and other intellectuals and in this way the Naxalbari rebellion was not limited there for long but it also had an impact on other states of India.The communist in 1965-66 already had gained grounds in the Naxalbari and its surrounding region by the help of Charu Majumdar, Kanu Sanyal and Jangal Santhal. Many peasant cells were created throughout the region (Amjed Jaaved, 2020)

(b) Second Stage (1977-2000): Under the second phase, Naxalism progressed further and during this period the Naxalites also organized movements against social evils such as prostitution, Gambling, etc (Sodhar & Keskin, 2020). This helped the Naxalites to gain the sympathy of the people, especially women. Naxalite activities simultaneously became more violent, including kidnappings of officials and killings of police officers, and from here they started using landmines in their attacks. Training was provided to new members in guerilla training camps. The People`s Guerrilla Army was active during this period. People War Group (PWG) was formed by Kondapalli Seetharamaiah 22, April 1980 who is associated with Communist Parti of India. On 12 February 1992, 38 people belonging to the Bhumihar community were killed in Bara village, Gaya district, Bihar. On 18 March 1999, 34 people again killed in Senari village, Jehanabad district, Bihar (Amarnath Tewary, 2016). Basically, in this stage Naxalism adopted guerilla warfare strategy.

(c) Third Stage (2000 -2010): During this period leftist parties learned lessons from the disintegration of the Soviet Union and started various activities to inject new life into the communist movement. Although Naxalites had to face severe setbacks due to the aggressive action of the police but they were active to counter the government. In February 2005, the CPI (Maoist) killed 7 policemen, a civilian and injured many more during a mass attack on a school building in

Venkatammanahalli village, Pavgada, Tumkur, Karnataka. (Deccan Herald, 2005). There were more than 40,000 displaced people in 2006. (Thomson Reuters Foundation, 2009). On December 2006, 14 Indian policemen had been killed by Maoists in a landmine ambush near the town of Bokaro (BBC News, 2006). On 6 April 2010, Naxalite rebels killed 76, consisting of 74 paramilitary personnel of the CRPF and two policemen in Dantewada district, Chhattisgarh. (BBC News, 2010). On 17 May 2010, a Naxalite landmine destroyed a bus in Dantewada district, killing up to 44 people including several special police officers (SPOs) and civilians. (NDTV, 2010).

(d) Fourth Stage (2010- till now): During this time, they caused huge losses to the security forces and politicians and organized their activities in the Dandakaranya area, but from time to time, they also suffered a lot of losses due to the actions of the security forces. The 2013 Naxal attack in Darbha valley resulted in the deaths of around 24 Indian National Congress leaders including the former state minister Mahendra Karma and the Chhattisgarh Congress chief Nand Kumar Patel (Suvojit Bagchiagencies, 2013). In the present time, although this problem is still not completely over. On 3 April 2021, 22 soldiers including 14 Chhattisgarh policemen and 7 jawans of the CRPF, including 6 members of its elite COBRA unit, were killed in a Maoist ambush on the border of Bijapur and Sukma districts in southern Chhattisgarh. One CRPF jawan was held captive by the Maoists. (Sanjiv Krishnan Sood, 2021) (Table-1). The influence of Maoist ideology on educated youth is gradually decreasing. According to the data of the Home Ministry, at present 70 districts of the country are Naxal affected, whose number was up to 200 in the year 2000. According to the Press Information Bureau, Government of India, in this time phase, the Central Government has taken various measures to control Left Wing Extremism which includes augmenting the strength of Central Armed Police Forces; establishment of National Security Guard (NSG) hubs at Chennai, Kolkata, Hyderabad and Mumbai; strengthening and re-organizing of multi-Agency Centre to enable it to function on 24x7 basis; and sanctioning of new Specialized India Reserve Battalions (SIRB). The Central Government also proposes release of funds under the Special Infrastructure Scheme to the States of Bihar, Chhattisgarh, Jharkhand and Odisha to raise Special Task Force to combat Left wing extremism.

Current Situation of Naxal Problem in India

In India, the issue of Naxalism has persisted for the past 50 years and has not yet been resolved. The number of districts afflicted by Naxalism has decreased dramatically, even though statistics indicate that things have improved slightly. However, this issue continues, and currently, if we examine the data from

2009 to 2019, we find that the problem of Naxalism has killed us more than the issue of Kashmir.

Table-1: Achievements by Government of India

Indicators	From May 2005 - April 2014	From May 2014 - April 2023	Percent Decline
Total Incidents of Violence	14862	7128	52%
Left Wing Extremism related deaths	6035	1868	69%
Security Personnel`s deaths	1750	485	72%
Civilian deaths	4285	1383	68%
Districts reporting violence	96 (2010)	45 (2010)	53%
Police stations reporting violence	465 (2010)	176 (2010)	62%

Source: Ministry of Home Affairs

According to the Ministry of Home Affairs, in 2003, about 200 districts were affected by Naxalism, whereas in 2008, this number reduced significantly and its number became 165. In 2013 it further decreased and about 120 districts remained affected by Naxal by 2018 its number reached 90 and at present in 2023, a total of 70 districts are affected by Naxal. Thus, we are seeing that the number of Naxal-affected districts is continuously decreasing. At the same time, in last 20 years, it is also known that there has been a continuous decline in deaths due to Naxalism. There has been a significant decline in total deaths from 1999 to 2019. While this number was 859 in 1999, it has come down to 347 by 2019. Although there was not that much reduction in the period from 2003 to 2011, a very important reason behind this was the Salwa Judum movement. Salwa Judum (meaning "peace march" in the Gondi language) was a militia that was mobilized and deployed as part of counterinsurgency operations in Chhattisgarh, aimed at countering Naxalite activities in the region. The militia, consisting of local tribal youth, received support and training from the Chhattisgarh state government.

Current Situation of Naxal problem in Chhattisgarh and Jharkhand.

(a) Chhattisgarh

There are currently 14 districts in Chhattisgarh that are listed as being afflicted by Naxalism, making it the most affected state in India, according to data given by the Home Ministry of the Government of India. These 14 districts are as follows- Balrampur, Bastar, Bijapur, Dantewada, Dhamtari, Gariyaband, Kanker, Kondagaon, Mahasamund, Narayanpur, Rajnandgaon, Sukma, Kabirdham and Mungeli. Although Chhattisgarh has been heavily affected by Naxalism for the last 20 years its geographical condition is also favourable for it (Fig. 1). The Dandakaranya plateau provides a suitable dense forest area for the Naxalites, where they can carry out their activities, but their activities have also reduced significantly in the last few years (Table-2).

Table-2: Fatalities due to Naxalism in Chhattisgarh (2000-2023)

Years	Civilian	Security Forces	Terrorists / Extremists	Not specified	Total
2000	0	0	0	0	0
2001	6	4	3	0	13
2002	0	2	5	1	8
2003	9	21	16	0	46
2004	7	1	20	0	28
2005	53	48	26	0	127
2006	184	52	117	0	353
2007	78	198	74	18	368
2008	32	67	68	2	169
2009	76	127	154	2	359
2010	80	150	91	1	322
2011	37	82	73	0	192
2012	32	30	44	0	106
2013	55	36	34	0	125
2014	25	64	49	0	138
2015	33	41	41	0	115
2016	36	35	135	0	206
2017	32	59	76	0	167
2018	59	57	132	0	248
2019	30	19	73	0	122

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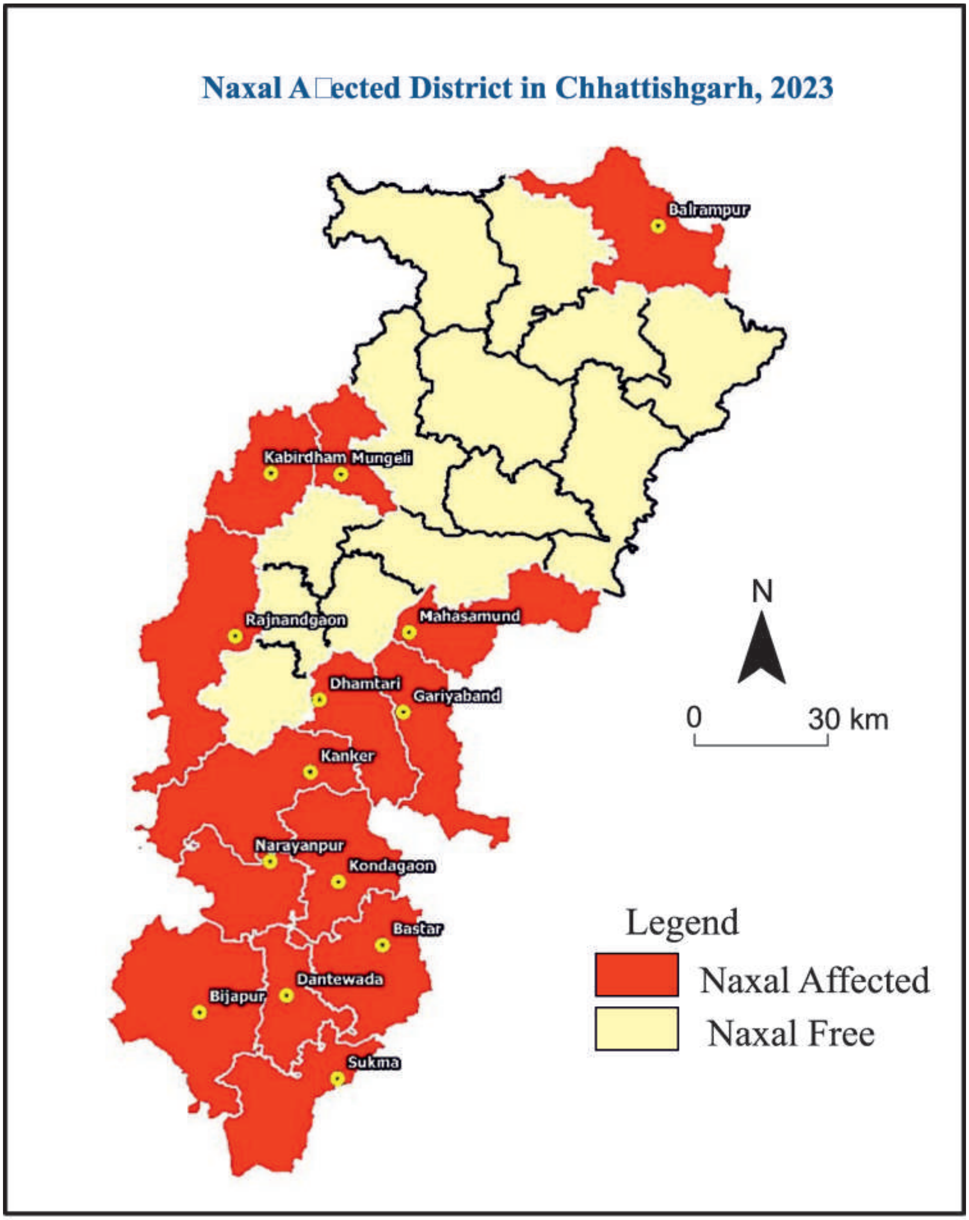
Naxal A□ected District in Chhattishgarh, 2023
Balrampur
Kabirdham
Mungeli
Rajnandgaon
Mahasamund
Dhamtari
Gariyaband
Kanker
Narayanpur
Kondagaon
Bastar
Dantewada
Bijapur
Sukma
N
0
30 km
Legend
Naxal Affected
Naxal Free

Fig. 1

2020	28	37	70	0	135
2021	29	45	45	0	119
2022	30	10	32	0	72
2023	23	31	22	0	76
Total	982	1208	1400	24	3614

Source: South Asian Terrorism Portal (S.A.T.P.)

(b) Jharkhand

Jharkhand is the second most Naxal-affected state in India after Chhattisgarh. A total of 16 districts here are included in the Naxal affected list which is as follows- Bokaro, Chatra, Dhanbad, Dumka, East Singhbhum, Garhwa, Giridih, Gumla, Hazaribagh, Khunti, Latehar, Lohardaga, Palamu, Ranchi, Saraikela-Kharaswan, West Singhbhum. Although Jharkhand has been heavily affected by Naxalism for the last 20 years its geographical condition is also favourable for it. The Chota Nagpur plateau area provides a suitable dense forest area and valleys for the Naxalites. Where they can carry out their activities, but their activities have also reduced significantly in the last few years (Table-3 and Fig. 2).

Table -3: Fatalities due to Naxalism in Jharkhand (2000-2023)

Year	Civilian	Security Forces	Terrorists / Extremists	Not specified	Total
2000	13	3	11	9	36
2001	36	44	38	10	128
2002	25	77	15	1	118
2003	43	19	44	8	114
2004	16	36	18	7	77
2005	28	28	20	20	96
2006	18	48	34	0	100
2007	65	8	46	0	119
2008	61	38	61	0	160
2009	68	71	61	0	200
2010	73	25	46	0	144

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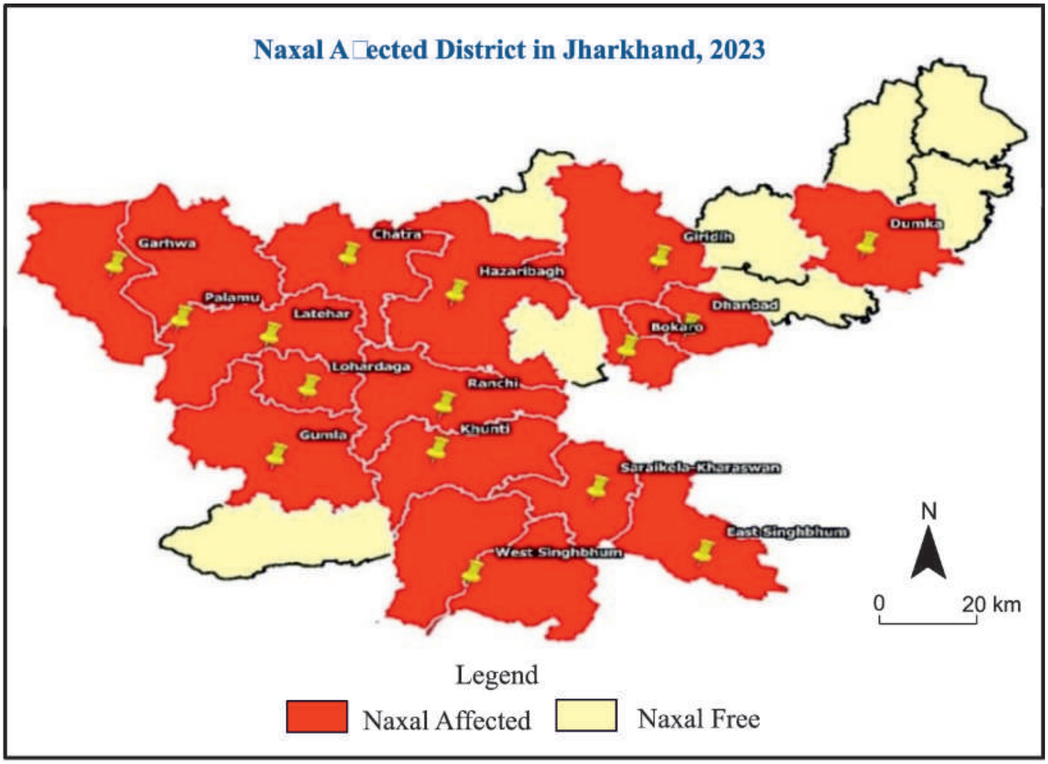
Naxal A□ected District in Jharkhand, 2023
Garhwa
Chatra
Hazaribagh
Giridih
Dumka
Palamu
Latehar
Dhanbad
Bokaro
Lohardaga
Ranchi
Khunti
Gumla
Saraikela-Kharaswan
East Singhbhum
West Singhbhum
N
0
20 km
Legend
Naxal Affected
Naxal Free

Fig. 2

2011	79	29	50	0	158
2012	49	25	29	0	103
2013	47	26	57	0	130
2014	49	14	39	0	102
2015	15	5	37	0	57
2016	34	8	40	0	82
2017	27	4	27	0	58
2018	17	10	26	0	53
2019	20	13	31	0	64
2020	8	2	18	0	28
2021	11	6	8	0	25
2022	6	2	2	13	23
2023	13	5	5	13	36
Total	821	546	782	55	2204

Source: South Asian Terrorism Portal

Major Schemes Started by Government of India

Numerous initiatives are being carried out by the Ministries/Departments to promote the overall development of areas impacted by LWE. These are some of the significant development projects that have been implemented, particularly in the LWE-affected areas.

(a) Road Requirement Plan-I (RRP-I): The Ministry of Road Transport and Highways has been doing this since 2009 to increase road connectivity in 34 districts of eight states that are affected by LWE. 5,422 km of new roads are planned under this scheme, of which 4,537 km have already been built.

(b) Road Connectivity Project for Left Wing Extremism Affected Areas: The Government has recently approved this Scheme for the construction of 5412 km of roads and 126 bridges/culverts in 44 LWE-affected districts with an estimated cost of Rs. 11,725 crores.

(d) Skill Development in the LWE affected districts: Being implemented by the Ministry of Skill Development and Entrepreneurship since 2011 for the establishment of 01 ITI each in 47 LWE districts and 02 Skill Development Centres each in 34 LWE districts. So far, 15 ITIs and 43 Skill Development Centres have been completed.

(e) **Educational Initiatives:** The Department of School Education & Literacy has sanctioned 8 new Kendriya Vidyalayas and 5 new Jawahar Navodaya Vidyalaya in the most LWE-affected districts, which did not have any KVs/ JNVs. Under Rashtriya Madhyamik Shiksha Abhiyaan (RMSA) 1,590 new/ upgraded Schools and 350 girl's hostels have been sanctioned in 35 most LWE-affected districts.

(f) **Mobile Towers:** Being implemented by the Department of Telecom. In the first phase, 2329 mobile towers have been installed.

(g) **Special Central Assistance for 35 most LWE-affected districts:** The Government approved this new Scheme on 27.09.2017 for providing public infrastructure and services in the most Left-Wing extremist-affected districts. The Scheme will continue for 3 years from 2017-18 to 2019-20 with a total outlay of Rs. 3,000 crores.

(h) **Surrender-cum-rehabilitation schemes:** The government to discourage misguided youth and bring hardcore militants to the mainstream, has introduced surrender-cum-rehabilitation schemes.

(i) **SAMADHAN Scheme (2017):** SAMADHAN scheme is the one-stop solution for the LWE problem. It encompasses the entire strategy of government from short-term policy to long-tern policy formulated at different levels. SAMADHAN stands for:

S	Smart Leadership
A	Aggressive Strategy
M	Motivation and Training
A	Actionable Intelligence
D	Dashboard based Key Performance Indicators & Key Result Areas
H	Harnessing Technology
A	Action plan for each Theatre
N	No access to Financing

Source: Ministry of Home Affairs

Conclusion

In conclusion, the document provides a comprehensive overview of the Naxalism issue in the central tribal belt of India, focusing on the current situation, improvements, and challenges. It highlights the reduction in the number of

Naxal-affected districts from approximately 200 in 2000 to 70 in 2023, indicating some improvement. However, the problem persists, impacting the development of affected states. The study emphasizes the need for rehabilitation, reintegration, and socio-economic development to address the challenges posed by Naxalism in India. It also underscores the importance of civil society and the media in pressuring Left-Wing Extremists to give up violence and integrate into society. The document emphasizes the government's efforts to counter the issue through various schemes and initiatives, such as surrender-cum-rehabilitation schemes and the SAMADHAN scheme. Overall, the study provides insights into the multifaceted nature of the Naxalism issue and the complexities involved in addressing it effectively.

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LANDUSE DYNAMICS OF PARVATI-ARGA RAMSAR WETLAND AND ITS ENVIRONS IN GONDA DISTRICT, UTTAR PRADESH

Shivam Verma, Srabani Sanyal and Prashant Kushwaha

Abstract

In a time marked by global warming, population growth and their associated challenges, wetlands stand out for their immense significance, offering a multitude of benefits to humanity. These are ecotonal areas and provide different ecosystem services to humans as well as habitat for various species of flora and fauna. In spite of their pivotal role in ecological processes, wetland ecosystems are under threats due to ever-increasing need of humans. This study endeavour to evaluate the dynamic changes taking place within a 5 km radius surrounding the Parvati-Arga wetland, which serves as a bird sanctuary using geospatial techniques. Located in the Gonda district of Uttar Pradesh, India, this wetland holds the prestigious designation of being a Ramsar site. The land use and land cover (LULC), Normalized Difference Water Index (NDWI) and Modified Normalized Difference Water Index (MNDWI) are assessed using datasets of Landsat 7 ETM+ for 2001, Landsat 5 TM for 2011 and Landsat OLI/TIRS for 2021. LULC classification was done by using a supervised classification method with maximum likelihood algorithm. For NDWI, green and near-infrared (NIR) bands were used, whereas for MNDWI green and middle infra-red bands of Landsat imagery were used. The study indicate a concerning trend wherein the area occupied by water bodies has diminished significantly over the observed period from 720.40 hectares (2.94% of the total area) in 2001 to 480.96 hectares (1.96% of the total area) in 2021. A notable increase in agricultural land from 62.48% in 2001 to 67.52% in 2021 and of the built-up area from 5.28% in 2011 to 8.29% in 2021. Although the area under river and reserve forest has remained same, there has been a decline in the vegetation and barren land. The change of water bodies to aquatic vegetation and agricultural land intensifies anthropogenic pressure on wetland ecosystem. This transformation has led to a reduction in both NDWI and MNDWI values between 2001 and 2021, indicating a decline in water content within the study area. These trends highlight the urgent need for effective conservation measures to mitigate further loss of wetland habitats and maintain ecological balance.

