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Editorial Column

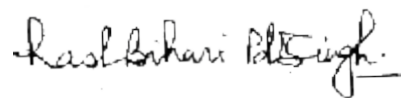
Dear Fellow Readers

I am privileged to place the Silver Jubilee year volume of this Journal in your hands. It is not a small achievement for the Association of Geographers, Bihar and Jharkhand (AGBJ) to publish the journal continuously without any gap year since 2000. This is a Journal of 21st Century and the emerging trends of geographical thought have been given due space so that the importance and need of geography could be understood by all stakeholders who are active in making the world sustainable and survivable for the mankind. At the same time, our efforts have been to publish such papers which are area-based and results of the study are contributory ideas in the transformation of demographic trends, socio-economic landscapes and the well-being designs of the governing agencies at different levels. Young geographers from all over India are given due consideration in selecting the research papers for publication in this Journal.

Dear friends, I am confident that your academic support will continue and that will help in achieving the global recognition to this Journal. J-Gate recognition is already achieved and the UGC-CARE listing of this Journal is in process. We hope to get enlisting in the next year.

The present volume consists of fifteen research papers and one book review. All research papers are carefully selected on the basis of the recommendations of peer reviewers. Our efforts to make it a Journal of global acceptability need your creative support. Your critical views on grey areas will always be welcome and the editorial board will look into the merits of your criticism and suggestions so that the necessary accommodation of your suggestions may be made in the next volume of the Journal.

I wish to seize this opportunity to express my sincere thanks to the members of Advisory Board, Editorial Board, Peer Review Committee and the Office Bearers of the AGBJ for their warm support in the completion and publication of this volume of the Journal.



(Rash Bihari Pd. Singh)

Editor-in-Chief

Foundation Day Lecture**REVISITING THE ISSUES OF CLIMATE CHANGE AND REMEDIAL MEASURES IN INDIA****Salahuddin Qureshi***

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Climate change is talk of the town among Earth Scientists, Environmentalists, Geographers and Development Planners. Geographers are laying special emphasis on this challenging phenomenon. Geographers concern and keen interest is evident in the fact that most of the National and International Conferences in geography are addressing their focal theme on issues pertaining to climate change. Even though the terrestrial climates had always been changing throughout the history of the earth in all geological time periods, the change was slow natural occurrence in millions of years. For example, even in the shortest Pleistocene period there were as many as seventeen climate change phases, each happening in a time interval of several thousands of years. However, it is the Anthropocene period, since the Industrial Revolution, which is the cause of concern for inducing and inflicting the unprecedented manmade climatic changes within our own lifetime scale of decades only. It is the timescale and intensity which is an alarming issue of climate change.

Issues Pertaining to Climate Change

The first and foremost issue of climate change is environmental challenges which undermine the socio-economic sustainability. Under the increasingly inclement weather conditions there is a decreasing labor efficiency. It would undermine the per capita productivity. Climate change is leading to yawning income inequalities and social exclusion. Climate change is also a pretext to both the persistent and proxy inflation. Much of the present climate change is taking place due to our reckless energy consumption. It is leading to atmospheric pollution and resource-waste dumping in the hydrospheric bodies of shallow coastal seas and rivers. The atmosphere-hydrosphere coupling is getting disturbed from its normal routine. Among all the natural phenomena, rivers are the most vulnerable and endangered natural assets. Almost all the major and megacities of the world have been located on the rivers for their sustainability. In India, all the massive cities are located on the rivers and lakes. Indian water bodies are under double pressure of burgeoning industrial-commercial growth on one hand and mounting pilgrimage pressure on the other.

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The burgeoning megacities appear to be the nuclei of global warming and climate change. In view of United Nations (2021) list of the largest cities, in 2021 there were 37 megacities in the world. Out of these a staggering number of 24 megacities were located in Asia. In South America there were 5 megacities. In Africa 3 megacities were reported. In Europe and North America, 2 each were recorded, whereas 1 megacity of Mexico was reported in Central America. Indian megacities are the nuclei of regional warming and local climate change. Urban climates are, in fact, microclimates. Geographically, the urban climate change is more pronounced along the '*Western Urban Corridor*' of India. It is because of the distinctly high rate of urbanization, infrastructural growth and economic gravity along this corridor. India's Western Urban Corridor comprises the major and megacities of Delhi, Jaipur, Ahmedabad, Surat, Mumbai, Pune, Hyderabad, Bengaluru and Chennai. There is only one megacity of Kolkata to the east of India's Central Meridian. Hence, 80 per cent of Indian urbanization is to the west of the Central Meridian. It not only depicts a highly skewed but spatially imbalanced urbanization and the resultant urban climate change in India. Urban climate change in India is of even greater concern because there is top-heavy skewed urbanization in India. This is evident in the fact that out of around 10,000 urban centers in India only 10 major to megacities comprise over 22 per cent of India's total urban population. Most of the megacity urbanization along the western parts of India is also evidence of the historically centralized tendency of the Indian economy.

The resultant urban climate change is not merely a problem of growing temperatures in the name of urban heat islands. As a matter of fact, the urban climate change is causally integrated with temperature, pressure, rainfall, humidity, wind velocity and calm weather changes which majority of the urban inhabitants are faced with. There is widespread evidence that larger is the city size in area, population and functions, greater is the propensity of urban climate change. Hence, the extent of urban climate change in India is considerably alarming in the megacities of Delhi, Mumbai, Kolkata, Chennai, Bengaluru, Hyderabad and Ahmedabad. There can scarcely be a denial to the fact that urban climate change is posing a much more serious threat in the rapidly growing cities of the developing countries than their counterparts in the developed world. Moreover, there is a tendency of sustainable decentralized urbanization in the developed countries as against the huddling of centralized economic tendencies in the developing countries.

Smaller urban centers with mostly single or few double story buildings and wider open spaces with immediate countryside do not form climate change nuclei. On the other hand, the tall high-rise skyscrapers in large cities have multi-tier built up surfaces to absorb and induce thermal conductivity in the city environment. It has been observed that the urban microclimates are complex due to a number of anthropogenic influences. There are considerable seasonal variations between the climates of large cities in comparison to the smaller towns. Similarly, there are considerable diurnal variations in the thermal and other

meteorological characteristics of the larger cities as compared to the smaller urban centers. Hansen *et al.*, (2012) of NASA described the growing seasonal uncertainties as '*Climate Dice*'. Urban climate change is a major cause of concern as we live on an environmentally endangered planet. Larger cities are the hotspots of urban climate change. Urban climate is becoming one of the alarming environmental issues of the modern industrial-commercial world. It is because the adverse effect of urban climate change is largely inflicted on the middle income and lower income labor in the city majority of the developing countries like India. Nearly, 70 to 80 per cent of the population in India's large cities are lower- and middle-income inhabitants. Further, the population densities are alarmingly high in the urban built up spaces which inhabit 57 per cent of the global population on 5 per cent of the total geographical area.

Growing urban carbon footprint, excessive energy consumption and increasing greenhouse effect have led to unprecedented urban climate change. As per the United Nations definition, climate change refers to long-term shifts in temperature and weather patterns. Benton (1970) emphasized upon the role of carbon dioxide in triggering global warming and climate change. IPCC (2013) highlighted the physico-chemical basis of climate change. Adve (2019) highlights the adverse impacts of global warming and climate change on the downtrodden and deprived weaker sections. It brings out the growing problems faced by the defenseless labor of the exploitative unorganized sector of India. We should not lose sight of the fact that the private sector labor is the primary producer to the surplus economy.

Parameters of Climate Change

Climate change is the biggest challenge to environmental sustainability in the modern competitive and coercive world of globalization. Kulsum (2022) has measured the crucial parameters of climate change in the major cities of India. Climate change is characterized with seasonal extremities and weather uncertainties. There is distinctly emerging empirical evidence of expanding and further intensifying summer season in the tropics. There is also growing evidence of shrinking winters and diminishing spring season in India. Climate change is not a problem of temperature rise alone. In fact, the immeasurable 'sensible heat' is surmounting over the measurable temperatures. Increasing number of extreme heatwave days coupled with rising humidity have further compounded the enervative sensible heat. The number of calm weather days have considerably increased as another evidence of climate change in the Indian cities. The number of extreme warm nights have also considerably increased in the last 50 years. The frequency of thermal inversion has also increased in the Indian cities. As a cumulative effect of the hot enervative condition, morbidity is dangerously exceeding over mortality. In the climate change scenario, the 'post summer solstice' months in India are becoming more uncomfortable and enduring than the 'pre summer solstice' months of higher temperatures. It may be relatively easier to live with and manage the hot, dry early summer than the hot and sultry late summer monsoon season.

Rainfall occurrence and intensity has evidently changed over the large cities. This is leading to the recurrence of urban floods. Hence, urban climate change is an anthropogenically driven persistent natural hazard. If not seriously addressed at local level, the growing climatic uncertainties would further increase the income inequalities, marketing unreliabilities with decreasing economic growth. This inherently carries the processes of social exclusion in the developing poor countries. As a compound effect of climate change, there seems a decreasing feasibility of all the 17 Sustainable Development Goals of the United Nations.

Govindasamy and Caldeira (2000) suggested geo-engineering methods to restore the radiative balance in order to mitigate the effects of climate change. Thomson (2010) utilized the evidence of climate change in order to realize the limited options we have at our disposal to mitigate the problem. As a climate change remedial measure, Abrar (2018) highlighted the expansion and modernization of services in an Indian city of Pune. The modern services would curtail the physical mobility and the pollutant emitting greenhouse gases. It highlights the impact of modern e-services in reducing the transportation load and city congestion. Another study on the remedial measures of climate change by Abubakar (2021) illustrates the role of corporate houses in the modernization of large cities. The e-services and modern infrastructure would help reduce the urban congestion in the global cities. Aggarwal (2021) highlights the necessity of Judiciary's injunctions in setting limits to fire-crackers in curtailing the air pollution during the festivals. Anandh *et al.*, (2022) used the climate change models to analyze the future trends of wind velocity in India in order to harness the climate conducive green energy as a remedial measure to urban climate change.

Remedial Measures to Climate Change

As a public-cum-private sector remedial measure to climate change, it is crucial to harness the modernization of energy production and consumption. It is an index of modernization of industry, commerce, transportation, agriculture and the overall economy. Common place transformation of transportation to electronic vehicles is not too far a significant remedial measure to the unprecedented challenges of climate change. Fossil-fuel based energy is both combustible and cumbersome. On the other hand, solar, wind and tidal energy is non-combustible, non-conventional and clean, green energy. Consumption ratio between the non-combustible and combustible energy may be considered the ratio of modern versus traditional identity of a nation. As a remedial measure of environmental sustainability, we need a faster paradigm shift from the *Eco Frowning* Fossil Fuel Energy to *Eco Friendly* Solar, Wind and Electronic energy. Attridge *et al.*, (2012) have noted that the climate policy of India is embedded in a wider economic policy of a fast-developing country. Dolsak and Prakash (2018) have identified mitigation and adaptation as the two pillars of climate change management. Kulkarni (2022) has emphasized upon India's ambitions and priorities of climate action in the National Policy. It is to our own benefit of national sustainability as well as to the

advantage of the progeny, we need to popularize a new phrase of *Energy Harnessing and Future Security*. Due to a chain of remedial measures, India in 2022 has improved her rank from 10th to 8th position in Climate Change Performance Index (CCPI). It is suggested that a prudent energy consumption behavior with a contained urban carbon footprint is an indispensable remedial measure to climate change.

Conclusion

Urban climate change in the major cities of India may be seen as a consequence of top-heavy rapid urban growth and unprecedented greenhouse effect. As India is now the largest populated country in the world with over 1458 million population, the problem of labor-intensive economy doesn't seem to find a solution to the climate change for some time. The problem of labor-intensive economy and low national productivity can be related to the proportion of high rural-urban migration. Urban climate change may have a far-reaching impact upon the vulnerable poor industrial and commercial labor of the exploitative private sector. To address the threatening problem of urban climate change there is a need for the decentralization of the economy as well as urbanization. It is suggested to promote austerity in consumption behavior to reduce the burden of carbon footprint upon the environment. Restrained consumption and conservation is at least a passive production to control the inflation. It is suggested to reduce the domestic wastage of food which would help conserve the water for the ecology. There is a need to promote behavioral urbanism over urbanization. Export of water intensive crops like rice and vegetables is equivalent to the export of precious water of the ecology.

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FOSTERING SUCCESS: EXAMINING FIRST-GENERATION LEARNERS' EMPOWERMENT IN THE CONTEXT OF PATNA DISTRICT

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ABSTRACT

First Generation Learners (FGLs) are such groups of children whose parents and guardians are illiterate. Various studies indicate that FGLs are more likely to be older, women, ethnic minorities, and belong to economically weaker sections. Therefore, exclusive problems forbid them from reaching their goals. They withdraw earlier than their classmates. First-generation Learners in Patna, face a unique set of challenges as they pursue higher education. This research paper aims to study the barriers that hinder the academic progress and empowerment of these students in Patna. It explores the socio-economic, cultural, and psychological factors that contribute to their difficulties. Additionally, the paper examines various initiatives and strategies, both by educational institutions and policymakers, that can bridge the gap and empower first-generation students in Patna. The research emphasizes the importance of fostering an inclusive and supportive environment to ensure that these students can access and succeed in higher education. The paper is based on a multi-stage stratified random sampling of three hundred households in Patna.

Keywords: First Generation Learners, Inclusive Education, Economically Weaker Section, Gender, Academic Progress, Course Choice, Policy, Patna.

Introduction

Education stands as a cornerstone for personal and socio-economic development, empowering individuals with essential tools for success in the contemporary world. However, not all students embark on their educational journey from an equal starting point. First- Generation Learners (hereafter, FGLs), whose parents and guardians are illiterate, encounter unique challenges. India, with the enactment of the RTE Act in 2010, joined 135 other nations in recognizing education as a fundamental right for children aged six to fourteen. Initially, FGLs were a minority compared to Continuing-Generation Learners (hereafter, CGLs). With increased awareness and government support, a significant number of FGLs have entered the education system. They tend to be older, women, ethnic minorities, and from economically disadvantaged backgrounds, facing distinctive obstacles on their educational path, often leading to early withdrawal compared to CGLs.

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Many authors acknowledge that the presence of a large number of FGLs can affect the overall educational quality in a class, primarily due to their lower academic performance. This may result from a lack of preparedness, guidance, and support at home. Consequently, a substantial body of research has emerged, highlighting significant differences between FGLs and CGLs in terms of family support, available resources, off-campus living, work commitments, social and structural integration, study habits, course choices, and the impact of academic and extracurricular experiences, including working full-time while attending college.

This paper aims to analyze the obstacles that impede the academic advancement and empowerment of First-Generation Learners in Patna. It explores the socio-economic, cultural, and psychological factors underlying their challenges. Furthermore, it assesses a range of initiatives and strategies, originating from educational institutions and policymakers, that can mitigate the disparities and empower first-generation students in Patna.

Literature Review

The concept of First-Generation Students (FGLs) first emerged in 1978 at Iowa meeting addressing ways to identify non-financial obstacles to post-secondary education. In 1982, Billson and Terry became the first researchers to use the FGLs concept by publishing their findings on the differences in dropout rate among First-Generation Students and Second Generation Students in their work titled 'In search of the Silken Purse: Factors in Attrition among First-Generation Students'. The participation and experiences of First-Generation Learners (FGLs) in post-secondary education, as outlined by Auclair et al., indicate a disadvantage compared to their counterparts. This section delves into the socio-economic and demographic characteristics of FGLs, emphasizing factors such as age, gender, race, class, space, place of residence, individual characteristics, access issues, and educational aspirations.

Research underscores significant challenges faced by FGLs, revealing distinctions in age, gender, ethnicity, and economic status. FGLs are more likely to be women, belong to ethnic minorities, be older, and hail from economically weaker sections. Studies indicate a likelihood of FGLs to be 30 years or older, showcasing a delayed start in education. Gender differences surface in educational attainment, with females more likely to pursue advanced degrees. McCarron and Inkelas found out in their study that First-Generation males and females tended to have similar levels of attainment. However, females showed slightly higher attainment for degrees such as master's and Ph.D. 's, males showed slightly higher attainment for a bachelor's degree. Ethnicity plays a role, as FGL college learners tend to be more likely Hispanic, associated with lower-income and ethnic minority groups. US scholars Penrose, Warburton, Bugarin, and Nuñez focus on FGLs whose parents attended high school in small towns or rural areas. Rahman, Situ, and Jimmo add variables such as region of residence, place of residence

(rural or urban), and family structure to the explanation. Place of residence, region of the country, family income, rural or urban setting, and family structure impact participation in post-secondary education. Family structure, particularly single-parent families, is highlighted by Horn & Nuñez.

The intersection of race and class introduces unique inter and intrapersonal conflicts for FGL college learners in the U.S. Disagreement exists regarding the effects of FGLs' educational aspirations, with Billson and Terry suggesting that FGLs' aspirations are comparable to their counterparts. Access to education for FGLs is determined by various factors, including lower educational aspirations, academic preparation, limited parental support, and financial constraints. Auclair et al. differentiate between access and continuation of studies, examining participation proportions, social group distribution, and mechanisms leading to unequal participation. A gap exists between FGLs and non-FGLs in terms of educational aspirations, expectations, and encouragement. FGLs' status impacts the likelihood of dropping out, influenced by institution type and cultural origins. Differences in acquiring intellectual skills and academic performance are noted, with FGLs facing challenges in balancing work and education.

Encouragement and support from the community, family and friends greatly affect the educational plan of FGLs. An extensive review of the literature finds that a multitude of researchers have proposed that many families, siblings, and friends of FGLs' may not understand the benefits of the educational experience. This can lead to a barrier to attaining education and aspiration of FGLs. According to Auclair et al (2008), "FGLs mostly have weaker academic preparation than other students, and this affects the way they attend college, as most of them have to take remedial courses. But when the academic preparation is equal, the differences disappear between the FGLs and Non-FGLs at college". Faculty support becomes crucial, with recommendations for intensive counseling, support groups, and orientation programs aimed at FGLs. Quality interactions between FGLs and faculty are seen as facilitators for integration.

Objectives

- To study barriers that hinder the academic progress of FGLs
- To examine various initiatives and strategies for empowering First-Generation Learners in Patna

Methodology

Database: Data for this study is drawn from secondary and primary sources. Secondary data sources are NSS 64th Round, July 2007- June 2008, Report No. 532(64/25.2/1), NSS 75th Round, July 2017- June 2018, Report No. NSS KI(75/25.2), and Census of India District

Census Handbook (Primary Census Abstract, Village and Town Directory, 2011).

Study Area and Sample Design: The work tries to look into the role of different spaces in shaping the relative position of FGLs. According to NSSO 75th Round, the highest percentage of FGLs were registered in Patna (Table 1). Therefore, to analyse the objectives, Patna district is selected for the study.

Table 1: Households with First-Generation Learners, NSSO 64th & 75th Rounds

Districts	Total FGLs Households in Percent	
	64 th Round	75 th Round
East Champaran	1.32	3.58
Muzaffarpur	1.20	3.32
Vaishali	0.98	4.11
Madhubani	0.98	1.19
Patna	0.97	6.63
Bihar	21.03	14.28

Source: Computed from NSSO unit-level data, 64th Round (2007-08) and 75th Round (2017-18)

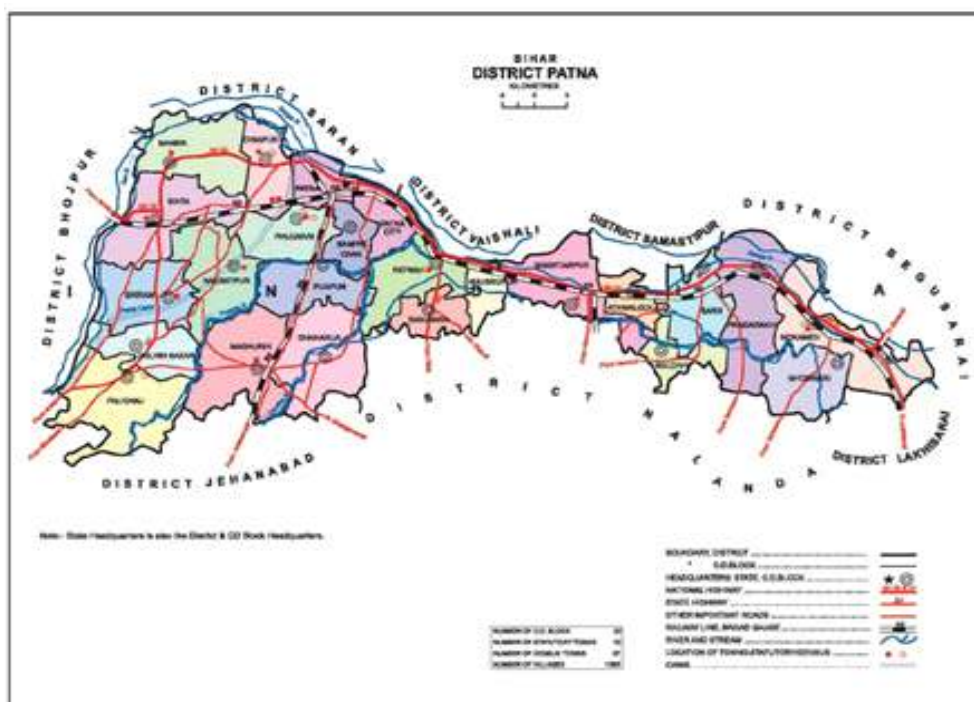


Figure 1 : Patna District



Patna district comprises a total of twenty-three blocks, from which one block was chosen based on literacy rate. Phulwari block, located in Patna, was selected for the study. Within this block, one town and six villages were further chosen to represent respective settings. A total of three hundred samples were selected: one hundred eighty from the six villages and one hundred twenty from the urban wards. The sampling method employed was Stratified Purposive Snowball Sampling to select sample households.

The field survey procedure encompasses several steps, starting with identifying First-Generation Learners' (FGL) households through a pilot survey. This involves the use of open-ended and multiple-choice qualitative questions. The survey also involves identifying schools and conducting focus group discussions. The study encompasses households with First-Generation Learners, regardless of age, which includes learners from both schools and colleges. It also includes those learners who dropped out, as well as illiterate or never-enrolled children.

Methods: To analyze the collected data, statistical techniques like frequency distribution and cross-tabulation are computed using the Statistical Package for Social Sciences (SPSS). Additionally, qualitative analysis is undertaken.

Result and Discussion

Barriers to Academic Progress

FGLs in Patna, often face challenges that restrict their academic journey. One of the primary challenges is socio-economic in nature. A significant proportion of FGLs come from economically disadvantaged backgrounds, where financial constraints significantly limit their access to essential educational resources. The burden of pursuing higher education often necessitates a delicate balancing act of combining studies with part-time work to support their families. This balancing act can lead to academic burnout, reduced performance, and ultimately, premature withdrawal from education. Inadequate access to resources such as a conducive study environment, and reliable transportation further compounds their difficulties.

Religion and Social Group

Approximately ninety-seven percent of the sampled First-Generation Learners' (FGLs) households adhere to the Hindu faith, with the remaining being Muslim. Of these, thirty-seven percent are classified as Scheduled Castes, while sixty-three percent are categorized as Other Backward Castes. More than 40 households belong to the Ravidas and Chamar communities, placing them at a higher risk of discrimination. This discrimination is particularly evident in the villages when compared to the urban wards. Notably, none of the First-Generation households fall under the general category/caste, a reflection of the historical subjugation of scheduled and backward caste populations.

Household Size and Overcrowding

Occasionally, larger household sizes result in an increased workload for female First-Generation Learners (FGLs). This became evident in the sampled data, where sixty-one percent of FGLs lived in households of medium size, typically consisting of five to seven members. Among the three hundred households surveyed, two hundred and thirty-eight were deemed overcrowded, lacking the necessary space and conducive environment for effective home study.

Economic Situation

The FGL category represents an economically disadvantaged sector of society. Over 50% of household heads are engaged in labor work, typically earning around 350-400 rupees per day with uncertain job security. A significant 55% fall within the poorest income quintile, 27% in the Poorer category, and 76% are landless, as land ownership is rare. Due to the backward and minority status of the surveyed group, land ownership is uncommon, with most rural households leasing land for cultivation. In Patna's urban areas, only 6% of households own land. Families allocate limited funds for education, with most students attending government schools.

Assets and Infrastructure

Female first-generation learners bear the weight of excessive household chores, leaving them with limited study time. The region generally enjoys an adequate water supply, with 47.7 percent having access near their premises. However, the task of fetching water predominantly falls on female family members, with 50 percent walking zero to two hundred meters. Only 1.3 percent have to travel further. Despite water proximity to 48 percent of households, the time saved doesn't necessarily reduce the overall water-fetching effort, as hand pumps are the primary water source. This necessitates carrying buckets, with 82 percent spending less than 5 minutes, while 18 percent find it laborious. Cooking fuel, primarily LPG, is common in many households, but females are responsible for procuring firewood and cow dung cakes. Approximately 34 percent must travel over 500 meters, taking over 30 minutes to gather these resources.

Choice of Course

Approximately 57 percent of females in Patna opt for arts or humanities, as science subjects often demand additional tutoring, which none of them pursue at higher educational levels due to limited financial resources. Families consider investing in girls' science tuition a poor choice, leading to zero cases of girls choosing this field. The prevalent belief is that girls will marry, making substantial investments in their education seem impractical. Consequently, arts, humanities, and commerce remain favored over science.

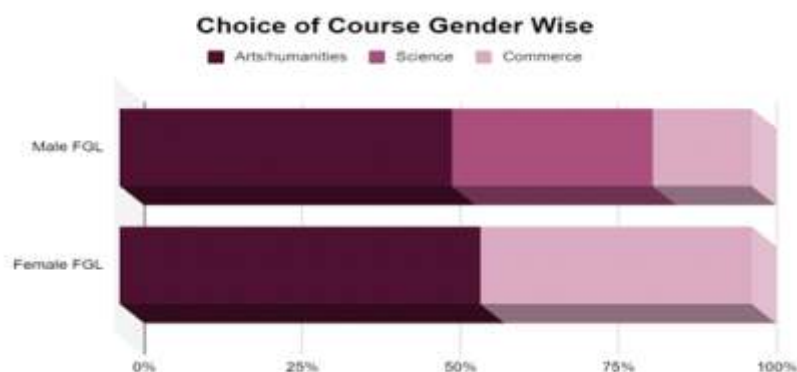


Figure 3: Gendered Selection of Course

Household Environment

In the context of female First-Generation Learners (FGLs), disparities between boys and girls regarding access to private education are evident. Approximately 82 percent of FGLs attend school regularly, yet girls often face challenges due to a lack of interest (60 percent) and domestic chores (40 percent).