Introduction

The changing land use and cover has continued to be a crucial indication for understanding local, national, and international challenges to the environment as well as their causes. The continuous change in land use is due to ever-increasing human population needs. Wetlands are the most vulnerable habitat on the earth, vanishing three times faster than forests. In the preceding 50 years, 35% of the total world's wetlands have vanished, since 1970. Human activities such as pollution, overfishing and resource exploitation, invasive species, drainage and infilling for building and agriculture, and climate change all contribute to the loss of wetlands (United Nations, 2024). Wetland loss accounts at 50% globally since 1900, 90% in New Zealand, and around 50% in the United States (Spiers, 1999). Though wetlands cover only 1.5 % of the total geographical area but provides approximately 40% of total ecosystem services (Zedler & Kercher, 2005). Wetlands are a conspicuous feature on the surface of the earth they lie in the transition between terrestrial and aquatic ecosystems. Wetland ecosystems, which consist of reservoirs, ponds, and lakes etc., are essential to the earth's water cycle and significantly influences the climate system and the global ecology. It is crucial to comprehend as to how to manage water resources and map the spatial distribution of wetlands while monitoring and analyzing their hydrological process (Ehsani et al., 2017). In a wide sense, the word 'wetland' is an umbrella term that is used to describe numerous types of water bodies and encompass distinct hydrological units, such as marshes, swamps, bogs, wet meadows, potholes, and river flooded areas (Tiner, 2016). Under Ramsar convention, wetlands have been defined as the are areas of marsh, fen, peatland, or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters". The Ramsar Convention is the only international agreement that was signed in 1971 aimed at developing national and worldwide action plans for the preservation of wetlands and their resources (Bassi et al., 2014).

Study Region

The Parvati Arga wetland located in the Tarai region (26°54' 41"- 26°56'45" N latitude and 82°6'47 "- 82°10'12" E longitude) is recognized as the home of many endangered species. The wetland comprises of two freshwater oxbow lakes and covers an area of 1084.84 hectares and at an elevation of about 93 meters in the Tarabganj tehsil of the Gonda district in Uttar Pradesh (Khanna, 2015). Gulriha nala connects these wetlands to the Terhi river (Site Management Plan, 2011).

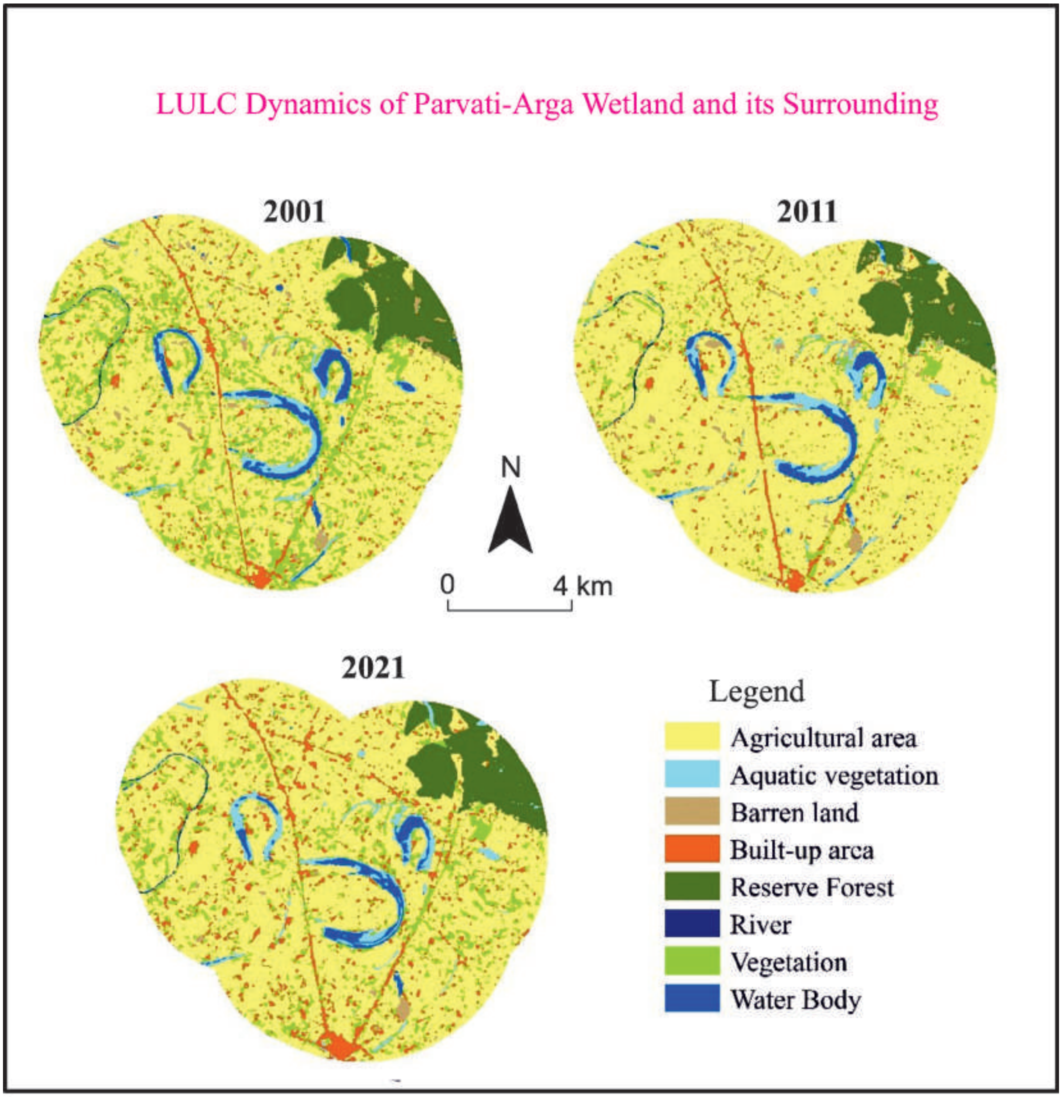
Among them, Kondar Lake is one of the largest oxbow lakes covering an area of 237.6 hectares. Geomorphologically, these are part of the paleochannels of the Ghaghara River which has left many tiny streams behind as it moved towards the south. Other important wetlands lying in the vicinity are Urva tal, Upadhia tal, Garela tal etc. The area experiences hot summers and moderate winters, here temperature varies from 4°C in the winter to 48°C in the summer and average annual rainfall of 1240 mm. Sand, silt, and clay layers have compacted to form the soil (Site Management Plan, 2011). The wetlands provides a varied ecosystem services and support huge diversity of flora and fauna. In 2022, Parvati Arga wetland (bird sanctuary), rich and heterogeneous in biodiversity located in the Gonda district of Uttar Pradesh was declared a Ramsar site. Many migratory birds such as ferruginous duck (Aythya nyroca), Gadwall (Anas Strepera), common Pochard (Aythya ferina) along with more than 35 species of flora belonging to seven distinct families and 64 species of fauna belonging to seven different families that have been recorded here (Ramsar Convention, 2019). However, land use dynamics poses a serious threat to the wetland. Infrastructural development, intensive agriculture, use of fertilizer and insecticides around the wetland causes eutrophication and shrinkages. Therefore, it is important to evaluate the water quality, ecosystem services and the mitigation strategies for restoration of the wetland (Verma et al., 2023).

Objectives

The objective of the present work is to evaluate the dynamics of land use within the vicinity of the Parvati-Arga wetland for the years 2001, 2011, and 2021. The focus will be on assessing changes in surface water within the wetland area, utilizing multiband indices such as NDWI and MNDWI for each decade.

Database and Methodology

To evaluate land use changes around the Parvati-Arga and Kondar wetlands, a 5 km buffer was created using ArcGIS 10.5, based on data (Asgher et al., 2019, Jamal & Ahmad, 2020). Landsat ETM+, TM, and OLI for the year 2001, 2011, and 2021 were acquired from the USGS Earth Explorer database. The toposheets of the Survey of India were used as the base map, while Google Earth Pro aided visualization during image processing. Erdas Imagine 2015 facilitated preprocessing and classification, with further image processing and classification conducted using ERDAS Imagine 2015 and ArcGIS 10.5 for spatial data analysis and visualization. The supervised maximum likelihood classification method was employed for image classification, with LULC types determined based on



LULC Dynamics of Parvati-Arga Wetland and its Surrounding
2001
2011
2021
N
0
4 km
Legend
Agricultural area
Aquatic vegetation
Barren land
Built-up area
Reserve Forest
River
Vegetation
Water Body

Fig. 1

training samples derived from personal experience, map analysis, and fieldwork (Jensen, 2015). A majority filter was applied to classified images to minimize the salt-and-pepper effect before generating LULC maps for 2001, 2011, and 2021, along with corresponding statistical analysis. Change detection analysis from 2001 to 2021 was carried out using ArcGIS 10.5, with the rate of land use change calculated. Multiband Water Indices utilizing NIR, MIR, and green bands were employed for the assessment.

Result and Discussion

For the present study eight different LU/LC classes are considered, namely, agricultural area, aquatic vegetation, barren land, built-up area, river, vegetation, reserve forest and water bodies. The analysis of LULC dynamics of the study area is based on 2001, 2011, and 2021 dataset (Table-1 and Fig. 1). Total area within the buffer was 24510.45 hectares. Among the eight classes agricultural area being the major, covers an area of 15315.18 ha. (62.48 %) in 2001, which increased to 18000.24 ha. (73.44%) in 2011, and 16548.85 ha. (67.52 %) in 2021. Agricultural area experienced increase in first decade (2001-11) and interestingly diminished in the later decade (2011-21). However, when considered for the entire period (2001-21) there seems to be an increase in agricultural land. Aquatic vegetation is a major apprehension for the health of any aquatic ecosystem (Elias et al., 2019). Area under aquatic vegetation depicts an increasing trend from 2001 to 2011 (645.16 ha. in 2001 (2.63 %), to 819.97 ha. in 2011 (3.35%), but declined to 767.10 ha. (3.13%) in 2021. This shows an increase of 18.90% in the aquatic vegetation cover within the wetland over the entire period due to eutrophication. Eutrophication is a significant ecological concern that negatively impacts both the aquatic ecosystem and the available potable water for human as well as animals (Akinnawo, 2023). Barren land shows an overall decline throughout the study period. Barren land was 517.32 ha. (2.11%) in 2001, that increased slightly to 566.95 ha. (2.31%) in 2011. Interestingly by 2021 it declined to 121.78 ha. (0.50 %). Built-up area under built-up has steady increase over the period. It was 1293.73 ha. (5.28%) in 2001, increased to 1345.26 (5.49 %) ha. in 2011, and further registered a drastic increase to 2030.93 ha. (8.29 %) by 2021. Reserve forest comprises of densely forested region which is a part of the Tikri reserved forest as notified by the government. No major changes were observed during this period (Fig. 1 and 2). It covered 1695.95 ha. (6.92 %) in 2001, that increased to 1716.81 ha. (7%) in 2021. Water bodies in the study area demonstrated a continuous decline from 720.40 ha. (2.94%) in 2001, to 580.92 ha. (2.37%) in 2011 that further declined to 480.69 ha. (1.96%).

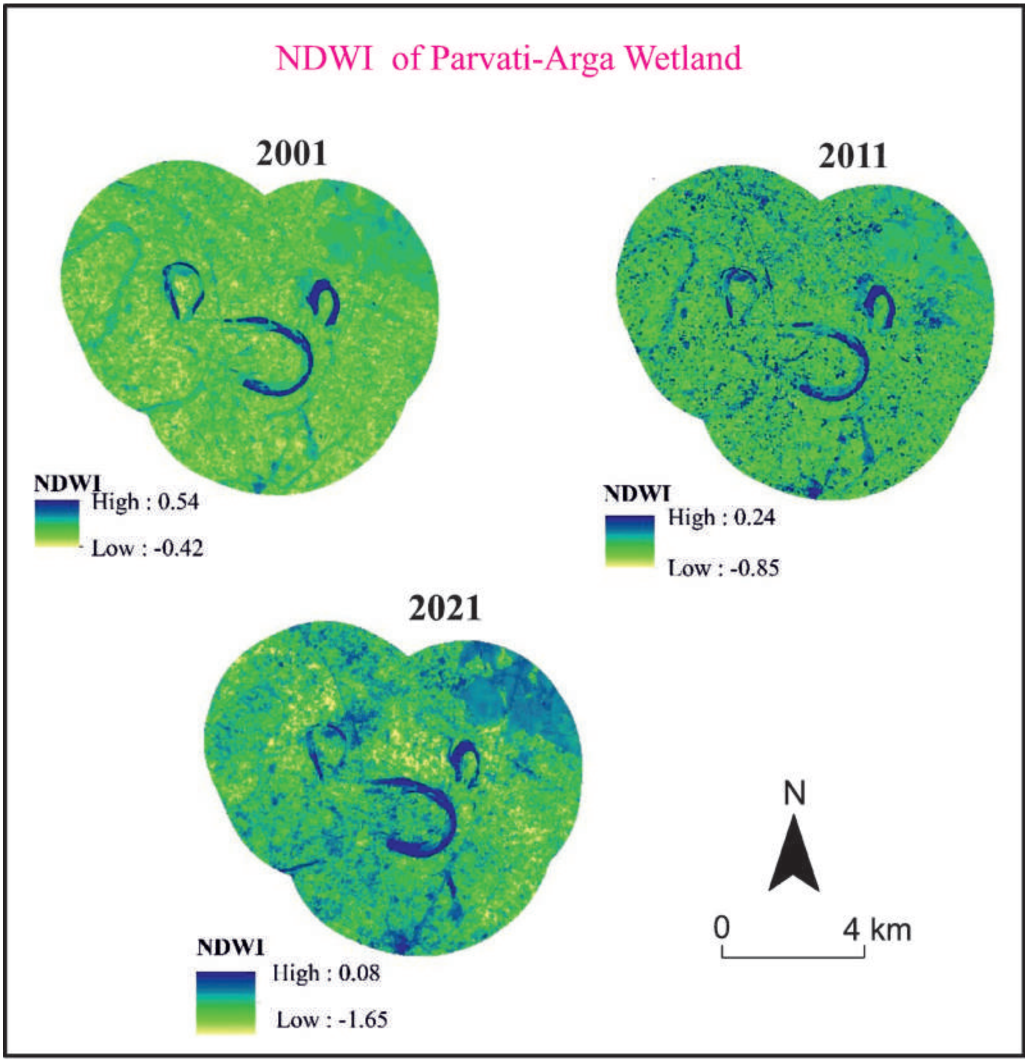

NDWI of Parvati-Arga Wetland
2001
NDWI
High : 0.54
Low : -0.42
2011
NDWI
High : 0.24
Low : -0.85
2021
NDWI
High : 0.08
Low : -1.65
N
0
4 km

Fig. 2

A narrow stream known as Terhi River is flows in the study area. Area under water bodies do not show any noteworthy alteration and remained with 0.19% of the total area in 2021.

Vegetative cover: Area under vegetation has registered a sharp decline throughout the study. It was 4276.81 ha. (17.45%) in 2001 and got reduced to 1458.78 ha. (5.95%) in 2011, but increased to 2798.58 ha. (11.42%) in 2021.

Rate of LULC Change

The statistics obtained from the LULC maps are used for calculating the rate of change in LULC. The formulae (Elias et al., 2019; Abebe et al., 2019) for calculating the rate of change for each LULC class in hectare per year is (refer equation 1 given below).

$$Rate\,of\;Change = \frac{A2 - A1}{Z} \ldots\ldots\ldots\ldots..equation\,1$$

Where, A2 is an area of LULC in ha. in time A1, A1 an area of LULC in hectare in time; Z is time interval between A2 and A1 in years. Analysis of the rate of change (in hectare/year) reveals that agricultural area expanded by 61.68 ha. per year during the period of 2001-21. Showing the same trend, the built-up area increased by 36.86 ha. per year during the same period. Aquatic vegetation and reserve forest registered positive increase, at the rate of 6.1 ha. per year and 1.04 ha. per year respectively. On the other hand, area under vegetation declined significantly at the rate of -73.91 ha. per year. Barren land, water bodies and river also declined at the rate of -19.78 ha., -11.98 ha. and -0.01 ha. respectively. Continuous rise in human population resulted in increase in agricultural and built-up area, at an expense of vegetative, barren and water bodies.

Overall Change in Area under Different Classes

Four classes of the LULC, that are agricultural area, aquatic vegetation, built-up area, and reserve forest registered a positive change in area during the period of 2001-2011. The most significant increase was registered for built up area, which increased by 56.98%. Similarly aquatic vegetation increased by 18.90%, while agricultural area by 8.06%, and reserve forest by 1.23%. On the other hand, barren land, water bodies, vegetation and river registered a negative net change in area during 2001-2021. Barren land decreased significantly by -76.46%, and vegetative cover by -34.56%, water bodies by -33.27%, and rivers by -0.45% (Table-1).

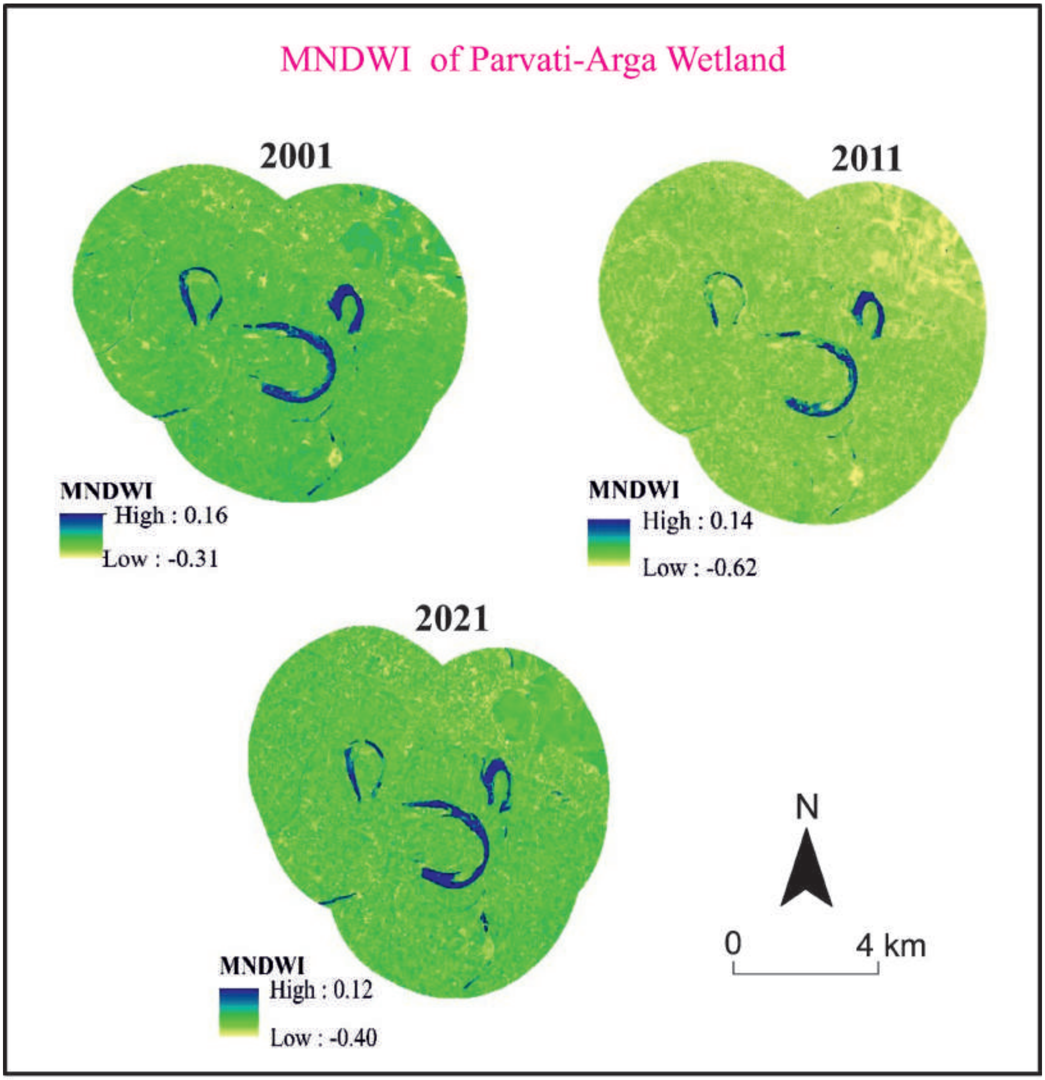

MNDWI of Parvati-Arga Wetland
2001
MNDWI
High : 0.16
Low : -0.31
2011
MNDWI
High : 0.14
Low : -0.62
2021
MNDWI
High : 0.12
Low : -0.40
N
0
4 km

Fig. 3

Table-1: Landuse Change in Study Area (2001 to 2021)

LULC Class	2001		2011		2021		Change 2001-21	
	Area (ha)	Area (%)	Area (ha)	Area (%)	Area (ha)	Area (%)	Net Change (ha)	Net Change (%)
Agricultural area	15315.18	62.48	18000.24	73.44	16548.85	67.52	1233.67	8.06
Aquatic vegetation	645.16	2.63	819.97	3.35	767.10	3.13	121.94	18.90
Barren land	517.32	2.11	566.95	2.31	121.78	0.50	-395.54	-76.46
Built-up	1293.73	5.28	1345.26	5.49	2030.93	8.29	737.20	56.98
Reserve forest	1695.95	6.92	1695.69	6.92	1716.81	7.00	20.85	1.23
River	45.90	0.19	42.63	0.17	45.70	0.19	-0.21	-0.45
Vegetation	4276.81	17.45	1458.78	5.95	2798.58	11.42	-1478.22	-34.56
Water bodies	720.40	2.94	580.92	2.37	480.71	1.96	-239.68	-33.27
Total	24510.45	100.00	24510.45	100.00	24510.45	100.00		

Source: Computed by Authors

Spatio-temporal Change in NDWI and MNDWI

Multiband indices like NDWI and MNDWI are long used in the assessment of water resources and coastal management. McFeeters (1996) proposed the Normalized Difference Water Index (NDWI) for detecting and measuring surface waters of wetlands. Positive value shows water surface and negative value shows drought or non-aqueous surface. However, Fig. 1: LULC dynamics of Parvati Arga wetland and its surrounding for the year 2001, 2011 and 2021 (Fig. 3). There is one drawback with the NDWI index that it mixes the built-up area with water feature. By replacing the NIR band with MIR, the problem could be resolved. A new index known as Modified Normalized Difference Water Index replaced the old one. In this index positive value shows surface water, while, negative value shows built-up and other features (Xu, 2006). A continuous and significant decline in NDWI was registered throughout the study period. Maximum value of Normalized Difference Water Index (NDWI) was 0.54 in 2001, which decreased to 0.24 in 2011 and further declined to 0.08 in 2021. The primary reason behind this decrease in the NDWI was the expansion of aquatic vegetation and agricultural area. As discussed earlier agricultural area and aquatic vegetation have registered an increase 8.06%

and 18.90% respectively from 2001 to 2021. Unsurprisingly, higher values of NDWI were recorded in and around the wetlands, while, agricultural and vegetation area have low NDWI value. However, an inherent problem of NDWI is that built-up areas are detected as water bodies. For rectifying this error, the Modified Normalized Difference Water Index (MNDWI) was devised by Xu (2006). The MNDWI calculated for the same period and area, shows a declining trend similar to NDWI. Comparison of Fig. 2 reveals that MNDWI gives a clearer distinction between built-up land and water bodies, by reducing the built-up land noise. Maximum MNDWI value was 0.16 in 2001, 0.14 in 2011 and further declined to 0.12. The findings from NDWI and MNDWI are consistent with the results of LULC analysis i.e., area under water bodies have registered continuous decline throughout the period (Table-2).

Land Transformation

To measure land transformation in the study, change detection analysis was performed for the period of 2001-2011. The land use changes have been shown in the fig. 2 and Table-2. The results demonstrate that major changes are observed in the agricultural area, barren land, built-up area, vegetation and water bodies. Agricultural area increased primarily on vegetation and barren lands. Approximately 2892 ha. area of vegetative cover changed to agricultural, while 259.11 ha. of barren land also got converted to agricultural land during the period of 2001-11. Furthermore, about 173.04 ha. of aquatic vegetation, and 12 ha. of water bodies also changed to agriculture. Barren land registered a decrease due to conversion to agricultural land and vegetation. Approximately 259.11 ha. of barren land got transformed to agricultural area, 63.18 ha. to reserve forest, and 90.28 ha. to vegetation. Built-up area increased to the loss of agricultural area, aquatic vegetation, barren land and vegetative cover. 692.42 ha. of agricultural area, 19.04 ha. of barren land, 13.18 ha. of aquatic vegetation, and 12.56 ha. of vegetation, got converted into built-up area. Reserve forest (RF) area shows a slight increase over the study period. About 74.57 ha. of land under the reserve forest converted into agricultural area. However, this decrease in area was compensated by conversion of barren land to reserve forest as discussed earlier. Also, the area under rivers remained more or less the same during the study period. During 2001-11 there has been a continuous decline in area under vegetation. 2892 ha. of vegetative cover changed to agriculture, 133 ha. into aquatic vegetation, 10 ha. to barren land, 12.56 ha. to built-up, 31.11 into reserve forest. It is noteworthy that 1372.6 ha. of agricultural land, 90.28 ha. of barren land, 73.55 ha. of water bodies and 70.04 ha. of aquatic vegetation changed to vegetation

Table-2: Change Detection Matrix of LULC

	LULC Classes	LULC Class 2021								
		Agricultural area	Aquatic vegetation	Barren land	Built-up	Reserve forest	River	Vegetation	Water Bodies	Grand Total
Class 2001	Agricultural area	13134.37	61.63	27.55	692.42	18.76	1.98	1372.46	6.03	15315.18
	Aquatic vegetation	173.04	271.15	1.12	13.18	3.11	3.72	70.04	109.79	645.16
	Barren land	259.11	5.49	77.74	19.04	63.18	0	90.28	2.48	517.32
	Built-up	0	0	0	1293.73	0	0	0	0	1293.73
	Reserve Forest	74.57	9.16	4.82	0.00	1600.65	0	6.75	0	1695.95
	River	3.61	5.31	0	0.00	00	32.50	4.47	0	45.90
	Vegetation	2892.15	133.66	10.55	12.56	31.11	7.51	1181.03	8.25	4276.81
	Water Bodies	12.00	280.69	0	0.00	0	0	73.55	354.16	720.40
	Grand Total	16548.85	767.10	121.78	2030.93	1716.81	45.70	2798.58	480.71	24510.45

Source: Computed by Authors

during the same period. Similarly, area under water bodies declined throughout the period. About 280.69 ha. of water bodies converted to aquatic vegetation, 73.55 ha. to vegetation, and 12 ha. to agriculture. Area under aquatic vegetation significantly increased at the loss of water bodies and vegetative cover. While, 280.69 ha. of water bodies and vegetative cover (133 ha.) converted to aquatic vegetation.

Accuracy Assessment

The features in the study area are very diverse and heterogeneous. The presence of heterogeneity in the image and an unequal distribution of data might lead to errors in maximum likelihood classification (LULC) since many pixels in the class remain unclassified while some got misclassified (Owojori & Xie, 2005). Recoding of the classes of the classified image was carried out in the Erdas Imagine 2015. After the final mapping, it is essential to verify the classified image. Verification of the classified map was done by capturing the results of the classification with the ground truth and reference data. For this an accuracy assessment was conducted in Erdas Imagine 2015 to validate the classified image by randomly generating a series of points from each class. The classified image was compared by identifying the land cover type of each location with the help of Google Earth Pro. The stratified random sampling was adopted in the selection of the sample points. 256 points were generated for each decade. Accuracy assessment of all the LULC maps of each decade was carried out through error matrix. Results denote an overall accuracy of 84.77% 83.20% 85.94% and kappa coefficient was of 0.82 0.80 and 0.83 for 2001, 2011 and 2021 respectively.

Conclusion

Human endeavour has significantly transformed earths' surface and created cultural landscape. However, this transformation resulted in the loss of natural ecosystems like forests, vegetation and wetlands. The LULC dynamics for the year 2001, 2011 and 2021 and it was found that agricultural land is the major land use encompassing 62.48% of the study area during 2001, which increased to 67.52% by 2021. Vegetative cover was 17.45% in 2001 which reduced to 11.42% by 2021. Reserved forest cover was 6.92% in 2001, which slightly increased to 7% by 2021. Most significant increase in area was registered for built up area, aquatic vegetation agricultural area and reserve forest. Conversely, barren land, area under vegetation, Water bodies (-33.27%), and rivers (-0.45%). Area under agricultural land expanded by 61.68 ha. during the period 2001-21. Maximum value of NDWI and MNDWI decreased from 0.54 to 0.08 and 0.16 to 0.12 respectively throughout the study period. This indicates that water bodies have registered continuous decline throughout the period. Water bodies are under threat due to conversion to agricultural land, also due to loss in surface water because of low rainfall, growth of aquatic vegetation (aquatic weeds). This indicates land use change at a higher pace in the study area during last three decades.

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SOCIAL WELLBEING IN ARIYALUR DISTRICT OF TAMIL NADU USING GIS-BASED APPROACH

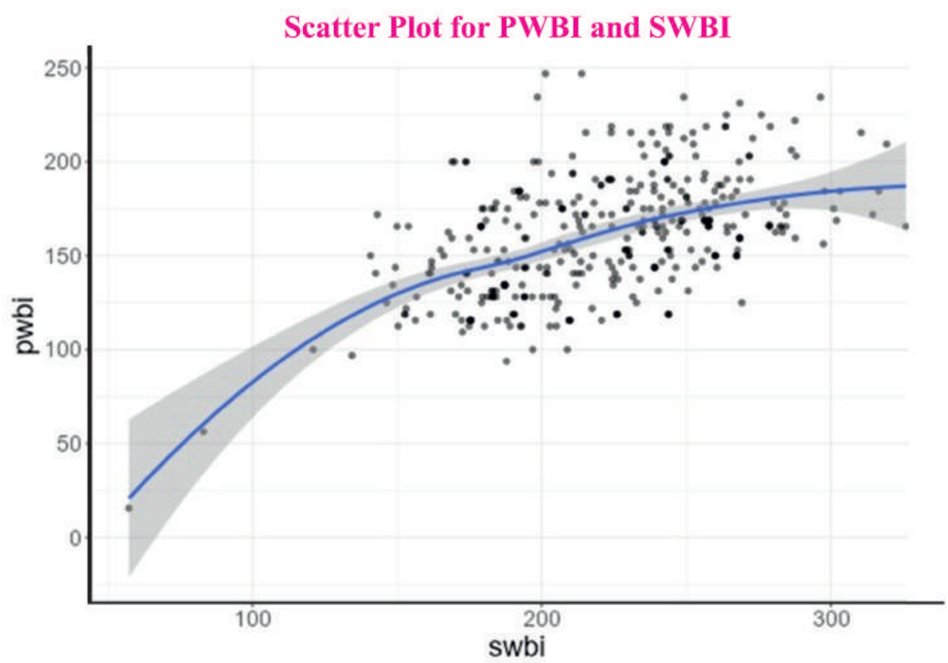
Rajakokila K. and Jegankumar R.

Abstract

Regularly monitoring the effectiveness of essential services is imperative to ensure their sustainability. Our research has made a significant contribution to exploring the benefits and potential of GIS in mapping social vulnerability. By combining questionnaire responses with statistical analysis using Jamovi, we have successfully achieved our study objectives. Our investigation focused on the Ariyalur district, a disadvantaged region in South India, and our findings have demonstrated that GIS is an invaluable tool in identifying areas with high and low levels of vulnerability. This has enabled to prioritize the improvement of basic infrastructure where it is most needed. Through the use of ArcGIS and Jamovi software, we are confident in shedding light on the social well-being of the study area and uncovering areas that require further investment.

Introduction

In today's world, providing adequate housing, sanitation, health, and other facilities in an area is a significant challenge. Sustainability of these services can only be achieved through proper monitoring on a regular basis. Every community must prepare for and respond to hazardous events, whether they are natural disasters such as tornadoes or disease outbreaks, or anthropogenic events such as harmful chemical spills. A community's ability to prevent human suffering and financial loss in the event of a disaster can be affected by certain social conditions such as high poverty, low percentage of vehicle access, or crowded households. These factors describe a community's social vulnerability. The Social Vulnerability Index (SVI) provides specific socially and spatially relevant information to help public health officials and local planners better prepare communities to respond to emergency events such as severe weather, floods, disease outbreaks, or chemical exposure. The SVI can be used to allocate emergency preparedness funding by community need, estimate the amount and type of needed supplies such as food, water, medicine, and bedding,



Note: (1) Personal Well-being Index
(2) Social Well-being Index

Fig. 1

decide how many emergency personnel are required to assist people, identify areas in need of emergency shelters, create a plan to evacuate people, accounting for those who have special needs, such as those without vehicles, the elderly, or people who do not understand English well and also to identify communities that will need continued support to recover following an emergency or natural disaster.

Inadequate sanitation and unhygienic toilets pose serious health risks to individuals, both at home and in public areas, leading to diseases such as cholera, diarrhea, dysentery, hepatitis A, typhoid, and polio. Even though 5.5 billion people, or 74% of the world's population, have access to basic sanitation facilities, nearly 2.0 billion individuals still lack even the most basic facilities like toilets or latrines. Shockingly, 673 million people still practice open defecation. Poor sanitation is responsible for an estimated 432,000 fatalities each year, often caused by intestinal worms. To prevent infections from unclean toilets, it is essential to improve sanitation facilities by offering basic services such as toilets and latrines, as well as educating people about good hygiene practices. The main objective of the present study is to identify the spatial variation block-wise to prepare for, respond to and recover from any upcoming health hazards and find out the core areas of social vulnerability well being index based using hot spot analysis and to generate a Vulnerability map of the study.

Study Region

Ariyalur District has a geographical area of 1,949 sq. Km and lies between the latitude 10o 54' and 11o30' of North longitude 78 o40' and 10 o30' of East and is shown in the Fig-1. Based on the size of the land area, Ariyalur district stands at 29th rank in the State. Ariyalur district consists of 2 Revenue Divisions, namely Ariyalur and Udayarpalayam and 3 Taluks (Ariyalur, Udayarpalayam and Sendurai) comprising of 189 Revenue Villages. For development reasons, the district is divided into 6 Community Development Blocks with 2 Municipalities and 2 Town Panchayats. The district has an average rainfall of 951.1 mm. The maximum temperature is 38°C and the minimum temperature is 24°C. Land of Limestone Ferruginous red loam occurs in Ariyalur district.

Database and Methodology

The methodology involves various processes,first primary data collection done in the form of Questionnaire .A total of 385 respondents were collected from various PHC centres throughout the study area. Data is cleaned to ensure accuracy and summarizing the data using descriptive statistics is done and finally compiled

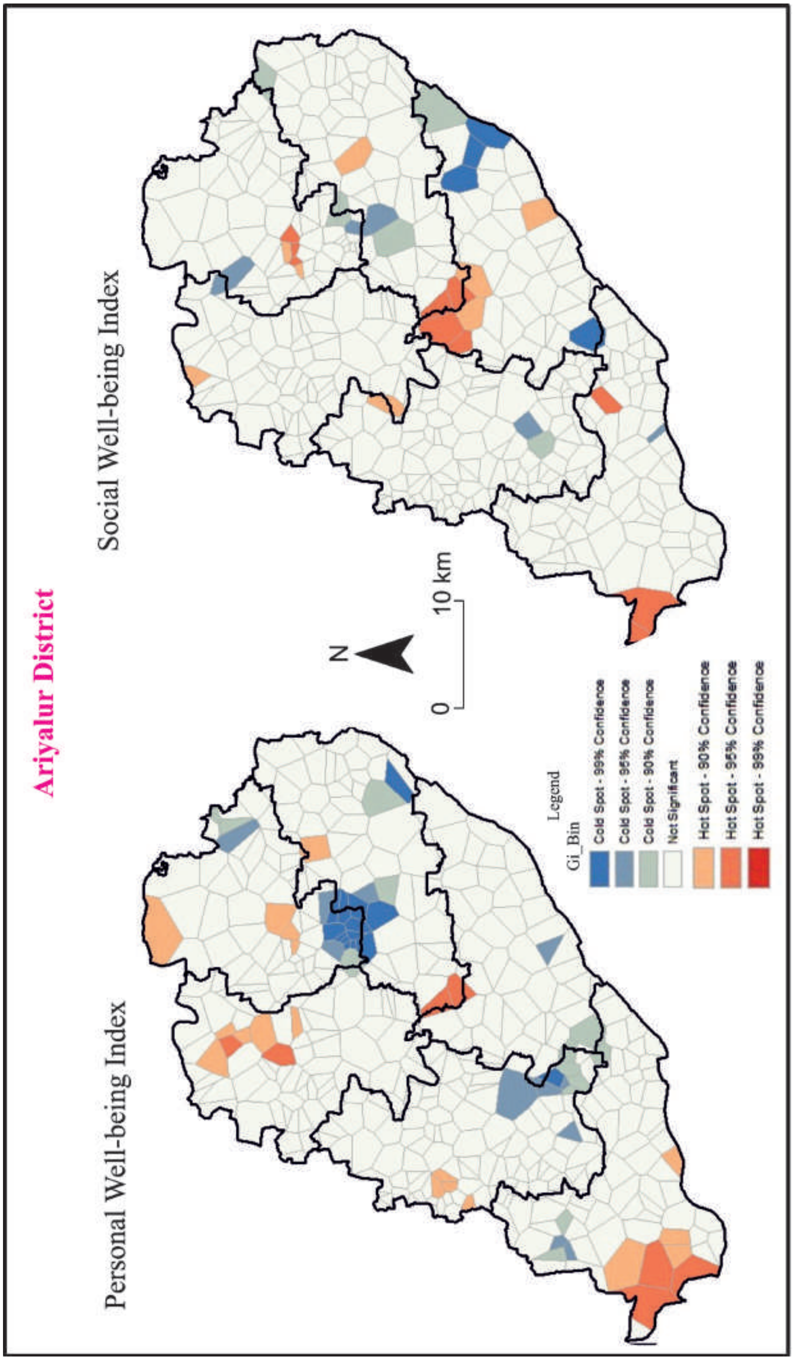

Ariyalur District
Personal Well-being Index
Social Well-being Index
N
0
10 km
Legend
Gi_Bin
Cold Spot - 99% Confidence
Cold Spot - 95% Confidence
Cold Spot - 90% Confidence
Not Significant
Hot Spot - 90% Confidence
Hot Spot - 95% Confidence
Hot Spot - 99% Confidence

Fig. 2

in Jamovi software to get statistical results. Next, ArcGIS 10.8 software is used to map the results, and also Hotspot analysis is done to show the social vulnerability prone higher and lower areas in the study area.

Result and Discusion

Social Vulnerability Assessment can be done by combining two index components , Personal well-being Index (PWBI) and the Social well-being Index (SWBI). Emotional well-being, Life Satisfaction, Positive functioning, Vitality, Awareness, Income & Transport Related, Relationships and Trust are some of the consolidated criteria derived from the Questionnaire which deals with personal and social wellbeing. These two indexes are derived from the related indicators and the results arrived are shown using hot spot analysis .The scatterplot is done for PWBI & SWBI and shown in Figure-2 . Most of the respondents scored above average for well-being, indicating an average level of satisfaction with their daily lives. The social well-being questionnaire has 40 questions that aim to assess social well-being from two dimensions Personal well being (PWB) and Social well being (SWB). PWB consisting of emotional wellbeing,life satisfaction,positive functioning and vitality and SWB consisting of awareness, income satisfaction,relationship coherence and trust . In this questionnaire, two The items are scored on a five-point Likert scale as “Strongly Agree = 5”, “Agree = 4”, “No Opinion = 3”, “Disagree = 2” and “Strongly Disagree = 1” and yes or no questions are scored as 1 for yes and 0 for no. To get the score for each dimension, the total score of the questions related to that dimension was added together and divided by the number of items in that dimension.

Therefore, the minimum and maximum scores obtained from this questionnaire is of 15 and 25 for PWB and 57 to 326 fo SWB respectively. The total score of all questions is added together to get the total score of the questionnaire. Higher scores will indicate higher social well-being and vice versa.Hotspot analysis is done for Personal Well-being Index score and shown in Fig.3. The analysis of hotspots that highlights cold spot areas unequivocally indicates highly vulnerable regions (Fig. 1, 2 and 3). Conversely, the presence of hotspots signal less vulnerability. The southern parts of Andimadam and Ariyalur block, with low Personal Well-being Index scores, are undoubtedly considered high-risk areas, while Thirumanur and Sendurai block, with high Personal Well-being Index scores, are incontrovertibly less vulnerable than other blocks. questions related to emotional wellbeing, two questions related to life satisfaction, eight questions related to positive functioning and three questions related to vitality in PWB . Five questions related to awareness,

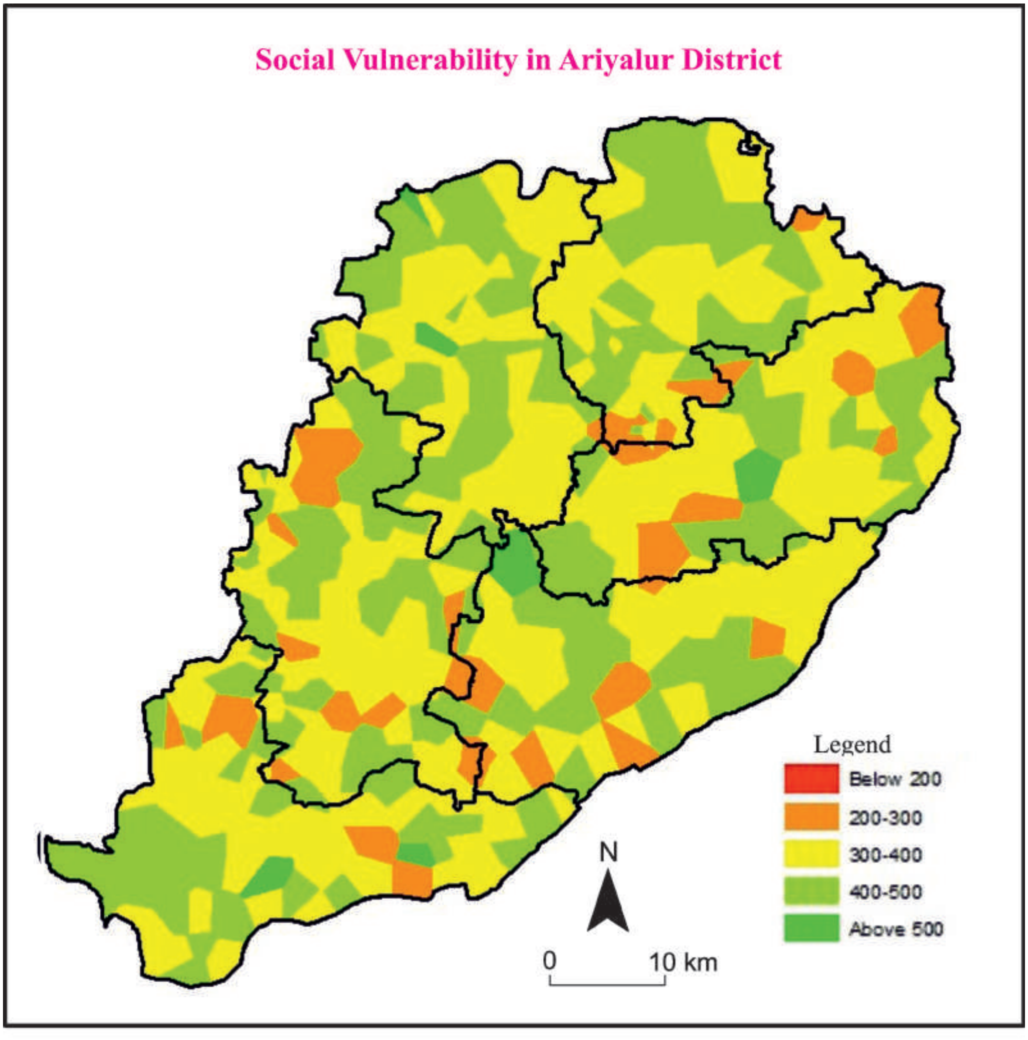

Social Vulnerability in Ariyalur District
Legend
Below 200
200-300
300-400
400-500
Above 500
N
0
10 km

Fig. 3

five questions related to income satisfaction, eight questions related to relationship coherence and seven questions related to trust in SWB. Hotspot analysis is done for Social Well-being Index score and shown in Fig. 4. Tpalur block has both low and high Social Well-being Index scores compared to other blocks. However, it is crystal clear that the north-eastern part of the block is highly vulnerable, while the north-western part is less vulnerable.Based on the overall scores divided into five categories as below 200, 200-300,300-400,400-500 and above 500 depicting very high to very low social vulnerability . The map is prepared for the same and shown in Figure-5.Sendurai,Thirumanur and Andimadam block is having normal social vulnerability.Remaining blocks having higher social vulnerability. The analysis of hotspots that highlights cold spot areas is indicative of highly vulnerable regions. Conversely, hotspots signal less vulnerability. The southern parts of Andimadam and Ariyalur block, with low wellbeing index scores, are considered high-risk areas, while Thirumanur and Sendurai block, with high wellbeing scores, are less vulnerable than other blocks in terms of Personal Well-being Index. Tpalur block has both low and high wellbeing index scores compared to other blocks in terms of Social well-being. Based on the index, it is apparent that the north-eastern part of the block is highly vulnerable, while the north-western part is less vulnerable. Finally, Sendurai,Thirumanur and Andimadam block is having normal social vulnerability. Remaining blocks having higher social vulnerability.Priority should be given to areas with low wellbeing scores in both aspects, and existing basic infrastructure should be enhanced. Thus, GIS prove to be an invaluable tool in identifying areas with high and low levels of vulnerability. This will help planners to identify areas where basic infrastructure needs improvement.