Within their households, about 92 percent of FGLs receive support from elder siblings in their studies, and private tutoring is sought by roughly 90 percent, with a higher percentage among boys.

FGL girls in rural areas bear heavier responsibilities, including cleaning, cooking, water collection, and sibling care, amounting to 45 percent of rural children dedicating about five hours to domestic chores, with 73 percent being girls and 27 percent boys.

Furthermore, psychological factors, including self-doubt and feelings of imposter syndrome, are prevalent among FGLs. The lack of guidance from family members who have not navigated the educational system themselves contributes to a sense of isolation and hinders academic self-confidence. These psychological hurdles may deter FGLs from persisting in their educational journey.

It's essential to note that these barriers are not isolated issues but are often interconnected and mutually reinforcing. Socio-economic challenges can exacerbate cultural and psychological hurdles, creating a complex web of obstacles.

Empowering First-Generation Learners

Recognizing the unique challenges faced by FGLs, a range of initiatives have been implemented in Patna to empower these students. Educational institutions have introduced mentorship programs, which provide academic and emotional support. These programs pair FGLs with experienced students or faculty members who offer guidance and encouragement. Mentorship creates a sense of belonging and provides valuable guidance to navigate the complexities of higher education.

Policymakers have also taken steps to address the barriers faced by FGLs in Patna. Scholarships and financial aid opportunities have been expanded to alleviate the financial burden on these students. Access to financial support is crucial in reducing the economic barriers that often force FGLs to abandon their academic pursuits. By offering financial incentives and support, policymakers aim to level the playing field and create opportunities for all aspiring learners.

Furthermore, awareness campaigns have been launched to challenge cultural norms and emphasize the value of education, especially for female FGLs. These campaigns aim to shift the perception of education within communities and encourage families to prioritize the educational aspirations of their children. Such awareness programs are vital in promoting a cultural shift and enabling FGLs to pursue their educational dreams without the constraints of cultural biases.

Government schools and colleges provide many incentives in Bihar (Table 2). Some of the policies in Bihar are the Cycle Scheme, Remedial Coaching for students from weaker sections,

Bihar Student Credit Card Scheme, Chief Minister Girl's Uniform Scheme/ Uniform Scheme, Bihar Satabdi Chief Minister Girl's Uniform Scheme, State Medhvruti Scholarship, Bihar Mukhyamantri Protsahan Yojna 2020, Mukhyamantri Nishchay Swayam Sahayata Bhatta Yojana, Mukhyamantri Kanya Utthan Yojna under this all the girls who have.

Table 2: Schemes Implemented by Bihar to Increase Access, Equity, Inclusion

	Fees	Scholarship	Textbooks	School Uniform	Cycle	MDM
Pre Primary	Free		Free	Free		Free
Primary (I-V)	Free	I-IV: ₹600 V: ₹1200	Free	Free Uniform Scheme for all students I-II: ₹400 III-V: ₹500		Free
Middle (VI- VIII)	Free	VI: ₹1200 VII-VIII: ₹1800	Free	Free Uniform Scheme for all students VI-VIII: ₹700		Free
High/ Secondary (IX- X)	Free	₹1800		Free uniform only for girls: ₹1000	IX: Cycle Scheme for all: ₹2500	
XI-XII (School)	Free for SCs, STs and Women	₹1800		Free uniform only for girls: ₹1000		
Intermediate (College)	Free for SCs, STs and Women					
Bachelor	Free for SCs, STs and Women					

Source: Compiled from different sources. Selected Information on School Education 2011-12. Government of India, Ministry of Human Resource Development, Statistics Division, New Delhi, 2014. MDM stands for Mid Day Meal.

Conclusion and Suggestions

First Generation Learners in Patna face a unique set of challenges that hinder their academic progress and overall empowerment. This research paper has explored the socio-economic, cultural, and psychological factors contributing to their difficulties. It has also examined the various initiatives and strategies put in place by educational institutions and policymakers to empower FGLs in the region.

This study provides valuable insights into the unique experiences of First Generation Learners. Continued efforts must be made to support and empower this underrepresented group, as their

success contributes to the advancement of society as a whole. By addressing socio-economic, cultural, and psychological challenges and promoting an inclusive education environment, Patna can create a brighter future for its First Generation Learners, setting a powerful example for other regions facing similar challenges.

Lastly, the following factors can help FGLs to be empowered:

- Overcoming Socio-economic Challenges of FGLs
- Psychological Support and Mentorship
- Inclusive Education
- Quality and quantity of teachers at government schools as well as colleges should be enhanced.
- Skill development programmes for FGL should be organised.
- Free tutorials for FGLs should be arranged.
- Counseling sessions should be organised at both schools and colleges. Dropouts should be counseled as most of the time FGLs drop out due to lack of interest.
- Entrepreneurship and MSME (Micro, Small, and Medium Enterprises) Funding for encouraging small businesses.
- Inclusive academic environment to be created collectively by the institution only, school and society.

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IMPACT OF VARIABILITY OF RAINFALL AND TEMPERATURE ON AGRICULTURE SECTOR: A SPATIO-TEMPORAL STUDY OF WEST CHAMPARAN DISTRICT, BIHAR

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ABSTRACT

Climate is the sum of the long-term pattern of weather in a particular extensive area. At present time, climate change is a global issue. As a part of climate change, variability in rainfall and temperature can be seen at small scale. Rainfall and temperature both are very important climatic factors which affect the agricultural activities in an agrarian society and overall socio-economic status also. This paper aims to study about spatio-temporal variability of rainfall-temperature and resultant vulnerability in West Champaran district of Bihar. Agriculture is the main source of livelihood in the study area. Due to variability in temperature and rainfall, agricultural activities have been affected in manifolds. As a consequence of climatic vulnerability, flood and drought both affect their main source of livelihood and increase the input cost in agricultural practices as well as damage crops production too. Therefore, they have to move urban areas for getting perennial better economic opportunities. This paper is based on primary as well as secondary data. Primary data have been collected by observation method as well as interview method. Secondary data have been collected from various sources. The nature of the paper is descriptive and analytical. This paper will help in planning for the stakeholders.

Keywords: Agriculture, Climate, Livelihood, Rainfall-Temperature Variability

Introduction

Climate is the long long-term pattern of weather in a particular extensive area. An ideal period used for describing climate is 30 years, as defined by the World Meteorological Organisation. Climate consists of many variables such as temperature, rainfall, atmospheric pressure, humidity etc. Climate doesn't change daily as it is based on averages of atmospheric conditions on longer period of time. However, climate condition is variable as well as climate variability is the way aspects of climate (such as temperature and rainfall) differ from an average (Centre for Science Education, UCAR). Climate variability, which is defined by the World Meteorological Organization as “variations in the mean state and other statistics of the climate

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on all temporal and spatial scales, beyond individual weather events.” In simpler terms, variability is the range of climate compared to its average. The fluctuations comprising climate variability can influence patterns of rainfall, temperature and other variables on time scales anywhere from a few weeks to a few decades (Columbia Climate School International Research Institute for Climate and Society). Climate variability is often natural however, climate change is causing an increase in the probability of many extreme weather events and those events contribute to climatic variability. The term climate change refers to long term changes in temperature, humidity (not to day-to-day variations) and cloud (IPCC 2007). Climate Change is one of the biggest global challenges. It is important to recognise that climate change is part of a larger problem of environmental degradation that is occurring around the world. Climate Change tends to adversely impact on lives and livelihoods through increased temperature, inter and intra seasonal changes in rainfall and temperature regimes and sea level rise. If we talk about an agrarian society, the expected result is an overall decline in food grain production and trigger the rural-urban migration for getting better economic opportunities. Global climate change may influence long term rainfall patterns impacting the availability of water along with the danger of increasing occurrences of droughts and floods. Rainfall and temperature are one of the most important fundamental parameters of climate as these parameters determine the environmental conditions of the particular region which affect the agricultural productivity. Agriculture and allied sectors, food security and energy security of any region are crucially dependent on the timely availability of adequate amount of water and a conducive climate.

India is an agriculture dominant country and has around 195 million hectares land under cultivation out of which 63% area is rainfed while only 37% area is irrigated. Agriculture sector plays a vital role for food security and socio-economic development of the nation. Evidently, this sector is also particularly vulnerable to climate change as climatic variability is also a sign of climate change. Water scarcity, drought, erratic rainfall, groundwater depletion, intensified use of pesticides are expected to be major challenges for all agricultural sector in future.

In the study area 2,78,519 hectare is cultivatable land out of 4,84,351 hectares. 82.25% of total worker of the district is associated with agricultural activities. Paddy, Wheat, Sugarcane, Vegetables etc are the main agricultural product that are used to produce here. Total population of the district is 39,35,042 and population density of the district is 753/km². In the study area agriculture is main source of livelihood and 97% of farmers belong to marginal and small categories and they still not aware about smart agriculture. The study area shows that 1,33,700 hectares area comes under rainfed out of 2,71,000 hectares sown area which implies that nearly 49% of the sown area is dependent on rainfall for good harvest. If there is less rainfall, it impacts the economic health of farmers dependent on this.

Rainfall variability is a crucial climatic factor for society, agriculture and the environment. The rainfall received in an area is an important factor in determining the amount of water

availability to meet various demands such as agriculture, industrial, domestic water supply and for hydroelectric power generation. The pattern and amount of rainfall is the most vital factor that affect agricultural production and agriculture. In India, despite recent progress in industrialisation, the soundness of economy is significantly dependent upon the gross production of agricultural output and millions of cultivators' dependent upon natural rainfall for irrigation. Major kharif crops like paddy, maize, and sugarcane are totally dependent on strong south-west monsoon for irrigation and growth. Rainfall variability also connects extreme wet and dry events, floods and droughts which pose threats to the environment as well as society.

Besides rainfall, optimum temperature is also an important factor of climate that affect live and livelihood. Sometimes due to heavy rainfall they have to face the challenges of flood like situation and sometimes, due to high temperature and less rainfall badly affect their desiccation of crops. These climatic variabilities increased their input cost in agriculture and they feel vulnerable and for getting better economic opportunities they have been forced to migrate in urban areas.

Study Area

West Champaran district is situated in north-west corner of Bihar state. The district lies between 26°16' and 27°31' North Latitude and 83°50' and 85°18' East longitude. The district occupies an area of 5,228 km² and holds rank first in terms of area in the state with a population of 39,35,042. On the basis of latitudinal extension and geographical location, it comes under sub-tropical zone but on the basis of situation monsoon climate also can be felt. Based on changing pattern of weather, climate of West Champaran can be sub-categorised into three parts 1. Summer 2. Rainy 3. Winter. The district is primarily based on agriculture but also the area is seriously affected by flood during the monsoon season. During pre-monsoon drought persist making farming difficult for the farmers. Main crops Kharif, Rabi and Garma (Zaid) are grown.

Objective

The main objective of this research paper is to determine the trend of rainfall-temperature variability and its impact on agriculture in the study area.

Research Questions

How rainfall and temperature are varying annually in the study area?

How rainfall and temperature variability affecting the livelihood in the study area?

Methodology

This paper is based on primary as well as secondary data. Primary data have been collected by observation and interview method. Secondary data have been collected from various sources like newspaper, articles, Prediction of Worldwide Energy Resource of NASA etc. To show the variability in rainfall and temperature, Standard Deviation has been applied. MS-Excel software has been used for analysing the data. The nature of this paper is descriptive and analytical.

Result and Discussion

Rainfall and temperature are very important factor of climate that affect lives and livelihood. West Champaran district is primarily based on agriculture and variability in rainfall-temperature affect their agricultural activities. 82.25% of total workers of the district associated with agriculture and agricultural activities. In the study area 97% of its population belong to marginal and small category farmers and they practise agricultural activities in traditional manner. 49% of cultivable land is dependent upon rainfall for irrigation. Rainfall variability results in sometimes flood and sometime droughts.

Rainfall Variability

Rainfall variability refers to varies in rainfall from year to year. In other word, we can say rainfall variability means that it is likely to be irregular from one year to the next year- heavy rainfall in some years and little rainfall in another years. The data of rainfall of the period between 1981-2022 for West Champaran reveals its variability nature evident from the table given below.

Table 1 : Annual Rainfall in West Champaran District (1981-2022)

Year	Total Annual Rainfall (cm)	Year	Total Annual Rainfall (cm)
1981	128.672	2002	55.371
1982	87.012	2003	63.809
1983	51.68	2004	119.707
1984	95.977	2005	118.125
1985	110.742	2006	120.762
1986	82.266	2007	146.602
1987	110.742	2008	178.77
1988	101.25	2009	105.469
1989	66.973	2010	110.742
1990	99.668	2011	126.035
1991	60.645	2012	109.16
1992	58.535	2013	149.238
1993	64.863	2014	131.836
1994	62.754	2015	119.707
1995	79.629	2016	112.324
1996	84.902	2017	124.98
1997	68.027	2018	102.305
1998	84.902	2019	135.527
1999	58.535	2020	176.133
2000	90.703	2021	214.158
2001	83.32	2022	138.041
Average Annual Rainfall = 104.538 cm			

Source: POWER Project, NASA, USA

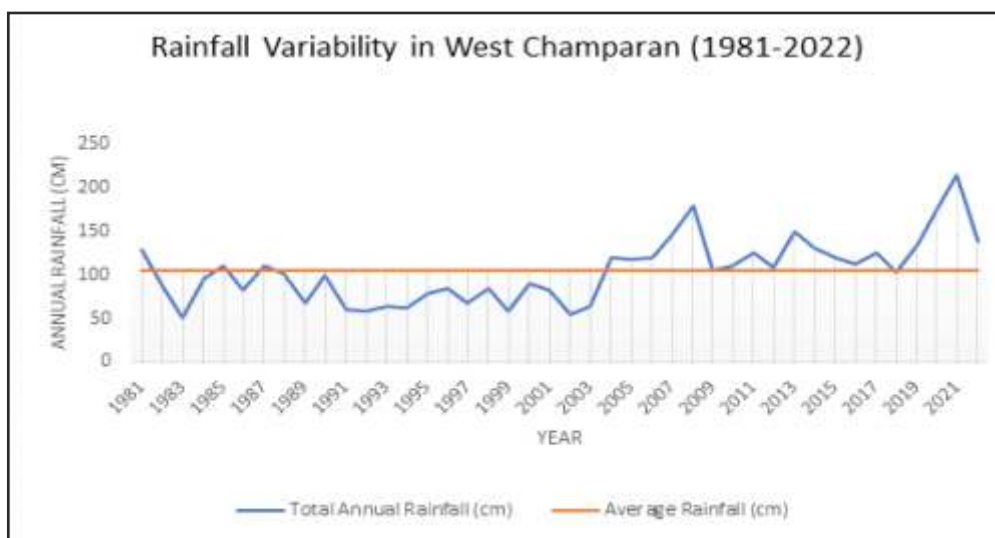


Figure 1 : Showing Rainfall Variability in West Champaran (1981-2022)

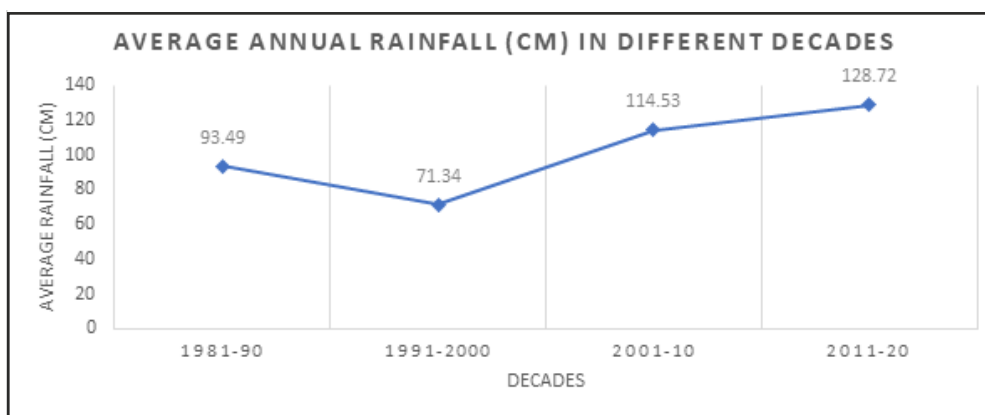


Figure 2 : Showing Average Annual Rainfall (cm) in Different Decades in West Champaran District

Source: POWER Project, NASA, USA, Chart prepared on MS Excel

Table 2. Standard Deviation of Rainfall(1981-2022)

Decades/Years	S.D.
1981-1990	21.34
1991-2000	11.74
2001-2010	34.92
2011-2022	30.01

Standard Deviation of annual rainfall for the time period of 1981-2022 = 35.81

$$SD = \sqrt{\frac{\sum (x_i - \bar{x})^2}{N}}$$

Where SD= Population Standard Deviation

X_i = Each Value from the Population i.e. Yearly Rainfall

$\bar{x}$ = Population Mean i.e. Mean Rainfall during time period of 1981-2022

N = Population Size i.e. Total Number of Years

Table 2. shows the Standard Deviation of annual rainfall for the period of 1981-2022 is 35.18 cm which shows the variability in rainfall from mean annual rainfall of 104.53cm. S.D. for last two decades are 34.92cm (2001-2010) and 30.01cm (2011-2022) respectively, which shows the high variation in rainfall as compare to S.D. of first two decades i.e. 21.34cm (1981-90) and 11.74cm (1991-2000).

Coefficient of Variation of annual rainfall for the time period of 1981-2022:

$$\text{Coefficient of Variation} = \frac{\text{Standard Deviation}}{\text{Mean}} \times 100$$

$$\begin{aligned} C.V. &= \frac{35.81}{104.53} \times 100 \\ &= 34.25\% \end{aligned}$$

In the district average annual rainfall of 104.53 cm occurred during the time period of 1981-2022. But it was 93.49 cm, 71.34 cm, 114.53 cm, 128.72cm of average (annual rainfall) occurred during first decade, second decade, third decade and fourth decade respectively in the time period of 1981-2020. Fig 1. and 2. show the increasing trend of average rainfall in West Champaran district. If we talk about last 30 years, 111.21 cm of average rainfall occurred. Annual total rainfall of 176 cm occurred in 2020 and 214 cm in 2021 which is the maximum rainfall ever occurred but just in next year 2022, only 138 cm rainfall recorded. During this period 51.68 cm rainfall occurred in 1983 which is minimum during this period. From the table 1. it can be seen that Less than 100 cm rainfall occurred in following years-1982, 1983, 1984, 1986, 1989, 1990, 1991, 1992, 1993, 1994, 1995, 1996, 1997, 1998, 1999, 2000, 2001, 2002 and 2003 (See Table 1.). After 2003 annual total rainfall always occurred more than 100 cm but not in a constant way. In 2003, only 102 cm rainfall occurred and in 2022 total 214 cm rainfall recorded that show the high level of rainfall variability in the study area.

Table 3 : Monthly Rainfall (cm) of June, July, August and September (1981 to 2022)

Year	June	July	August	September
1981	11.074	55.898	23.203	14.766
1982	11.602	23.73	19.512	14.238
1983	10.02	17.402	10.02	4.219
1984	20.039	25.312	21.621	23.203
1985	4.219	43.242	25.312	23.203
1986	14.766	32.168	16.875	4.219
1987	3.691	33.75	32.695	28.477
1988	11.602	33.223	34.277	8.965
1989	7.383	26.895	14.766	8.438
1990	12.129	57.48	15.293	11.074
1991	7.383	15.82	17.402	15.82
1992	8.438	18.457	15.293	8.438
1993	13.184	13.711	14.766	15.293
1994	8.965	18.457	12.656	17.402
1995	12.656	23.203	25.84	10.02
1996	13.711	18.457	30.059	8.965
1997	6.855	27.949	16.348	6.328
1998	5.273	28.477	30.059	12.656
1999	13.184	13.184	14.238	6.328
2000	23.203	18.984	23.73	17.402
2001	13.711	18.457	18.984	19.512
2002	7.91	15.293	8.438	7.383
2003	14.238	19.512	10.547	9.492
2004	20.566	39.023	20.039	12.129
2005	12.656	39.551	31.641	8.965
2006	25.312	34.805	20.566	22.148
2007	17.93	42.715	33.75	26.895
2008	45.879	52.207	40.605	22.676
2009	11.602	30.586	35.859	8.965

Source: POWER Project, NASA, USA

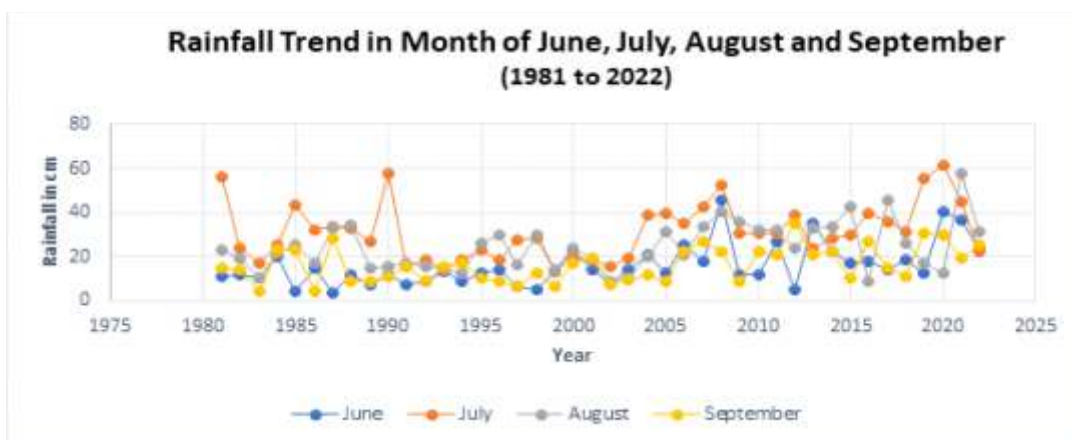


Figure 3 : Showing Rainfall trend in Month of June, July, August and September (1981-2022)

Source: POWER Project, NASA, USA, Chart prepared on MS Excel

In West Champaran district rainfall mainly occurred during South-west Monsoon season. 84% rainfall of total rainfall in a year occur in only four months, June, July, August and September. Table 3. Shows that during these four months average 88.12cm out of average 104.53 cm rainfall occurred during this period of 1981-2022. Average of 15.97 cm, 31.21cm, 24.54cm and 16.38 cm rainfall occurred in June, July, August and September respectively from 1981 to 2022. In the month of June during this period average rainfall is 15.97 cm but the high variability also can be seen, as 3.6 cm rainfall in 1987 and 45.8 cm in 2008. In the month of July during this period average 31.21 cm rainfall occurred. Minimum 13.18 cm in 1999 and maximum 61.17 cm in 2020 occurred which show the variability with range of 47.99 cm. During this period in month of August minimum 8.43 cm rainfall occurred in 2002 & 2016 and maximum 57.38 cm in 2021 with range of 48.95 cm. During the same period in the month of September minimum 4.21 cm rainfall occurred in 1983 and maximum 35.33 cm occurred in 2012 with range of 31.12 cm. In these particular months high level of variability can be seen during this time period as 42.18 cm, 47.99 cm, 48.95cm and 31.12cm rainfall range can be seen in month of June, July, August and September respectively (See fig.3 & table 4.)

Temperature Variability

Temperature is an important meteorological index to show hotness or coldness on certain scale of any region. Temperature variability affects different aspects of human welfare including health, agricultural production ultimately socio-economic status. In today's world extreme

event such as heat wave and increasing temperature are one of the most challenging aspects of climate change for societies.

Table 4 : Monthly Minimum, Maximum and Annual Average Temperature in West Champaran (1981-2022)

Year	Monthly Min. Temperature (°C)	Monthly Max. Temperature (°C)	Avg. Annual Temperature (°C)
1981	15.01	34.85	24.99
1982	15.56	35.47	25.83
1983	14.56	36.86	26.85
1984	14.96	36.02	25.35
1985	15.16	37.82	25.78
1986	14.23	36.94	25.83
1987	14.4	38.82	25.85
1988	14.83	35.55	25.9
1989	13.51	35.82	26.16
1990	16.6	37.62	26.35
1991	15.41	37.81	26.98
1992	15.53	36.62	26.87
1993	15.04	36.23	26.46
1994	15.77	37.41	26.9
1995	14.85	38.17	26.62
1996	14.61	37.22	26
1997	14.41	37.14	26.19
1998	14.33	37.86	26.37
1999	15.35	35.97	26.9
2000	14.71	35.76	25.66
2001	13.61	35.56	25.86
2002	15.18	35.41	26.92
2003	13.37	35.57	26.26
2004	15.06	33.7	25.28
2005	14.31	36.6	25.68
2006	13.79	34.9	25.23
2007	12.98	34.6	24.64
2008	13.94	34.65	24.56

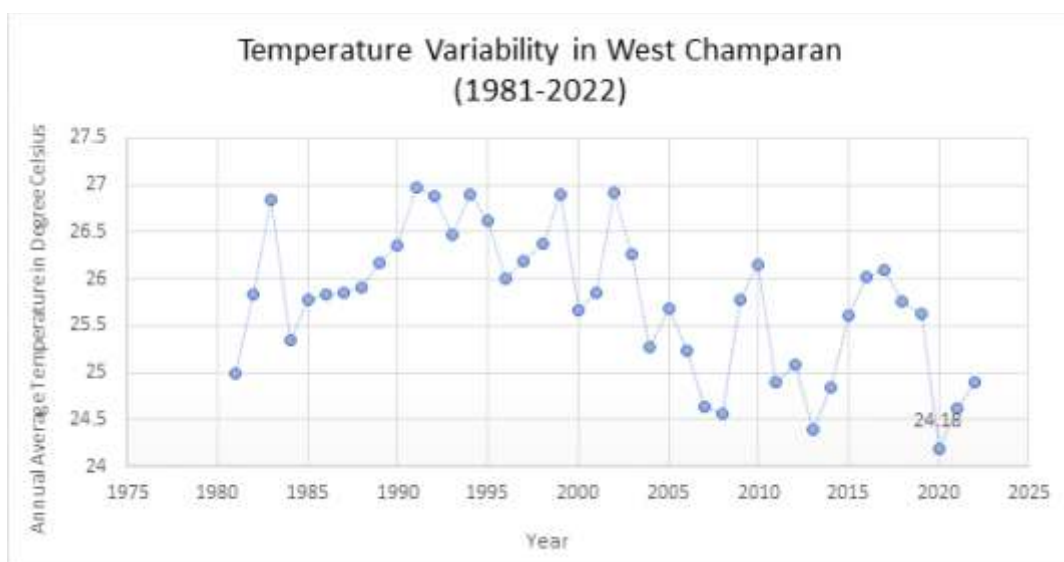


Figure 4 : Showing Temperature Variability in West Champaran District.

Source: POWER Project, NASA, USA, Chart prepared on MS Excel

Table 5. Standard Deviation of Temperature (1981-2022)

Decades/Year	Standard Deviation
1981-1990	0.48
1991-2000	0.42
2001-2010	0.69
2011-2022	0.61

Standard Deviation of Mean Annual Temperature for the time period of 1981-2022: 0.74

$$SD = \sqrt{\frac{\sum (x_i - \bar{x})^2}{N}}$$

Where S.D.= Population Standard Deviation

X_i = Each Value from the Population i.e. Yearly Temperature

$\bar{X}$ = Population Mean i.e. Mean Annual Temperature during time period of 1981-2022

N = Population Size i.e. Total Number of Years

Table 5. shows Standard Deviation of annual temperature for the time period of 1981-2022 is 0.74°C which shows the degree of variability in annual temperature from average annual temperature of 25.76°C . In last two decades/years SD is 0.69°C (2001-2010) and 0.61°C (2011-2022) which shows more variation in annual temperature as compare to first two decades of annual temperature as their S.D. is 0.48°C (1981-90) and 0.42°C (1991-2000).

Coefficient of Variation of mean annual temperature for the time period of 1981-2022:

$$\text{Coefficient of Variation} = \frac{\text{Standard Deviation}}{\text{Mean}} \times 100$$

$$\begin{aligned} C.V. &= \frac{0.74}{25.76} \times 100 \\ &= 2.87\% \end{aligned}$$

$$\text{Compound Variability of Rainfall and Temperature} = \frac{C.V. \text{ of Rainfall} + C.V. \text{ of Temperature}}{2}$$

$$\text{CV for the time period of 1981-2022} = \frac{34.25 + 2.87}{2} = 18.56$$

Figure 4. shows high level of temperature variability during the period of 1981-2022. Average annual temperature during this period is 25.76°C , but not always equal to this average temperature. 24.18°C average annual temperature, is the minimum temperature in the year 2020 and maximum annual average temperature 26.98°C in 1991 results the temperature range of 2.8°C that show the high level of temperature variability. In this period seventeen times average annual temperature was above 26°C , sixteen times 25°C to 26°C and nine times below 25°C . Annual average temperature was 25.89°C , 26.38°C , 25.35°C and 25.20°C in the first decade, second decade, third decade and fourth decade respectively during 1981-2022. In first two decades temperature increased and then temperature decreased. December and January are the coldest month in the year average temperature of December recorded 15.3°C and 14.62°C in January during this time period. January month of 2013 is the coldest month with 11.35°C ever. May is the hottest month in the year with average 35.12°C . 38.82°C is the highest average monthly temperature recorded in June of 1987 (See Table 4.). From above discussion it can be seen as rise and fall in monthly as well as annual temperature that shows there is no any certainty regarding temperature.

Variability and Vulnerability

The Standard Deviation of rainfall and temperature during the last two decades (2001-2022) is very high as compare to first two decades (1981-2000). During the recent years, variability in rainfall and temperature is seen more, which badly affect the agricultural practices of the

farmers, because rainfall and temperature being an important factor for better agricultural production besides soil and input labour. As agriculture is one of the most important sources of livelihood in the study area which get affected by variability of rainfall and temperature. In the study area *Garma*, *Bhadai*, *Kharif* and *Rabi* all the crops are being cultivated but the high variability in rainfall and temperature badly affects their cropping season.

Unpredicted and high level of variability in rainfall causes situations like flood and drought. Variability and vulnerability are interrelated to each other. When variability increases vulnerability also increase. From above discussion it showed that rainfall trend had been varied and rainfall increased also in last few years. Year 2020 and 2021 made attention with heavy rainfall of 176 cm and 214 cm respectively. West Champaran district is very rich in network of river system. Heavy rainfall in the district as well as rainfall in Terai Region and Someshwar Range increased the volume of water in rivers like Gandak, Harha/Masan, Pandai, Manihari and Sikrahana etc. Blocks like Bagaha, Piprasi, Thakhranha Sidhaw, Madhubani, Bairiya, Bhitaha, Chanpatiya, Lauriya, Ramnagar, Narkatiyaganj, Mainatandare mostly affected as they are situated near the Gandak, Sikrahna (Burhi Gandak) rivers and their tributaries.

The primary data collected by interviewing several farmers of different blocks from the study area shows the degree of severity in these places. A local affected farmer from Sidhaw Block (Bagaha-2) says that during the year of normal rainfall approx. 16 quintal of rice was produced on 1 acre of land but in the recent years (2019-21) due to heavy rainfall their production reduced by 40-50% accounts for only 8-10 quintals due to destroying of standing paddy crop in the field. He also mentioned that due to irregular pattern of rainfall they fail to start ploughing and sowing the field on time. Generally, they used to sow the paddy crop in the last of June, but delay in onset of monsoon compel them to either setting back their paddy cultivation or depends on irrigation facility which hiked the input cost, consequently reducing their agricultural income and forces them to migrate. Less rainfall in the end of monsoon period makes the soil moisture deficient hence affecting the Rabi crop production.

Another farmer from Biranchi Village (Mainatand Block) situated near Manihari river stated that due to heavy rainfall in short span of time increases the water level of Manihari River and its bank erosion wreaked havoc in the village, as a result about 200 acres of land had been engulfed by the river worsening the cultivation practices of farmers.

A consensus of all interviewed farmers related to vegetable farming stated that the flowering season of vegetables get affected due to heavy rainfall and water logging, results in failure of vegetable production. Because of these climatic vulnerabilities, people have to migrate towards urban areas for getting better economic opportunities.

During visit in study area, it has been observed that temperature variability also like high temperature and less rainfall cause condition of drought, affecting their agricultural activities. During the advent of summer season due to high temperature and blowing *loo* (the most dried wind) desiccate the wheat plant resulting in stunted wheat grains.

In the regime of deficient rainfall water table goes down and surface water vapourised away which makes the watering of Zaid (*Garma*) crops like vegetables, garma paddy field, and maize difficult.

Very high temperature triggers heat waves and *loo*, the local wind blows in the study area affect their health. Due to heatwave conditions, significant influx of patients suffer from a variety of heat related illness like skin diseases, dehydration, heatstroke, stomach disease and headaches. Not only high temperature, Minimum and decreasing temperature in month of December and January also affects their lives and livelihood.

According to report of Mapping India's Climate Vulnerability, A District Level assessment, 2021 by CEEW (Council on Energy, Environment and Water) West Champaran district comes under category of flood hotspot zone. West Champaran district holds rank 13 with vulnerability index score of 0.925.

Conclusion

From above discussion it can be concluded that West Champaran district is climatically vulnerable district mainly by floods. Rainfall and temperature are very important factors of climate which are responsible for the proper growth of crops and their production as well as practising sustainable agricultural. But, uncertainty and high variability in rainfall and temperature affects their agricultural practises. The area faces excess rainfall in July-August and deficient rainfall at the end of South-West Monsoon affects the rabi crops. The main source of livelihood in the district is agriculture and due to climatic vulnerability, their livelihood is being threatened which promotes rural to urban migration in search of better economic opportunities. Climate change is one of the most pressing threats to humanity, and it has no simple solution. To mitigate climatic vulnerability as well as to improve their socio-economic status, government policies should be implemented at ground level. To curb the migration at local level alternate source of livelihood should be developed. Sense of awareness and preparedness should be infused among the community in respect to climatic vulnerability.

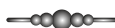
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CHANGING FOREST COVER AND CHALLENGES FOR SUSTAINABILITY IN JHARKHAND, INDIA

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ABSTRACT

The changing forest cover and challenges for sustainability in Jharkhand is the subject matter of this paper. The study analyzed forest as a resource, the change of forest covers (loss), to explore the causes for concern deforestation and propose sustainable forest management programmes in Jharkhand. Forest utilization is threatened with accelerating deforestation. The rate and trend of deforestation is challenging. Policy department has not received the attention they deserve. The state of Jharkhand is ethnically diverse but economically very poor. About 50 % of its total population is below the poverty line and 80 % of the population is dependent upon rain fed-based agriculture and productivity which is very low. The study has the following objectives i) to examine the spatial and temporal processes of changing forest cover, ii) to explore the problems and causes related to deforestation, and iii) finally, propose sustainable management programmes in the tribal and non-tribal regional society and their prospects. To achieve this objective the state of Jharkhand is selected for study which is well endowed with forest resources with approximately 30 percent of the total area under forest cover. The study area covers about 4 percent of India's total forest. The study uses secondary source of data obtained from Annual Report of Forest Survey of India, Forest Research Institute, India and Action Plan of Jharkhand. The study identifies and suggests approaches to sustain and manage deforested areas in Jharkhand. It creates awareness and policy interventions among community in decision making and support system to conserve, manage and planning of natural forest. It will certainly fetch better result in decision making support system.

Keywords: Distribution of forest, Deforestation, Economic and Political forces, Forest management, Tribal and non-tribal society, and forest sustainability.

Introduction

The changing forest cover (Deforestation) is a rampant phenomenon. It occurred throughout the world and represents a global issue mostly caused by human influence. Since the early 1970s it has increased markedly and become a major environmental challenge because of its role in reducing biodiversity, increasing global warming and expanding desert (Haigh, 1999). Deforestation is not only evident at the national and regional levels but also at the local level because the cause of forest depletion varies from region to region (FAO, 2005). Recently, it is a big challenge before the state of Jharkhand, India which has posed a threat to livelihood support to the people and key to the economic and socio-cultural life of tribes and provide

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abode to a large tribal population of India. Jharkhand has lost some of the precious forest covers and its products since its formation; it is because of increasing pressure of human population and reclamation of forested land for cultivation, construction of dams, roads, mining, industries, power plants, extension of settlements and also many other uses like growing demand for timber and firewood; the demand for raw material and fuel by industries; and the demand for wood for sleepers and fuel by the railways. The enormous demand thrust by the railways on forests was leading to deforestation. To meet these needs people have destroyed the forests and converted them into food growing fields or space for house building etc. Therefore, limiting human population growth is essential for sustaining forests resources. There are some encouraging current trends toward maintaining forests and aquatic ecosystems. But the rate and trend of deforestation is alarming and challenging.

Deforestation

Deforestation is defined as the loss of trees cover or cleared of forest land to put for other uses (Gorte and Sheikh, 2010). The initial definition of deforestation was a change in forest area over time. But forest area is an ambiguous concept. At the global scale, it varies widely with no obvious trend (Allen and Barnes, 1985). Deforestation has long been the imputed cause of ecological degradation. According to Forest Department, deforestation only occurs when the forestland transfer to other purposes. The conversion of woodlands to other land uses is an index of deforestation. The land under the forest department when overexploited or clear felled is not considered as undergoing deforestation, because it can always regenerate and re-forest itself. Here, forest is a legal category, and any land so defined is forest area, irrespective of tree cover. Hence, department lands face deforestation only when that land is transferred to others uses through disforestation or declared as non-forest land. Most studies agree on roughly similar definition of deforestation and forest degradation. 'Deforestation', is the complete clearing of tree formation and their replacement by other land-uses (Lanly, 1982). 'Degradation', on the other hand, involves significant degrading of forest ecosystems without eliminating the forest cover outright (Myers, 1989).

Deforestation is an environmental problem that threatens the survival of the entire biosphere. It directly influences the climatic variables. The changing amount of rainfall and increasing degree of temperature causes water scarcity and affects hydrological cycle also. The forests remove atmospheric carbon dioxide and transform it into wood, soil, peat, coal etc. and also pump water into the atmosphere. The moisture produced creates clouds, which cool both the forests and the planet by reflecting solar radiation. The rain from these clouds helps to sustain more forest in areas that would otherwise be too dry (Dickinson, 1987). Deforestation is also reducing the planet's ability to cool itself by removing carbon dioxide from the atmosphere. There is frequent drought and flooding because of loss of resilience of the ecosystem. Therefore, forests play a key role in maintaining water quality, clean air, and help in regulating

climate, floods pollination, biological control of diseases, etc providing various regulating services (Bahuguna and Bisht, 2013).

Deforestation started in India by the British, which continued even after the Independence. The teak forests were over-exploited to meet the requirements of British Navy. The sandalwood trees of Karnataka found their way to European markets. The early years of railway expansion (1853-1891) used the Himalayan deodar forest wood for railway sleepers. Before the coal mines of Damodar valley become fully operative, the railway companies also used local timber as fuel for the locomotive. Since Independence, deforestation has assumed alarming proportion. In fact, trees were cut on the pretext to suit a variety of needs. It is a district wide phenomenon. In Jharkhand the conversion from forest to other uses is not new; indeed, it has been occurring for many centuries and can be attributed to many causes. But, the greatest acceleration in deforestation has been in recent decades. The key to that process lies with the social and political fabric of the ruling oligarchies in the countries concerned and their control of the land and its resources. The growing demand for food and fuelwood, Industries, mining and quarrying activities and construction of roads and dams leads to deforestation. It is also ruthlessly depleted by illegal greedy contractors and other agencies without considering the implications of forest cover on environmental degradation and soil erosion in Jharkhand.

Deforestation is still going on and the rate is also very high in the plateau districts which are good grazing grounds for domesticated animals throughout the year. Due to state government's permission, private contractors also exploit timber for commercial purposes. But they destroy the forest through reckless and immature cutting of trees for their maximum benefit. In this process, highly affected species are Eucalyptus, Shisham, Teak, Chir, Deodar, Fir, Spruce and Kail. This type of exploitation accelerates deforestation. The cutting of wood for fuel is taking place by the Forest Department, purchasers, right holders and free grantees. The average lopping rate by a family per year is very high which is expected to shoot up in near future also. Awareness of the deforestation problem in India emerged in the early 1970s when several study by scientists of possible adverse impacts on ecosystems and climate (Myers, 1980).

Literature Review

This paper reviews briefly the world-wide tropical deforestation and then focuses on national and regional level. This review shows that research literature on deforestation is complex, multidisciplinary, scattered and often hard to evaluate. Many scholars have shown that deforestation in developing countries is one of the outcomes of relationship between population growth and the environment. Population growth contributes to deforestation both directly by encroaching on land and indirectly by increasing the demand for food products in the country (Rudel, 1995). According to Grainger, 1993 and Myers, 1994 deforestation is a complete destruction of forest cover through clearing for agriculture and other purposes. It

means deforestation is a permanent conversion of forest land use to non-forest land use area. As per Food and Agricultural Organization (FAO), deforestation is the complete clearing of tree formations and their replacement by non-forest land uses. It is considered as the quantitative reduction in the structure or density of the forest and qualitative deterioration of the forest, resulting from human interference, which adversely affects the ability of forest to perform its functions. Deforestation is not only identified in terms of the declining forest cover, but also in the function of extracting more wood than the reproductive capacity of forests. In Jharkhand the forest cover is being severely depleted at a fast rate. It may have constructive or destructive consequences depending upon ecological conditions over time. Conventionally, the conversion of woodlands to other land uses has also been seen as the index of deforestation. The pace of deforestation is very high with district wide variations being significant. Major part of loss in forest cover occurred in the densest part of western and northern area of the state.

Deforestation compels the people to clear the land for cultivation or forces the people to depend on fuelwood required for energy consumption. Myers (1993) suggests population expansion, poverty, national indebtedness, migration, economic development, expansion of road networks and political policies are the basic destructive practices of deforestation. Angelsen (1995) also supported that deforestation is an investment when it gives land rights to a farmer. It is not the population but market forces that regulate the deforestation process. Improved technology, higher output prices, lower transportation cost: lower opportunity cost of labour, tenure security will also increase deforestation. Tole (1998) indicates twin processes driving deforestation including development and scarcity. Scarcity includes population growth/ density, economic stress, value of forest products, pressure on land, encouraging conversion to pasture or arable land, and per capita energy consumption, because wood is a traditional fuel (Bawa and Dayanandan, 1997).

The paper by Thapa and Weber 1991 on Deforestation in the Upper Pokhara Valley, Nepal deals with its spatial and temporal processes. Due to massive deforestation and consequent soil erosion, the study area has become focus of environmentalists' concern at the international level. The study has used land use maps of three years 1957, 1978 and 1988. The forests are composed largely of broadleaf evergreen species. Major causes identified are expansion of agricultural lands, shifting cultivation, fuel wood, fodder and livestock grazing. The authors have suggested the forest conservation and management strategy in the form of decentralized forest management, changing the mode of economy and population control. This strategy will also be conducive to institutionalizing sustainable rural- regional development. Several researchers have also evaluated the deforestation in various parts of India as relatively high, Menon and Bawa, 1997; Giriraj et al., 2008; Josheph et al., 2009; Reddy et al., 2017; (Ahmad and Goparaju 2017), using remote sensing and GIS for large-scale deforestation occurred in the forests in Jharkhand.

Kumar and Saikia 2020, studied Forest Resources of Jharkhand: Socio-economic and Bio-ecological perspectives and suggested that attempts should be made for its large- scale cultivation and multiplication in order to meet its escalating demand as well as long-term sustainability. There is an urgent need to carry out detailed investigations on the geographical distribution patterns, habitant utilization patterns, feeding ecology, and impact of herbivores on important plant populations. Again they presented the patio-temporal forest cover change in Palamu Tiger Reserve, Eastern India, using temporal remote sensing imageries during 1975-2015 to deduce the influence of natural and anthropogenic factors in forest cover change. The study showed minor forest loss (1.34 %) was observed in the north-eastern and north-western parts due to the high population and settlement density. There was no significant forest degradation observed, which shows that the state forest department of Jharkhand took authoritarian maintenance efforts.

The review of the various attempts for finding the process of deforestation is not very simple and breeds difference of opinion among the authors, though all face the problem with the same objective. Therefore, this study in particular, will examine the status of forest, the causes of deforestation and to propose sustainable forest management programmes in Jharkhand.

Objectives, Data Source and Methodology

The main objectives of the study are to: i) analyze the district level pattern of forest resources of two decades between 2001 and 2021, ii) explore the problems and related causes of changing forest cover and iii) finally, to propose sustainable management programmes in the tribal and non-tribal regional society. The present study is based on secondary source of data. District has been used as a unit of study. The study includes 18 districts at base year 2001 and 24 districts in current year 2021. To avoid the problem of collecting and splitting the data only 18 districts have been considered for analysis. To depict the changing pattern of deforestation, the two time periods chosen pertains to 2001 and 2021 respectively because the formation of new state Jharkhand came into existence in 2000. Data of 24 districts are not available at base year. The forest cover data from 2001 to 2021 has been collected from various sources: like Annual Reports of Forest Survey of India, 2003 to 2021; Forest Research Institute, India, Statistical Handbook and Action Plan of Jharkhand 2005, and also from agencies and organizations. The spatial distribution of forest cover during the last two decades (2001-2021) has been also collected from Satellite and Internet Websites. Data has been represented with the help of Tables and Figures. For explanation diagrammatic and cartographic techniques have been used at various levels. To identify the levels of deforestation in Jharkhand has been analyzed with the help of maps, official report, books, journals, articles, newspapers and internet websites. Further, choropleth maps of Jharkhand have also prepared to demarcate deforestation regions into high, medium, low and very low category for both the periods and analyzed in depth.

The Study Area

The state of Jharkhand is the study area. It is located in the easternmost continuation of the Peninsular India. The word 'Jharkhand' itself means “land mass covered with bush or forest” and is the home for various ethnic tribes such as Munda, Oraon, Ho, Santhal, Paharia and traditionally, these indigenous people have friendly relations with nature and forests. Jharkhand has regular land locked boundary from all sides. The state has amorphous shape with narrow base in the south and broad in the north. It is surrounded by hills, intermountain, rivers, river valleys, streams and forests. It extends from 21° 58'N to 25° 18'N latitudes and 83° 23'E to 87° 57' E longitudes (Figure 1). It is bounded by fertile alluvial Middle-Ganga plain in the north (or 150 m contour line), Odisha in the south, West Bengal in the east and Uttar Pradesh and Chhattisgarh in the west. Jharkhand has been blessed with plentiful natural resources (such as minerals, forests, flora and fauna, land, water, and energy) due to its favorable climatic and topographic conditions which provide basic foundation for development. It is endowed with natural resources that need to be conserved and utilized in a sustainable manner for all-round development of the state in general and the marginalized tribal population and forests in particular. Jharkhand lies under the tropical monsoon climatic region which has the luxuriant forests and lush green rolling seasonal meadows since the ancient times. It has attracted many tribes; Munda, Oraon, Ho, Santhal, Paharia, who later on settled in this region due to their dependence on forests resources. Local festivals like 'Sarhul' and 'Karma' are customarily related with worshipping of trees. Jharkhand is prone to forest fires due to the dominance of dry deciduous forest that is occupied by tribal people. They are dependent on the forest for their livings and are often blamed for forest fires (Megevand, 2013 ; Banerjee and Madhurima, 2013; Kumari and Pandey, 2019). The forest depletion and degradation was started long back in Jharkhand. Nature has carved out its form, but man has defined its significance by his attainment.

Jharkhand is a home of 32.3 million people comprising 2.72 percent of India's total population. Population density is 414 persons per km² Census of India 2011 which is marginally higher in comparison to India (382 persons per sq. km). The proportion of population living in urban areas is 20 percent. Culturally, the region is well marked on the map of India for its tribal population. There are 30 tribal groups living in this state, which include eight minor tribes, known as Primitive Tribal Groups (PTG). This area is the home land of aboriginal races pulling such as the Sandals, Munds, Orisons, Hoes, Chair, Bruin, Birchers, etc. These indigenous people of the area are known as *Adivasi* literally meaning 'original settlers' or the earlier settlers.



Figure 1 : Study Area

Forest Resources of Jharkhand

Forest is a fundamental component of environment and one of the great resources of Jharkhand. It plays a vital role in the sustenance of life, economy, culture and social lives and supporting rural livelihoods for food security. It provides several benefits of basic human needs like food, medicines, shelter, environmental services to ecosystem, timber, fuel, fiber and fodder for domestic animals, raw materials for industries, and social values and many other products required in almost every walk of life. Apart from that, forest also indirectly controls floods and drought; checks soil erosion, landslides and desertification; maintains atmospheric temperature; and increases rainfall and humidity. Perhaps the most distinguishing characteristics of this resource are that the survival of mankind depends upon the distribution, availability, use and proper management of bio resource. It is threatened by human activities of growing population. Perhaps a more important attribute is that their varieties are disappearing at an unprecedented rate give birth too many environmental problems the humanity is facing today (Wilson, 1989).

A forest is a group of trees growing closely together with either meeting or overlapping canopy, (Abhay, 2012). A forest is a collection or a stand of trees in which canopy is generally closed. It is a continuous and extensive area of land dominated by trees of any size, which represent the natural cover of the land or have been specially planted and which is capable of producing

timber or other forest products. Jharkhand is home of tropical moist deciduous forest and the dominant plant species and variety of animals, insects, birds, amphibians, reptiles and mammals live. The state of Jharkhand has larger areas under natural forest about 23,605 sq km (29.45 % of the total area) which contains reserve forest of about 18.6 %, protected forest of 81.3 % and unclassified forest about 0.1 %, which were gradually cleared for several uses (agriculture, mining, industrial, settlements and urban growth), Ministry of Forest and Environments 2021. The per capita forest area in Jharkhand was estimated 0.88 hectare. It ranks 10th among all the states and Union Territories of India considering the area under forest cover. Forests resource represents the climax form of vegetation which is one of the important and conspicuous geographic features. It plays an important role in the development of Jharkhand.

Over-exploitation of useful plants, lack of knowledge and awareness about the plants, over-grazing are some of the severe threats endangering the existing plants. They perform protective as well as productive functions. Protective functions are moderating local climates, regulating stream flow, reducing soil and controlling floods. In addition, forests also play a vital role in enhancing the quality of environment. Forests provide productive function through the sale of firewood and forage, grazing, logging and grass cutting, forest-based handicrafts and cottage industries, sericulture, lace husbandry beekeeping, charcoal burning, plate making from leaves, liquor making, rope making and basketry, medicines collection, processing and marketing. It also provides secondary employment and livelihood opportunities for tribal people, notable among them are sawmilling, rayon, pulp and paper, plywood and panel products, wood seasoning and preservation, tanning, sports goods, match splints, veneers, wooden boxes bamboo and cane products, agricultural implements, furniture, structural wooden items musical instruments, bidri making educational goods wood carving, wooden utensils etc. (Pant, 1984; Gera, 2002).

Tribes are nature loving people who live in harmony with nature and maintain a close link between man and the environment (Sajem and Gosai, 2006). They pay great respect to trees, flowers, animals, birds etc. and depend mainly on forests and its product. The dependency on forests is very high because there are 17 tribal districts out of the total 24 FSI (2017). Tribes and forests have the symbiotic relationship (Saha and Sengupta, 2014). The people living in and around these forests live off these products which give them succor in times when no other livelihood opportunities and food are available to them (Kumar and Saikia, 2020). Economic activities, domestic livelihood system and herbal medicines all are gathered from the forests. But the forests are being depleted at a faster rate. In this process, Jharkhand has lost some of its precious forest cover (about 1.22 %) since its formation, but the forest cover has slightly increased from 28.34 % in the year 2005 to 29.61 percent in the year 2017, ISFR (2017). Such dense forest is a good house for most of the wild animals. It provides natural habitat and

favorable surroundings for their survival. But diminishing dense cover poses a threat for the future prospects of the wildlife. To tackle this problem, the Central Board of Forestry has recommended that forested areas should not be diverted to non-forestry uses and in case of any inescapable diversion; it should be adequately compensated by providing equivalent alternative land for afforestation.

Forest Cover Change Between 2001 and 2021: The Forest Survey of India began analyzing the density (above 40 percent), open (crown density between 10 and 40 percent) and degraded or scrub forests (crown density below 10 percent). Forest degradation can result in denudation of the forest land due to over exploitation and lack of regeneration. The dense forest areas constitutes about 15 percent are distributed in the northwest and the southeast of the State, the open forest areas are evenly distributed in the north, central and southeastern parts of the State and constitute about 13.6 percent of the forested area whereas the non-forested area is about 71.6 percent of the State's geographic area. The Forest Survey of India in the biannual State of Forest Report (SFR) reported the net annual loss of 99,850 ha of forest in Jharkhand during 2009, 2011 due to high level of urbanization in Ranchi district (Kumar and Saikia, 2020).

However, the total forest area has been gradually increased from 2011-2019. The increase occurred mainly due to the adequate protection including plantation drive and forest protection measures by the Village Forest Protection Committees (VFPC) and also State Forest Department FSI (2011). Initiatives have been taken by the State government to increase its forest cover in response to climate change. Forest Resource Survey are also being conducted at district level for better management and planning which also includes utilizing the existing infrastructure for tackling the wasteland development on non-forest areas. The state also formed Joint Forest Management (JFM) committee besides forest- based livelihood development, wildlife management, biodiversity conservation, clean environment and waste disposal plans.