Conclusion

Generally, regular monitoring the effectiveness of essential services is imperative to ensure their sustainability. Social vulnerability index on well-being is one of the important measure that provides specific socially and spatially relevant information to help public health officials and local planners better prepare communities to respond positively. We examine data on well-being from primary data collection done in the form of questionnaire collected from various PHC centres throughout the study area to determine social vulnerability prone higher and lower areas. By combining questionnaire responses with statistical analysis using Jamovi, we have successfully achieved our study objectives and proved that GIS is an invaluable tool in identifying areas with high and low levels of vulnerability. This will enable to prioritize the improvement of basic infrastructure where it is most needed.

Through scatterplot analysis it is understood most of the respondents scored above average for well-being, indicating an average level of satisfaction with their daily lives. We combine data according to eight different well-being measures. These include four personal wellbeing variables based on emotional wellbeing, life satisfaction, positive functioning and vitality and four social wellbeing variables of awareness, income satisfaction, relationship coherence and trust. Based on scores obtained in each dimension were combined accordingly hotspot analysis is done for both personal well-being index and social well-being index. The results shows that the southern parts of Andimadam and Ariyalur block, with low and Thirumanur and Sendurai block, with high wellbeing scores in terms of Personal Well-being Index. North-western parts of Tpalur block has low and North-eastern parts of Tpalur block has high wellbeing index scores compared to other blocks in terms of Social well-being. Finally, Sendurai,Thirumanur and Andimadam block is having less social vulnerability. Remaining blocks having higher social vulnerability. Priority of efficient health services should be given to areas with low wellbeing scores in both aspects, and existing basic infrastructure should be enhanced. Thus, this study has made a significant contribution to exploring the benefits and potential of GIS in mapping social vulnerability.

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SOCIAL CRIME DENSITY AND SPATIAL JUSTICE-
A SPATIOTEMPORAL ANALYSIS IN MANIPUR CENTRAL VALLEY

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Abstract

Crime is a perennial and universal problem to all the society, defined legally as behaviour contravening the legal code. Manipur Central Valley, which is characterised by diverse socio-cultural dynamics, grapples with various social crimes due to factors like social disorganization and urbanization (modernisation). Unravel the spatial pattern of Social crimes within Manipur's Central Valley, is the aim of the present study. Crime data from law enforcement agencies had studied, using spatial statistical technique to find hotspots of IPC crime. The focus crime variable of the study include Murder, Attempt to commit murder, Culpable Homicide not amounting for murder, Rape, Kidnap and Abduction, Dacoity, Preparation and Assemble for Dacoity, Robbery, Burglary and Theft (Social Crime). The Other crime is the remaining IPC crime in the Indian Legal Code context. The main objective of the study is to find of social, real IPC, and other crime densities, comparison of social crime with other crime densities, evaluation of relationships across crime densities, and examination of space-time clustering of social crimes. Methodologically, the study adopts a modified statistical technique such as Density analysis (crime per sq km), correlation, and index of difference of density, alongside GIS- based cartography. The mention technique (used by Population Geographer, Demography, and Cartographer from population study) had adopted to analyse spatial variations in crime density, alongside correlation analysis and GIS-based cartography. Results indicate a fluctuating yet generally increasing trend in both IPC crime density and social crime density over the decades. The study had identifies factors, such as Urbanisation (modernisation, congestion of population), drug trafficking (from Myanmar and poppy cultivation), social instability and unemployment as a key contributor to crime in the region. The importance of targeted interventions tailored to specific challenges in each area, had stress from the detailed district wise analysis. By understanding, the changing dynamics of crime density and leveraging historical data (NCRB, 1981-2021) policymakers can

formulate evidence-based strategies to prevent crime and improve public safety, supplemented by increased community awareness and participation.

Introduction

Giving a precise, methodical, and logical explanation of the factors relating to the earth's surface is the aim of geography (Hartshorne, R, 1959). Social Geography, a part of Human Geography seeks to identify the different region of the earth's surface according to association of social phenomena related to the total environment. The subject matter of social geography includes the study of social problem. Crime, being an element created by human society ever since dawn of civilization, had considered a serious important matter for any society, rural or urban community; peasant or industrial society etc. The legal definition of crime is that, it is a behaviour or activity in violation of the legal code (Mishra, S.N, 2022). Social problems such as crime arise, as a "deviation from the social ideal remediable by group effort (Wash, Mary E & Furfey, Paul H, 1961). Manipur's Central Valley encompasses a diverse landscape characterized by unique socio-cultural dynamics and historical legacies (Brown, R, 1874). However, the region grapples with various social crimes, posing challenges to community safety and well-being because of social disorganisation, urbanisation, and social change (Ziipao, 2020). Understanding the spatial distribution and variation of social crime density within the urban centre in the Manipur Central valley is essential for devising effective crime prevention strategies and enhancing public safety (Ziipao, 2020). Existing literature on spatial crime analysis provides valuable insights into the methodologies and approaches for examining crime density patterns in diverse geographical contexts (Chainey & Ratcliffe, 2005). Studies focusing on the spatial distribution of social crimes offer a theoretical foundation for this research (Weisburd et al., 2004). In Manipur, many studies had done in the crime, specially crime against women (Ragui, S., & Sing, T.B, 2018). The study seeks to uncover hidden spatial patterns, identify hotspot areas, and discern spatial relationships that may hold the key to understanding the prevalence and distribution of social crimes within Manipur's Central valley.

Study Region

In a state like Manipur that has an abundance of mountains, the most remarkable geographical feature is the Manipur Central valley. The region covers 2,067 km2 and is located between latitudes 24°20' N and 25°0' N and longitudes 93°0' E and 94°0' E. The Eastern and Western Hills encircle this little Himalayan intermont valley. Nearly two-thirds of the population of Manipur are concentrated in a fertile area (Manipur Central Valley) of encircled by mountains. Towards the southeast of the valley is the rectangular in shape saucer-shaped depression that gives rise to Loktak Lake (Singh, Nabakumar, Th, 2014). The Central valley is drain by Imphal, Iril, Thoubal, and Nambul River. Under "Koppen's scheme" the climate of the region fall under the "cwg" zone (Bhattacharyya, N.N, 2006). The geography of the region provide a space for the support of 16,33,672 population (Directorate of Census Operation, Manipur, 2011), and projected 18, 41,363 (2021) population recently (as calculated using Arithmetic projection method, from previous census record), along with diverse societal community, such as schedule caste, schedule tribe, Nepali, Sikh, Meitei, Muslim, Jain and Marwalis etc. According to 2011 Census, there were 985 females for every 1000 male in Manipur. The Manipur Central valley has highest sex ratio (997) compare to Hill Districts (939). Among the district, Imphal West had the highest sex ratio (1030) and Chandel had the lowest sex ratio (936) (Directorate of Census Operation, Manipur, 2011). The settlement in Manipur have classified into Rural and Urban Settlement (Bhattacharyya, N.N, 2006). The number of villages in the valley has been decreasing for every year from 591 villages in 1981 to 471 village in 2001. While the number of rural settlements in the highlands has increased from 1402 villages in 1971 to 2111 villages in 2011. (Bhattacharyya, N.N, 2006). The Manipur Central Valley had five Central place; Imphal West, Imphal East, Thoubal, Kakching and Bishnupur with well-established Hinterland to support the population of Central valley and Manipur (Singh, Nabakumar, Th, 2014). Manipur (particularly the central Valley) has a staggering array of religious beliefs and faiths. Religious is a sort of social organisation and it expresses personalised social expression of one's religious identity, which leads to important conduct patterns. Based on the Census of India 2011, the numerous groups of Religious in Manipur Central Valley may be classified as: Hindiusm, Sikh, Jainism, Buddish, Islam, Christianity, other, and religious not started, with a total of 28,55794 people following different religious beliefs. (Bhattacharyya, N.N, 2006).

Objectives

(1) Determine Social, Actual IPC, and Other Crime Densities.
(2) Compare Social Crime with Other Crime Densities.
(3) Analyse Correlation among Social, Other, and Actual Crime Densities.
(4) Investigate spatio-temporal clustering of social crimes for dynamic understanding.

Database and Methodology

This research adopts a spatial analysis approach, leveraging GIS technology (Arcgis) and spatial statistical techniques (crime per Area) to analyse social crime density in Manipur's Central Valley (Imphal East, Imphal West, Thoubal, Kakching, and Bishnupur). Crime data, obtained from law enforcement agencies (NCRB and Superintendent of Police, Central district), are geo-coded and spatially analysed to identify social crime hotspots and spatial clusters central regions. The demography data have collected from Primary Census of Manipur, 2011. The primary data had collected from the field survey using personal observation and unstructured interview and discussion with the expert in the field. The social crime variable of the study includes Murder, attempt to commit murder, Culpable Homicide not amounting for murder, Rape, Kidnap and Abduction, Dacoity, Preparation and Assemble for Dacoity, Robbery, Burglary and Theft. The Other crime is the remaining IPC crime in the Indian Legal Code context (see Indian Penal Code by Mishra). The methodology utilised, in the present study is a modified statistical technique (weightage method) from population geography. The technique allows us to identify different IPC crime committed in a geographical space. The formula had given below:

$$\varnothing = \frac{c}{a}$$

Where, Ø = Crime Density; C = Number of IPC recorded in a region; A = Area of the region in per sq. km.

The Second Technique is the difference of the above weight age, density. The formula is express as:

$$Dd = S.C.D - O.C.D$$

Where Dd = Density difference; S.D.C = Social Crime Density; O.D.C = Other Crime Density.

Third technique is the calculation of the Correlation matrix. The three Crime Density, had further coded (X1, X2 and X3) to calculate the correlation matrix between the variables Crime Density (X1), Social Crime Density (X2), and Other Crime Density (X3). Then, the correlation coefficient between each pair of variables had computed using the Pearson correlation coefficient formula. This involves comparing each variable's data points to find how they vary together. Once we have the correlation coefficients for all pairs of variables, further arrange them in

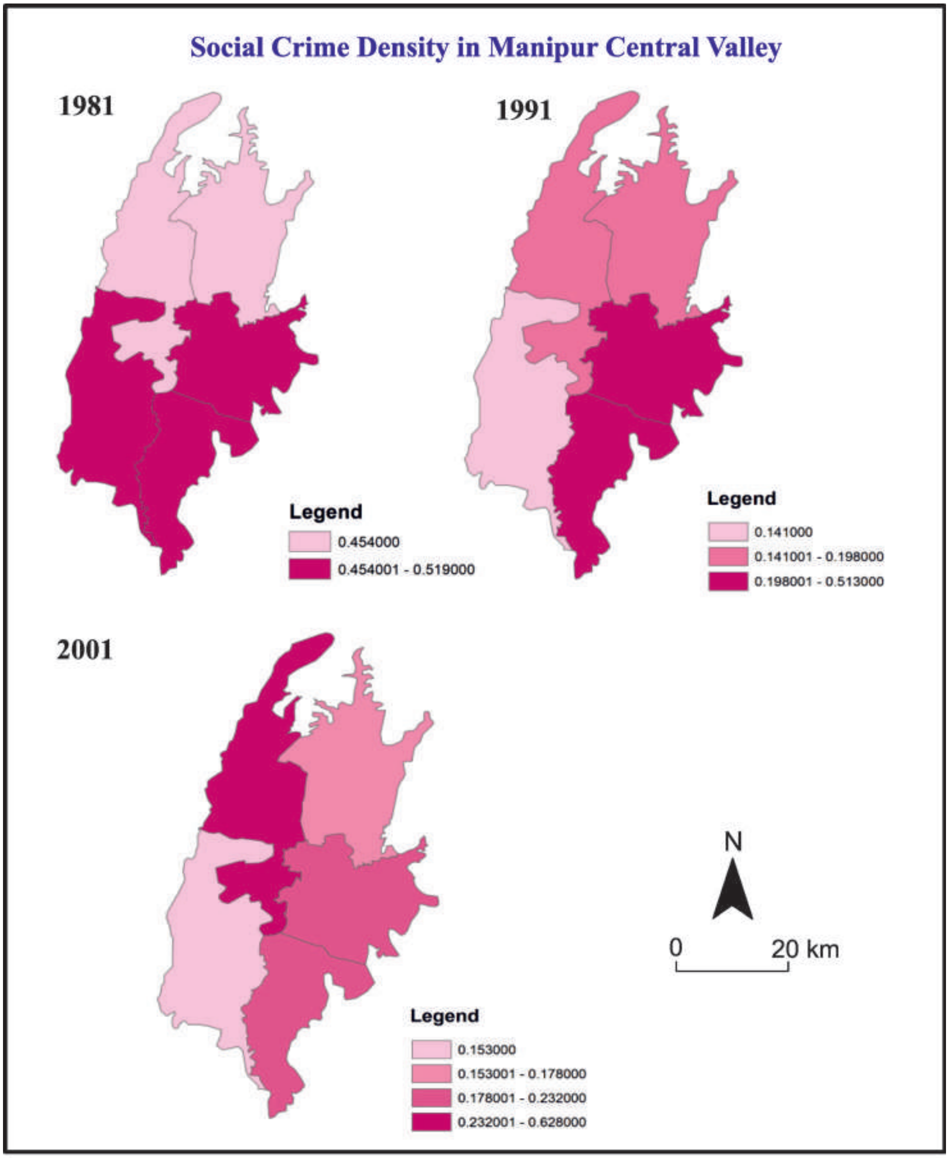

Social Crime Density in Manipur Central Valley
1981
Legend
0.454000
0.454001 - 0.519000
1991
Legend
0.141000
0.141001 - 0.198000
0.198001 - 0.513000
2001
Legend
0.153000
0.153001 - 0.178000
0.178001 - 0.232000
0.232001 - 0.628000
N
0
20 km

Fig. 1

a 3x3 matrix. Then each element in the matrix represents the correlation between two variables, with the diagonal elements being correlations between the same variable (which are always 1). The matrix will gives a comprehensive view of the relationships between the crime density indices. Statistical software, such as Excel and SPSS software had utilised to analyse and prepared the data for the Cartography of the Deviant Act (Crime) in the Manipur Central Valley.

Result and Discussion

The Social Crime Density (phi index) has calculated from the data (NCRB, 2021; Superintendent of Police, Central District, 2017) in the Table 1. The density per sq. km for the Social Crime was 0.55 in 1981, followed by 0.15 in 1991, 0.29 in 2001, 0.59 in 2011 and 0.50 in 2021 respectively. For the IPC crime density, the highest was record in 1981 (1.135) and lowest in 1991 (0.705) respectively, as shown in Table-1.

Table-1: Manipur Central Valley: Other Crime and Social Crime Density Index

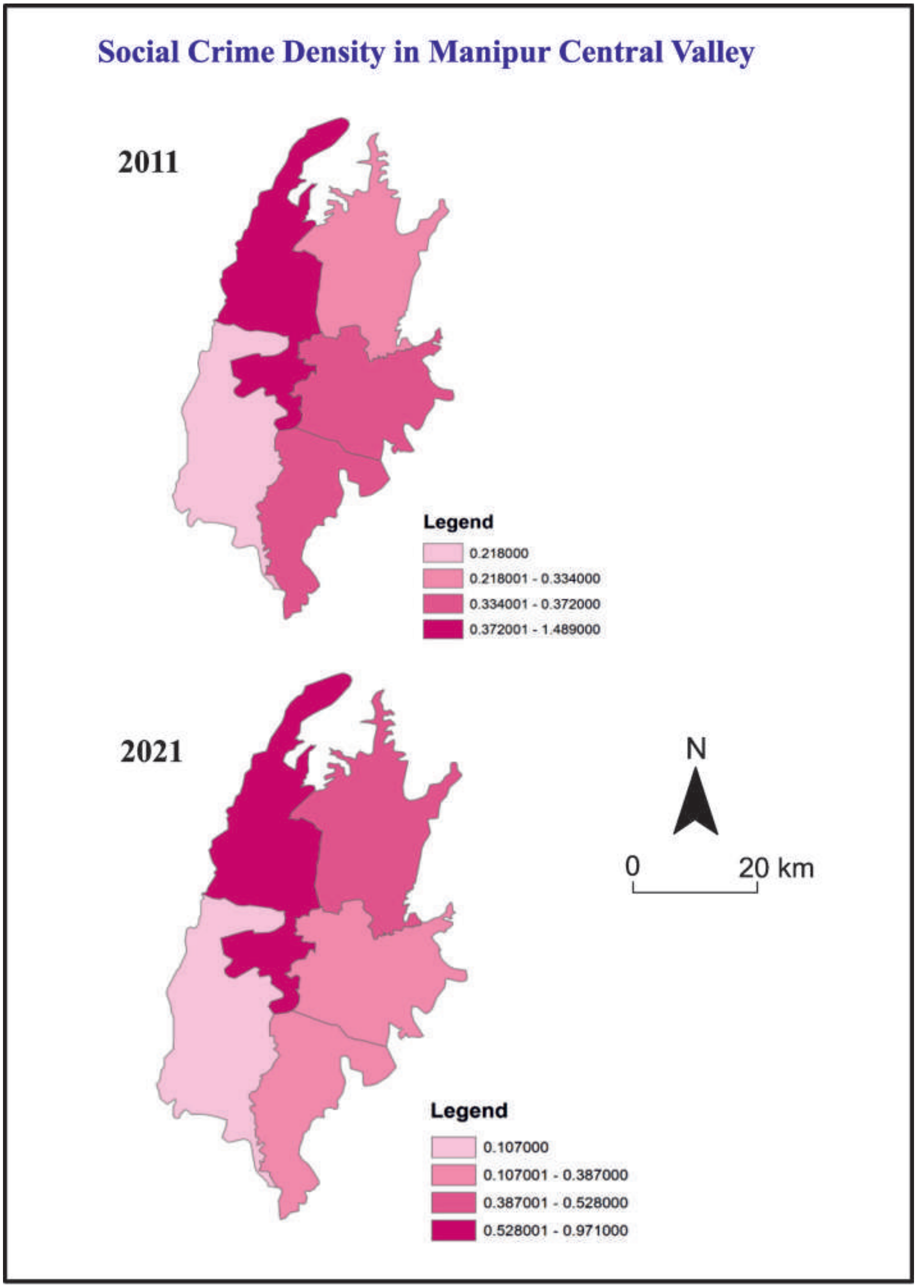
Year	Actual Crime	Social Crime	Area	Actual Crime Density index	Social crime Density index	Other crime Density index
1981	2540	1224	2238	1.135	0.55	0.585
1991	1577	329	2238	0.705	0.15	0.555
2001	2139	647	2238	0.956	0.29	0.666
2011	2079	1322	2238	0.929	0.59	0.339
2021	2130	1130	2238	0.952	0.50	0.452

Source: Calculated from NCRB and report from superintendent of Central Valley

The Other Crime is the remaining IPC, had calculated from the difference of Actual IPC and Social Crime (10 impactful crime in Manipur Central Valley) as shown in the Table1.

Density Difference Analysis

The difference of Social Crime and other crime will further provide the spatial pattern for the distribution of IPC in the Manipur Central Valley (Fig. 1). In three out of five decades, Social Crime is lower than Other Crime. This means that in the majority of the observations provided, the rate of Social Crimes is less than the rate of Other Crimes. Specifically, Social Crime rates fall below Other Crime rates in 60% of the cases. In two decade (2011-2021), Social Crime is higher than Other Crime.



Social Crime Density in Manipur Central Valley
2011
Legend
0.218000
0.218001 - 0.334000
0.334001 - 0.372000
0.372001 - 1.489000
2021
N
0
20 km
Legend
0.107000
0.107001 - 0.387000
0.387001 - 0.528000
0.528001 - 0.971000

Fig. 2

This indicates that in 40% of the observations, the rate of Social Crimes exceeds the rate of Other Crimes. It shows that while it is less common, there are notable occasions where Social Crimes are more prevalent than Other Crimes (NCRB, 2011). The observed differences between Social Crime and Other Crime vary significantly, from (-0.405 to 0.251) with the smallest difference being -0.405 (1991) and the largest being 0.251 (2011). This range highlights the variability in the relationship between these two types of crimes across different observations. The most significant negative difference is -0.405, indicating a much lower rate of Social Crime compared to Other Crime. The largest negative difference occurs in one of the observations where Social Crime is considerably lower than Other Crime. This analysis underscores the variability in the relationship between Social Crimes and Other Crimes, suggesting that the relative prevalence of these crime types can differ widely depending on the specific observation (Fig. 2).

Correlation Analysis

The correlation between the Crime Density had been provided in Table-2. The three Densities had further coded with X1, X2, and X3. From this Table-2, we can observed that here is a strong positive correlation (0.743) between the Actual Crime Density index (X1) and the Social Crime Density index (X2). This implies that areas with higher actual crime density tend to have higher social crime density.

Table-2: Correlation Matrix of Crime Density

	X1	X2	X3
X1	1	0.743465972	0.102524908
X2	0.743465972	1	-0.58902584
X3	0.102524908	-0.58902584	1

Note: X1=Actual Crime Density, X2=Social Crime Density and X3=Other Crime Density.

There is a very weak positive correlation (0.103) between the Actual Crime Density index (X1) and the Other Crime Density index (X3). This indicates that there is almost no linear relationship between actual crime density and other types of crime density. There is a negative correlation (-0.589) between the Social Crime Density index (X2) and the Other Crime Density index (X3). This suggests that areas with higher social crime density tend to have lower other crime density, and vice versa.