During the year 2001 to 2011 about 194 km² of area was brought under tree cover; similarly, the tree cover in about 162 km² of scrub land has also improved. The net area under very dense forest has reduced during the last decade but no changes in area have been seen during the last five years. Physical conditions like topography, soil erosion, forest fires and flood act as a platform on which human factors are working upon, aggravating the deforestation process. The forest destruction was initiated by the British, which continued even after the independence of India. Forest was declared a state property, upon which local people did not have any legal rights. On the one hand, forest destruction was done on a large scale by the government. On the other hand, increasing population put pressure on the existing forest. In the initial phase, forest destruction was a slow process, but later on, it increased rapidly with market demand of timber. It remained high for a long time, due to the policy of Government of

India to increase food and industrial production in the country. Due to shift in government's policies in eighties of preserving and conserving forest resources, the commercial exploitation was stopped in the state, but, the deforestation is still going on. Table 1 provides the district-wise forest cover in Jharkhand, 2001.

Table 1: District-Wise Level of Forest Cover in Jharkhand, 2001

Range	Figure in percent	Name of Districts
Very high	> 40	Chatra, Kodarma, Palamu,
High	30 - 40	Garhwa, Hazaribag, Lohardaga, Pashchimi Singhbhum, Sahibganj
Medium	20 - 30	Gumla, Purbi Singhbhum, Ranchi, Bokaro
Low	10 - 20	Giridih, Godda, Pakur
Very Low	< 10	Dumka, Deoghar, Dhanbad

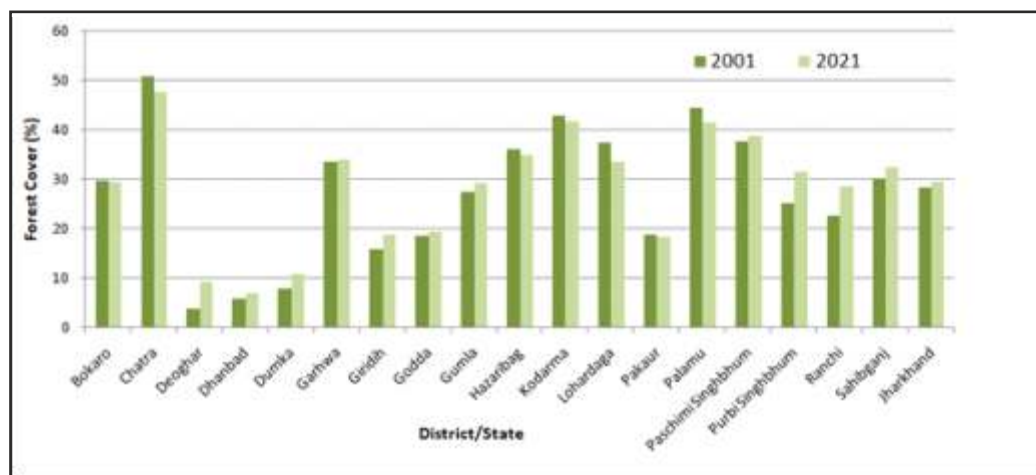


Figure 2 : Jharkhand: District-wise Changing Forest Cover, 2001-2021

Table 2: District-Wise Level of Forest Cover in Jharkhand, 2001

Range	Figure in percent	Name of Districts
Very high	> 40	Chatra, Kodarma, Palamu,
High	30 - 40	Garhwa, Hazaribag, Lohardaga, Pashchimi Singhbhum, Sahibganj
Medium	20 - 30	Gumla, Purbi Singhbhum, Ranchi, Bokaro
Low	10 - 20	Giridih, Godda, Pakur
Very Low	< 10	Dumka, Devghar Dhanbad

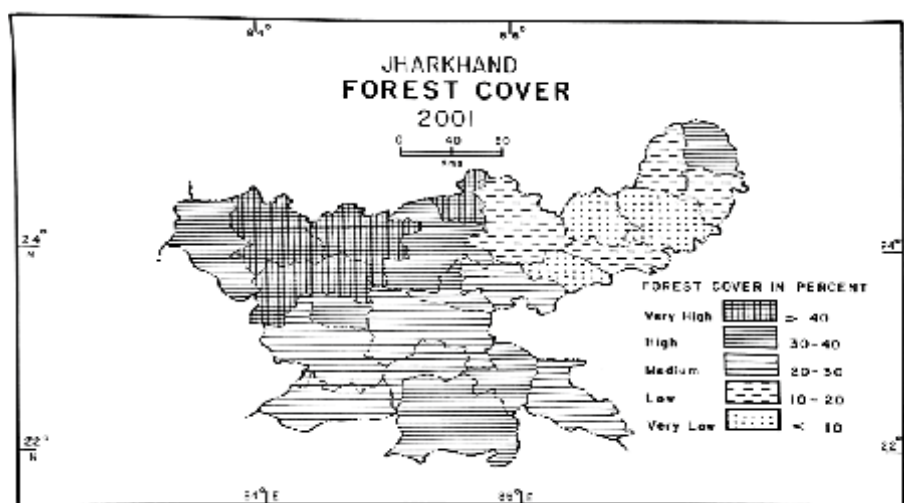


Figure 3 : Forest Cover of Jharkhand, 2001

Table 2 indicates that about 17 percent of the total districts covered with closed or dense forest are placed in very high category. It is more than forty percent and located in Chatra (52), Kodarma (43) and Palamu (45) districts, respectively. Out of this, 28 percent in Garhwa (33.6), Hazaribag (36), Lohardaga (37.36), Paschimi Singhbhum (37.62) and Sahibganj (30.0) are placed in high categories and Gumla (28), Purbi Singhbhum (25), Ranchi (22.5) and Bokaro (29.7) districts are placed in medium categories cover 21 percent, while 34 percent of the total districts are in low category covering the districts of Giridih (15.7), Godda (18.5), Pakur (18.7), Deoghar (3.5), Dhanbad (5.8) and Dumka (7.8) districts. Forest depletion took place in these districts, probably conversion of land into cultivated field and due to population growth and mining.

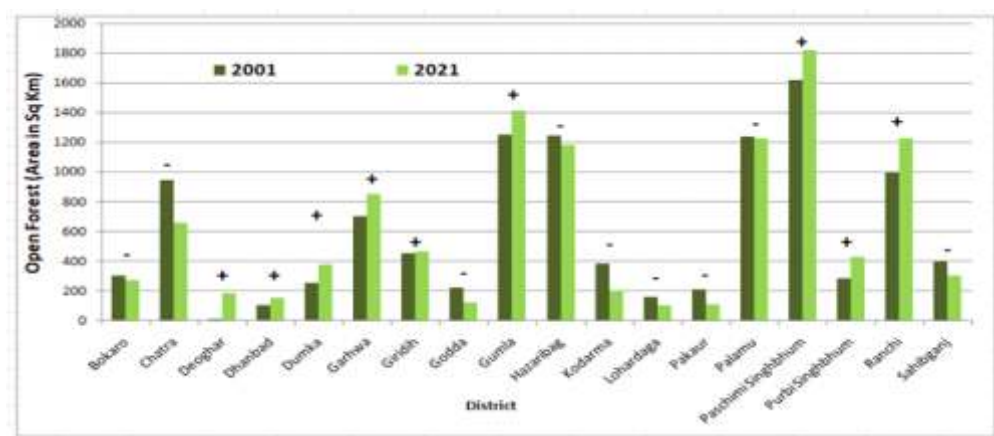


Figure 4 : District-wise Changes in Open Forest in Jharkhand, 2001-2021

Table 3: District-Wise Level of Forest Cover, 2021

Range	Figure in percent	Name of Districts
Very High	> 40	Chatra, Kodarma, Palamu +Latehar
High	30 – 40	Garhwa, Hazaribag, Lohardaga, Purbi Singhbhum +Saraikela, Pashchim Singhbhum, Sahibganj,
Medium	20 -30	Bokaro, Gumla + Simdega, Ranchi,
Low	10 - 20	Dumka + Jamtara, Giridih, Godda, Pakur
Very Low	< 10	Deoghar, Dhanbad

Table 3 shows the district-wise forest cover in Jharkhand, 2021. Out of 22 districts only three districts have very high concentration of forested area above 40 percent in the state. They are located in Chatra (47.7), Kodarma (41.7), and palamu (41.4) districts. These districts are bordered along the western and northern border of Chattisgarh and Bihar state which is a part of central and core area of forest land of India. Next, high percent of forested district lies between 30 and 40 percent located below the dense forested area mainly in Hazaribag (34.9), Garhwa (33.9) and Lohardaga (33.5) along very high forested area while Purbi Singhbhum (31.6.), and Pashchmi Singhbhum (38.7) in south and south-eastern part of the plateau region. A small pocket of Sahibganj (32.3) district is located in the north eastern corner of the state. The remaining 33 percent of the total districts are placed in medium, low and very low categories. They are located in northern, eastern and central part of the state. The area under forest in this region decreases, despite the area declared under reserved forest. In fact, cutting of trees are banned, the broken logs or barks are the state's property. Even the district management and conservation policies, the forest area have been cleared for cultivation and mining purposes. Due to population pressure, urban expansion and transportation development, there is a great loss of forest in these districts. The area under low categories of forest cover fall below 20 percent in Bokaro (29.4), Gumla+Semdega (29.3), Ranch (28.4), Giridih (19.7), Godda (19.3), Dumka+Jamtara (10.8), Pakur (18.3), Deoghar (9.2), and Dhanbad (6.7) districts in Jharkhand.

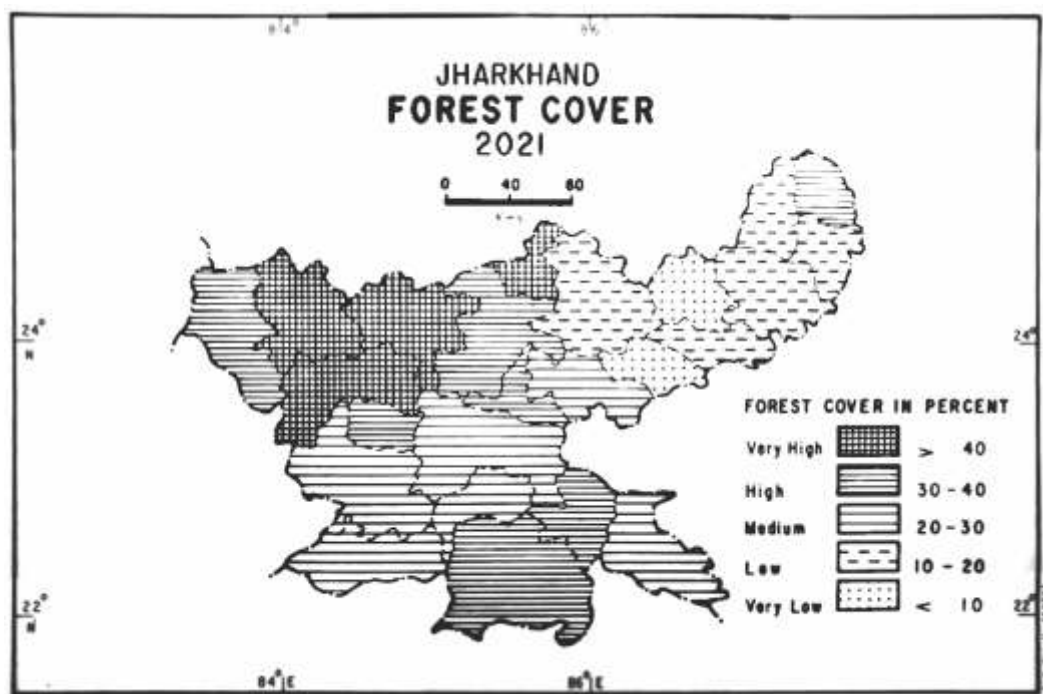


Figure 5 : Forest Cover of Jharkhand, 2021

Table 4: Comparative Analysis of Forest Cover in Jharkhand: 2001 to 2021 (Area in Km²)

Year / Forest Cover	2001	2003	2005	2007	2009	2011	2013	2015	2017	2019	2021
Dense Forest	N.A	2544	2593	2590	2590	2590	2551	2601	2598	2603	2587
Moderate Forest	11787	9076	9892	9899	9873	9917	9586	9692	9684	9687	9667
Open Forest	10830	8518	10235	10405	10205	10470	10450	11231	11231	11321	11219
Non Forest	56101	55123	56316	56820	56096	56054	55444	55507	55491	55417	56241
Total Geographic Area	79714	79714	79714	79714	79714	79714	79714	79714	79716	79726	79672

Source: Based on Indian State Forest Report, 2021

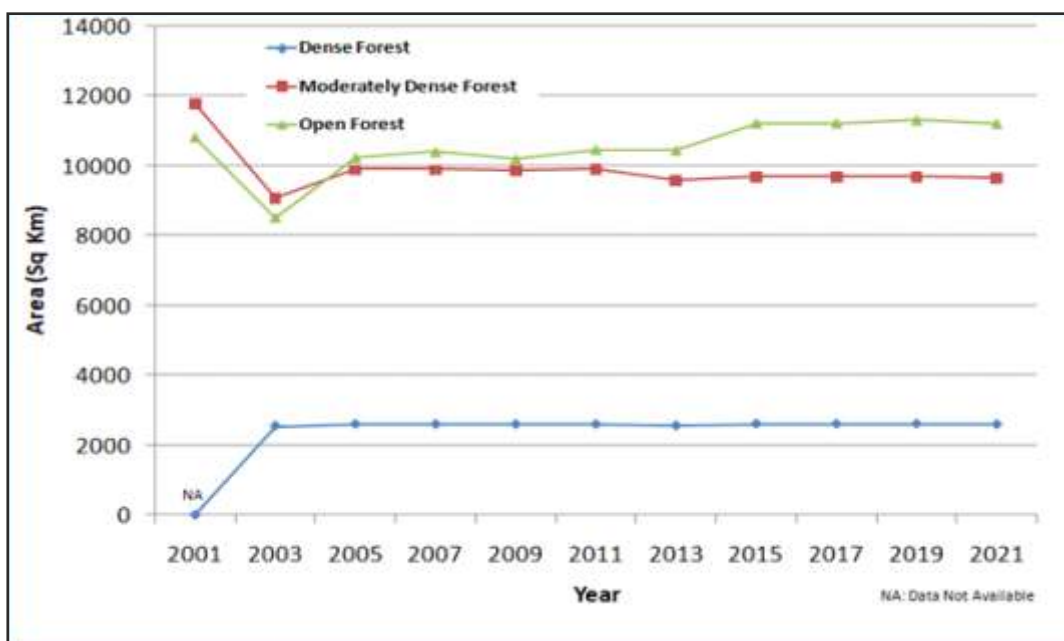


Figure 6: Comparative Analysis of Forest Cover in Jharkhand, 2001-2021

The comparative analysis of forest cover in Jharkhand is shown in Table 4. It clearly shows that the forest cover in the state has increased with passing year, but the percentage of tree cover has fallen rapidly from 06.29 % in the year 2003 to 03.49% in the year 2017. It may be due to high level of urbanization and construction of houses in and around the capital district of Ranchi and large part of demand of industry raw material and also local rural population demand of timber and fuelwood as energy resources. It reveals some interesting trends. The state has lost some of its precious forest covers since its formation but according to data the forest cover in the year 2001 has slightly increased from 28.34% to 29.61% in the year 2017. This may be due to large part of demand of industry and local rural population in terms of timber and fuelwood is met from the tree outside the forests. This trend has also seen between 1917 and 2021.

Causes of Deforestation

To explore the causes of deforestation are complex and changes with time and space. Various factors working together lead to depletion and degradation of forest. The technological advancement and cultural change have not only increased the rate of deforestation, but also has changed its form. Changing social and economic systems have also a dramatic effect on forests. It marks the conversion of a traditional economy to a modern agricultural and urban economy. It has affected everywhere that civilized society has taken root. Certainly,

deforestation is also an agency of environmental degradation, and it can be the nemesis of development. But local people are main factors causing deforestation. The paper by Ahmad and Goparaju (2017), on Long Term Deforestation Assessment in Jharkhand state, deals on the basis of grid analysis for the year 1935 to 2015. During these 80 years of span more than 50 % forest cover has been lost in Jharkhand. The driving factors of deforestation between 1935 and 2015 were industrialization, urbanization, mining activity and conversion of forest land to other land use purpose viz, dam construction, agriculture purpose etc. Within the state the losses of forest ecosystems are more pronounced in those areas where population was high. The underlying causes of deforestation are the following: **rapidly increasing population, agriculture expansion, shifting cultivation, source of fuel wood, poverty, construction of road and railways, irrigation and power projects, fodder and grazing, mining activities, and miscellaneous.**

* Population growth is a significant driver of deforestation. In Jharkhand the dependency on forests is very high because there are 17 tribal districts out of the total 24 (FSI 2021). The tribal people depend mainly on forests and forests products. Tribes and forests have the symbiotic relationship (Saha and Sengupta, 2014). The increasing human population impels the conversion of forest area due to the search of new suitable agrarian terrains for land and wood, Nacoulma et al. 2012. The ratio of population to land is very high and reflects the heavy pressure on land for food in Ranchi, Dhanbad, Palamu, Bokaro and Purbi Singhbhum districts in the state. As an outcome, forest covers are being converted into farming, pastureland, and impervious surfaces significantly affecting the biodiversity and ecosystem functioning in this area of Jharkhand (Pereira et al., 2010; Lucas et al., 2015; Lal et al., 2017).

* Growing populations need expanding more cropland, means cutting more forests are cleared by shifting cultivators for annual or permanent crops. Rates of clearing are likely to be higher where agricultural productivity or land productivity falls rapidly after the natural forest cover is removed. Forests have been cleared for resettlement schemes in India, provides an example from Uttarakhand, where forest decline from 75 to 65 percent, while the cultivated area increased from 12.5 to 18.5 percent. Another, example cited of Kerala in India where 256,000 ha of forests were cleared between 1964 and 1984 to agriculture and for irrigation and hydroelectric works. In Jharkhand this trends also seen and about 80 % forest loss is due to agriculture extension (FAO, 2021).

* In Jharkhand shifting (Jhuming) cultivation is also practiced by the *Aadibasi*. It started felling trees and lumbering them to increase the fertility of the soil on which they grew crops for a year or two and then left it to resume the process elsewhere. When their number increased more and more trees were cut and they cleared up the forest area for cultivation. It allows relatively low population densities compared to other cultivation systems. Shifting cultivators

are mobile in space and time but with different frequencies durations and relative locations. Its chief characteristics are rotation of fields rather than crops, clearing forests by means of fire, absence of draught animals and maturing, use of human labour only and employment of double-stick or hoe. Today, shifting cultivation is responsible for 50 percent of tropical deforestation in Jharkhand (FAO, 2017).

* Forests provide an array of benefits to human societies. These benefits are described as resources that people can draw upon for heating, cooking and industrial needs. It plays an important role in generating energy requirements to rural dwellers. The demand for wood energy has been augmented by the recent dramatic increase in oil prices, which have prevented the switch to non-wood-based fuels. Such use of woodlands and forests –including forest reserves–by growing population in search of woodfuel is one of the most commonly cited causes of deforestation (Allen, 1983). More than 49 percent of total population use fuelwood for cooking in India (FSI, 2011), whereas, in Jharkhand 57.6 percent people depend on fuelwood. Since 1990s overutilization of forest fuelwood leads to more than 30 percent deforestation. In Jharkhand, people nearby the forest often set fire when the trees shed leaves in order to facilitate for collecting *mahua* flowers, fruits, new plant shoots grass and other minor forest products. Deforestation is caused by setting fire in the forest during summer season when trees shed their leaves. Fire removes the humus from the forest floor and burns the seedling. People make the reproduction of forests impossible and open up the soil to erosion. Rural dwellers generally prefer deadwood which provide cooking fuel. Therefore, people are facing fuelwood scarcity as energy crisis.

* Deforestation also linked with poverty, illiteracy, underdevelopment and poor awareness about the role of forests. In Jharkhand, majority of the rural people are engaged in primary sector, either in livestock rearing or cultivation. Agriculture fetch people use dung as fertilizers in their agriculture fields and milk for self consumption, while they do not have to pay for fodder. Due to low purchasing power, they do not spend money on their fodder and medicine. Moreover, due to less income from the livestock, they do not want to spend money on them. The income from agriculture is also low due to small land holdings. Being poor, they do not afford to spend on modern technology and equipment. People who are landless, poor or posse's small agricultural land, that is, not economical to cultivate, divert their work from cultivation to work as labourer in different factories (chemical, cement, limestone mining, etc.). Large number of people has left cultivation in rural areas as returns from land are meager. Moreover, it required high inputs in terms of human labour in plateau and stony terrain with no irrigation facilities. In fact, deforestation is associated with population pressure and poverty. In Jharkhand the demand of food and space has increased. About 50 % of its total population is below the poverty line and 80 % of the population is dependent upon rain fed-based agriculture and productivity which is very low, Ahmad and Goparaju 2017. In some areas, due to urban

influence and better education level, people earn their livelihood from secondary and tertiary sector.

* Road construction by the government has caused removal of forest cover. In order to expand and widen the road, trees were cut after the formation of Jharkhand state. Forest is also being cleared for approach roads, offices, residential quarters and storage of construction material with reduction in forest cover. It can be observed all over the state along roads. Its effects are aggravating due to topography. The major advantage of road construction and road transport is its flexibility which allows it to operate over short distances. Wood and wood products in country played a significant role in the construction and expansion of railways. Das (2010) has analyzed the process of deforestation caused by railway expansion in Punjab between 1859 and 1884. The expansion of railways in northern India was considerably dependent on the supply of sal and deodar sleepers from the sub- Himalayan and Himalayan forests. The demand for wood by the railways began to decline from 1920s when railway expansion slowed down. Around this time, Dangwal (2005) industrialization began in the country and new industries made demands on forests for raw material as well as for fuel. A massive deforestation in Jharkhand also caused expansion of railway line. The most recent project of linking Hazaribag by railway line has caused massive felling of trees. At least three laths trees have been cut to implement this project recently.

* Canals, rivers, reservoirs and dams have affected the forest thickness. A number of large multi- purpose projects have been completed in India during the period of planned development since Independence. The basic objectives of these projects are to regulate the flow of river system, provision of irrigation water, regulation of flood control, hydroelectricity generation and traditional benefits including navigation, recreation, fishing and water supply. These projects have directly or indirectly affected Jharkhand state forests particularly, Palamu, Singhbhum, Ranchi, Khuti, Gumla, Hazaribag and Giridih districts.

* Other causes of deforestation in Jharkhand state have been developed as overharvesting of forest through overgrazing, overlapping and overcutting of branches and trees. Commercial logging operations deplete forest stocks. As people are dependent on nature, they also perceive that, if, deforestation continues, will, have less fodder. The collection of *sal* leaves is reduced and due to less undergrowth it will be difficult for them to collect grass from the forests. The people living close to forest take their cattle's into forest for grazing due to scarcity of grazing land around the village. While grazing the forest land, the cattle regularly eat up the tender shoots of the plants and stamp the other species of the forest. Gradually, plants and grasses disappear. There have been drastic decrease in common grazing lands. In India, every hectare of land has to support 0.76 cattle, compared to only 0.076 per hectare in China (ten times less). This would mean that a sound grazing policy would have to be evolved and adopted by each state.

* Mining activities and mineral transportation takes place in close vicinity of forests. Mining and mineral activities, damage forest resources. Rampant mining has turned, for decades, large tracts of forests in Jharkhand into wastelands. A significant portion of the Aurania coalfield, over 57 sq km, lies within the 10 km of the Palamu Tiger Reserve. Open cast mining, particularly in palamu, Dhanbad, Giridih, Bokaro districts has dealt a severe blow to animal conservation efforts and their movement has suffered. The tiger and elephant animals have also come under threat.

* Deforestation is the result of a combination of factors. They are fire and disease, government economic incentives, earning foreign exchange from exports of wood and settlement of evicted persons. Forest fires constitute a major threat. The forests in the state are mostly dry deciduous and are prone to forest fire during summer season. Most of the fires are associated with the activities of forest dependent communities for *mahua* and sal seeds collection and the desire to promote better grass growth after the rains. The fires caused by *mahua* collectors are common in March and April and are the cause of widespread fire damage to the forest growth. Brothers (1997), present a useful case study of a village where deforestation was associated with the construction of access roads, agricultural colonization and pasture conversion. A large number of changes in policy and strategy of action are needed if deforestation trends are to be reversed. It is, thus, concluded that national and state governments bear a major responsibility for deforestation.

Sustainable Forest Management (SFM)

These days sustainable forest management is facing enormous challenge to achieve goals of sustainable production, meet domestic need from forests and meet the energy demands of growing economies. The Sustainable Forest Management embraces a wide range of activities including harvesting trees, protecting watersheds, wildlife habitats, wilderness and recreational sites, maintaining stream erosion control projects, and safeguarding the aesthetic qualities of forests (Klee, 1991). India's forest management has adopted many approaches changing with time and requirements. Previously forests management was exploited and many areas became completely devoid of forest cover. Faced with increasing rates of deforestation, and the attendant problems of loss of biodiversity and other socio-environmental costs, global warming, exacerbated by the heavy use of fossil fuel in the recent past the greenhouse gases are on the rise and the loss of forest is also continuing. Therefore, the sustainable management of the forest and its proper utilization needs the following strategy of action. They are: absence of an integrated forest policy, population control, demand dynamics, poor coordination, poor awareness, lack of involvement of users etc in the state of Jharkhand.

Forest policy: The forest policy should be revised and a uniform and comprehensive set of regulation brought immediately. There has been inordinate delay in revising and formulating

forest policy which could help in the stimulation of forest cover. Absence of a long-term policy is thus a major gap in forest policy. There is an urgent need to formulate appropriate conservation measures and strategies in deforested and degraded forest areas. A counterproductive changes in government forest policies and compounded by increasing population pressure on land resources and farmers' strong dependency on the local subsistence agricultural system especially cereal crop cultivation. It requires strategy based forest management system, changing the mode of economy, and alleviating the ubiquitous and constantly increasing population pressure on forest and agricultural land resources. The policy could not keep pace with the desired objectives and was not fully practiced due to various reasons.

Population control: Unless population growth is controlled proper forest management could not ensure effectiveness in forest conservation. The population control programmed should be integrated with the rural development programmed. People are reluctant to adopt family planning because of high demand of labour in agricultural enterprises as well as non-farming activities to supplement their agricultural earnings.