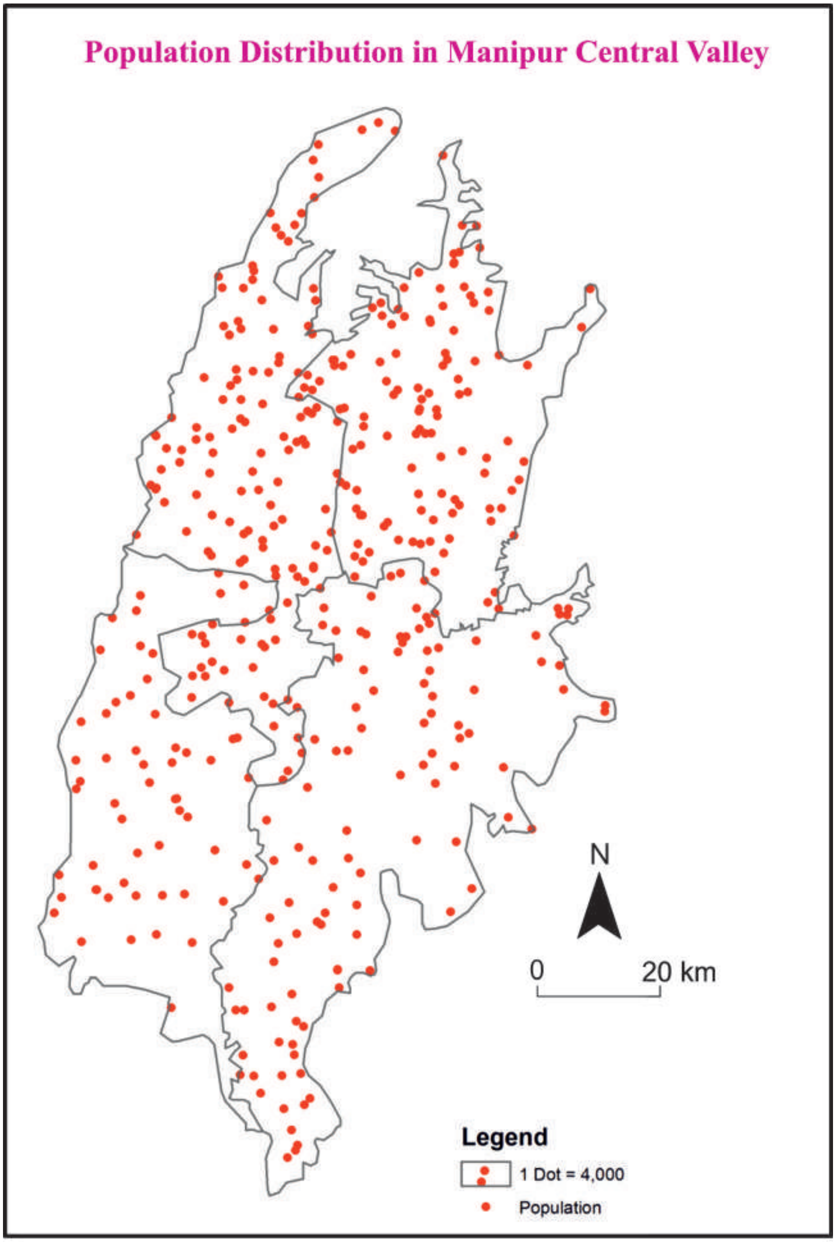

Population Distribution in Manipur Central Valley
N
0
20 km
Legend
1 Dot = 4,000
Population

Fig. 3

Spatio-temporal Pattern of Social Crime Density

The spatio-temporal distribution of social crime density in the districts of the Manipur Central Valley reveals a dynamic and non-uniform pattern over the years (Fig. 1). In 1981, the crime density in the Imphal region and other districts (Thoubal including Kakching and Bishnupur) exhibited relatively similar levels, with Imphal region's density at 0.45 (lower) and the other valley districts at 0.51 (higher). Moving to 1991, Bishnupur district showed a decrease in crime density to 0.141, lower than the total valley. However, the overall crime density for the valley decreased to 0.258 with Thoubal (including Kakcing) being highest (0.519) and Imphal Region, Imphal East and Imphal West (0.198). By 2001, Imphal West emerged with the highest crime density at 0.628, contrasting with Bishnupur lowest density of 0.153. Despite the decrease in overall valley crime density since 1991, significant variations persisted across districts. In 2011, Imphal West stood out with a notably higher social crime density of 1.489 compared to other districts. Bishnupur and Thoubal (Kakching included) witnessed increases in social crime density, while Imphal East showed a moderate rise to 0.334. The total valley's social crime density increased primarily due to a substantial surge in Imphal West. Moving to 2021, Imphal West retained its position with the highest social crime density of 0.97, while Bishnupur and Thoubal maintained moderate levels at 0.11 and 0.39, respectively.

The total valley's social crime density remained relatively stable compared to 2011, with Imphal West still significantly contributing to the overall figures. Overall, these observations underscore the spatial and temporal dynamics of social crime distribution in the Manipur Central Valley, highlighting the need for targeted interventions tailored to the specific challenges and trends observed in each district (Fig. 2 and 3). The data shows a fluctuating yet generally increasing trend in both IPC (Indian Penal Code) crime density and social crime density over the decades. This trend suggests a rising challenge in managing and preventing these types of crimes. The spatio-temporal distribution indicates varying levels of crime density across different districts and years. Certain areas, like Imphal West (most urbanised region of Manipur), consistently exhibit higher crime rates, indicating potential hotspots requiring focused attention and intervention. Durkheim's concept of anomie refers to a state of normlessness or breakdown of social bonds within society. Fluctuating crime trends and persistent hotspots in the Manipur Central Valley may indicate varying levels of social integration across different districts. High crime rates, particularly in areas like Imphal West, could reflect underlying social disintegration or weakened collective consciousness (Durkheim, Émile, 1951). Rapid social change and economic disparities can contribute to crime by disrupting social cohesion. The following are some of the result for the decline in social integration.

Urbanization and Crime

Urbanization is a significant driver of crime in Manipur, particularly in the Central Valley region, where the majority of towns are concentrated. With 42 out of 51 towns located in the Central Valley, urbanization rates are notably high, especially in districts like Imphal East and Imphal. These districts, with 15 and 13 towns respectively, exhibit rapid urban growth, which can exacerbate social crime density (Bhattacharyya, N.N, 2006). However, the morphology of town classification in Manipur had solely based upon the population concentration in a region. One of the primary challenges associated with urbanization is overcrowding (Fig.2, the map is based on the 2011 census; Kakching included in Thoubal). As urban areas become increasingly populated, the density of people living in close proximity rises, creating fertile ground for criminal activities. Overcrowded neighbourhoods often lack adequate resources and infrastructure, (Bhattacharyya, N.N, 2006) leading to increased competition for limited resources and heightened social tensions, which can manifest in various forms of crime (Nickerson, 2023). Moreover, urbanization often exacerbates economic disparities within communities. While cities may offer opportunities for economic advancement, they also widen the gap between the wealthy and the marginalized (David, Harvey, 1973). Economic inequality can breed resentment and disillusionment among disadvantaged populations, increasing the likelihood of engaging in criminal behaviour as a means of survival or protest against perceived injustices (David, Harvey, 1973). Additionally, the rapid pace of urbanization can lead to the breakdown of traditional community structures and social norms. As people migrate from rural areas to cities in search of employment and better living conditions, they often leave behind established social networks and support systems. This fragmentation of community bonds can create feelings of alienation and isolation, making individuals more susceptible to criminal influences and less inclined to uphold societal norms (Durkheim, Émile, 1951). Common crimes associated with urbanization include theft, robbery, burglary, and vandalism, which thrive in environments where opportunities for illicit gain abound. The anonymity afforded by densely populated urban areas (Fig.2), coupled with the transient nature of urban populations, further complicates crime prevention effort and makes it easier for offenders to evade justice (Durkheim, Émile, 1951).

Social Instability and Unemployment

Social instability and unemployment are significant factors contributing to social crime in Manipur's Central Valley. These socio-economic challenges disrupt traditional community bonds and social norms, leading to a breakdown in social cohesion and an increase in various forms of criminal activities (Durkheim, Émile, 1951). Unemployment, in particular, is a pervasive issue in the region, with a significant portion of the population lacking access to stable employment opportunities. The lack of viable employment options leaves many individuals economically marginalized and vulnerable, led to engaging in criminal activities as a means of survival. Moreover, unemployment exacerbates feelings of frustration, disillusionment, and hopelessness among the youth population, making them susceptible to recruitment by criminal gangs or insurgent groups (Durkheim, Émile, 1951). Social instability, fuelled by factors such as political unrest, ethnic tensions, and corruption, further exacerbates the problem of social crime. Instability erodes trust in government institutions and undermines the rule of law, creating an environment conducive to criminal behaviour (David, Harvey, 1973). In such a volatile climate, criminal elements exploit the prevailing uncertainty and insecurity to engage in activities such as abduction, extortion, and gang robbery, destabilizing communities and instilling fear among the populace (Nickerson, 2023). Additionally, other forms of violence, including domestic violence, communal clashes, and politically motivated crimes, had exacerbated by social instability and unemployment. Disenfranchised individuals, frustrated by their socio-economic circumstances, may resort to violence as a means of expressing their grievances or asserting control over their surroundings.

Impact of Indo-Myanmar Border Agreement

The signing of the Indo-Myanmar Border agreement in 1994 had a profound impact on the social crime dynamics in Manipur's Central Valley. This agreement, aimed at regulating cross-border activities between India and Myanmar, inadvertently contributed to an escalation in social crimes in subsequent years. One significant consequence of the border agreement was the increased sensitivity to smuggling activities along the porous border between Manipur and Myanmar. The relaxed border controls and porous nature of the Indo-Myanmar border facilitated the smuggling of various illicit goods, including drugs, arms, and contraband, into the region (Bhattacharyya, N.N, 2006). The influx of these illegal commodities fuelled existing social problems such as substance abuse, organized crime, and violent conflicts, leading to a surge in social crime rates. The availability of illicit goods, particularly narcotics like heroin, brown sugar, and pharmaceuticals, exacerbated substance abuse issues within the community. Drug trafficking networks flourished along the border, exploiting the porous boundaries to smuggle drugs into Manipur's Central Valley, in North AOC and Chingmeirong region (is a red light region of Manipur, where the news of prostitution is widely heard) of Valley. Further, the cultivation of Poppy as a lively source and income in the Hill region also add fuel in the burning flame. Substance abuse, in turn, contributed to a range of social crimes, including theft, robbery, assault, and even homicide, as individuals resorted to criminal activities to fund their addiction or settle disputes related to drug deals (Devi, Phurailatpam Keny, 2022b). Furthermore, the influx of illegal arms and ammunition through the Indo-Myanmar border fuelled the proliferation of armed groups and insurgent activities in the region (Angam et al., 2005). The presence of armed factions for control over territory and resources led to heightened levels of violence and instability, contributing to a climate of fear and lawlessness. This environment provided fertile ground for various social crimes, including extortion, kidnapping, and acts of terrorism, perpetrated by certain groups and criminal syndicates operating along the border (Hill region). The abrupt rise in social crime observed in 2011 and 2021 had attributed, at least in part, to the cumulative effects of increased smuggling activities and the proliferation of illicit goods following the Indo-Myanmar Border agreement. The porous nature of the border, coupled with inadequate border surveillance and enforcement measures, facilitated the unchecked flow of contraband into Manipur's Central Valley, exacerbating social tensions and crime rates.

Poverty and Prostitution

Poverty serves as a potent catalyst for prostitution in Manipur's Central Valley, compelling vulnerable women, particularly widows or divorced individuals, to engage in sex work as a means of economic survival. The region grapples with pervasive poverty, exacerbated by factors such as limited employment opportunities, inadequate social welfare programs, and economic disparities (Merton, 1967). As a result, marginalized women find themselves trapped in cycles of poverty with few viable alternatives for earning a livelihood. Engaging in sex work exposes these women to various forms of exploitation, coercion, and violence. They are often subject to physical and sexual abuse by clients, pimps, or brothel owners who exploit their vulnerable positions. Moreover, the clandestine nature of the sex trade leaves them susceptible to manipulation and coercion by criminal syndicates and human traffickers, further exacerbating their vulnerability (Devi, Phurailatpam Keny, 2022a). In addition to the immediate dangers posed by prostitution, these women also, face long-term health risks, including the transmission of sexually transmitted infections (STIs) such as HIV/AIDS. The lack of access to healthcare services and protective measures further compounds their vulnerability to these diseases, placing their health and well-being at grave risk (Devi, Phurailatpam Keny, 2022a).

Youth Vulnerability and Juvenile Delinquency

Impact of Social Disorganization, the breakdown of traditional social structures in urban areas can lead to personal disorganization among youth, increasing the likelihood of juvenile delinquency. Factors such as easy access to drugs and lack of opportunities for education or employment can further exacerbate this issue (Devi, Phurailatpam Keny, 2022b). Dr. Angam in his investigation of the " Homicide fatal firearm injuries" suggested that, most of the victim of Homicide victim brought to JNIMS hospital were at age of 21-41, which are mostly unemployed and related to Insurgency group (Angam et al., 2005). Looking from Socio-political view, urbanisation highlights the impact of rapid socio-spatial changes on patterns of violence. Imphal evolving urban landscape, characterized by socio-political tensions and economic disparities, may manifest in forms of spatial fragmentation and social polarization (David, Harvey, 1973). The concept of spatial justice (fairness and equity in the distribution of space) underscores the role of power relations (Government authority, Corporation and other influential group) in shaping spatial practices (urban planning, housing policies, and the allocation of public services.) and producing uneven geographies of violence (Social Crime) in the Manipur Central Valley (Soja, E. W, 2013). The detailed district wise analysis highlights the importance of targeted interventions tailored to specific challenges in each area. By focusing resources and strategies on high-crime regions like Imphal West, authorities can effectively address local crime issues. The availability of detailed historical data allows policymakers to formulate evidence-based strategies. Understanding the changing dynamics of crime density helps in developing proactive measures to prevent crime and improve public safety. Increased awareness and participation from local communities can supplement law enforcement efforts and contribute to crime prevention. By working together and pooling resources, agencies can implement more comprehensive and coordinated strategies.

Conclusion

In conclusion, the analysis of the spatio-temporal distribution of social crime density in the central place of the Manipur Central Valley reveals a nuanced picture of crime dynamics over the years. Several key findings emerge. The distribution of social crime density across districts is not uniform, with significant variations observed both spatially and temporally. Over the decades, there have been fluctuations in social crime density. However, these trends are not consistent across all districts. Imphal West consistently stands out with notably higher social crime density, while Bishnupur and Thoubal tend to maintain moderate levels. The findings suggest the need for tailored interventions that take into account the unique socio-economic, cultural, and geographical characteristics of each central place of Manipur. Targeted strategies should address specific challenges and trends observed within each locality. Given the dynamic nature of social crime distribution, continued monitoring and analysis are essential for identifying emerging trends and evaluating the effectiveness of intervention efforts. Addressing social crime requires a collaborative approach involving government agencies, law enforcement, community organizations, and other stakeholders working together to implement comprehensive and sustainable solutions.

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AN ASSESSMENT OF SOIL AND AGRICULTURAL LANDUSE IN SHAHJAHANPUR DISTRICT, UTTAR PRADESH

Urvashi and Dr. Shri Prakash Asthana

Abstract

Soil is the one of the most important determinants of Agriculture land use in the district. An assessment of spatial distribution of soil helps to determine the type of agricultural land use in a district. Agricultural land use assessment is a prerequisite for effective planning and development in a region. Shahjahanpur district of Uttar Pradesh has Gross Sown Area occupying 607012 hectares and Net sown area occupying 364614 hectares of its total geographical area of 437469 hectares, (138.76% and 83.35% area respectively). Therefore, predominance of agriculture is evident here. It is hence vital to assess the agricultural land use in the district to maximize the resource value of land and to minimize competition and conflicts that have arisen due to immense pressures on land. The objective of this study is to study the soil types and their distribution in the district. The Agricultural Land Use Pattern at the block level in the district has been assessed, the Trends of Change in Agriculture Land Use in the district over the past two decades has been studied and an estimate of the available cultivated land in the district for future decades has been calculated. The variation and distribution in various land use categories in each block has been discussed and reasons identified. The methodology involves information derived from secondary sources published like Government reports, books and research papers, using quantitative methods and qualitative analysis. Reasons like changes in agriculture techniques, development of efficient irrigation systems, soil reclamation practices along with scientific, technological, social and economic transformation have been identified as major factors influencing Agriculture Land Use Change in the district. Suggestions have been provided to ensure that Agriculture Land Use is economic and environmentally sustainable for the region.

Introduction

According to Soil Science Society of America Soil refers to the unconsolidated mineral or organic material on the immediate surface of the Earth that serves as a natural medium for the growth of land plant. It reflects the effects of genetic and environmental factors such as climate, macro- and microorganisms, modified by relief, acting on parent material over a period of time. Soil makes up the top surface of the land surface i.e. the weathered material (sand, silt, clay and organic material) above the rock layer. Soil Characteristics are a major determinant of Land use in any area. As per Agriculture Survey, 2014-15 of Agriculture Department of Uttar Pradesh approximately 165.98 lakh (68.7%) land is used for cultivation in Uttar Pradesh. The district Shahjahanpur has Gross Sown Area of 607012 hectares and Net Sown Area of 364614 hectares which is 138.76% and 83.35 percent respectively of the total geographical area of 437469 hectares of the district (Source: District Statistical Bulletin 2020).Taking account of the magnitude of agricultural predominance in the district it is appropriate to assess and evaluate the soil characterstics and land use here. The complexity of land-use systems calls for multidisciplinary analyses (Clayton and Radcliffe, 1996). Initial efforts aimed at modelling land-use change have focussed primarily on biophysical attributes (e.g. altitude, slope or soil type), given the good availability of such data. Incorporation of data on a wide range of socio-economic drivers of change is however required (Turner et al., 1995; Musters et al., 1998; Wilbanks and Kates, 1999). The United Nations Development Programme (UNDP) document on Sustainable Development Goals (SDG) envisions in SDG 2 to "End hunger, achieve food security and improve nutrition and promote sustainable agriculture" and chapter 14 of Agenda 21 of United Nations Earth Summit has highlighted the importance of land resource management in ensuring food security. The ever increasing human needs and economic activities are causing immense pressures on land resources. There is competition and conflict leading to sub optimal use of resources. In this aspect, by examining land use in an integrated manner it is possible to minimise conflicts and ensure most efficient trade-off. Effective soil and land management practices will have far reaching consequences in reducing the consumption of resource-intensive products and increasing the productivity of land, making it possible to ensure sustainable agriculture in the district.

Study Region

Shahjahanpur district lies between 23º 37' and 28º 20' North latitude; 79º 37' and 80º 23' East longitude. It is bordered by Pilibhit district in the North, Lakhimpur-Kheri on East, Hardoi and Farrukhabad towards the South and Bareilly and Budaun to the West. The physiographic divisions include Ganga Khadar (Jalalabad Tehsil) Ram Ganga flood plain (Tilhar, Shahjahanpur Tahsil), Shahjahanpur plain (Shahjahanpur, Powayan and Tilhar tehsils) Gomti basin (major part of Powayan tahsil).

The Ganga Khadar is situated along river Ganga, along the boundary line of the district. Ram-Ganga flood plains have Ramganga, Baghul, Andhoi, Aril rivers. Patches of 'Bhur' occur along Ramganga. Shahjahanpur plains occupy Central part of the district. Deoha is the main stream. Khanaut, East Baghul, and Garai are the streams. General slope of land is southwards. Natural levees and eroded surface occur as main physical features. Gomti basin forms Eastern Shahjahanpur district. Gomti and its tributaries like Basna, Jokai, Bhainsi, Kathna and Ul. The slope of land is towards South East. Alluvium and Dun gravel formations exist. The main crops of district are in the form of Kharif, Rabi and Zaid. Rice, Wheat, Barley, Jowar, Bajra and Maize are the primary cereals. Pulses include urad, moong, masoor and arhar. Oilseeds includes mustard, til, groundnut. Cash crops include sugarcane, tobacco, oilseeds, fodder and potatoes etc. There are five kinds of land holdings viz- marginal (size is less than 0.50 hectares), small (size is from 1 to 2 hectares) Semi medium (size is 2 to 4 hectares) Medium (size is 4 to 10 hectares) and Large (size is above 10 hectares). Animal husbandry plays an important role in the economy of farmers. Livestocks like cattle buffalo, sheep, goat’s pigs, poultry are reared. Animal husbandry is a source of additional income, alternative employment, food, social security and organic manure for the farmers. Veterinary hospitals, animal development centres, artificial insemination centres, sheep development centres, piggery development centres ensure healthy livestock There are four tahsils namely- Shahjahanpur, Powayan, Tilhar and Jalalabad and 15 Community Development Blocks namely Banda, Khutar, Powayan, Sindhauli, Khudaganj (Katra), Jaitipur, Tilhar, Nigohi, Kanth, Dadrol, Bhawalkhera, Kalan, Mirzapur, Jalalabad, Madnapur.

Objectives

(1) To study the soil types and their distribution in the district.
(2) To find the land use pattern in the study area and to provide an estimate of cultivated land for the future.

Database and Methodology

The present study attempts to use quantitative and qualitative analysis based on Primary and Secondary sources of data. Soil Characterstics have been identified by using data from Krishi Vigyan Kendra and resources from the internet. The time period of 2018-19 has been used for assessing the land use pattern at block level. The Changes in land use are assessed during the decades 1999-‘00 to 2008-09 and 2008-09 to 2018-19. The data has been taken from secondary sources of information.

The Shahjahanpur District Statistical Bulletins of the research study period has been analysed. Sources like Census of India. Different Journals, Magazines and Books have also been studied. Research papers based on similar works have been studied to ensure precise and accurate studies. Maps have been formulated. The use of mathematical calculations for quantitative analysis has been done. Analysis of data and explanation has formed the basis of qualitative study.

Result and Discussion

Soil Types

Although clay and sandy soil dominate the region however going to variation in physiography the composition of soil varies in the region the soils in the district can be divided into 3 major categories: 1) Domat clayey soil 2) Clayey Soil 3) Sandy soil. However, owing to variation in composition of moisture, nutrients and influence of local geographical conditions and prolonged anthropogenic interventions (leading to modifications in soil properties) the district has the following soil types in totality

(a) Clayey or "Matiyar" Soil- This soil is found in those parts of the district which have excess moisture and poor drainage that causes waterlogging. This soil has less sand (about 40%) and more clay (about 60%). It is found in Jalalabad, Kalan, Mirzapur Blocks. In Shahjahanpur, Powayan and Banda Block. It is found in the water logged lower parts. This soil develops cracks in summer seasons. Nitrogen content is very high in this soil. The soil is extremely beneficial for agriculture. It is locally known as "Jhabar" or "Dhankand".

(b) Domat Soil- This type of soil extends in the north eastern part of Gomti River Nigohi, Tilhar, Powayan etc. have this soil. It is light brown in colour and is very useful for agriculture. Sufficient irrigation facilities used on this soil has improved sugarcane and wheat production in the region.

(c) Clayey Domat- The soil extends in Banda, Tilhar, Khutar, Sindhauli, Shahjahanpur and Nigohi development blocks in the district. This soil has more than 50 % of clay and less phosphorus and nitrogen. Paddy potato which sugarcane etc are grown using irrigation in the soil region.

(d) Sandy Domat- Sandy Domat has 14 to 29% of sand and 40-45% of nitrogen. Sugarcane, groundnut, Arhar, Mustard, Jowar and Bajra are grown here. Nigohi, Jalalabad, Kanth and Tilhar block have predominance of the soil.

(e) Saline alkaline Soil- In the absence of adequate drainage facility various types of salts accumulate in the region. This gives rise to saline alkaline soil.

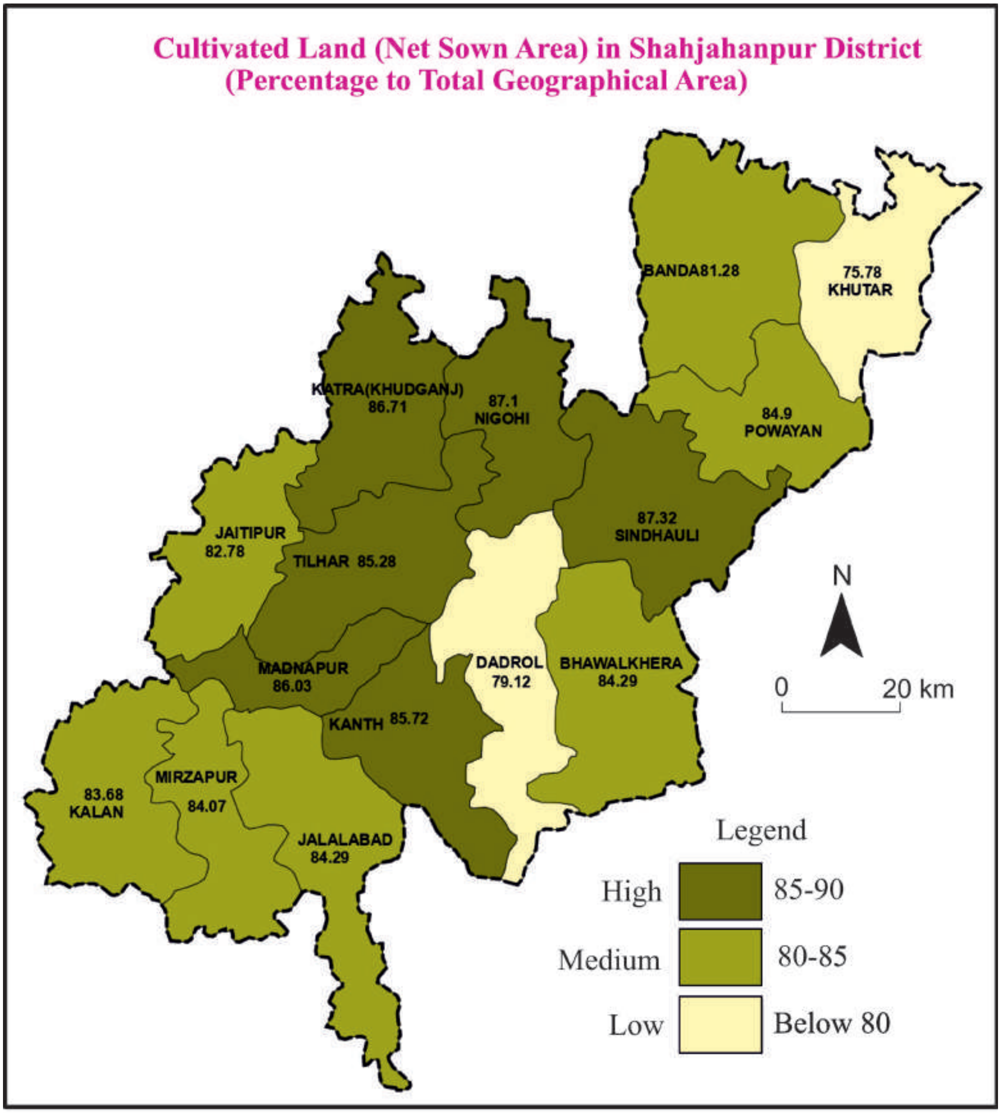
Cultivated Land (Net Sown Area) in Shahjahanpur District
(Percentage to Total Geographical Area)
BANDA81.28
75.78
KHUTAR
KATRA(KHUDGANJ)
86.71
87.1
NIGOHI
84.9
POWAYAN
87.32
SINDHAULI
JAITIPUR
82.78
TILHAR 85.28
N
MADNAPUR
86.03
DADROL
79.12
BHAWALKHERA
84.29
0
20 km
KANTH 85.72
MIRZAPUR
84.07
83.68
KALAN
JALALABAD
84.29
Legend
High
85-90
Medium
80-85
Low
Below 80

Fig. 1

It has magnesium, calcium chloride and sodium salts. It is unfit for agriculture and is locally called as "Reh" or "usar". The extent of this soil is very limited in district. It is found in Mirzapur and Jalalabad blocks.

(f) Sandy Soil- This soil is found along the banks of the rivers which are frequently flood prone. Jalalabad, Banda, Tilhar, Katra, Powayan blocks have this soil. In the new alluvium or khadar regions it is often also referred to as "Kachchari" soil.

That Fertility of the soil determinants its productivity. Dependent on the type of nutrients and minerals present in the soil. The major nutrients in the soil are Nitrogen(N), Potassium (P), Phosphate (K), these nutrients affect the per hectare production of the crops. On analysing the fertility level of soils based on Information obtained from Soil Testing Labs at Krishi Vigyan Kendra (KVK) in the district it is found that the blocks have deficiency of Nitrogen. Except Bhawalkhera, Sindhauli, Khudaganj Katra all the other blocks have moderate level of Phosphate. Banda, Jalalabad, Sindhauli, Kalan, Powayan, Mirzapur, Khutar have low level of potash while remaining blocks have very low level of Potash. The above description clearly conveys that deficiency of Nitrogen and Potash exist in the district. In order to increase fertility of the soil organic manure should be used.

Agricultural Landuse

Scholars like Pandey and Tiwari (1987), have studied land use dynamics in Uttar Pradesh with respect to ecological implication. Regional agricultural land use across various states of India has been studied by Pandey V.K. & Tiwari, S.K. (1996). Nandkarni & Deshpande (1979) have studied the trends of underutilisation of land in India between 1960-1961 and 1970-71, also taking into account the drought year of 1972-73. Pandey and Ranganathan (2018) studied inter-sectoral changes in land use between 1950-51 to 2011-12. They found that there was an increasing shift in land use pattern towards non-agricultural activities, with ecological implications for the same. Prem Kumar& Seema (2013) study changes in agriculture land use such as Net sown area in Karnataka and India between 1991 and 2010-11. Laxmi et al (2015) used Markov chain analysis to study land use changes in Dharwad district of Karnataka. (Adhikari and Sekhon (2014) studied land use trends in Punjab using compound growth rate for 30 years from 1980-81 to 2009- 10. Singh and Singh (2019) found that area under non-agricultural uses continues to increase at an increasing rate since 1990s in Punjab (Fig. 1 and 2). The studies of land use in an area provide accurate knowledge of land utilisation and that helps in making Future Plans (Edwards C.J.W., 1967). The nature of land utilisation in a

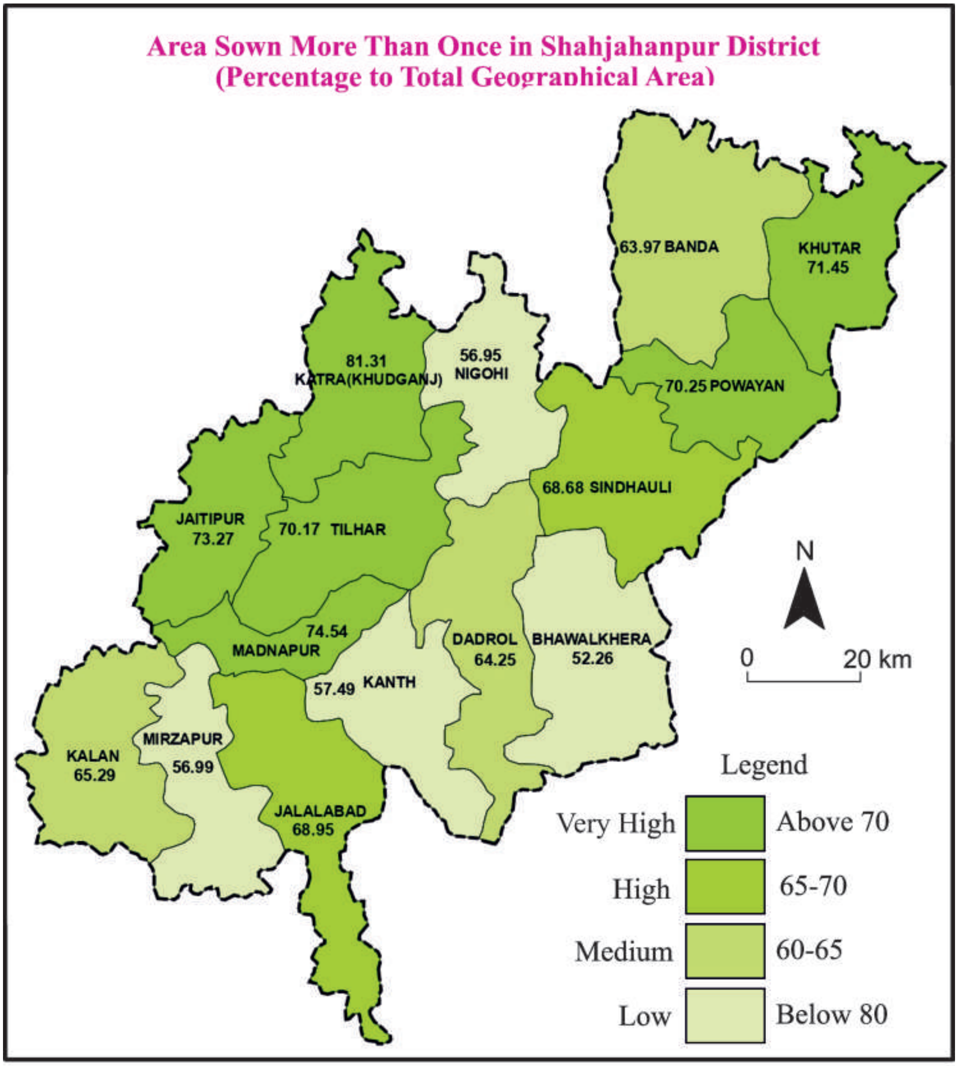
Area Sown More Than Once in Shahjahanpur District
(Percentage to Total Geographical Area)
63.97 BANDA
KHUTAR
71.45
81.31
KATRA(KHUDGANJ)
56.95
NIGOHI
70.25 POWAYAN
68.68 SINDHAULI
JAITIPUR
73.27
70.17 TILHAR
74.54
MADNAPUR
DADROL
64.25
BHAWALKHERA
52.26
57.49 KANTH
KALAN
65.29
MIRZAPUR
56.99
JALALABAD
68.95
N
0
20 km
Legend
Very High
Above 70
High
65-70
Medium
60-65
Low
Below 80

Fig. 2

region is influenced by physical factors like relief and physiography, soil properties such as nutrient content, texture, structure, porosity, density, stability etc. as well as socio-economic factors. The Agricultural land use in district shows variation at the block level depending upon the prevailing local geography as socio-economic compulsions. However, the major factor responsible for the pattern of land use is an inclination towards maximizing the available land area to ensure that the net sown area reaches its full potential. The land use in the district (1999-2019) does not exhibit any definite pattern. Out of the total 437469 hectares Geographical area, 364614 hectares is occupied by cultivated land, 14927 hectares by cultivable and 47430 hectares by uncultivable land in 2018-19 crop year the land use categories have been discussed separately in the following pages (Table-1.)

Uncultivable Land

47430 hectares (10.84%) land of the district is uncultivable which includes usar and uncultivable land (5333 hectares) and land put to non-agricultural use (42097 hectares). It has been observed that block Dadrol covers the maximum uncultivable area (15.53%) while block Khutar occupies the minimum (0.08 percent). Major portion of the district in 13 blocks possess 10-15% uncultivable area scattered throughout it. Two blocks Banda (7.89%) and Khutar (0.08%) have exceptionally low percentage of uncultivable land. Since this region has more dependence on cultivation than others.

Cultivable Land

This category of land use covers 14927 hectares (3.41%) of the total geographical area consisting land under trees, groves and orchards (2461 hectares) permanent pastures (1050 hectares) fallow (old and new, 9182 hectares) and cultivable waste (2234 hectares) Block wise percentage of cultivable land is highest at Jaitipur (5.34%) and least at Banda (1.3%). The present state of cultivable land is attributed to good irrigational facilities. Area under fallow land is highest in Jaitipur (1085 hectares). This block has land under current fallow (0.19%) far greater than land under other fallow (0.06 percent). Blocks of Dadrol, Kalan, Mirzapur, Jalalabad have fallow land spreading over 800 hectares. Khutar with fallow land spread in 260 hectares has the least area while blocks of Powayan, Banda, Sindhauli, Nigohi, Tilhar, Kanth, Bhawalkhera, Madnapur have fallow land spread in area ranging between 350-686 hectares. Pastures predominate Kanth followed by Dadrol and Bhawalkhera (117-130 hectares).Tilhar has the least area under pastures(25 hectares) followed by Jaitipur (27 hectares) The remaining blocks have pastures spread in area ranging between 36 to 96 hectares. Area under Bush forest and garden has the highest share in Powayan Block with (718 hectares) while Katra (35 hectares) has the least area under this category. Jatipur, Tilhar, Nigohi have Bush, forest and garden spread in area ranging between 35 to 74 hectares. The remaining ten blocks have this share in 130-170 hectares. Spatially block Kalan (298 hectares) and blocks Sindhauli (284 hectares) have maximum area under barren cultivable waste while block Katra (63 hectares) has minimum area under Barren cultivable waste. Blocks of Dadrol (232 hectares), Kanth (189 hectares), Jalalabad (156 hectares) Bhawalkhera(171hectares),Khutar(125 hectares),Tilhar(113 hectares),Powayan(107 hectares) have Barren cultivable waste in an aerial extent of over 100 hectares. While the remaining blocks have Barren cultivable waste spread over an area of 60 to 96 hectares.

Net Sown Area

83.35% of the geographical area in the district is occupied by cultivated land. Blocks of Sindhauli (87.32%), Nigohi (87.10%), Katra (86.11%), Madnapur (86.03%), Kanth (85.72%), Tilhar (85.28%), Powayan (84.90%), Bhawalkhera (84.29%), Jalalabad (84.29%), Mirzapur, Kalan (83.68%) have higher percentage share of cultivated land more than the district percentage, While Blocks of Jaitipur (82.78%), Banda (81.28%), Dadrol (79.12%) and Khutar (75.78%) have share lesser than the district percentage. It is notable that the patches of lowest share of cultivated land (below 84%), coincide with highest share of cultivable land. Such coincidence is found in blocks of Kalan, Jaitipur, Dadrol, Mirzapur, Jalalabad, Bhawalkhera and Powayan. On the other hand, the highest share of cultivated land (more than 85%), occurs in Block with lowest share of cultivable land. These include Sindhauli, Nigohi, Katra, Madnapur, Kanth, Tilhar. (Fig.1)

Area Sown More Than Once

Area sown more than once has increased by 17.34% in the first decade while decreased by 7.48% in the second decade. The increase in share of areas sown more than once by 8.5% in the two decades is attributed to Agricultural Innovation and Technological advancements in the district. Agriculture innovation such as improvement in crop varieties with early maturing varieties of crops being preferred to medium or late maturing varieties, use of mechanization in production and harvesting phase has shortened the duration of crop cycle and the entire agriculture process. Thus, the available land can be sown multiple times, therefore increasing area sown more than once in an agricultural year (Fig. 2).

Changes in Landuse Pattern

Landuse changes represent the human adaptability to the physical, economic, technological, and institutional transformation (Venkataramanan L.S and Prahaladchar, M. 1978). Within last 20 years the changes in land use pattern have exhibited fluctuating trend in the study area as seen in Table 2 of the following sections. The uncultivable land has increased 1.12% between 1999-2009 and by 0.11% between 2009-2019. There has been an overall increase in uncultivable land by 1.23% during the two decades. The total uncultivable land in the first decade was spread in 46855 hectares which increase to 47430 hectares in the second decade. The change in availability of uncultivable land is attributed to changes in usar and uncultivable land as well as utilisation of land in non- agricultural activities. It is noteworthy that during the two decades there has been a substantial decrease in usar and uncultivable land. This category of land decreased by 7.24% in the first decade and by 24.1% in the second decade. The overall decrease in usar and uncultivable land was by 29.5% in the two decades (1999-2019). District Shahjahanpur has witnessed increasing efforts towards reclamation of usar and uncultivable land. There has been a continued increase in the share of land put to non-agricultural use. This share increased by 2.73% in the first decade and by 4.32% in the next decade.

There is an overall increase by 7.16% between 1999 to 2019. This increase in the share of land put to non-agriculture used is attributed to increasing urbanization in the district marked by construction of concrete structures, building and roads as well as modern day infrastructure. The share of cultivable land has decreased by 18.47% in the first decade and by 48.90% in the following decade. There has been a significant decrease in the share of barren uncultivable wasteland by 51.67% between 1999 to 2019, as the share of cultivable land has decreased to 14927 hectares in the year 2018-2019 from 35824 hectares in the year 1999-2000. The change in cultivable land is attributed to changes in share of area under Bush, forest and garden pastures, fallow land and Barren cultivable waste in the two decades. It is noteworthy that the district has witnessed an increase in the share of pastures consistently from 953 hectares in the year 1999-2000 to 1050 hectares in the year 2018-2019 showing an overall increase of 0.63% in the first decade and 9.49% in the second decade. There was an increase of 10.12% in the share of pastures in the two decades. This trend of increase in land and the pastures has been a result of improved land and water management practices wherein improved irrigational facilities have enhanced land productivity and hence the uncultivated and usar land has gradually been converted to pastures which are the most suitable land usage activities for reclamation of barren usar land. Area under Bush, Forest and Garden has decreased by 40.88% from 4163 hectares to 22461 hectares in the two decades. Decline is reflected as decrease by 11.87% in the first decade and by 32.92% in the following decade. Increase in the demand for fuel and building material may be the reason behind for this decline. There has been a decrease in share of area under fallow land from 26086 hectares in the year 1999-2000 to 9182 hectares in 2018-2019. This has followed a trend of decrease of 20.48% in the first decade and a decrease of 55.74% in the following decade with an overall decrease of 64.80% in the two decades. This reduction in the share of fallow land is attributed to increasing inclination of population towards agricultural activities and development works. The increase in population in the district and their associated needs for sustenance has led to more intense use of available land resources thus leaving land as fallow has been unfeasible. Area under Barren cultivable waste has reduced by almost half (51.67%) during the two decades from 4622 hectares in 1999-2000 to 2234 hectares in 2018-2019.The trend of reduction has been in the form of decrease of 16.98% in the first decade and 41.78% in the subsequent decade. This indicates towards more extensive use of cultivable waste.

The decrease in cultivable land in the district may be attributed to increasing awareness of population towards better utilisation of available land resources. Thus, modern technology and scientific knowledge has been harnessed to ensure that hitherto underutilized land resource in the form of cultivable land is put to intensive and extensive agriculture practice. This has resulted in increase in share of cultivated land in the district. On analysing the trend of cultivated land in district it is observed that this category of land has shown fluctuating trend as there was a decrease by 3.85% from 364434 hectares in the year 1999-2000 to 350392 hectares in 2008-09. However, cultivated land increased to 364614 hectares in 2018-19 showing 4.06% increase between 2009-19. Thus, the abrupt trend there has been an overall increase of 0.05% in the share of cultivated land in the district in the two decades. Therefore, it is noteworthy that increase in cultivated land points to a situation of improved agricultural techniques and practices in the district where land is efficiently used. The cultivable land is decreasing while cultivated land has increased, indicating active efforts towards productive utilisation of land in agriculture. The improved methods of cultivation, improvements in crop pattern and crop varieties and farming systems coupled with efficient and reliable irrigation system has reduced crop failures. The incentive given for land reclamation and improving land capability by structural and non-structural measures has facilitated increase in cultivated land.

Table-1: Agricultural Landuse Pattern, 2018-19

Blocks	Reported Area	Uncultivable Land		Cultivable Land		Cultivated Land (Net Sown Area)		Area Sown more than Once	
Banda	44959	3548	7.89	600	1.3	36545	81.28	23378	63.97
Khutar	41305	3426	0.08	582	1.41	31302	75.78	22366	71.45
Powayan	28489	2941	10.32	1178	4.13	24199	84.90	17001	70.25
Sindhauli	29565	2808	9.50	906	3.06	25819	87.32	17733	68.68
Katra (Khudaganj)	26638	2841	10.67	698	2.62	23099	86.71	18782	81.31
Jaitipur	23891	2831	11.85	1276	5.34	19777	82.78	14491	73.27
Tilhar	22594	2718	12.03	600	2.65	19269	85.28	13522	70.17
Nigohi	25455	2752	10.81	566	2.22	22173	87.10	12628	56.95
Kanth	26147	2809	10.74	919	3.51	22414	85.72	12885	57.49
Dadrol	25601	3978	15.53	1353	5.28	20256	79.12	13015	64.25
Bhawal Khera	28855	3467	12.01	1063	3.68	24324	84.29	12711	52.26
Kalan	28569	3190	11.16	1471	5.15	23908	83.68	15609	65.29
Mirzapur	23716	2585	10.90	1192	5.03	19939	84.07	11365	56.99
Jalalabad	32166	3719	11.56	1332	4.14	27115	84.29	18696	68.95
Madnapur	27923	2919	10.45	979	3.51	24023	86.03	17907	74.54
Total	437469	47430	10.84	14927	3.41	364614	83.34	242398	66.48

Source: District Statistical Bulletin, (Sankyikiya Patrika) District Shahjahanpur, 2020.