Demand dynamics/Consumption of fuel wood: In India about 49 % of the total population use fuelwood for, cooking, whereas, in Jharkhand 57.6 % people depends on it for cooking after Chattishgarh, Tripura, Meghalaya, Assam, Nagaland, Odisha and Manipur. Since 1990, more than 33 % overutilization of forest resources as well as house construction leads in Jharkhand (Kumar and Saikia, 2020). Large quantities of fuel wood are consumed by the low income groups residing in squatter settlements of urban areas. The price of fuel wood is higher in urban areas and this has caused a flow of fuelwood from rural to urban markets. This aspect of demand was not even or studied until reported. There is urgent need to provide environmental education to the people and encourage rather involve them for tree planting, protecting forest for conservation measures plans. The driving factor for deforestation in Jharkhand must be closely monitored and restricted. Farmers are not over-utilizing fuel wood, but they are burning it inefficiently, because most of them use traditional, heat inefficient type of stove. Unavailability of a suitable stove (cylinder with gas) for large household, were other causes for not adopting improved stoves. Since farmers are likely to continue using fuel wood in the foreseeable future, owing to poverty and the almost free availability of fuel wood. A campaign for the efficient burning of fuel wood must be launched immediately to ensure the sustainable supply of fuel wood and to control rapid degradation of forests.

Poor coordination: local coordination with rural development programmes such as social forestry, dairy development, cattle development, fodder development, improved wood stoves programmes, housing schemes, etc, are implemented in different areas by different agencies. Lack of integration has resulted in poor utilization of resources. The government departments

dealing with these subjects do not have field organization or delivery systems that can reach the grass-root level. Without systematic delivery channels, the food-fodder-fuel wood problem cannot be solved. In Jharkhand the deforestation problem has no magical solutions since the problem is caused by poverty and small holding size. As such no systems have been planned for this. Overall poor awareness of the role of the forests and the consequences of deforestation is a basic issue. Forests have a basic role in maintaining the ecological balance since the soils are nutrient poor. It will be more difficult to control since the holding size is small and a large number of subjects have to be reached if it is to be stopped. Hence, large number of changes in policy and strategy of action are needed.

Public Participation: Forest cannot be protected purely by self regulation. It must be coupled with mass public participation which requires institutionalization. No programmed has been evolved for large-scale participation of local in aforestation in the recent Five Year Plan. A new forest policy, Government of India, 1988 was reserving the earlier revenue-oriented policy of 1952 and laid the foundation of the official Joint Forest Management (JFM) programmed. The central government issued a circular in 1990, specifically asking the state governments to involve local communities and voluntary agencies in the protection and management of degraded forest lands. The Jharkhand governments passed their own enabling resolutions and started JFM programs. Apart from these efforts, there are many self-initiated forest protection groups (SIFPGs) that have successfully regenerated forest patches in the vicinity of their village. In many places NGOs are also playing an important role in assisting the FDs and communities in Jharkhand.

The management policies ranged from state, district, panchayat, joint management to local people management. They have their own drawbacks. The local people cannot be given sole charge of forest as their needs override forest resource conservation. Similarly, the state cannot be given full authority to manage the forest resource, as it will bare local people to use it. In the Joint Forest Management, the state is the owner, beneficiary and provides finance for the management project, while people are the user and beneficiary. With this categorization, the whole responsibility of conservation is morally on the state than on the people. It leaves people without any duties of protection and conservation of forest. We cannot save the forest without the involvement of whole community living close to the forest area. The state is important in order to stop further degradation of forest in the region.

The *Adivasi* sustainable forest management and use of forest resource may be sound from ecological point of view; their traditional rights, that go back many centuries, are not recognized by the Forest Department. In many ways, official policy of the State Forest Department directly conflicts with the lifestyle of *Adivasi*. Conflicts arise especially over forest produce, encroachment into protected areas and non-compliance with recent environmental laws to protect the forest. Conservation policies of the State, that do not

recognize traditional *Adivasi* ownership of the forest, serve to spark off the conflict between people and forest department. *Adivasi* notions of rights and ownership in forest are neither exclusive nor permanent is disregarded. Meanwhile, the absence of traditional restrictions allows *Adivasi* to use any forest produce, that is, remarkable, without regard to regenerative capacity of the product.

The non government organizations and research organization have also play vital role in developing new technologies in monitoring the existing forest stock for optimum use of forest resource. Technically, biodiversity cannot be maintained without change in the existing forest management practices. Overall linkages between people, resources, environment and development must develop their own individual responses to achieve forest management. The forest department focuses on the integration of ecological, social and economic values, mostly in consultation with local communities and other stakeholders.

Therefore, on the basis of the analysis of the issues there is an urgent need to prevent by stopping deforestation and over exploitation of natural resources of India in general and Jharkhand in particular. Emphasis should be made to initiate and revive the spirit among the people to preserve the existing forest wealth, bring more land under forest and maintain the ecological balance throughout the country. The action plans of Jharkhand rare protection of forests by the local people and making alternative strategies for employment in the rural areas, controlling out migration and displacement of the *tribals* from their regions, and creating awareness among the rural people for conserving environment and natural heritage by preserving the forest.

Conclusions and Recommendations

The present study has attempted to evaluate deforestation in Jharkhand which is at alarming situation for forest decision maker. Existing forest policy and management practices need to be completely changed to balance the productive, protective and regulatory functions of forests. To assess the pattern, process and trends of forest depletion, the study uses secondary source of data for two points of time 2001 and 2002. Roughly 1.22 % of the forest cover area has lost between these periods. It is causing the problem not only for the forest but food and livelihood insecurity and social imbalance among tribal's and rural people in Jharkhand. Deforestation varies from forest to forest and from district to district in Jharkhand. The pace of deforestation is very high with district-wide. The major part of loss in forest cover occurred in the densest western and northern part of the state. The analysis confirms that the causes of deforestation are complex. In Jharkhand it is highly related to population pressure on agricultural land, road and railway expansion, shifting cultivation, illegal cutting, firewood and the past rate of wood production. Preventing deforestation will require a major change in cultural values, social attitudes and, most especially, the economic rules. There is a need to closely monitored and

restricted the driving factor for deforestation. There is an urgent need to strictly implement the government of India forest conservation act 1988 and formulate appropriate conservation measures and strategies in deforested and degraded forest areas. Deforestation is driven by government policies, by regional priorities and local economics. No doubt, the increase in forest cover occurred due to plantation and protection activities. Programmes are undertaken in a number of areas, but their impact is not satisfactory. The social forestry programmed was started with the objective of supplying fuelwood to the community needs, failed to increase the supply to the rural poor. Finally we recommend that for forests analysis using remote sensing and GIS data should be taken for policy/decision making.

There is an urgent need to provide environmental education to the people and encourage them for tree protecting forest which would involve local bodies for conservation measures plans. This involves decentralizing forest management, promoting efficient utilization of fuel- wood, increasing more non-farm economic activities and implementing population controls. Attention to involve local people and seek their cooperation and collaboration at every level in policy formation and implementation. There is also need to arouse people's consciousness and encourage mass movements, like 'Chipko Andolan'. A study of deforestation not only informs us of the scale of environmental changes but also opens up possibilities for further research focused on man - nature interactions in fragile ecosystems. The research should investigate the insights into the intricate relationship between man and nature on the process of commercialization of forests and their integration. In fact, the forest should be utilized in such a manner that its quality and quantity are not affected in decades and centuries to come; indeed, it should rather improve. The author has suggested many measures which can be adopted like agro-forestry which will solve erosion and water problems. Planting fast growing eucalyptus trees should be discouraged. Remedial measures to slow halt or even reverse this downward move are required. But the misinterpretation, myth, misinformation and misunderstanding are preventing identification of the problems so that we can work on the solutions.

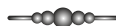
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ECOLOGICAL STATUS AND RESOURCE VALUE OF HAVASPUR BEEL WETLAND OF JAMALPUR BLOCK IN BARDDHAMAN DISTRICT, WEST BENGAL, INDIA

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ABSTRACT

Wetlands are ecosystems that provide numerous goods and services that have an economic value, not only to the local population living in its periphery but also to communities living outside the wetland area. Barddhaman stands first and second position respectively in terms of number and area of wetlands in west Bengal. The Havaspur Beel Wetland (HABW) is one of the important perennial wetlands of Jamalpur Block of Barddhaman District in West Bengal, India. The present study was conducted from 2009 to 2013 and especially water and soil samples were collected from March, 2012 to Jan, 2013. Documentary, field survey and laboratory analysis methods have been used in the present study. For identifying the capabilities and limiting factors of the Wetland this study was made through the continuous, systematic, extensive field inspections and direct field observation with questionnaire. As functions of ecosystem are ecological attributes resulting from the interaction among its physical, chemical and biological components many parameters have been considered to know the potentialities of wetlands. Result shows that B.O.D is high in summer season and low in the postmon soon. D.O ranges from 1.86 mg/l to 3.70 mg/l which is below the national standards. PH level is recorded the highest in pre-monsoon with 7.7 and the lowest in monsoon with 6.82 for rainwater input. It is increased to 7.26 in post-monsoon. Euphotic limit values are more or less same in all seasons (80 cm) because of its surface covered all time by thick vegetation. Turbidity is recorded as same in all seasons with about 25 ppm. Agri runoff, domestic uses, washing and taking baths are threats for wetland. Main threats of this Wetland are eutrophication, siltation and depletion of wetland animals.

It is recommended to make necessary study on physico-chemical and biological parameters of wetland and also the identified threats and opportunities. An immediate natural management (not mechanical management) is required to maintain the ecological balance on one hand and explore the resource potentialities of this wetland on the other.

Key words: Wetland, Ecological, Economic, Quality, Resource, Value, Ecosystem.

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Introduction

Wetlands are valuable ecosystems that occur extensively throughout the world in all climatic zones and are estimated to cover about 6% of the earth's surface. The safety of the Wetland is a new challenge to the Geographer (Khoram and Hosmand, 2011). "Be under no illusions: the impact of general water shortages is going to hit our cities. In the 21st Century, wars will be fought over water" – says UN Secretary General Kofi Annan (Kumar, 2007). The Havaspur Beel Wetland (HABW) is one of the important nature-made perennial wetlands of Jamalpur Block in Bardhaman District of West Bengal (Badsha and Jana 2014) (Figure 1). It is located in the left bank alluvial tract of Damodar River. The Geo-reference is 23°07'38.90"N to 88°00'45.30"E with the altitude of 21 meter from the mean sea level (Figure 2).

Wetlands are ecosystems that provide numerous goods and services that have an economic value, not only to the local population living in its periphery but also to communities living outside the wetland area (Khoram and Karami et al., 2010). The Wetlands are now considered to be distinct ecosystems with specific ecological characteristics, functions and values (Rao, 2002; Ragothaman and Trivedy, 2002).

Bardhaman district was the third most water resource demanded district after Kolkata, and North 24 Parganas in West Bengal (Rudra, 2009). According to Goswami (1995-2002), the *Expert Committee on Irrigation*, 1987 has not considered the *Eco-hydrology* of the study area during assessment of both the surface and ground water (P.C.B, 2009). The study area HABW is a biome or ecological unit of the broad bio-geographic zone - Gangetic Plain of India. Gangetic Plain is one of the most fertile regions of the world with a nearly 3000 years of Human occupation. It is also one of the most densely populated areas of the world. The region is famous for its floodplain wetland which is extremely productive in terms of vegetation, biomass and animal diversity (Islam and Rahamani 2008).

The microbes can increase the BOD by decomposing the organic wastes. (Roy & Roy, 2012). Das, Behera and Mishra (2015) have tried to identify and analyse the factors that influence the household use of wetlands in West Bengal, India.

Justification of Havaspur Beel Wetland as per Ramsar Convention

The wetland acts as a huge absorber of rainwater, surface runoff and eroded soil. It is the habitat for various indigenous fishes, local and wetland birds. 15 families are directly involved with this wetland. Water is used especially for pisciculture, domestic and irrigation. According to Ramsar Secretariat (2013), it is under the inland wetlands class and *Criterion-7* of Group B and also classified as *Tp--* Permanent freshwater marshes/pools; ponds (below 8 ha).

Study Area

The Havaspur Beel Wetland is perennial wetland having an area 3.7 ha (0.51% of total surveyed wetland) and it is situated in the Block of Jamalpur of which geo reference is 88°00'45.3" E and 23°07'38.9" N. It is a Nature made wetland. Water depth ranges between 8 to 15 feet. Maximum water depth is occurred in the rainy season. It is a productive wetland. 4 q/y fishes is being produced which is less than the average of 8.53q/h (water area)/y of this region.

Physical Background: Bardhaman District stands 1st and 2nd positions respectively in respect of the number and area of Wetlands. According to the *Department of Fisheries* of Bardhaman district the HABW covers 3.70 hectare area of Jamalpur Block of Bardhaman District (District Fishery Board, 2012-2013).

The geology of the study area represents younger alluvium. Soil belongs to Entisols group. From the topographical viewpoint this area is a part of the lower Damodar Basin. Bardhaman district form the core of Damodar Valley region of which 32,113 K.M. is in the Bihar and 26,366 K.M. in West Bengal. The River Damodar is flowing in the South-West region of Bardhaman district and along the western side of the study area (HABW). The Changes in river courses are the normal phenomenon in deltaic conditions. Slope is normal, from West to East and South-east side less than 10 (in meters per K.M.) Elevation ranges between 10-50 meters. Ground water table height is low towards South-east and ground water flows in the same direction. The study area is under monsoon climate and rainfall status is medium (1200-1400 mm/year). Maximum temperature is recorded 40°C (in the month of March) minimum temperature is recorded 6° C (in the month of January). Wet tropical vegetation is scatteredly found in this study area (Badsha and Jana, 2014).

Socio-Economic Background: The study area is famous for rice and potato cultivation. It is thickly populated for agriculture, fishing activities, agro-based industries and retail business. The study area is surrounded by a number of large and small towns viz. Jamalpur, Memari and Burdwan etc. (S.O.I. Toposheets, 1991).

According to the Census 2011, population of Havaspur Village is 1479, total population of the Jamalpur Block is 266338 (243474 in 2001), where the population of whole district is 7717563. Most of SC and ST population live in the Jamalpur Block of Bardhaman district. (District Statistical Handbook, 2011)

Location Map Of The Study Area

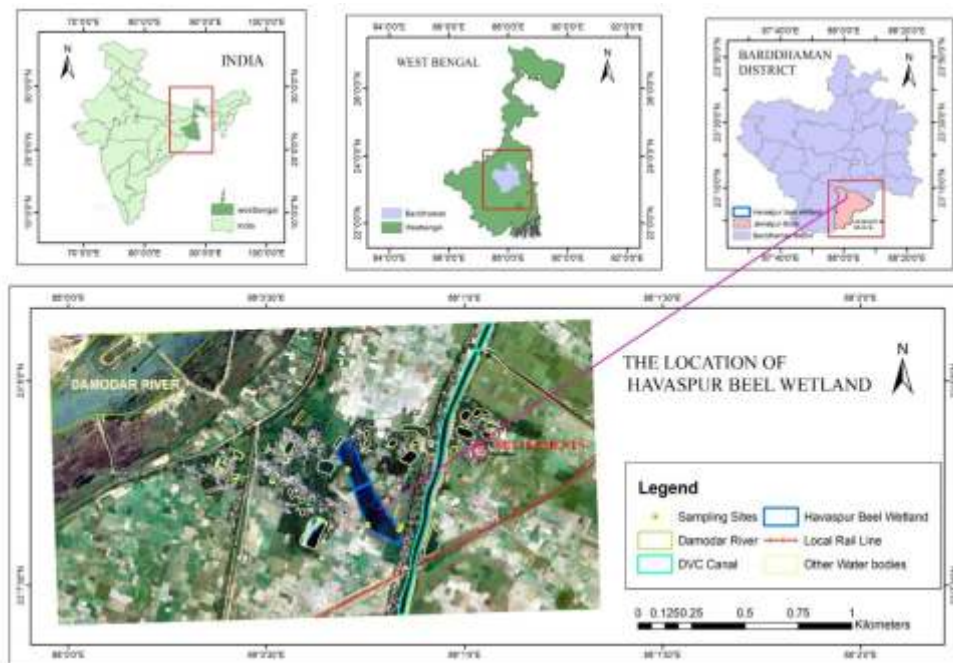


Figure 1 : Location of Havaspur Beel Wetland (HABW), Jamalpur Block of Bardhaman District in West Bengal, India



Figure 2 : A satellite view of Havaspur Beel Wetland (HABW), Havaspur Mouza of Jamalpur Block in Bardhaman District, West Bengal, India

Objectives of the Study

The objectives of the study are:

1. To assess the physico-chemical characteristics of soil and water of the wetland to detect physical, hydrological and biological status.
2. To assess the present resource value and limiting factors of the Havaspur Beel Wetland (HABW).
3. To suggest the selective remedial measures to enhancing the good health of the wetland as well as the sustainable development of the study area.

Data Base

For the fulfillment of aim of the present study various governmental and non-governmental documents have been used. Direct field survey has been conducted for collecting soil and water samples, data and information relevant to the study. Data of laboratory analysis, journals, books, unpublished PhD theses, web materials have also been used.

Materials and Methods

Various scientific methods such as APHA, P.C.B. guidelines have been followed for the analysis of soil properties and water quality. According to the report published by WHO (1996) seven parameters have been considered for surface water quality monitoring such as Temperature, Turbidity, DO, BOD, pH, Alkalinity and Hardness. The guideline of *Central Pollution Control Board (CPCB)* of India for wildlife and fisheries has been considered to know the present ecological status also. Both the observation and questionnaire field survey method have been used for preparing a wetland database. Various survey tools and analytical apparatus have been used such as GPS (Germin), Sachedisc, Thermometers, Digital camera etc. Topographical map, District Planning Map, Google Earth Image have been used for making location map and statistical data representation. The present study was carried out from 15th March 2012 to 15th January 2013 to recognizing the *capabilities (present uses)* and *limiting factors (threats)* of Havaspur Beel Wetland (HABW) in Jamalpur Block of Bardhaman District, West Bengal, India.

Result and Discussion

Physical Status

Natural Wetland is surrounded by various trees, settlements and grassland. Western embankment is covered by the agricultural field of rice, potatoes, the River Damodar, road and southern part is covered by the agricultural field of rice, potatoes and other vegetation. The

primary school of this village is on the southern side of the HABW. Northern and eastern parts are covered by settlements and railway line which is responsible for the encroachment of Havaspur Beel Wetland. A branch of Left Bank Main Canal (L.B.M.C) of the River Damodar is flowing in the eastern side from north to south direction. Surface runoff and breaching of south embankments are responsible for the siltation of this wetland. Once a DVC canal was connected with the HAB Wetland in the eastern side for the source of water but now it is closed. HABW is an important natural perennial wetland of the study area with rectangular shape. This wetland is under subtropical climatic condition. Average temperature is 26° C.

Hydrological Status

The water depth of Havaspur Beel Wetland ranges between 8-15 feet, maximum in the winter (Nov-Feb) and minimum in the summer season (March-May). Ground water table height is 20m above msl. The direction of ground water flow is from north-west to south-east. Main sources of water are rainwater, agricultural run-off. Once it was connected by the left bank main canal of Damodar River for irrigation. The depth of wetland's water varies with seasonal change but not expose any portion of wetland bed in any season. Therefore, it is called a perennial wetland.

Water quality

Table 1 : Water quality status of the Havaspur Beel Wetland (HABW)

SEASON	Air Temperature (°C)	Water Temperature (°C)	Transparency (cm)	Specific conductivity (µmho/cm)	Turbidity (ppm)	T.D.S (mg/l)	pH	Dissolve Oxygen (mg/l)	Alkalinity (mg/l)	Hardness (mg/l)	B.O.D (mg/l)	Salinity (%)	Euphotic limit (cm)
PRM	34.00	32.00	32.00	0.28	25.00	176.00	7.70	3.70	40.00	52.00	1.60	0.18	80.00
MON	32.75	30.50	31.75	0.14	25.00	88.32	6.82	1.86	21.00	48.00	0.36	0.09	79.38
POM	13.38	25.90	29.88	0.23	27.00	172.16	7.26	2.06	37.50	51.54	0.26	0.11	78.50

Source: Lab Analysis by the Author

Air Temperature: Air temperature is the lowest in post monsoon season (13.380C) and the highest with 34°C in pre-monsoon and 32.75°C in monsoon season (Figure-3). Air temperature is responsible for D.O concentration from water surface air.

Water Temperature: Water temperature level is maximum (32°C) in the pre-monsoon season which progressively decreases. According to the CPCB (2007) water temperature range is at the edge of stress limit (Figure-4).

Transparency (cm): Transparency is the lowest at 29.88 cm in post-monsoon and the highest transparency is 32cm in pre-monsoon (Figure-5)

Specific Conductivity ($\mu\text{mho/cm}$): Specific Conductivity ($\mu\text{mho/cm}$) is the lowest at 0.14 $\mu\text{mho/cm}$ in monsoon, 0.28 $\mu\text{mho/cm}$ in pre-monsoon and 0.23 $\mu\text{mho/cm}$ in post-monsoon season (Figure-6)

Turbidity (ppm): Turbidity is recorded same in all seasons with about 25 ppm which is normal as per the national standards (CPCB-2007, <12 - >80 p.p.m) (Figure-7).

T.D.S (mg/l): T.D.S of water sample is the lowest in monsoon season with 88.32 mg/l and highest in pre-monsoon season being 176 mg/l. While T.D.S of 172.16 mg/l was recorded in post-monsoon season. It is under the national standards of surface water quality (as BSI->500mg/l) (Figure-8)

pH: pH level is recorded the highest in pre-monsoon with 7.7 and the lowest in monsoon with 6.82. It is increased to 7.26 in post-monsoon. The pH values are within the CPCB Limits (<4 to >11) (Figure-9).

Dissolve Oxygen (mg/l): D.O of water sample is the lowest in the monsoon season being 1.86 mg/l and highest in the pre-monsoon season or winter (3.70 mg/l). Intermediate D.O (2.06 mg/liter) was recorded in post-monsoon. According to the CPCB limits it is too below from minimum standards of D.O (< 5 mg/l). The D.O is showing the stressed condition of wetland (Figure-10).

Alkalinity (mg/l): Alkalinity of water sample is the lowest in the monsoon season being 21mg/litre and the highest in pre-monsoon (40 mg/litre). Intermediate alkalinity (37.50 mg/liter) was recorded in post-monsoon. Thus from winter onwards there is a trend of increase in alkalinity till pre-monsoon.

All amount is under the acceptable range but in the monsoon season alkalinity is around the stress level with 21 mg/l. As per CPCB standards stress limits range is <20 to >300 mg/l (Figure-11).

Hardness (mg/l): Hardness level is recorded the highest in monsoon with 48mg/l and the lowest in pre-monsoon with 52 mg/l. It is increased to 51.54 mg/l in post-monsoon season.

All amount of Havaspur Beel Wetland is under the acceptable range. As per CPCB guidelines stress ranges between < 200 mg/l and >300 mg/l (Figure-12).

B.O.D (mg/l): B.O.D of water sample is the highest in the pre-monsoon season being 1.6 mg/l and the lowest in the post-monsoon season (0.26 mg/l). Intermediate B.O.D (0.36 mg/l) was recorded in monsoon (Figure-13).

Geographical Perspective

Except the value of pre-monsoon season all the values are not meeting desirable limit (range is 1-2 mg/l) but at present not in stress condition.

Salinity (%): Salinity level is recorded highest in 0.18 % in the pre-monsoon and lowest in monsoon season with 0.09 % and intermediate is 0.11 %. in the post-monsoon (Figure-14).

Euphotic limit (cm): Euphotic limit is the highest at 80cm in pre-monsoon and the lowest at 78.50 cm in post-monsoon season. Intermediate Euphotic limit is 79.38 cm in monsoon (Figure-15).

Soil Properties

Table 2 : Status of Soil Properties of the Havaspur Beel Wetland

SEASON	Soil Temperature (°C)	Soil pH	Organic Carbon (%)	Nitrate nitrogen (g/kg)	Phosphate phosphorus (g/kg)
PREMON SOON	34.00	6.09	0.73	0.58	0.30
MONSOON	32.60	6.78	0.80	0.42	0.24
POST MONSOON	27.47	7.88	0.79	0.11	0.23

Source: Lab Analysis by the Author

pH Status: The pH values are recorded as 6.78 in the rainy, 6.09 in the summer and 7.88 in post- monsoon season (Figure-16).

Organic Carbon: Organic Carbon ranges between 0.73 % to 0.80 % (Figure-17).

Nitrate Nitrogen: There are no such variations in values of Nitrate Nitrogen in different seasons. The Nitrate Nitrogen of HABW soil ranges between 0.11 g/kg to 0.58 g/kg (Figure- 18).

Phosphate Phosphorous: There are no such variations in values of Phosphate Phosphorous in different seasons. The Phosphate Phosphorous of HABW's soil ranges between 0.23 g/kg to 0.30 g/kg (Figure-19).

Ecological Status

Biodiversity Status: Only some species of floating leaved macrophytes like *Baro Pana* (*Pistiastratiotes*) and *Water hyacinth* (*Eichhorniacrassipes*) for ecological function, fuel and trap bacteria (www.indianflora.org) are available in this wetland. As the search for alternatives to fossil fuel intensifies in this age of modernization and industrialization, fuelled by

increasing energy costs, water hyacinth holds a strong promise as abundantly available in all time in any place in the 21st century bio-fuel industry. It has no such medicinal and other important use values than other conventional flora (*Jatropha curcas*, sunflower) for bio-fuel industry. Water hyacinth is creating additional sources and means for income generation and mitigating environmental pollution at both local and global levels (Sagar and Kumari, 2013). Plant status is high but as per plant types/coverage on wetland surface water macrophytes are not significant than microphytes.

Catching fishes are basically indigenous fishes (India) such as Rui (*Lebeorohita*), Katla (*Catla Catla*) and exotic (Japan) Silver carp (*Hypophthalmichthys molitrix*) and Shell fishes all are food fishes (Khanna, 1981).

Havaspur Beel Wetland is important from the viewpoint of conservation status. Depletion of plants and animals are the major problems of the wetland where plant status was rich and animal status was poor. Now depletion of plants is high than the depletion of animals in this wetland ecology. Many migratory birds spend part of their winter times in this wetland as well as local birds such as Goose, Swan, Ducks and habitat birds—Machhranga (*Alcedo atthis*).

Based on the results, HABW has no great capability regarding diversity of animals and plant species. No conservation process is being practicing in this site. There is no intention among the stakeholders to conserve the biological status of the great prospective wetland except catching fishes.

Nutrients: Phosphorous and nitrogen from the detergent, soap, surface runoff from excess fertilizers applied in the agricultural field and N.P.K and sulphur from sewage of households are entering continuously into this wetland as nutrients.