* Percent to Cultivated Land

Table-2: Change in Agriculture Landuse pattern in District Shahjahanpur (1999-2019)

Land Use Categories	1999-2000 (in Hectares)	2008-2009 (in Hectares)	2018-19 (in Hectares)	Change in Percent		
				1999-2009	2009-2019	2000-2019
Usar & Uncultivable Land	7571	7023	5333	-7.24	-24.10	-29.56
Land put to non-agricultural use	39284	40355	42097	+2.73	+4.32	+7.16
Total Uncultivable land	46855 (10.24%)	47378 (10.83%)	47430 (10.84%)	+1.12	+0.11	+1.23
Area under Bush, Forest and Garden	4163	3669	2461	-11.87	-32.92	-40.88
Pastures	953	959	1050	+0.63	+9.49	+10.12
Fallow Land	26086	20744	9182	-20.48	-55.74	-64.80
Barren Cultivable Waste	4622	3837	2234	-16.98	-41.78	-51.67
Cultivable Land	35824 (7.83%)	29209 (6.68%)	14927 (3.41%)	-18.47	-48.90	-58.33
Net sown Area / Cultivated Land	364434	350392	364614 (83.35%)	-3.85	+4.06	+0.05
Area sown more than once	312	262005	242398 (55.41%)	+17.34	-7.48	+8.5
Land prepared for Sugarcane	312	2444	137	+683	-94.39	-56.01
Total reported Area	457613	350392	437469	-23.43	+24.85	-4.4

Source: Calculated by researcher on the basis of data obtained from the statistical diaries.

Table-3: Landuse Estimated Availability of Cultivated Land in Future

S. No.	Blocks	Usar Land	Cultivable Waste	Fallow	Total Land	@Net Available Land 2020	2030 AD (50% less)	2040 AD (25% less)
1.	Banda	276	69	353	698	628	314	157
2.	Khutar	256	125	2602	628	577	289	144
3.	Powayan	223	107	277	607	546	273	137
4.	Sindhauli	255	284	394	933	840	420	210
5.	Katra Khudaganj	277	63	5641	904	814	407	204
6.	Jaitipur	180	92	1115	1387	1248	624	312
7.	Tilhar	195	113	406	714	643	322	161
8.	Nigohi	179	106	354	639	575	288	144
9.	Kanth	402	189	457	1048	943	472	236
10.	Dadrol	548	232	854	16341	1470	735	368
11.	Bhawalkhera	3503	171	628	11149	1034	517	259
12.	Kalan	390	298	904	1592	1433	717	359
13.	Mirzapur	412	861	903	1401	1261	631	316
14.	Jalalabad	845	156	926	1927	1734	867	434
15.	Madnapur	457	96	686	1239	1115	558	279
	Rural	5245	2187	9080	1652	14861	7480	3740
	Urban	88	47	102	237	213	107	54
	Total	5333	2234	9182	16749	15074	7587	3794

Source: Estimate based on the following assumption, * Maximum availability: Usar+ Cultivable waste+ Fallow, @Net Available: 90% of maximum available land, 10% land left for non-agricultural uses, social forestry, pastures, ** Estimated Availability: For 2030 AD- 50% of Net Available Land; For 2040 AD- 25% of Net Available Land. Maximum Availability (ha)* Estimated Availability (ha)**

Estimated Availability of Cultivated Land for Future Decades

Land is the most important natural resource of a country like India where agriculture sector is relatively more prominent than manufacturing sector (Laxmi et al 2015, Chaplot, 2017 and Pandey and Rangnathan, 2018). Thomas Robert Malthus (1798) in his book "An Essay on the Principle of Population" stated that there would be increased pressure on resources leading to future difficulties because the population increases in geometric progression (so as to double every 25 years) while food production or availability of resources increased in an arithmetic progression. This scenario of resource crunch aggravates if we allow the scarce resources to be wasted or deteriorated, resulting in the want of food, fertile land for agriculture etc. Taking account of these challenges. The Conference of the Parties (COP) to United Nations Convention to Combat Desertification (UNCCD) in their thirteenth session in 2017 adopted the UNCCD 2018−2030 Strategic Framework and encouraged Parties to apply it in their national policies, programmes, plans and processes relating to desertification, land degradation and drought. One of the primary objectives of the same is to improve the condition of affected ecosystems, combat desertification, land degradation, promote sustainable land management and contribute to land degradation neutrality. SDG 15 envisions to "Protect, restore and promote sustainable use of Terrestrial ecosystems, sustainably manage forests, combat desertification and halt and reverse Land Degradation and halt biodiversity loss".

Recognizing the relevance of effective land management an attempt has been made to estimate the availability of cultivated land for future decades in Shahjahanpur district. Table-3 shows that the estimated total available land in the district is 16749 hectares. In this area 2234 is cultivable waste, 533 ha is Usar land while 9182 hectares is fallow land which includes current and other fallow land. Assuming that 10% of this estimated land of 16749 hectares is used for non-agricultural activities such as construction of housing industries transportation purposes recreational activities social forestry and pastures. The net available land calculated 15074 ha for the entire district. In order to estimate the available agriculture land in the district for future decades of 2030 AD and 2040 AD, an assumption is made wherein the net available land is reduced by 50% and further 75% respectively for 2030 AD and 2040 AD, the district will have approximately 7587 hectares and 3794 hectares of land in the future which is 50.33% and 25.20% respectively of the net available land. Jalalabad 1734 hectares, Dadrol 1470 hectares, Kalan 1433 hectares, Jaitipur 1248 hectares, Madnapur 1115 hectare, are the blocks which will have very high net available land. High availability of land reflects situation where due to various physical, social and economic reasons the land use has not been optimum there is hence a need to judiciously utilise the available land. It is interesting to note that blocks Banda (628 ha), Khutar (577), Powayan (546) which have low level of available land are the most intensively cultivated area in the district that's reflecting the fact advance agriculture activities and cropping practices have utilised the land most productively leaving very less for usar, fallow and wasteland. It is evident from agriculture land use analysis that in present times scientific methods, if adopted on the available land would not only ensure productive agriculture and enhancement but also ensure agriculture diversification towards horticultural and commercial crops. The less fertile usar and fallow land could be used for afforestation purposes. This would enrich and protect the soil as well as the environment. The Soil and land resource in the district needs scientific management practices so that the entire available area is sustainably managed. The growing population and its requirements of nutrition and physical infrastructure (housing roads etc) has to be judiciously met so that both the needs of food security and development imperatives are taken into account. An effective strategy would include Land Capability Classification (suggested by the Soil Conservation Service of United States Development of Agriculture) that would determine the type of land use suitable in an area depending on its characteristics such as soil type, its depth, erosion conditions and fertility etc.

Balanced use of fertilizers (N:P:K=4:2:1) with gradual shift towards organic farming and conservation agriculture would minimise use of chemicals to restore fertility of soil. Widespread Use of soil health cards to assess the requirements and suitability of soil for cultivation would go a long way in preserving the soil qualities. Integrated management of land ecosystem must be ensured by balancing the needs of development and sustainable agriculture practices. The needs of infrastructure and development should be centred around barren land that is unfit for agriculture, similarly adopting Land Use Management Systems involving practices of Precision farming using remote sensing and GIS (drought and flood prediction, spectroscopy, biosensors) to assess soil fertility, soil-water content, automated irrigation, detection of pathogens would be beneficial in enhancing the agriculture prospects of Cultivable Land. Gradually, improvement in the land productivity and yield of Cultivated Land would occur. Eventually, Land Area Sown More Than Once can be increased. However careful efforts must be made to make such land use environmentally sustainable. Thus, not only would agriculture practice and land use emerge as a means to ensure nutritional and Livelihood security but also an environment friendly occupation that minimizes wastage of resources (soil, water). In this manner land, ecosystem in the district can be efficiently managed to ensure environmentally sustainable agriculture that also ensures economic development in the district.

Conclusion

Soil distribution in the district is dominated by Domat clayey soil, Clayey Soil and Sandy soil. Usar soil needs scientific management and has the potential to contribute towards future cultivation to compensate for decrease in agricultural land area owing to increased population pressure. Agriculture Land Use in Shahjahanpur district intends to maximize the available land to meet the needs of population pertaining to agriculture and infrastructure development. 10.84% land of the district is uncultivable. There is 3.41% of cultivable land. 83.35% of the geographical area of Shahjahanpur district is cultivated land. 10 blocks have cultivated land more than 83.35 percent with Sindhauli block (87.32%) having the highest share while Khutar (71.45%) having the least. On studying the changes of land use pattern, it is observed to be a fluctuating trend. The uncultivable land has increased in the two decades by 1.23%. Usar land has been reclaimed. Land put to non-agricultural use has increased. The share of cultivable land has decreased by 51.67% in the two decades. The cultivated land shows a fluctuating trend with a decrease of 3.85% in the first decade and then increase by 4.06% in the next decade. An overall increase of 0.05% is seen. Area Sown More Than Once has increased by 8.5% in the two decades due to agriculture Innovation and technological advancements. The district will have approximately 7587 hectares and 3794 hectare of land in the future in 2030 AD and 2040 AD. The present and future status of soil and land use must therefore ensure careful planning and management for sustainable development.

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POTENTIAL AND PROSPECT OF RAINWATER HARVESTING IN BOOMTAR REVENUE CIRCLE OF NAMCHI, SIKKIM

Dr. Ajay Chhetri

Abstract

Rainwater harvesting (RWH) offers a sustainable solution to water scarcity issues in the Boomtar Revenue Circle of Namchi, Sikkim, a region characterized by high rainfall and growing water demand. This study assesses the potential and prospects of RWH in this area by analysing rainfall patterns, topographical conditions, and socio-economic factors. The Boomtar Revenue Circle receives an average annual rainfall of approximately 2800 mm, presenting significant opportunities for rainwater collection and storage. By implementing RWH systems, both surface and rooftop methods, households and communities can reduce dependency on conventional water sources, thereby enhancing water security and promoting sustainable water management practices. The study involved field surveys and stakeholder interviews to gauge local awareness, acceptance, and challenges related to RWH adoption. Results indicate a high potential for integrating RWH into existing water management strategies, with positive socio-economic impacts such as improved water availability for domestic and agricultural use, reduced soil erosion, and enhanced groundwater recharge. Challenges identified include initial installation costs, maintenance issues, and the need for technical training. Policy recommendations include government incentives for RWH infrastructure, community training programs, and integration of RWH into local planning processes. By addressing these challenges and leveraging the region's natural rainfall abundance, RWH can play a pivotal role in achieving water sustainability in Boomtar. This study underscores the importance of multi-stakeholder collaboration and continuous monitoring to maximize the benefits of RWH and ensure its long-term success in Sikkim.

Introduction

Water scarcity is a growing global issue, impacting regions such as the Boomtar Revenue Circle in Namchi, South Sikkim. Despite receiving significant rainfall, the area struggles with water management due to irregular distribution, urbanization, and increasing population. Rainwater harvesting (RWH) offers a sustainable solution by collecting and storing rainwater for uses like drinking, irrigation, and groundwater recharge.

Boomtar's annual rainfall, averaging around 2800 mm, is a largely untapped resource. Effective RWH systems can alleviate water shortages and foster sustainable development. This study explores RWH potential in Boomtar by analysing local rainfall data, topography, and socio-economic factors. Field surveys and stakeholder interviews shed light on RWH feasibility and community attitudes. The research underscores RWH's socio-economic advantages, such as enhanced water availability for domestic and agricultural use, reduced reliance on traditional sources, and environmental benefits like decreased soil erosion and improved groundwater levels. Identified challenges include high initial setup costs, maintenance requirements, and technical skill deficits. Recommendations include policy support, community education, and incorporating RWH into local planning frameworks. Utilizing Boomtar's rainfall through RWH can significantly enhance water management and resilience to scarcity. This study emphasizes the need for coordinated action among governmental bodies, communities, and stakeholders to maximize RWH benefits in Namchi, Sikkim.

Study Region

The Boomtar Revenue Circle, located in Namchi, South Sikkim, is a region known for its unique geographical and climatic characteristics. Situated in the Himalayan foothills, Boomtar is part of the larger Namchi subdivision, which serves as the administrative headquarters of South Sikkim. The area is characterized by its hilly terrain, lush greenery, and diverse flora and fauna, making it a significant part of Sikkim's natural heritage. Boomtar experiences a temperate climate with distinct seasons, including a heavy monsoon period from June to September. The region receives an average annual rainfall of approximately 2800 mm, contributing to its rich biodiversity and agricultural potential. However, the heavy rainfall is not evenly distributed throughout the year, leading to periods of water abundance followed by scarcity, especially in the dry season. Agriculture is a primary occupation in Boomtar, with terraced farming being common due to the hilly landscape. Major crops include maize, paddy, millet, and various vegetables. The region also benefits from horticulture, with the cultivation of fruits like oranges and cardamoms playing a significant economic role. Despite the abundant rainfall, water management remains a challenge due to the lack of efficient storage and distribution systems.

The socio-economic profile of Boomtar is characterized by a mix of traditional lifestyles and increasing modernization. The local population comprises primarily indigenous communities with rich cultural traditions. Educational and healthcare facilities are gradually improving, but there is still a need for better infrastructure and services to meet the growing demands of the population. In recent years, there has been a growing interest in sustainable practices, including rainwater harvesting (RWH), to address water management challenges. The region's potential for RWH is significant, given its high rainfall and topographical suitability. Implementing RWH systems could enhance water security, support agricultural productivity, and contribute to the overall sustainable development of Boomtar. Stud Area, presents both opportunities and challenges in water management. Leveraging its natural rainfall through effective RWH practices can play a crucial role in ensuring sustainable development and improving the quality of life for its residents.

Objectives

(1) To assess Rainwater Harvesting Feasibility and d evaluate rainfall patterns and topography to determine the potential for effective RWH implementation in Boomtar Revenue Circle.

(2) To identify Socio-Economic Impacts: Explore benefits like improved water security and challenges such as installation and maintenance costs associated with RWH adoption.

Database and Methodology

The database for this study on rainwater harvesting (RWH) potential in the Boomtar Revenue Circle consists of meteorological data, topographical maps, and socio-economic surveys. Meteorological data, including rainfall patterns and annual precipitation levels, were sourced from the Indian Meteorological Department (IMD) and local weather stations. Topographical maps were obtained from the Survey of India, providing detailed information on the region's terrain and watershed characteristics. Socio-economic data were gathered through structured interviews and questionnaires targeting local households, farmers, and community leaders to understand current water usage practices, awareness, and attitudes towards RWH. The methodology involves a mixed-methods approach. Quantitative data analysis includes statistical evaluation of rainfall patterns to estimate potential rainwater yield and GIS mapping to identify suitable sites for RWH systems. The water balance method is used to calculate the potential volume of harvested rainwater, considering factors such as catchment area and runoff coefficients.

Qualitative methods involve thematic analysis of interview and survey responses to identify socio-economic factors influencing RWH adoption. Focus group discussions were conducted to gather in-depth insights into community perceptions and potential barriers to RWH implementation. A case study approach was employed to document successful RWH projects in similar regions, providing practical examples and best practices. The integration of quantitative and qualitative data ensures a comprehensive assessment of RWH potential and socio-economic impacts, facilitating the formulation of actionable recommendations for sustainable water management in Boomtar.

Result and Discussion

This section presents the findings of the study on the potential and prospects of rainwater harvesting (RWH) in the Boomtar Revenue Circle of Namchi, Sikkim. The discussion is structured into several subsections, including an analysis of rainfall patterns, topographical suitability, socio-economic impacts, and challenges associated with RWH adoption. The results from field surveys and stakeholder interviews are integrated into the discussion to provide a comprehensive understanding of RWH feasibility and implications for sustainable water management in Boomtar.

Rainfall Patterns: Annual Rainfall Analysis

The Boomtar Revenue Circle receives an average annual rainfall of approximately 2800 mm, with significant variations across different months. The monsoon period, from June to September, contributes majority of this rainfall, accounting for nearly 70% of the annual total. The high rainfall during the monsoon months presents a substantial opportunity for rainwater collection. However, the challenge lies in managing this resource effectively to ensure water availability during the dry months. To understand the variability and trends in rainfall, it's crucial to analyse the data over multiple years. Table-1 compares the annual rainfall data for Boomtar over the past five years.

The data reveals that while there are fluctuations in monthly rainfall amounts, the total annual rainfall remains consistent around the 2800 mm mark. However, the distribution of rainfall within the year can vary, affecting the availability of water during different periods. Rainfall Trends and Implications for Rainwater Harvesting Monsoon Dominance: The monsoon months (June to September) consistently contribute the bulk of annual rainfall. This period is critical for capturing rainwater to be used during drier months. Variability in Pre-Monsoon and Post-Monsoon

Periods: Rainfall in the pre-monsoon (March to May) and post-monsoon (October to November) periods shows more variability (Table-1). Efficient RWH systems need to account for these variations to maximize water storage. Dry Months: December to February are consistently dry months, emphasizing the need for stored rainwater to meet water demands during this period. Yearly Fluctuations: While the total annual rainfall does not show extreme variations, the monthly distribution can affect water availability. For example, a higher-than-average rainfall in one monsoon month but lower in others can impact the overall water harvesting efficiency.

Table-1: Annual Rainfall Data

Months	2019	2020	2021	2022	2023
Jan	40	55	45	50	48
Feb	60	75	65	70	68
March	110	95	105	100	98
April	140	155	150	160	145
May	310	320	290	295	310
June	620	590	610	605	595
July	760	740	730	755	770
Aug	710	680	720	690	710
Sep	480	520	510	495	505
Oct	360	340	370	355	360
Nov	90	110	95	105	100
Dec	40	35	30	25	28
Total	2780	2725	2740	2705	2737

Source: Metrological Department of India

Rainfall Trends and Implications for Rainwater Harvesting

Rainfall Trends (2019-2023): The data for the last five years (2019-2023) reveals several key trends in rainfall patterns. The total annual rainfall remains relatively consistent, averaging around 2737 mm. This indicates a stable climatic condition in terms of annual precipitation. There is significant monthly variability in rainfall distribution: December, January, February, and March generally receive the least rainfall. For example, December consistently has the lowest rainfall (ranging from 25 mm to 40 mm), indicating a dry season. June, July, and August are the wettest months, with July typically receiving the highest rainfall (averaging around 740 mm).

This suggests a monsoon or peak rainy season during these months. April, May, September, and October show moderate rainfall, serving as transition periods between the dry and wet seasons. Implications for Rainwater Harvesting Given these trends, several implications arise for effective rainwater harvesting strategies:

Maximizing Harvest during Wet Months

Storage Systems

It is crucial to have adequate storage systems in place to capture the substantial rainfall during the peak months of June, July, and August. Large tanks or reservoirs should be designed to store excess water collected during these months. Proper overflow systems must be established to handle the surplus water and prevent flooding or wastage.

Optimizing Collection in Transitional Months

(a) Rainwater Collection Areas

Ensure that rooftops, gutters, and other collection surfaces are well-maintained and cleaned before the onset of the transitional months to maximize efficiency.

Consider additional, smaller storage units to capture and utilize the moderate rainfall during April, May, September, and October, thereby ensuring a steady water supply.

(b) Strategic Use during Dry Months

Water Conservation: During the dry months of December, January, February, and March, the focus should be on conserving the stored rainwater. Implementing water-saving techniques and reducing wastage will be essential.

Demand Management: Adjust water usage patterns to align with the availability, prioritizing essential needs and postponing non-essential uses during these low-rainfall months.

(c) Infrastructure and Maintenance

Regular Maintenance: Continuous maintenance of rainwater harvesting systems is necessary to ensure efficiency. This includes cleaning gutters, checking for leaks, and ensuring that storage tanks are in good condition. Based on the observed trends, upgrading the capacity and technology of rainwater harvesting systems might be required to cope with increasing or varying rainfall amounts, particularly in the wetter months.

(d) Policy and Community Engagement

Community Programs: Initiatives to educate the community about the importance of rainwater harvesting and efficient water use during different times of the year can foster collective action.

Government or local authorities could provide incentives for households and businesses to install rainwater harvesting systems, ensuring widespread adoption and resilience against water scarcity. The analysis of rainfall patterns from 2019 to 2023 indicates stable annual precipitation with significant monthly variations. Effective rainwater harvesting must account for these trends by optimizing storage during wet months, conserving water during dry periods, and maintaining robust infrastructure. By implementing strategic measures, it is possible to ensure a reliable water supply throughout the year, enhancing water security and sustainability for the community. The consistent annual rainfall provides a reliable source for RWH, but the system design must accommodate the variability in monthly distribution. Here are key considerations. Storage Capacity: RWH systems need to be designed with adequate storage capacity to capture and store water during peak rainfall months for use during dry periods.

Potential Volume of Rainwater

To estimate the potential volume of rainwater that can be harvested, the water balance method was employed. The water balance method is a reliable approach for estimating the volume of rainwater that can be harvested. It involves calculating the amount of rainwater that can be collected from a given surface area, considering the efficiency of the collection system and the annual rainfall. This method is particularly useful for planning and designing rainwater harvesting (RWH) systems in residential and community buildings. The key components of the water balance method include the catchment area, the runoff coefficient, and annual rainfall. The catchment area is the surface from which rainwater is collected, commonly rooftops in residential and community buildings. Larger catchment areas typically yield more harvested rainwater. The runoff coefficient is a factor that represents the proportion of rainwater that can be effectively collected, accounting for losses due to absorption, evaporation, and system inefficiencies. The runoff coefficient varies based on the type of surface; for example, rooftops generally have a high runoff coefficient (around 0.8), whereas permeable surfaces like lawns have a lower coefficient. Annual rainfall is the total amount of rainfall received over a year, typically measured in millimetres (mm) or meters (m), usually obtained from meteorological records.

To illustrate, consider a typical scenario with a 100 square meter rooftop, a runoff coefficient of 0.8, and annual rainfall of 2.737 meters (2737 mm). Using the formula V=A×C×RV = A \times C \times RV=A×C×R, the potential volume of rainwater harvested is calculated to be approximately 218.96 cubic meters. This demonstrates the significant potential for RWH in both residential and community settings.

To illustrate, let's consider a typical scenario:

Catchment Area (A): 100 square meters (m^2)

Runoff Coefficient (C): 0.8 (80% efficiency)

Annual Rainfall (R): 2.737 meters (2737 mm)

The formula to calculate the potential volume of rainwater harvested (V) is:

V=A×C×RV = A \times C \times RV=A×C×R

Applying the values:

$V=100\,m^2\times0.8\times2.737\,m$

$V=100\times0.8\times2.737$

V=218.96cubic meters

Thus, for a 100 square meter rooftop with a runoff coefficient of 0.8, the potential volume of rainwater that can be harvested annually is approximately 218.96 cubic meters. In residential buildings, RWH can significantly reduce the use of municipal water, particularly for non-potable uses like gardening, toilet flushing, and car washing. This reduction leads to cost savings on water bills and contributes to sustainable living by minimizing environmental impact. In community buildings, which typically have higher water demands, RWH can meet a significant portion of this demand and serve as educational tools to promote water conservation and sustainability. Moreover, in regions prone to water shortages or droughts, RWH can provide a reliable alternative water source, enhancing community resilience. The advantages of RWH extend beyond water conservation. Environmentally, it reduces the volume of stormwater runoff, mitigating flooding risks and reducing soil erosion. Economically, it lowers water costs and can result in substantial savings, with many governments offering incentives, rebates, or grants to encourage RWH adoption. Socially, RWH enhances water security, ensuring a reliable supply of water during dry periods or water supply disruptions, and fosters a sense of community responsibility towards sustainable water management. Hence the water balance method provides a clear and practical way to estimate the potential volume of rainwater that can be harvested. By considering factors such as catchment area,

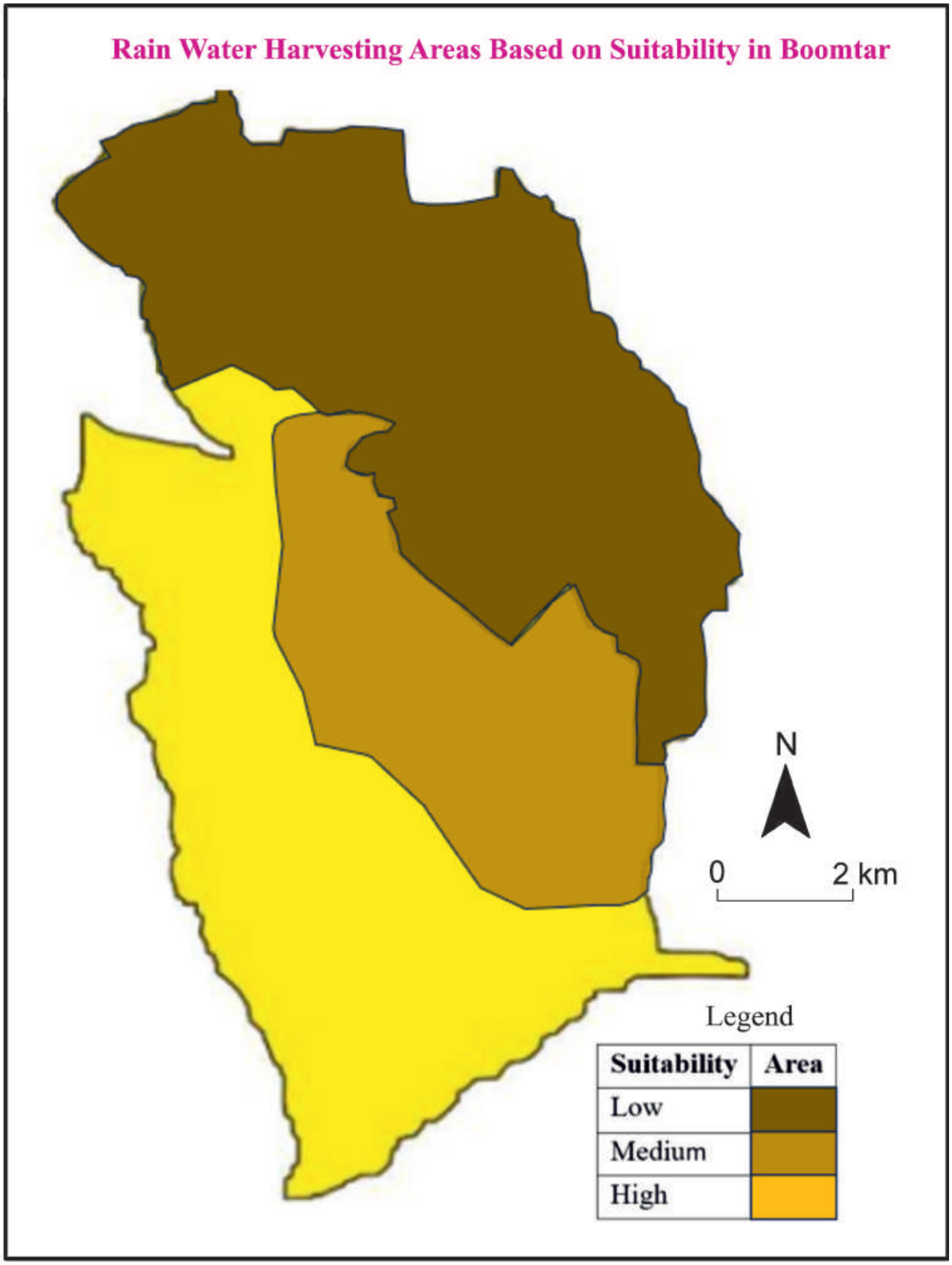
Rain Water Harvesting Areas Based on Suitability in Boomtar
N
0
2 km
Legend
Suitability
Area
Low
Medium
High

Fig. 1

runoff coefficient, and annual rainfall, this method demonstrates the significant potential for RWH in both residential and community buildings. The benefits of RWH include water conservation, economic savings, environmental protection, and enhanced community resilience, making it a vital component of sustainable water management strategies.

Terrain Analysis and GIS Mapping for Rainwater Harvesting Suitability in Boomtar

Boomtar's unique hilly terrain, characterized by steep slopes and extensive terraced agriculture, presents a complex landscape for implementing rainwater harvesting (RWH) systems. The varied topography offers both opportunities and challenges for maximizing the effectiveness of RWH initiatives. By leveraging Geographic Information System (GIS) technology, we can systematically analyse the terrain to identify the most suitable sites for different types of RWH systems. This study aims to explore the potential of RWH in Boomtar by examining the terrain through topographical maps and GIS analysis, ultimately proposing a strategic plan for the implementation of RWH systems.

Terrain Analysis

Boomtar's terrain is predominantly hilly, with steep slopes and terraced agricultural fields. The region's topography plays a critical role in determining the most effective RWH methods. Steep slopes are generally advantageous for surface runoff harvesting, where water can be collected from the land as it flows downhill. Conversely, areas with higher elevations and significant slopes are more appropriate for rooftop harvesting, where water can be captured from building rooftops and stored for later use (Fig. 1). The topographical maps of Boomtar reveal that the terrain is not uniform, with variations in elevation and slope across different regions. These variations necessitate a tailored approach to RWH, considering the specific characteristics of each area. The steep slopes in certain parts of Boomtar facilitate rapid surface runoff, which can be efficiently harvested through appropriate surface RWH systems. On the other hand, regions with terraced agriculture and higher elevations are better suited for rooftop RWH systems, where water can be collected from rooftops and used to supplement agricultural and domestic water needs.

GIS Mapping for Suitable Sites

GIS technology provides a powerful tool for identifying and analyzing suitable sites for RWH systems. By integrating various criteria such as slope, land use,

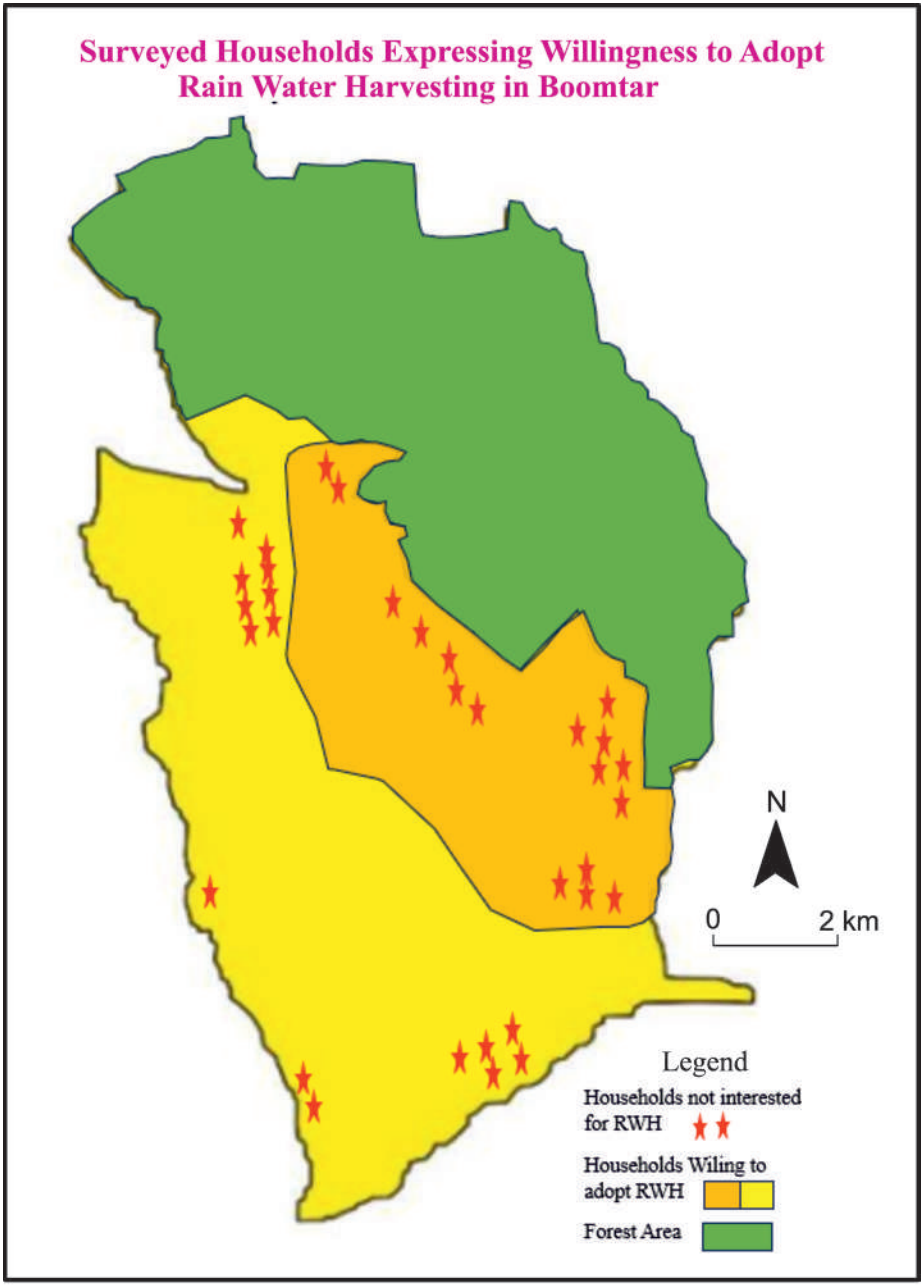
Surveyed Households Expressing Willingness to Adopt
Rain Water Harvesting in Boomtar
N
0
2 km
Legend
Households not interested
for RWH
Households Wiling to
adopt RWH
Forest Area

Fig. 2

proximity to water demand points, and soil type, GIS mapping can classify areas based on their suitability for different types of RWH systems. This spatial analysis allows for a strategic approach to RWH implementation, ensuring that systems are placed in locations where they can be most effective.

The GIS analysis conducted for Boomtar considered multiple factors to identify the most suitable sites for RWH systems. The criteria used in the analysis included:

(a) Slope: Steeper slopes are more suitable for surface runoff harvesting, while gentler slopes and higher elevations are more appropriate for rooftop harvesting.

(b) Land Use: Areas with agricultural land use are prioritized for surface runoff harvesting, whereas urban and residential areas are more suitable for rooftop harvesting.

Proximity to Water Demand Points

Sites close to areas with high water demand, such as agricultural fields and residential zones, are given higher priority.

Soil Types: The soil's ability to absorb and retain water is considered, with permeable soils being more suitable for surface runoff harvesting and impermeable soils being ideal for rooftop harvesting. Based on these criteria, the GIS analysis classified areas in Boomtar into three suitability classes: high, moderate, and low. The classification provides a clear indication of the potential for RWH in different regions. The results of the GIS analysis are summarized in Fig. 2 and Table-2 which outlines the classification of areas based on their suitability for surface and rooftop RWH systems.

Table-2: Classification of Areas Based on Suitability for RWH System

Suitability Class	Surface RWH (sq km)	Rooftop RWH (sq km)	Total Area (sq km)
High	15	10	25
Moderate	20	25	45
Low	10	10	20

Source: Topographical map & QGIS analysis

The GIS analysis indicates that approximately 25 square kilometers of Boomtar are highly suitable for RWH, comprising both surface and rooftop systems. This high suitability area represents significant potential for implementing effective RWH systems that can capture and store rainwater for various uses.

High Suitability Areas: The high suitability areas are characterized by favourable topographical conditions, including optimal slopes and land use patterns. These areas are ideal for both surface and rooftop RWH systems. Surface RWH systems in these regions can take advantage of the natural runoff, capturing water as it flows downhill. Rooftop RWH systems can be implemented in residential and agricultural buildings, providing a reliable source of water for domestic and irrigation purposes.

Moderate Suitability Areas: The moderate suitability areas cover 45 square kilometres and present a balanced potential for both surface and rooftop RWH systems. These areas may have less favourable slopes or land use patterns compared to the high suitability areas, but they still offer considerable potential for RWH. Strategic placement of RWH systems in these areas can enhance water availability and support sustainable water management practices.

Low Suitability Areas: The low suitability areas, totalling 20 square kilometres, are characterized by less favourable conditions for RWH. These areas may have challenging slopes, unsuitable land use, or soil types that limit the effectiveness of RWH systems. However, with innovative approaches and appropriate technologies, even these areas can benefit from targeted RWH interventions.

Implications for RWH Implementation

The GIS analysis provides valuable insights into the potential for RWH in Boomtar, highlighting areas where RWH systems can be most effectively implemented. By focusing on high and moderate suitability areas, stakeholders can prioritize efforts to maximize the benefits of RWH. The implementation of RWH systems in these areas can enhance water security, support agricultural productivity, and contribute to sustainable water management.

Strategic Planning

The results of the GIS analysis can inform strategic planning for RWH implementation in Boomtar. Decision-makers can use the suitability classifications to allocate resources and design RWH systems that are tailored to the specific conditions of each area. This targeted approach ensures that RWH systems are placed where they can have the greatest impact.

Community Engagement

Engaging local communities in the planning and implementation of RWH systems is crucial for success. By involving community members in the decision-making process, stakeholders can ensure that RWH systems are designed to meet local needs and preferences. Community participation also fosters a sense of ownership and responsibility, increasing the likelihood of long-term sustainability.

Policy and Incentive

Policymakers can use the findings of the GIS analysis to develop policies and incentives that promote RWH in Boomtar. Financial incentives, such as subsidies or tax breaks, can encourage the adoption of RWH systems by individuals and communities. Regulatory measures, such as building codes that mandate the inclusion of RWH systems in new constructions, can further support the widespread implementation of RWH.

Monitoring and Evaluation

Ongoing monitoring and evaluation of RWH systems are essential to assess their effectiveness and identify areas for improvement. By tracking the performance of RWH systems, stakeholders can make data-driven decisions and continuously optimize the design and implementation of RWH initiatives. The terrain analysis and GIS mapping conducted in this study provide a comprehensive understanding of the potential for rainwater harvesting in Boomtar. The results highlight the significant opportunities for implementing RWH systems in both residential and community buildings, with 25 square kilometres identified as highly suitable for RWH. By leveraging the insights gained from the GIS analysis, stakeholders can strategically plan and implement RWH systems that enhance water security, support agricultural productivity, and contribute to sustainable water management in Boomtar. Engaging local communities, developing supportive policies, and ensuring ongoing monitoring and evaluation are key to the success and sustainability of RWH initiatives in the region.

Socio-Economic Impact

Water Security Enhancement: Field surveys and stakeholder interviews revealed that RWH can substantially enhance water security for households and agriculture. Approximately 90% (including both the High and Medium suitability for RHW area only, since low suitability area is under reserved forest area) of surveyed households expressed a willingness to adopt RWH if provided with necessary support and training. Farmers highlighted the potential of RWH to provide a reliable water source during critical growing periods, thereby improving crop yields and reducing dependency on erratic monsoon rains. Map 2 explicit the willingness to adopt RWH. The economic analysis indicates that RWH systems, despite their initial installation costs, offer long-term financial benefits. Reduced expenditure on water procurement, improved agricultural productivity, and enhanced groundwater recharge translate into significant economic gains for the community. The environmental benefits of RWH are multifaceted, including reduced soil erosion, enhanced groundwater recharge, and improved microclimate conditions. By capturing and utilizing rainwater, RWH systems help in maintaining the natural hydrological cycle, thereby mitigating the impacts of climate variability.

Challenges and Barriers

One of the primary challenges identified is the high initial cost of installing RWH systems. Many households and communities find it difficult to afford these costs without external financial assistance. The study suggests that government subsidies and incentives could play a crucial role in overcoming this barrier. Maintenance and Technical Training: Maintenance of RWH systems is another significant challenge. The study found that while awareness about RWH is high, there is a lack of technical know-how regarding system maintenance and operation. Providing technical training and establishing maintenance support networks can address this issue. The success of RWH initiatives heavily depends on supportive policies and institutional frameworks. The study highlights the need for integrating RWH into local planning processes, ensuring that policies are conducive to the widespread adoption of RWH practices. Rainwater harvesting (RWH) offers a sustainable solution to water scarcity in Boomtar, a region characterized by its hilly terrain and variable rainfall patterns. Recommendations are aimed at fostering the implementation and sustainability of RWH systems in Boomtar, focusing on government incentives, community training programs, integration into local planning, and continuous monitoring and evaluation. One of the most effective ways to encourage the adoption of RWH systems is through government incentives. Financial incentives, such as subsidies, grants, and low-interest loans, can significantly reduce the initial investment required for installing RWH systems. This financial support is crucial, especially for households and communities with limited resources. By lowering economic barriers, the government can stimulate interest and participation in RWH projects across Boomtar. Subsidies can be targeted towards the purchase of materials and equipment necessary for RWH installations, such as gutters, storage tanks, and filtration systems. Beyond financial incentives, the government should consider launching awareness campaigns to educate the public about the benefits of RWH. These campaigns can highlight the economic advantages, such as reduced water bills, and the environmental benefits, including reduced runoff and groundwater recharge.

By raising awareness and providing financial support, the government can create a conducive environment for the widespread adoption of RWH systems in Boomtar. Effective and sustainable RWH systems require not only initial investment but also proper installation, maintenance, and management. To ensure the long-term success of RWH initiatives, it is essential to equip local communities with the necessary technical skills and knowledge. Organizing community training programs can play a pivotal role in this regard.

Community training programs should cover a range of topics, including the technical aspects of RWH system installation, maintenance procedures, and best practices for water management. Training sessions can be conducted by experts in the field and should be tailored to meet the specific needs of different community groups, such as farmers, residential households, and local businesses. By providing hands-on training and practical demonstrations, these programs can empower community members to take an active role in the implementation and upkeep of RWH systems. In addition to technical training, community programs should also promote water conservation practices and the sustainable use of harvested rainwater. This can involve educating participants on how to optimize water usage for irrigation, household needs, and other purposes. By fostering a culture of water stewardship, community training programs can enhance the overall impact of RWH initiatives in Boomtar. For RWH to become a widespread and sustainable practice, it must be integrated into local planning and development strategies. This involves making RWH a mandatory component of new construction projects and incorporating it into agricultural planning and urban development. Local governments should enact regulations that require the inclusion of RWH systems in the design and construction of new buildings. Building codes can be updated to mandate the installation of gutters, storage tanks, and other necessary infrastructure for rainwater collection. By making RWH a standard practice in new developments, the region can systematically increase its capacity for rainwater storage and utilization. Urban planning should also incorporate RWH into green infrastructure initiatives. This includes designing public spaces and landscapes that facilitate rainwater capture and infiltration. For example, parks and community gardens can be equipped with RWH systems to collect and store rainwater for irrigation. Additionally, urban planners can promote the use of permeable surfaces and green roofs to enhance rainwater absorption and reduce runoff. By integrating RWH into local planning, Boomtar can develop a holistic approach to water management that addresses both urban and rural needs. This comprehensive strategy will help build resilience to water scarcity and promote sustainable development in the region. Monitoring should involve regular inspections of RWH systems to check for any operational issues, such as leaks, blockages, or contamination. This can be done through a combination of community-based monitoring and professional assessments. Community members can be trained to perform basic inspections and maintenance tasks, while government or non-governmental organizations (NGOs) can provide more detailed evaluations and technical support. Evaluation should focus on both quantitative and qualitative aspects of RWH projects. Quantitative data can include metrics such as the volume of water harvested, the reduction in municipal water usage, and the financial savings achieved. Qualitative data can be gathered through surveys and interviews with community members to understand their experiences, challenges, and satisfaction with the RWH systems. Regular feedback from the community and other stakeholders is crucial for the continuous improvement of RWH practices and policies. Feedback mechanisms can be established to collect input from users, allowing them to report issues, suggest improvements, and share success stories. This participatory approach ensures that RWH initiatives are responsive to the needs and preferences of the community.

Conclusion

The adoption of rainwater harvesting systems in Boomtar presents a valuable opportunity to address water scarcity and promote sustainable water management. To achieve widespread and sustainable implementation, a multi-faceted approach is required. Government incentives can lower economic barriers and stimulate interest in RWH, while community training programs can equip individuals with the necessary skills and knowledge to maintain and optimize these systems. Integrating RWH into local planning ensures that it becomes a standard practice in new developments and agricultural activities, enhancing water availability and resilience. Continuous monitoring and evaluation provide the necessary feedback to assess the impact of RWH projects and guide ongoing improvements. By involving the community in these processes and using the insights gained to inform policy decisions, Boomtar can develop a robust framework for RWH that benefits both urban and rural areas. Through these concerted efforts, Boomtar can harness the potential of its hilly terrain and variable rainfall patterns to create a sustainable and resilient water management system. By prioritizing RWH and fostering a collaborative approach, the region can enhance water security, support agricultural productivity, and promote the well-being of its residents.

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