Problems: Siltation for agricultural runoff and sliding of embankment (Plate-3), eutrophication for sewage inflow and depletion of plants are main problems of this wetland.

Pollution/Threats: The main sources of pollution are pesticides from adjacent agricultural fields, bathing and washing in this wetland.

Resource Value of Havaspur Beel Wetland

1. Use Value

Economic Significance

Fish production: Average annual production is 4 q/y of which present market price is Rs. 40,000 or Rs. 10,811 ha/year. Basically various indigenous fishes (India) such as, Rui (*lebio rohita*), Katla (*catla catla*), Mrigale (*Cirrhina mrigala*) in this wetland.

Duck's egg value: Eggs value is Rs. 1,08,000 per year or Rs. 29,189 ha/y, which is lower than study area's average Rs. 17,670 ha/y.

Ducks meat value: Total 22,500 rupees per year or Rs. 6,081 ha/y is earned from the meat selling of ducks (150) and it is the study area's average of Rs.3,608 ha/y.

Irrigation values: Total 3.08 ha agri-land is depended for irrigation on the water of this wetland. Annual profit has been recorded 35,272 rupees or 9,533 ha/season or year.

Others: Water is using for lave, washing of clothes by the surrounding people. Various economically backward people collect various gugly (shell fish), small fishes and pray big fishes at night. There is no such significant direct benefit of wetland from recreations (Table-8.3).

Ecological Benefits

Natural habitats for wetlands birds: This is one of the natural habitats for the local wetland pet birds, e.g. goose, swan, ducks, habitat birds-Chhoto Machhranga (*Alcedo atthis*) and migratory birds.

Diverse assortment of wild life species: Grass is found on the riparian zone or upland which attracts various mammals, amphibians and wetland dependent animals and insects also such as fox, rat, snake, frogs. Wetland plant is significantly low which shows the negative significance.

Water conservation: Main source of water is rainwater and DVC Canal. In this way wetland is reserving and conserving water in its body.

Groundwater recharge: Indirectly this wetland is responsible for ground water recharging and maintaining the ground water table.

Erosion control: It is fed by rain water and DVC Canal water. So it receives huge eroded surface soil and allows them to settle on it.

Flood control: Due to its location in rural areas, it receives huge excess water during flooding situation and reduces a little bit damage by flood.

Water purification: Pesticides, nutrients (Phosphorous, Nitrate), various organism which entered into this wetland by the local drainage system is being treated by the wetland's self mechanism or by formation of algae- *Azola pinnata* (water fen). There are no such macrophytes or plant status except the micro-phytes - algal bloom at stage.

Microclimate stabilization: It acts as CO₂ reservoir and micro climate controller.

2. Non-Use Value

Socio-Cultural Value

Uplands areas social values: Agri-field is on most of the uplands of this wetland, which is enhancing the socio-economic development of this region. Partly dried land is used for grazing and source of fuel as dry wetlands plants.

Cultural values: Maximum 15 families are directly involved with this wetland where the average direct involvement is 41 persons per ha wetland. Wetland surroundings people basically economically backward people use its water for washing of clothes, cleaning agricultural machineries, bathing of people and cattles.

Status of animal and plants (biodiversity): Overall plant status is rich while animal status is poor.

The yearly money flow of Havaspur Beel Wetland is Rs 2,05,772 and Rs. 55,614 ha/year (Table-3)

Table 3 : Yearly Monetary Return from Havaspur Beel Wetland

Havaspur Beel Wetland, Jamalpur, WA-3.7/TWA-00	Yearly flow (INR/year)	Yearly flow/ha (INR/ha/year)
Direct use	00	00
fish production	40000	10811
Duck's egg	108000	29189
Ducks meat	22500	6081
Recreation and transport	00	
Irrigation	35272	9533
present upland	00	
Indirect Use	Not Estimated	
Non-use	Not Estimated	
TOTAL	205772	55614

Source: Field Survey by the author

Findings and Interventions Required

- According to water quality standards by C.P.C.B (2007) Havaspur Beel Wetland (HABW) is under the group-D. The obtained results show that biological status is very poor in this wetland. The depletion of plants in wetland is the main reason for decreasing D.O. B.O.D is also not meeting the desirable limits. PH is normal. Status of these three parameters indicate that some remedial measures are required to use it as a normal fishing ground and domestic uses where major uses of HABW are Pisciculture, domestic uses and irrigation. Low production of fishes can be increased by adequate intervention. Main threat of siltation is to be rectified for the sake of increasing potentiality of Havaspur Beel Wetland (HABW) in future.
- Water quality and quantity management will improve the ecological balance and wetland services. Stakeholders use wetland water for their fulfillment of need without any payment for management of wetland environment. The Havaspur Beel Wetland has great future prospects. It is obvious that investment from public and private sectors will help to realization of potential resource values of this wetland.
- Study and investigation of the area can be recommended to determine the depth of water for the measurement of water volume in various seasons. A comprehensive, continuous and systematic water quality monitoring is recommended for getting maximum services from the wetland. Both the central and state governments should try to put their efforts equally to maintain the ecological health of large wetlands like Havaspur Beel.
- Providing an initial training to local stakeholders related to environmental conservation of wetland will enrich them ecologically and economically that will be a remarkable step towards sustainable development of wetland environment and regional economy. A systematic conservation process is needed for HABW as soon as possible.

Conclusion

Havaspur Beel Wetland(HABW) is an unique Natural habitats for wetlands birds and wild life species. Wetland is being fed by rain water and Damodar Valley Corporation(DVC) Canal and this is recharging and maintaining the ground water table of the study area. This wetland becomes savior during flood situation of River Damodar by receiving huge excess water and reduces flood disaster risk.

Havaspur Beel Wetland acts as a water purifier for the stakeholders. It is treating pesticides, nutrients (Phosphorous, Nitrate), various organism which entered into this wetland by the local drainage system with the help of it's self- mechanism or formation of algae- *Azola pinnata(water fen)*. As per Central Pollution Control Board (2007) Havaspur Beel Wetland's

class is group-D. Water temperature range is at the edge of stress limit. The D.O is showing the stressed condition of wetland (< 5 mg/l). The depletion of wetland plants is the main reason for decreasing D.O. B.O.D is not meeting the desirable limits. In the monsoon season alkalinity is around the stress level with 21 mg/l.

Major uses of Havaspur Beel Wetland are Pisciculture, domestic uses and irrigation. Low production of fishes can be increased by adequate intervention. Main threat of siltation is needed to rectify for the sake of increasing potentiality of Havaspur Beel Wetland (HABW) in future.

The Havaspur Beel Wetland has great future prospects. The investment from public and private sectors will help to realization of potential resource values of this wetland. Both the central and state governments should take necessary actions equally towards maintaining the physical, hydrological and biological health of Havaspur Beel Wetland. A comprehensive, continuous and systematic wetland Study and investigation specially water quality and quality monitoring are recommended for getting maximum services from this wetland. The proper use of nearby Havaspur railway station (HPUR) for marketing the Havaspur Beel Wetland's products will enhance the economic status of local stakeholders by which local stakeholders can invest for scientific conservation and management of this wetland. An initial training of local stakeholders on wetland conservation is need of the hour which will increase their wetland ecology knowledge. The wetland conservation training will be a remarkable step towards sustainable development of wetland environment and regional economy. A systematic conservation process is needed for HABW as soon as possible.

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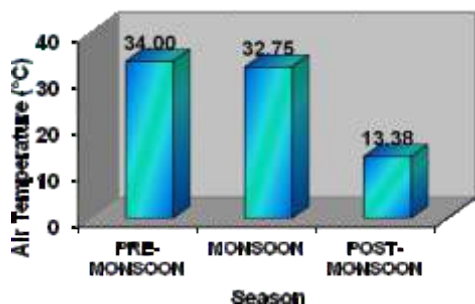


Figure 3 Air Temperature status of Havaspur Beel Wetland (HABW)

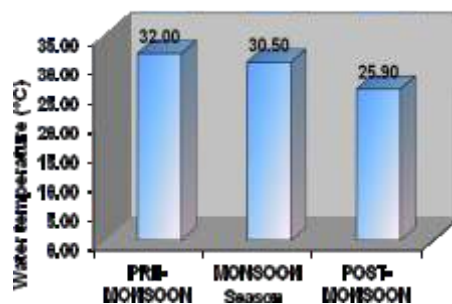


Figure 4 Water Temperature of Havaspur Beel Wetland (HABW)

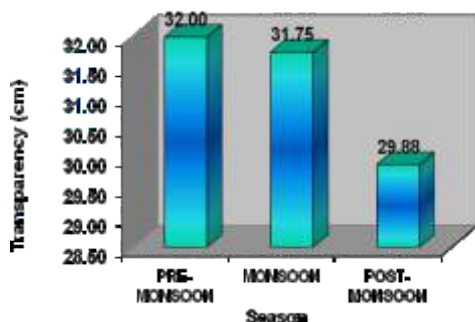


Figure 5: Transparency (C.M) Status of Havaspur Beel Wetland (HABW)

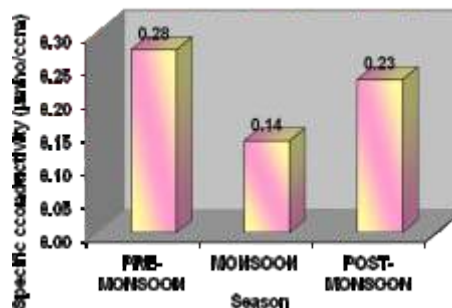


Figure 6: Status of Specific Conductivity (µmho/cm) of Havaspur Beel Wetland (HABW)

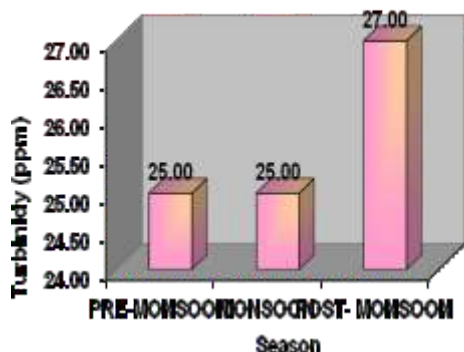


Figure-7: Status of Turbidity (PPM) of Havaspur Beel Wetland (HABW)

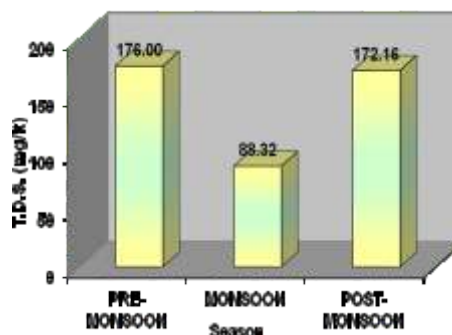


Figure-8: Status of T.D.S (mg/l) of Havaspur Beel Wetland (HABW)

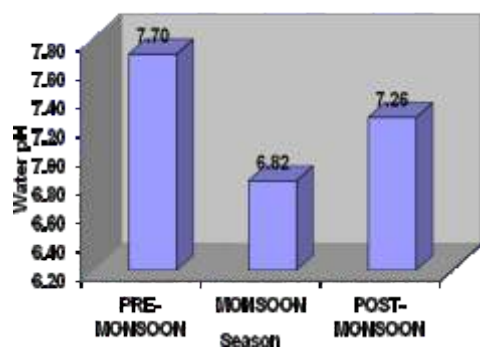


Figure-9: p^H Status of Havaspur Beel Wetland (HABW)

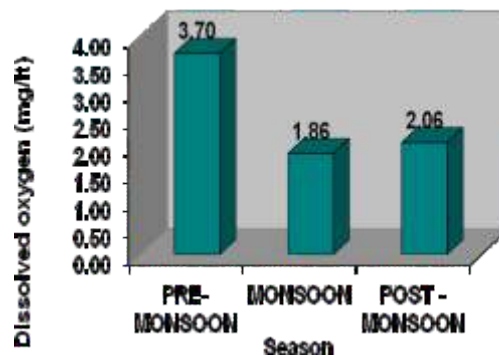


Figure-10: Dissolve Oxygen (mg/l) Status of Havaspur Beel Wetland (HABW)

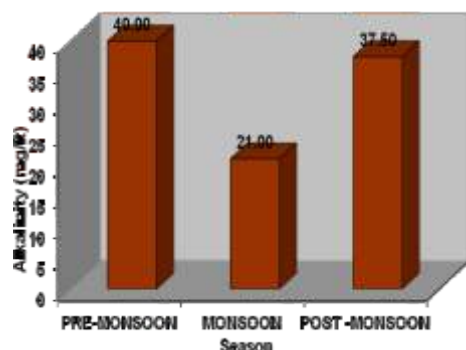


Figure-11: Alkalinity (mg/l) Status of Havaspur Beel Wetland (HABW)

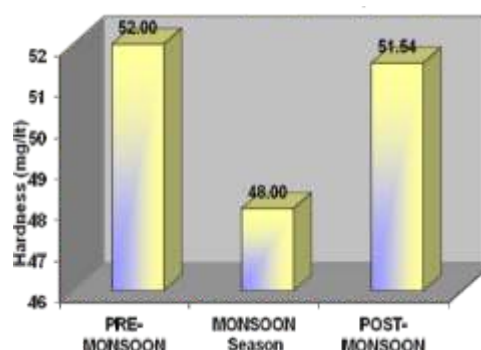


Figure-12: Hardness (mg/l) Status of Havaspur Beel Wetland (HABW)

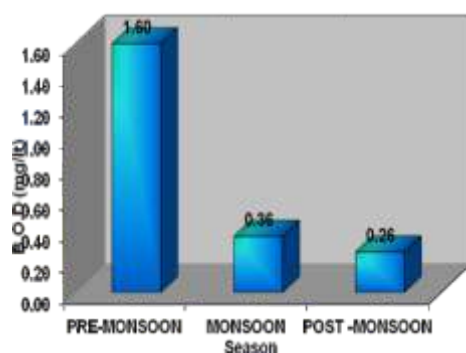


Figure-13: B.O.D (mg/l) Status of Havaspur Beel Wetland (HABW)

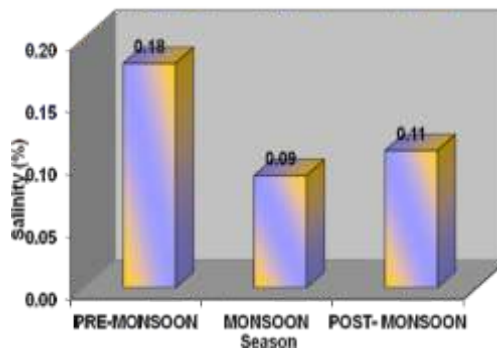


Figure-14: Salinity (%) Status of Havaspur Beel Wetland (HABW)

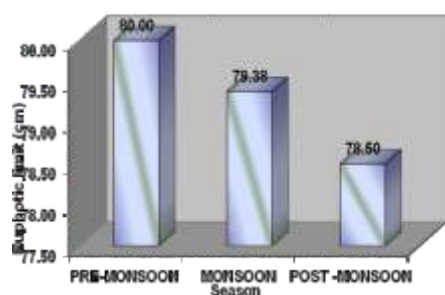


Figure-15: Euphotic limit (cm) status of Havaspur Beel Wetland (HABW)

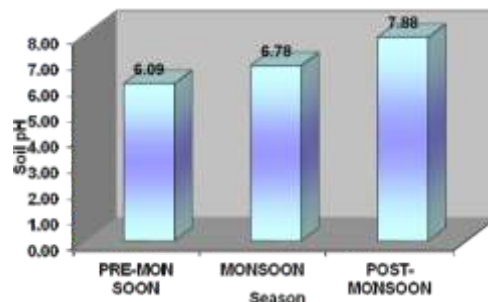


Figure-16: Status of Soil p^H of Havaspur Beel Wetland (HABW)

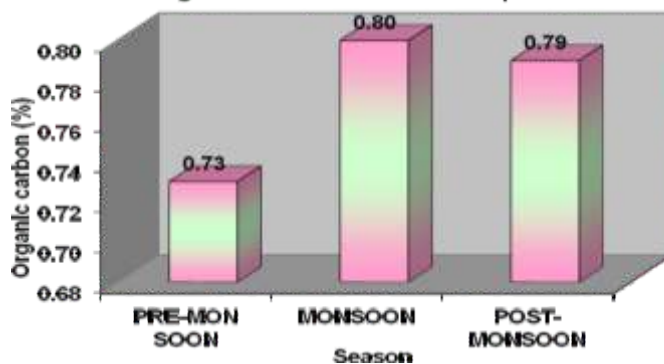


Figure-17: Status of Soil Organic Carbon of Havaspur Beel Wetland (HABW)

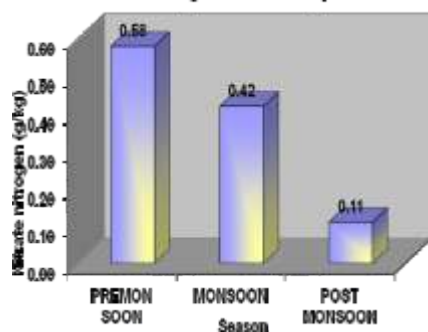


Figure-18: Status of Nitrate Nitrogen (g/kg) of Soil of Havaspur Beel Wetland (HABW)

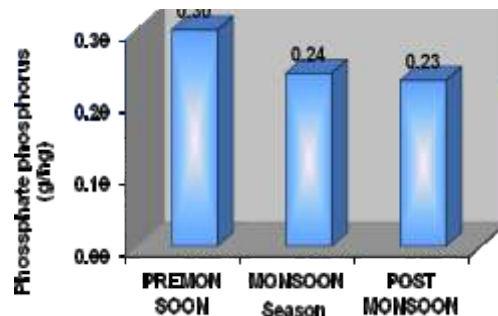


Figure-19: Status of Phosphate Phosphorous of Soil of Havaspur Beel Wetland (HABW)

FROM AGRARIAN FIELDS TO SUBURBAN CENTRES: A CASE STUDY OF LULC IN KOSI-GANDAK DOAB (2003-2023)

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ABSTRACT

Assessment of land use land cover (LULC) change plays an important role in determining morphological and functional changes in an area. Its varied applications mainly include analysis of urbanization, ecology, agriculture, hydrology, etc. Identifying, delineating, and mapping LULC is important for resource management, conservation, and planning activities. The present study focuses on the LULC transition in the Kosi-Gandak doab region of North Bihar. The area is drained by Gandak, Kosi, and Ganga which makes it highly fertile and is extensively utilized for agriculture. For this study satellite images of Landsat (7-9) were used for the period 2003-2023. An unsupervised classification was used for the classification of land use categories. Topographical sheets were used as ancillary data. Five LULC categories were identified and mapped i.e., built-up area, water bodies, barren land/fallow land, agricultural land, and forested area in the region. Accuracy assessment of the land use classes was done with the help of the kappa coefficient. The study finds that rapid change in land use has been witnessed over the past 20 years. Agricultural lands were transformed into residential areas and commercial plots. Agricultural land hasn't changed largely. Overall, there is an increase in the built-up area by 0.07%. There is a substantial reduction in wetlands by 0.92%, but barren land has been utilized mainly at places like Darbhanga, Samastipur, Madhubani, and Muzaffarpur. In the future, unplanned development and an unregulated increasing rate of urbanization will significantly impact upon present patterns of LULC.

Keywords: Land use, urbanization, unsupervised classification, Kappa coefficient, unplanned development

Introduction

A shift from agricultural to non-agricultural uses such as mining, construction, commercial facilities, or residential settlements is known as land use land cover change (LULC) or land conversion. Land use and land cover patterns are influenced by environmental and socio-

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economic forces, as well as human activity over time and space (Amin and Fazal, 2012). Monitoring and mapping land use land cover changes is crucial for assessing human impact on the environment over time and understanding the earth's structure and dynamics (Khaldi et al., 2022). Remote sensing and GIS techniques enable such assessments, as land use changes significantly affect global dynamics, responding to environmental and socio-economic factors (Hurni et al., 1998). When combined with GIS, remote sensing offers valuable insights from multi-temporal, multi-spectral, and accessible data for mapping, tracking, and evaluating changes at the landscape level (Das and Sharma, 2024). These changes impact climate patterns, natural hazards, and socio-economic dynamics at both global and local scales (Hegazy & Kaloop, 2015). Change detection identifies differences in various elements like farmland, barren land, built-up areas, vegetation cover, and water bodies over time. "Land use" and "Land cover" are often used interchangeably, but they differ. Land use refers to human activities associated with land cover features, while land cover describes the biophysical features on the earth's surface, such as vegetation, urban infrastructure, water, and bare soil (Amin and Fazal, 2012; Sudhakar and Rao, 2010). Land use changes have a direct impact on the quality of living as there is a link between regional development activities and an increase in population due to land use changes (Astuty and Dimyati, 2024). Changes in land cover can induce flood intensity because they disrupt the hydrological features, resulting in a drop in infiltration rate and an increase in surface runoff (Farid et al., 2022). Land cover identification provides baseline data for tasks like thematic mapping and change detection analysis.

Land transformation refers to the change in land use or land cover, and it's a human-induced environmental transition since neolithic times which accelerated and diversified with the advent of the industrial revolution, globalization, population growth, and technological advancement (Fazal, 2000). It involves land use and land cover changes and it's crucial for the optimal land use planning for development at the grassroots level (Gupta et al., 2024). LULC analysis is vital for effective natural resource planning and management, requiring knowledge of the existing landscape state, its changes, and spatial distribution. The transformation, where agricultural land is repurposed for stores, buildings, or mines, is termed agricultural transformation (Dolly, Kismartini, and Purnaweni, 2018) and it's mainly due to the rapid rate of industrialization and urban growth (Li et al., 2024). It is a crucial element of rural planning and sustainable land management. This change stems from both natural and man-made factors, influencing the physical environment, food security, and human livelihoods in various positive and negative ways (Hossain and Moniruzzaman, 2021). Several macroeconomic, social, and infrastructural development factors significantly drive agricultural transformation, with a higher rental value of urban land compared to agricultural land being a primary cause (Abduh, Muhammad, 2023; Rondhi et al., 2018).

Land use land cover change has been witnessed across the globe where a growing population and economic value of land play an important role in its conversion. In the United States and Canada, there has been a significant shift in land use patterns, moving from agricultural practices to non-agricultural uses with high economic rent such as industries, transportation, schools, housing, and other human activities. In the United States alone, 500,000 hectares of agricultural land are converted annually to non-agricultural activities, with railways and roadways playing a pivotal role in this transformation (Francis et al., 2012). Similarly, in Nigeria, agricultural land in the Kaduna metropolis decreased from 59% in 1980 to 43.4% in 2012, transforming into built-up areas due to the increasing population and its growing needs (Saleh et al. 2014). Unlike the West, in Asian countries agriculture remains the predominant land use, making land one of the continent's most critical natural resources (FAO, 2016). In South Asia, 70-75% of the people are engaged in agricultural and allied activities and it contributes about 33% of GDP (Shafi, 2000). The ability of Asian countries to achieve their food security, climate change, and human security goals heavily relies on sustainable agricultural land use (Prabhakar, 2021). Recently, Asia has witnessed significant changes in agricultural land use, with two types of agrarian transformations: agricultural land use change and agricultural intensification (Prabhakar, 2021). Between 1986 and 2005, China saw 12.9 million hectares of agricultural land repurposed for other uses, posing a threat to food security and the rural economy, driven by rapid economic development and urban sprawl (Song and Liu 2017). In Indonesia, the reduction in agricultural land is attributed to growing urbanization where with rising urban populations demanding housing and increasing the value of agricultural land for non-agricultural purposes (Rondhi et al., 2018).

In the Indian Subcontinent, agriculture dates back to about 9000 B.C. During the British era, the major agricultural transformation was from traditional practices to commercialized agriculture, focusing on cash crops like cotton, indigo, opium, jute, and tea. The British introduced other cotton varieties to boost production and enforced indigo planting while monopolizing the opium trade (Pathak, Mishra, and Mohapatra T, 2022). British-built canals and dams for irrigation led to agrarian reforms in Punjab, Narmada Valley, and Andhra Pradesh (Roy 2006). Post-independence, the Green Revolution transformed India from a food-importing nation to a food-surplus nation, but this put immense pressure on land resources. Urban expansion continues to erode agricultural land in most states (Dolly, Kismartini and Purnaweni, 2018). Between 2001-02 and 2010-11, India lost 1.6 million hectares of farmland to non-agricultural uses, with Tamil Nadu experiencing the greatest reduction between 1992-93 and 2005-06, losing 7350 hectares (Govindaprasad and Manikandan, 2014).

Land use change transformations had a slow place in Bihar owing to its status as a disaster-prone state and low investment in public-private sectors. NITI Aayog's Multidimensional

Poverty Index measures poverty across health, education, and living standards using 12 indicators. Bihar has the highest proportion of multidimensionally poor people, with 51.89% of the population, which declined to 33.76% in 2019-21 due to improvements in nutrition, schooling, sanitation, and cooking fuel, driven by various government schemes (NITI Aayog, 2023). In Bihar, the net sown area decreased by 5.83% from 2003 to 2013, while the area under non-agricultural uses increased by 3.81% in the same period (Sinha, Ahmad, and Singh, 2018). This shift is due to housing needs for the growing population, public infrastructure expansion, recreational grounds, and industrial setups (Sinha, Ahmad, and Singh, 2018). Transportation infrastructure plays a crucial role in urbanization and overall development. In Bihar, the construction of national and state highways between 2003 and 2023, including NH-31, 102, 19, 77, 28A, 74, and 75, has driven significant land transformation (Annual Report, Government of Bihar 2022-23; Ministry of Road Transport and Highways, Government of India). Bihar lags behind other states in urban centres and industrial development, with its urban workforce primarily engaged in wholesale, retail trade, and services rather than manufacturing, which is essential for urban development. South Bihar is more urbanized than North Bihar, which is limited to large cities (Endow, 2017). Bihar experiences the highest out-migration rate in India due to a lack of agricultural, industrial, and infrastructural development, with migration becoming a livelihood strategy and way of life in rural Bihar (Das, Priya, and Sharma, 2024; Datta and Mishra, 2011). North Bihar has a higher migration rate than South Bihar, possibly due to the higher degree of urbanization in South Bihar (Datta and Mishra, 2011).

This study aims to explore the land use and land cover (LULC) dynamics within the study area. This includes classifying different types of land use, detecting and quantifying changes over a specified period, and evaluating the accuracy of the LULC classifications.

Research Objectives

- i. To make an inventory of land use classification of the study area.
- ii. To detect changes in LULC in the study area.

Research Questions

- i. What are the different categories of land use present in the study area?
- ii. What significant land use land cover changes have occurred over the study period?
- iii. What factors might have contributed to these observed changes in LULC?
- iv. What is the accuracy level of the land use classification derived from the study?

Study Area

The study is being carried out in the Kosi-Gandak doab region of North Bihar. Its eastern and western borders are delineated by the Kosi and Gandak rivers respectively, while the Ganga River defines its southern boundary. On the north, it is bounded by the international boundary

of India and Nepal. The slope gradient of this area is towards the southeast and the rivers finally join the Ganga River flowing west to east. Rivers from the Himalayas that flow down to the Ganges in various tributaries include the Gandak, Burhi Gandak, Bagmati, Kamla-Balan, Kosi, and others. The Kosi River has long been referred to as be sorrow of Bihar due to its propensity to alter course. The Gandak, Burhi-Gandak, and Kosi rivers flow into the Ganga, while the Bagmati-Adhwara, Kamla-Balan, and other rivers enter the Ganga through the Kosi River. Geographically, it is located between 25°16'4.3"N to 27°31'25.6" N latitude and 83°51'9.9"E to 87°14' 42.8"E longitude. With a spatial extent of 251.2 kilometres from North to South and 377.7 kilometres from West to East, this Doab region is comprised of about 27,972 square kilometres. This area lies in the middle Ganga plain at a height of 748 meters above mean sea level.

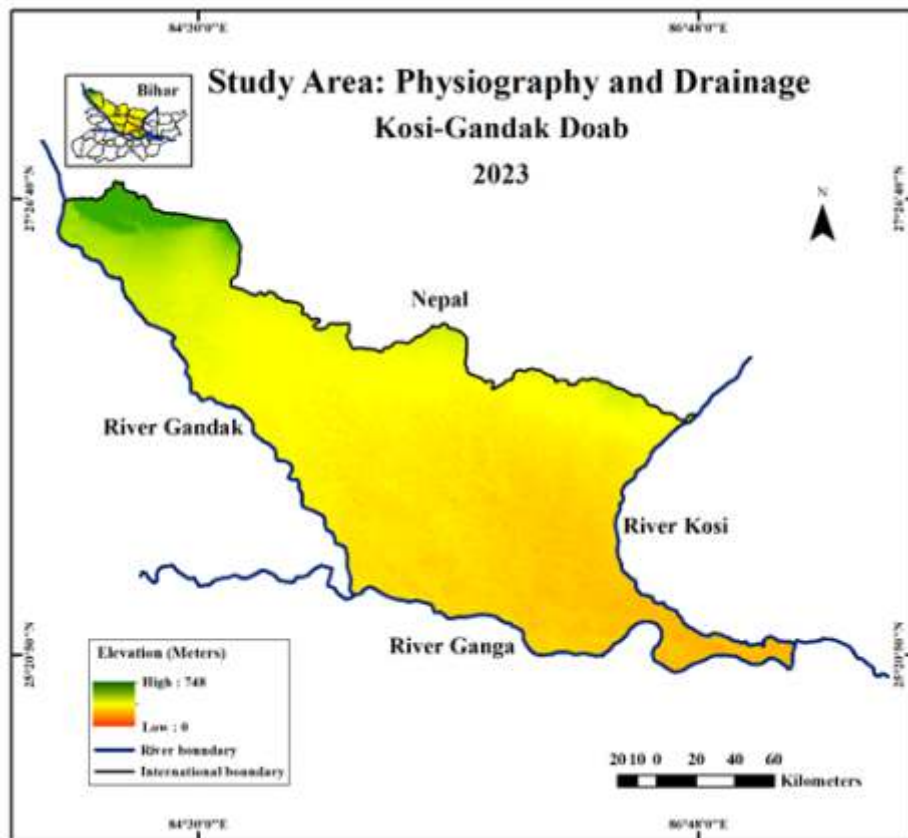


Figure 1: Study Area

Source: Prepared by the authors using SRTMDem(2024) (NASA Shuttle Radar Topography Mission (SRTM) (2013). Shuttle Radar Topography Mission (SRTM) Global. Distributed by Open Topography. <https://doi.org/10.5069/G9445JDF>. Accessed: 2024-02-20)

Large seasonal variations in temperature and rainfall characterize the climate of the study area. The area falls under sub-tropical climate (IMD, 2011) with a mean annual precipitation of 1180mm (Sattar et al., 2018). The highest rainfall occurs during the monsoon season in mid-June to September accounting for about 85 percent of the total annual rainfall with July and August being the wettest month (Sharma and Priya, 2023, Sattar et al., 2018). The natural vegetation of this region comprises mainly deciduous forests. Only a small proportion of the entire region is covered with forests.

This region's economy is based primarily on agriculture, and the cropping pattern of this region shows a mixture of wet and dry crops. Here rice is a predominant crop while wheat, corn, barley, and pulses are other important supplementary crops. There are three cropping seasons in a year Kharif, Rabi, and Zaid. Kharif crops are sown during the southwest monsoon (June-September) and harvested during October-November; Rabi crops are sown during the retreating southwest monsoon (November-January) and harvested in the spring season (February to May); and Zaid crops are cultivated in the short summer season between Rabi and Kharif (Kumar and Kumar, 2022).

This study area includes the whole or part of about 12 administrative units of Bihar i.e. districts of Bihar namely West Champaran, East Champaran, Sitamarhi, Sheohar, Muzaffarpur, Vaishali, Madhubani, Darbhanga, Samastipur, Khagaria, Begusarai, and Bhagalpur. The total population of this area is 41,653,034 which accounts for about 40% of the total population of Bihar (Census of India, 2011). It is one of the most densely populated areas with a population density of about 1489 persons per square km (Census of India, 2011). The area is primarily rural with most of the population living in compact or clustered villages in the cultivated plains.

Kosi-Gandak doab region is one of the most fertile areas of the middle Gangetic plain nourished by Kosi, Gandak, and Ganga rivers. This region receives fresh alluvium deposits almost every year due to riverine floods which makes it the best region for agricultural practices. However, the agricultural and infrastructural development is almost insignificant despite all the favourable conditions. Therefore, it is imperative to carry out an in-depth assessment of the LULC changes in this area.

Data Sources and Methodology

Data Collection

In this study, secondary sources of data are used. Landsat satellite images of the year 2003 and 2023 were obtained from the United States Geological Survey (USGS).

(<https://earthexplorer.usgs.gov>). Landsat 7 ETM+ (Enhanced Thematic Mapper Plus) and Landsat 8-9 OLI/TIRS (Operational Land Imager/Thermal Infrared Sensor) satellite imageries were used. The Digital Elevation Model (DEM) of the study area was obtained from the Shuttle Radar Topography Mission (SRTM) of the USGS with a spatial resolution of 30 meters. Toposheets with R.F 1:50000 were taken from the open series map of the Survey of India. Google Earth web was used as an ancillary source for image classification.

Image Processing

After acquiring Landsat data, it was extracted and converted into tiff format. For compiling all the tiles, the process of mosaic was undertaken. Then, the multi-spectral (MSS) raster imageries for different bands (1-7 for both ETM+ and OLI/TIRS) were composited. The study area imagery was extracted from the composite layer. Arc Map 10.8.2 was used to conduct the spatial analyst functions and raster data functions. For preparing the Digital Elevation Model of the study area, SRTM data was mosaiced and the study area was extracted using clip features. SOI toposheet with R.F. 1:50000 was georeferenced and compiled using the mosaic feature.

Image Classification and Change Detections

The process of classifying raster images into different classes of land use is known as 'Image classification' (Yedage et al., 2015). In this study, an unsupervised image classification technique was used to classify the satellite images. Unsupervised classification is used when there are no training samples available for classification (Madariya, Pandey, and SK, 2022). It is a process of classifying each image in a raster dataset as belonging to one of the inherent categories of the image collection without using previously defined labeled training samples (Olaode et al., 2014). It is a process of automatic detection of similar pixels based on their spectral values in a satellite image. Clustering techniques are used to group the image pixels in this classification method. The image computes clusters and classifies them according to the system based on knowledge. After automatic pixel clustering, land-cover classes for each cluster are verified to obtain a well-classified satellite image. Several small clusters are merged into a single land cover class for convenience of understanding. In the end, change detection was carried out to study the changes in LULC patterns in the study area. A change matrix of LULC was created to analyze changes in classes of land use categories over time in Kosi-Gandak doab. MS Excel was used for calculation and table formation.

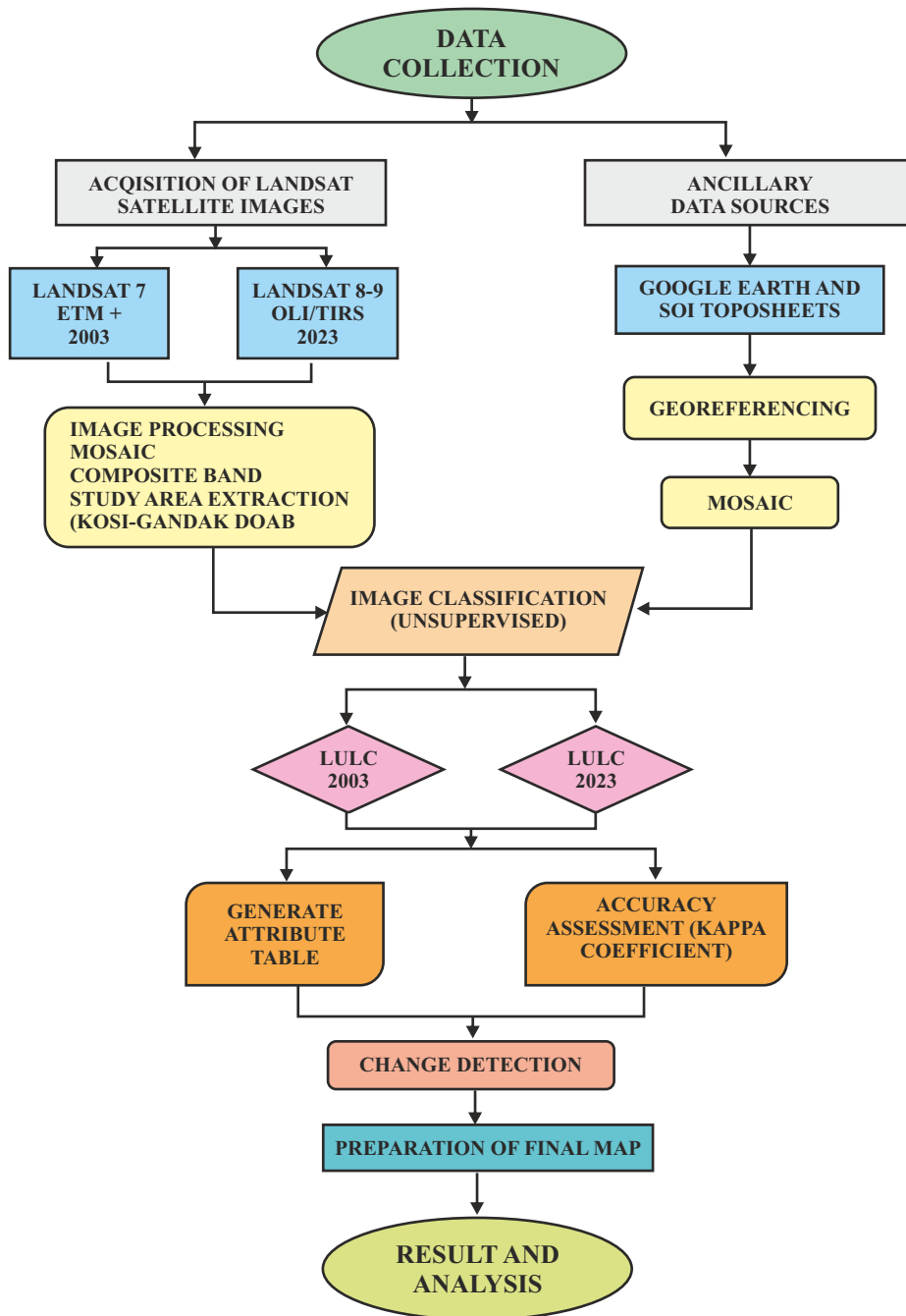


Figure 2 : Methodology for LULC Transformation in the Kosi-Gandak Doab

Source: Prepared by the authors (2024)

Accuracy Assessment

The classified LULC maps are verified through an accuracy assessment to show how accurately the LULC maps are produced (Shahfahad et al., 2022). It also illustrates the effectiveness of the classification technique (Shahfahad et al., 2021; Manandhar, Odeh, & Acnev, 2009). The classification accuracy measures the quality of maps produced and helps to evaluate the applicability of a map for a particular use. For accurate interpretation and identification, the classified map must have a minimum accuracy of at least 80 percent (Anderson, Hardy, Roach, & Witmer, 1976). Several studies have already used methods such as the Kappa coefficient, error matrix, and index-based techniques to evaluate the accuracy of the produced LULC maps.(Manandhar et al., 2009; Rahman, Mohiuddin, Al Kafy, Sheel, & Di, 2019; Talukdar et al., 2020; Shahfahad et al., 2021). In this study, Kappa coefficient technique has been used to evaluate the accuracy of LULC maps of Kosi-Gandak doab.

One discrete multivariate method for accuracy evaluations is Kappa analysis. (Rwanga and Ndambuki, 2017). Kappa analysis yields a Khat statistic (an estimate of KAPPA) that measures agreement or accuracy (Congalton, 1991). The Khat statistic is computed as:

$$K = \frac{N \sum_{i=1}^r x_{ii} - \sum_{i=1}^r (x_i + Xx_{+i})}{N^2 - \sum_{i=1}^r (x_{ii} Xx_{+i})}$$

Where,

r = number of rows and columns in the error matrix,

N = total number of observations (pixels)

x_{ii} = observation in row i and column i,

x_{i+} = marginal total of row i, and

x_{+i} = marginal total of column i

When the Kappa coefficient is close to 0, it indicates that the agreement is no better than would be predicted by chance, whereas a value of 1 indicates complete agreement (Rwanga and Ndambuki, 2017). The classification of the Kappa statistic is given below in Table 1.

Table 1 : The classification of the Kappa statistic

K-Value	Rating	Agreement
≥ 0.81	Excellent	Almost perfect Agreement
0.81-0.61	Good	Substantial Agreement
0.61-0.41	Moderate	Moderate Agreement
0.41-0.21	Poor	Fair Agreement
0.21-0.0	Bad	Slight Agreement
<0.0	Very Bad	Less than chance Agreement

Result and Discussion

The study has identified five major land cover categories: built-up areas, water bodies, barren land, farm areas, and vegetation cover. The objective of the study was to find the land use classification and detect changes in the land use land cover classification. The dominant land use land cover was farm areas whereas water bodies covered a smaller proportion of the study area.

LULC Pattern of Kosi-Gandak Doab in 2003

For the LULC classification of 2003 using Landsat 7 ETM+ satellite images, supervised classification was applied to delineate different land use categories. Spectral signatures for each category, including farmland, barren land, vegetation, built-up areas, and water bodies, were collected and analyzed. Farmland (76.15%) is identified using Band 4 (NIR) and Band 3 (Red) due to vegetation's high NIR reflectance and red absorption. Barren land (10.90%) is classified with Band 5 and Band 7 (SWIR), which highlight the high reflectance of bare soil. Vegetation (7.43%) also uses Band 4 (NIR) and Band 3 (Red) for its unique spectral signature. Built-up areas (3.92%) are identified with Bands 7 and 5 (SWIR) and Band 1 (Blue), which differentiate impervious surfaces. Water bodies (1.60%) are detected using Band 1 (Blue), Band 4 (NIR), and Band 2 (Green) due to water's low NIR reflectance. Critical spectral bands such as Band 5 (NIR) and Band 7 (SWIR) were utilized to distinguish barren land, which typically exhibits high reflectance in these bands. To validate the classification, topographical sheets from the Survey of India (Open Map Series) were used for cross-verification. This ensured that land use categories, particularly barren land, matched the features identified in the satellite imagery, thus providing reliable and accurate results shown in the pie chart (Figure 2) and land use map .

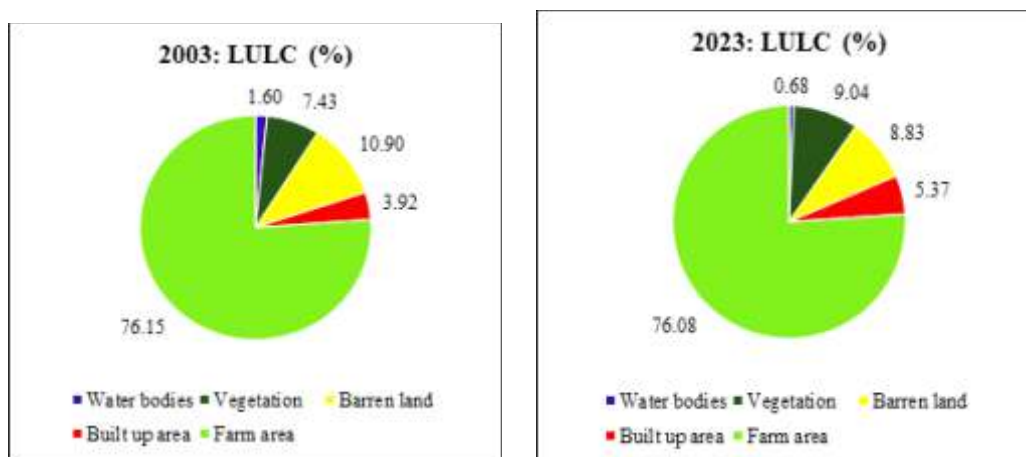


Figure 3 : LULC in the year 2003 and 2023.

Source: Calculated by the authors(2024)

LULC Pattern of Kosi- Gandak Doab in 2023

The analysis of Land Use Land Cover (LULC) data for 2023, derived from Landsat 8-9 OLI/TIRS satellite imagery, reveals significant changes in the landscape over the years. The classification results demonstrate shifts across various land use categories, which are detailed in percentage terms in the pie chart (Figure 3), and visually represented on the map. Despite small fluctuations over the years, the farm area continues to dominate the landscape, covering 76.08% of the total land area. This confirms that agriculture remains the primary land use in the region, with only a marginal decrease of 0.07% from 2003 (76.15%). The minimal change suggests that agricultural practices have remained stable over the 20 years, maintaining the region's agrarian base. The vegetation cover has experienced a notable increase, rising from 7.43% in 2003 to 9.04% in 2023. This growth (1.61% increase) could be attributed to efforts in afforestation, reforestation, or natural vegetation regrowth in certain areas. The increase in vegetated land also reflects positive environmental management practices, indicating an enhancement in green cover, which could improve local biodiversity and contribute to better ecological balance. The built-up area has grown substantially from 3.92% in 2003 to 5.37% in 2023, reflecting an increase of 1.45%. This expansion is indicative of urbanization and population growth over the last two decades. As more land is converted for residential, commercial, and industrial use, this trend underscores the region's development and increasing human footprint. Barren land, which consists of areas with little to no vegetation, has decreased from 10.90% in 2003 to 8.83% in 2023, showing a decline of 2.07%. This trend suggests improvements in land utility or an overall reduction in non-productive land. The area occupied by water bodies has significantly decreased, from 1.60% in 2003 to 0.68% in 2023,

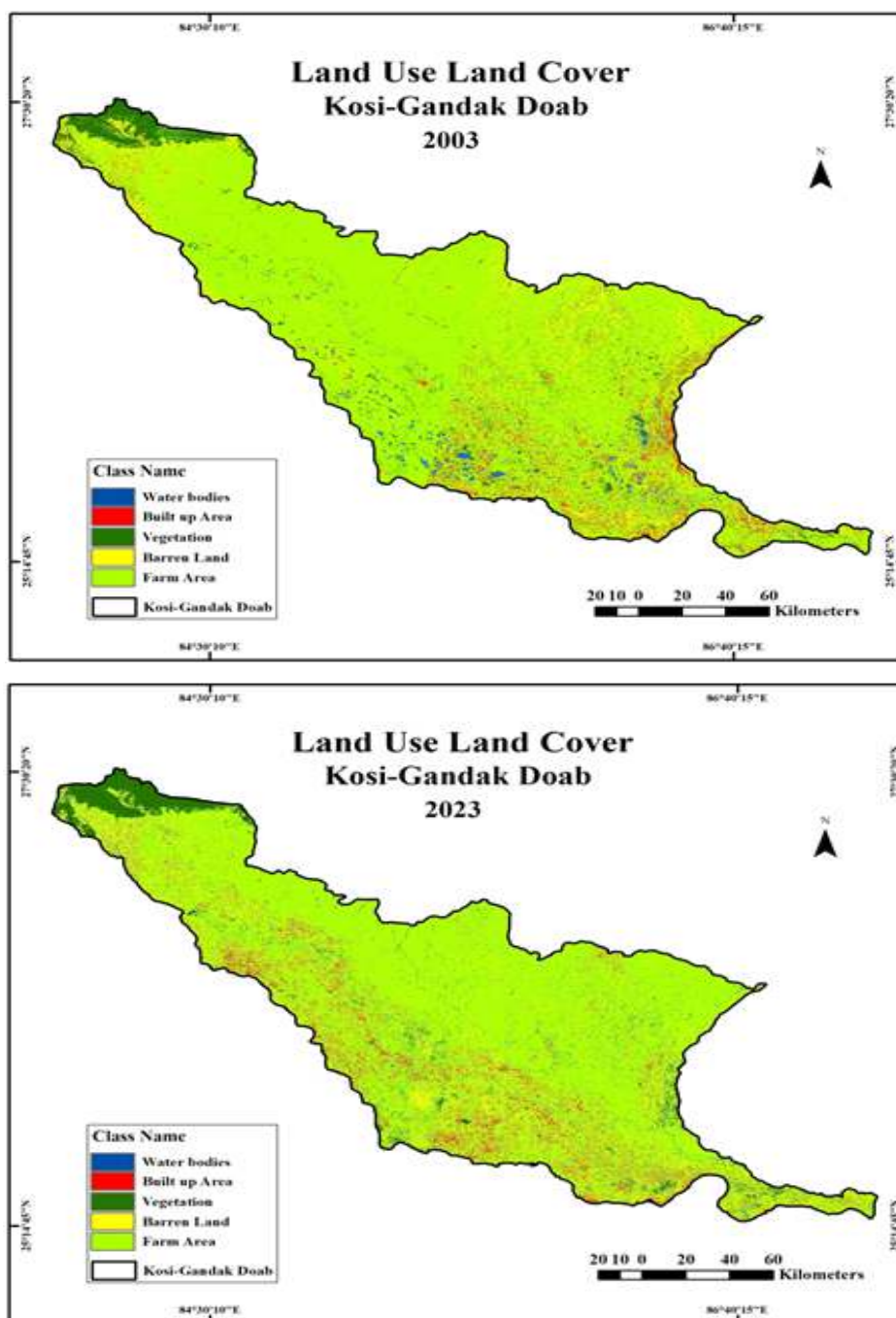


Figure 4 : LULC Map of 2003 and 2023

Source: Prepared by the authors(2024)

reflecting a decline of 0.92%. This substantial reduction might be attributed to water scarcity, the drying up of lakes and ponds, or the conversion of water bodies into land for other uses, possibly due to urban encroachment or agricultural expansion. The reduction of water bodies is an environmental concern, as it could impact water availability, local ecosystems, and biodiversity.

Data Interpretation and Analysis

In the Kosi-Gandak Doab region, farm area has traditionally been the predominant land use, but it has seen a slight decrease of 0.92% between 2003 and 2023. This reduction is attributed to the conversion of water bodies and barren land into built-up areas and agricultural areas, as well as the transformation of farm areas into built-up spaces and vegetation. This indicates a reluctance among the population to convert agricultural land into non-agricultural uses such as industrial or commercial purposes, which could be a factor contributing to the region's low industrial growth. Conversely, built-up areas have increased by 1.45% over the same period (Table 2).

Table 2: LULC Classification

Year	2003		2023		Net Change	
Classes	Area (in hectares)	Area (in %)	Area (in hectares)	Area (in %)	Area (in hectares)	Area (in %)
Farm Area	2129932	76.15	2128019	76.08	1913	0.07
Barren Land	304875	10.90	247091	8.83	57784	2.07
Vegetation	207885	7.43	252787	9.04	44902	1.61
Built-up Area	109624	3.92	150188	5.37	40564	1.45
Water bodies	44863	1.60	19094	0.68	25769	0.9

Source: Compiled by the authors (2024)

This expansion is largely due to the conversion of farmland, water bodies, and barren land into developed areas, particularly along the rivers Ganga and Kosi. The most significant urban growth has been observed in Muzaffarpur, Vaishali, Darbhanga, and Madhubani, driven by urbanization, improved living standards, employment opportunities, commercialization, and infrastructure development. Muzaffarpur's designation as a Smart City, Darbhanga's advancements in medical and educational facilities, the impact of its airport facility, and Vaishali's inclusion in the Buddhist circuit have all contributed to this growth.

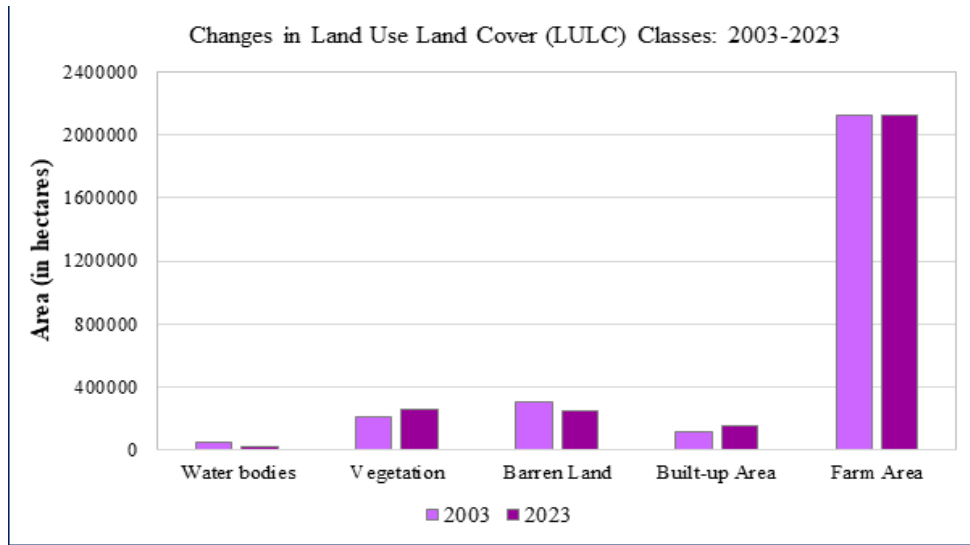


Figure 5 : Area of LULC Classes of Kosi-Gandak Doab

Source: Compiled by the authors (2024)

Vegetation cover has increased by 1.61% from 2003 to 2023, with notable growth in the northern part of West Champaran. This positive environmental development is due to the conversion of farmland into vegetation by farmers adapting to new agricultural practices under government beneficiary initiatives such as the Jal Jeevan Hariyali Mission, Green India Mission, and Nagar Van Yojana (2020). The barren land has decreased by 2.07% during this period, particularly in Madhubani and Begusarai districts. This reduction is due to the conversion of barren land into built-up areas, farmland, and vegetation to meet the demands of a growing population for food, housing, and commercial activities. Water bodies have seen a 0.9% decrease between 2003 and 2023. In 2003, the southwest region contained many oxbow lakes, ponds, and chauras, particularly in Madhubani, Darbhanga, Begusarai, Khagaria, Samastipur, and Vaishali. By 2023, many of these water bodies had vanished due to human activities such as converting wetlands into farmland and built-up areas, as well as reduced rainfall. This reduction in water bodies poses a threat to future water availability, impacting potable water supplies.

The assessment was performed using Kappa statistics and a confusion matrix to compare classified images with ground truth data (Forkuor & Cofie, 2011). Accuracy assessment, crucial for classification, showed high accuracy levels for various land cover types: 98% for farm areas, 94% for vegetation, 88% for built-up areas, 86% for barren land, and 83% for water bodies. The overall accuracy for land cover classification in the Kosi-Gandak Doab region is 89%, which falls within a very good range according to classification standards.

Conclusion

The study identified five major land cover categories: farm areas, barren land, vegetation cover, built-up areas, and water bodies, with a focus on detecting the shifts in these categories over two decades. Agriculture remains the dominant land use, covering 76.08% of the area in 2023, with only a slight decrease of 0.07% compared to 2003. This stability reflects the region's continued reliance on agriculture, which remains largely unaffected by industrial or commercial conversions. However, the most significant change has been the expansion of built-up areas, which increased by 1.45%, indicating the ongoing urbanization driven by population growth, infrastructure development, and economic opportunities in cities such as Muzaffarpur, Darbhanga, and Vaishali.

Vegetation cover has shown a positive trend, increasing by 1.61% between 2003 and 2023, likely due to afforestation and reforestation efforts, as well as government initiatives like the Jal Jeevan Hariyali Mission. This growth in green cover is a positive sign for biodiversity and environmental health in the region. On the other hand, barren land has decreased by 2.07%, reflecting improvements in land use as previously unproductive areas have been converted to farmland, vegetation, or urban areas. However, a significant concern is the reduction in water bodies, which have declined by 0.92%. This reduction is primarily due to the drying up of lakes and ponds or their conversion into other land uses, raising environmental concerns about water scarcity and its potential impact on local ecosystems and water availability.

The observed changes in the LULC matrix are driven by several factors, including population growth, urban expansion, agricultural stability, and environmental management practices. Urbanization has led to the conversion of farmland, barren land, and water bodies into built-up areas, driven by economic growth and improved living standards. At the same time, government-led environmental initiatives have contributed to the increase in vegetation cover. The reduction in water bodies, however, points to a growing environmental challenge, likely exacerbated by human activities and changing rainfall patterns.

Based on these observations, several recommendations are proposed. First, there is an urgent need for effective water resource management to conserve and restore the region's water bodies. Policies aimed at protecting wetlands and improving water management strategies should be prioritized to address water scarcity. Additionally, urban growth should be managed through careful planning to minimize its impact on agricultural land and natural resources. Expanding afforestation and land recovery programs will be crucial for maintaining the region's ecological balance. Finally, modern agricultural practices that conserve both land and water resources should be introduced to enhance agricultural productivity while promoting environmental sustainability. In conclusion, while the region has maintained its agricultural base and seen positive trends in vegetation growth, the rapid urbanization and loss of water

bodies demand immediate attention to ensure a balanced approach to land use, environmental protection, and sustainable development.

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GEOSPATIAL ANALYSIS OF LAND USE LAND COVER CHANGE DETECTION IN INTEGRATED WATERSHED MANAGEMENT PROGRAM - A CASE STUDY OF SABARKANTHA, GUJARAT

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ABSTRACT

This study focuses on a micro watershed of the Saberkantha district in Gujrat state, India, which has been a priority area for land reclamation efforts by governmental and non-governmental organizations over the past decade. The primary objective is to assess the impact of the watershed management program on land use and land cover (LULC) changes in selected watersheds, and also to study the spatial pattern using multi-temporal remote sensing data and GIS. The research applies LULC classification and post-classification techniques to detect changes between 2010, 2018, and 2023. Increase in built-up area and intensified land farming have led to significant LULC changes, influenced by agricultural expansion, and government policies. The analysis uses Landsat-7 and sentinel-2 images of 2010, 2018, and 2023, classified through supervised classification (Random Forest) based on ground truth, and post-classification comparison techniques. The integration of ancillary data further improves classification accuracy as shown by the change matrix. The results indicate an increase in agricultural land, and water bodies, along with a reduction in scrubland and degraded forest areas, highlighting the significant positive impact of watershed management programs.

Keywords: Land cover, change detection, remote sensing, supervised classification, GIS.

Introduction

The watershed management program has emerged as an effective and comprehensive development strategy specifically designed for arid and semi-arid regions in India. These programs, bolstered by supportive government policies, emphasize soil and water conservation alongside rural development. The positive development of both economic and natural resources in these regions has facilitated sustainable growth. The Integrated Watershed Management Program (IWMP) targets the development of micro watersheds throughout India. At regional and local levels, monitoring changes in land use/land cover (LULC) and vegetation cover serves as a metric to evaluate the impact of these initiatives. LULC maps are

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instrumental in understanding the efficient use of natural resources, offering insights and guiding future developmental prospects due to watershed management efforts. Globally, land degradation and soil erosion are significant issues linked to deforestation driven by agricultural expansion, industrialization, and urban growth. Urbanization due to increasing population and economic development is inevitable process. Land use/land cover changes play an important role in the global environmental change process (Patel, D.P., Gajjar, C.A., Srivastava, P.K., 2013). To predict and analyze the environmental consequences due to changes in land use land cover, more accurate data on land cover change is necessary for future planning (Giri, C., Zhu, Z., Reed, B., 2005). Remote sensing can identify changes in satellite data using change detection techniques. Remote sensing and GIS derive useful outputs by integrating spatial data through modelling (Gupta, M., Srivastava, P.K., 2010). Digital change detection is defined as the process of identifying changes in LULC properties based on multi-temporal remote sensing data. Many researchers have studied the problem of monitoring LULC change in different geographical areas accurately. For change detection, different techniques have been formulated, applied and evaluated (Gupta, M., Srivastava, P.K., 2010). The objective of the present study area is to analyze and assess land cover changes over 8 years, and to integrate supervised classification with visual interpretation using GIS to identify the capabilities of RS and GIS in evaluating the spatial distribution of LULC.

Objective

- To evaluate land use changes in selected watersheds.
- To study the spatial pattern of land use and land cover changes (Agriculture, Forest, Built-up etc.) over time within the municipality.

Study Area

Sabarkantha District, located in northeastern Gujarat, India, spans latitudes 23.03°N to 24.30°N and longitudes 72.43°E to 73.39°E. The district features diverse topography with the Aravalli Range, plains, and several rivers like the Sabarmati, Hathmati, Vatrak, and Meshwo. It has a semi-arid climate, characterized by hot summers, moderate monsoons, and mild winters, with annual rainfall ranging from 600 to 1000 mm. The soil varies from alluvial in the plains to rocky and sandy in the hilly regions, supporting deciduous and scrub forests. Sabarkantha is rich in natural resources, including minerals like quartz and limestone, and its forests provide timber and non-timber products. The economy is primarily agrarian, with significant dairy farming. The district is also a biodiversity hotspot, home to various wildlife species, and features numerous cultural and historical sites, making it a notable destination for tourism and research. This program aims to enhance soil conditions and fertility while also

focusing on developing surface water and groundwater recharge systems. These improvements are intended to support agricultural activities during the non-rainy season, thereby enhancing the socio-economic conditions of the local population.

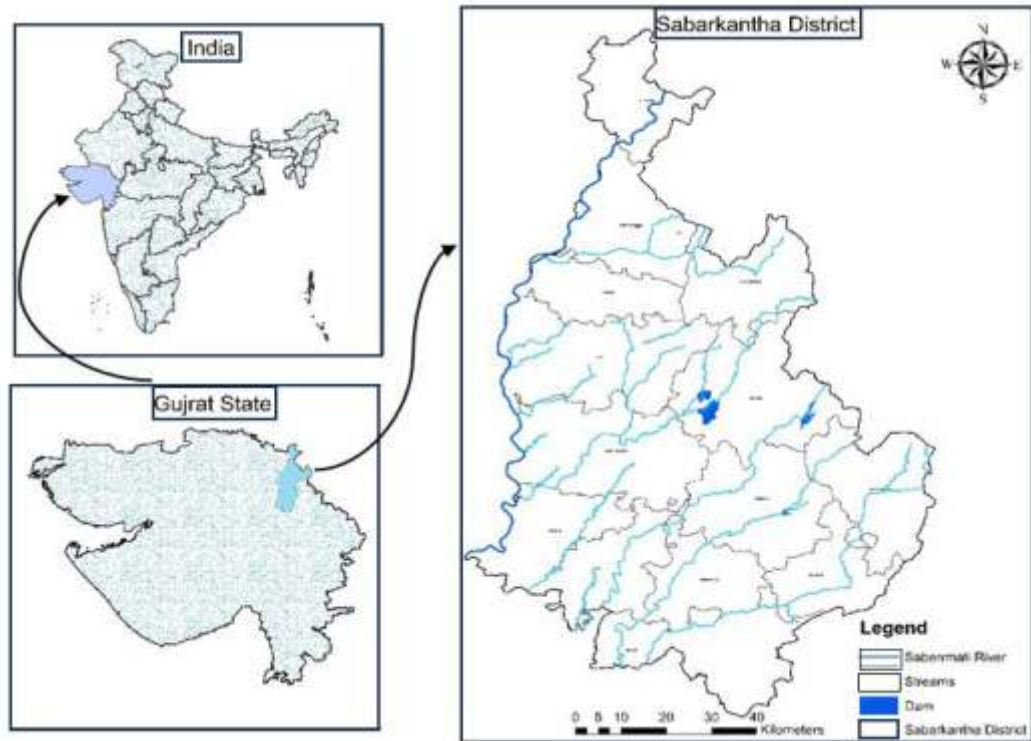


Figure 1: Location Map of Sabarkantha District



Figure 2 : Sabarmati River

Source: Field Visit 2017.



Figure 3 : Sabarmati Sangam Point (Sabarmati and Hathmati river)

Source: Field visit 2017.



Figure 4 : Hathmati River and Micro Watershed

Source: Field visit 2017.

Data and Methodology

Remote sensing images from three different sensors with a range of spatial resolutions were utilized in this study. For LULC (Land Use Land Cover) classification, landsat-7 and sentinel-2 with a spatial resolution of 15 meters and 10 meter was employed, using data acquired in 2010,2018 and 2023. Ground truth information was collected using the Global Positioning System (GPS) and high-resolution Google Earth images. This study involves monitoring changes across the Sabarkantha district, utilizing high-resolution imaging and smartphone-

derived Points of Interest (POIs) to assess the impact of the IWMP project. The methodology includes acquiring micro-watershed or project boundaries and verifying essential attributes in the shapefile. The process involves selecting and extracting satellite data for three time periods (T1, T2 and T3). A field-level inventory of water table activities was conducted using a GPS, allowing for real-time data modifications. Assets are categorized, and quality checks were performed on the vector data of the micro-watershed or project boundaries, with necessary adjustments based on the drainage network. Subsequently, a Land Use Land Cover (LU/LC) map has been created for the study area project area, along with a change detection map showing the changes in the district. A classification scheme was then developed to systematically analyze and interpret the data, ensuring comprehensive monitoring and evaluation of the project's impact in the study area.

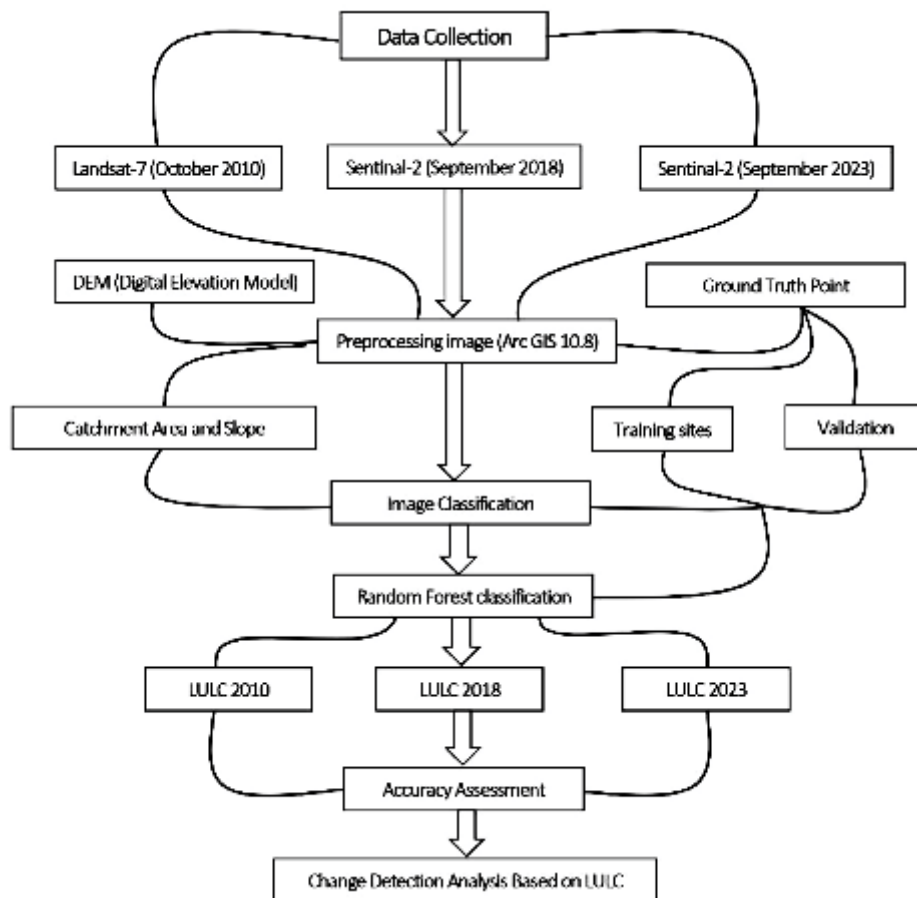


Figure 5 : Flow Chart

Image Enhancement and Visual Interpretation

Image enhancement to improve the visual interpretability of an image by increasing the apparent distinction between features. This process leverages the complementary capabilities of computers and the human mind. Contrast stretching was applied to images from 2010, 2018 and 2023 to create false colour composites (FCC). These FCCs were then used for visual interpretation to delineate land cover classes, such as agriculture and forest, that can be easily identified.

Image Classification

This method groups pixels with similar Digital Numbers (DN) using statistical techniques. There are two primary methods: supervised and unsupervised. In this study, the supervised Random Forest

Classification (RF) method was applied, as it is the most widely used for supervised classification. RF uses each category's spectral response patterns, based on variance and covariance, to accurately classify unknown pixels. Lillesand (T.M., Kiefer 2004) The classification utilized ground check points and satellite images of the study area, with training pixels selected for each category to facilitate digital automated classification. The main land cover classes in this area include built-up areas, Kharif crop, rabi crop, double/triple crop, current fallow land, deciduous forest, degraded forest, barren land, scrub forest, and water bodies. Accuracy assessment was conducted using ground control points from field data, chosen based on a random stratified method to represent different land cover classes. To improve classification accuracy, ancillary data and visual interpretation were integrated using GIS, resulting in enhanced outcomes.

Land Cover Land Use Change Detection

The Land Use Land Cover (LULC) analysis reveals significant changes between 2010 (T1), 2018 (T2) and 2023(T3). Change detection is always followed by a post-classification Change matrix (Green. K., Kempka, D., Lackey, L.,1994) There has been an overall increase in built-up areas, streams/rivers/reservoirs, and water bodies, while scrubland and forest areas have decreased. Specifically, the area of water bodies was 4204.14 ha in (T1), 3779.72 ha in (T2), and 4013.95 ha in (T3). The decrease in water bodies in 2018 (T2) is attributed to lower rainfall compared to 2010 (T1) and 2023 (T3), as shown in Table 1. Agricultural land increased by 15,603.94 ha in (T3), with 214.56 ha being converted into built-up areas. Additionally, river and reservoir areas observed in (T2) were converted into seasonal agriculture in (T3) as show in Table 2. In this case study, field observation data clearly demonstrated changes between the image acquisition dates. The post-classification change detection method was employed to compare the images individually. (Mouat, D.A., Mahin, G.G., Lancaster, J., 93).

Table 1: Yearly rainfall (in mm) trends for Sabarkantha from 01-Jan-2010 to 01-Sep-2023

Yearly rainfall (in mm) trends for Sabarkantha from 01-Jan-2010 to 01-Sep-2023		
Year	Average Rainfall (in mm)	Actual Rainfall (in mm)
2010	793	852.49
2011	793	908.06
2012	793	871.49
2013	793	1089.88
2014	793	879.77
2015	793	767.35
2016	793	840.77
2017	793	951.39
2018	793	624.58
2019	793	1059.79
2020	793	802.15
2021	793	673.29
2022	793	993.79
2023	793	903.83

Source: India-WRIS (indiawris.gov.in)

Accuracy Assessment

Accuracy assessment becomes more reliable when ground truth data is combined with aerial imagery. It measures the quality of information obtained from classified satellite images. In this study, several ground control points (GCPs) were collected during field visits in 2017, which were used as reference data. Random stratified sampling was employed to reduce bias when classifying images. A visual interpretation process was conducted to identify different land use classes. A total of 1000, 1200 and 1300 pixels were selected for land use and land cover (LULC) mapping as training pixels for the years 2010, 2018 and 2023, respectively. Overall accuracy and user and producer accuracy were calculated using error matrices.

The Kappa coefficient was calculated as per Bishop and Fienberg, 2007 (eq. 1)

$$K = \frac{N \sum_{i=1}^r x_{ii} - \sum_{i=1}^r (x_{i+})(x_{+i})}{N^2 - \sum_{i=1}^r (x_{i+})(x_{+i})}$$

where:

- N is the total number of observations.
- r is the number of rows in the error matrix.
- xii is the number of observations in row i and column i (the diagonal elements of the error matrix).
- Xi+ is the total number of observations in row i.
- X+i is the total number of observations in column i.

Results And Discussion

The analysis of Land Use Land Cover (LULC) changes between 2010 (T1), 2018 (T2) and 2023(T3) using remote sensing and GIS techniques reveals significant transformations in the Sabarkantha district, attributed to integrated watershed management programs. The LULC analysis indicates an overall increase in agricultural land, built-up areas, rivers/reservoirs, and water bodies, while scrubland and forest areas have decreased. Specifically, scrubland decreased, converting primarily into agriculture, built-up areas, and water bodies. Agriculture increased with notable conversions from scrubland and forest areas Table 2. Forest area decreased, transitioning mainly into agricultural land and built-up areas. The increase in agricultural land and the reduction in scrubland and degraded forest areas reflect the positive impact of watershed management initiatives. Enhanced soil fertility and improved water management practices have facilitated the reclamation of previously unusable land for agriculture. The increase in water bodies further supports the effectiveness of surface and groundwater recharge systems implemented under the Integrated Watershed Management Program (IWMP).

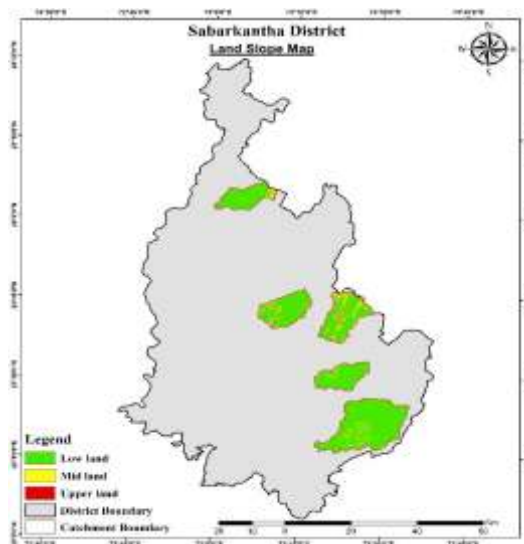


Figure 6 : Land Slope Map of Catchment Area in Sabarkantha District

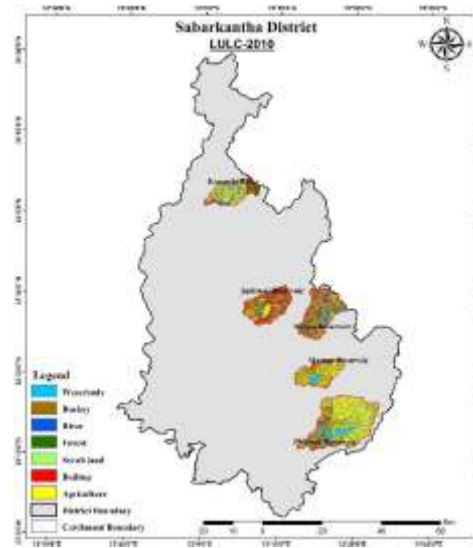


Figure 7 : Land use Land Cover map in 2010

**Table 2: Change matrix of land cover classes between 2010,2018 and 2023
(area in hectares)**

Grid Code	LULC Category	Area (in Hect.) Year-2010	Area (in Hect.) Year-2017	Area (in Hect.) Year-2023
1	Waterbody	4204.14	3779.72	4013.95
2	Rocky Area	20672.88	20672.88	20672.88
3	River	6516.17	6103.38	4374.66
4	Forest	4579.13	4432.13	4368.73
5	Scrub Land	18814.16	15427.16	13939.55
6	Built-up	10902.2	12906.87	13801.99
7	Agriculture Land	11087.03	13453.57	15603.94
Total Catchment Area		76775.71	76775.71	76775.71

The study highlights the efficacy of integrated watershed management in transforming the LULC of Sabarkantha district. The use of geospatial technologies, including remote sensing and GIS, provided critical insights into the spatial distribution and temporal changes of land cover. The findings underscore the importance of continued investment in watershed management programs to promote sustainable land use practices and enhance the socio-economic conditions of rural areas.

This highlights the important role of GIS and remote sensing in detecting land cover changes, as they are powerful tools for analyzing crucial information about the spatial distribution of these changes. Classification accuracy is essential, as errors can lead to the misclassification of pixels. In the present study, the overall improvement in vegetation classes and the reduction in waste and degraded forest areas indicate a positive shift towards sustainable development.

Conclusion

Land cover classes changed significantly from 2010, 2018 and 2023. Optical remote sensing data, such as Landsat-7 and Sentinel-2, were used to study these changes. Integrating visual interpretation and ground truth data collected during field visits with GIS and remote sensing provided more accurate results for examining and analyzing the spatial distribution of different land cover classes. The study area experienced significant land cover changes due to the IWMP program, including a considerable increase in forest cover and agricultural areas. Additionally, the area of natural vegetation increased substantially.

The Ministry of Rural Development of the Government of India took a significant step in 2009 by merging the Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS) with the Integrated Watershed Management Programme (IWMP). To ensure the success of this initiative, pilot projects should be launched in selected districts, addressing any

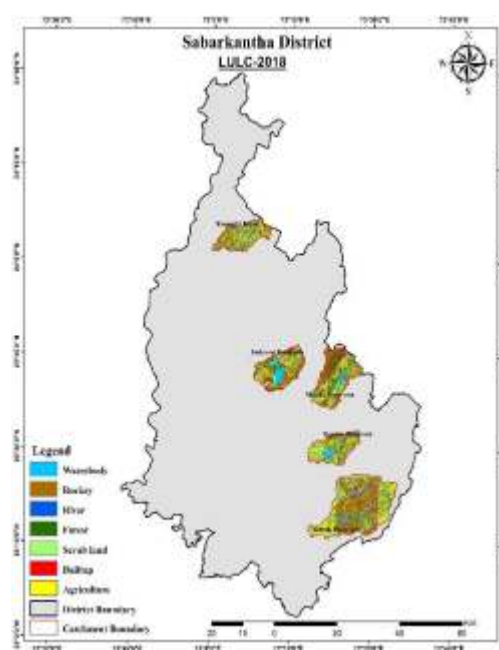


Figure 8: Land use Land Cover map in 2018

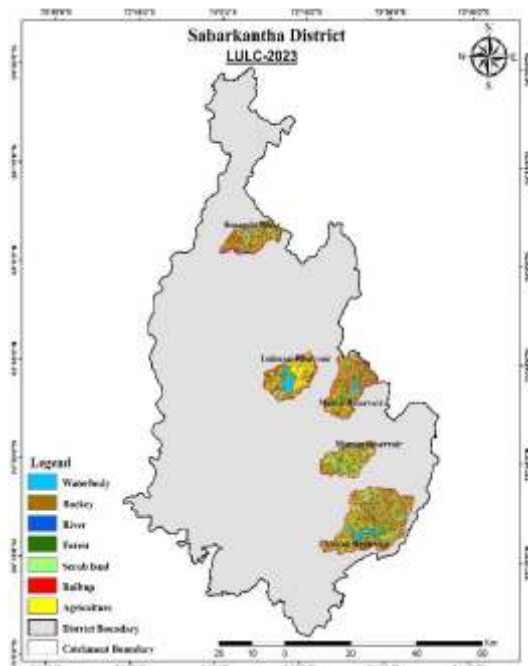


Figure 9: Land use Land Cover map in 2023

Catchment Name	Area (in ha.)
Kosambi River	10367.94
Indrasai Reservoir	13421.04
Meswo Reservoir	15833.57
Mazum Reservoir	10812.89
Vatrak Reservoir	31970.17

In this study, the overall accuracy was found to be 75% for both 2010, 2018 and 80% accuracy in 2023. (Anderson, R. E. 1976) The highest accuracy was achieved for agriculture and waterbodies classes, attributed to effective visual interpretation alongside the classified images. Conversely, the lowest accuracy was observed for current – Forest and Scrub land, likely due to the semi-arid conditions and sparse vegetation in these areas, which led to classification confusion. Remote sensing data and GIS facilitate the combined analysis of spatial data with ancillary data obtained from ground truth. The change matrix of images allows for the comparison of land cover classes between three images of the same class, providing valuable insights into changes over time.

initial challenges during the 12th Plan period. For effective IWMP implementation in the state, it is recommended that the Agriculture Department, Soil Survey & Conservation Department, and the Irrigation Department act as nodal agencies. These departments, with their substantial manpower and available infrastructure, should collaboratively manage responsibilities and consult regularly to drive the IWMP's success.

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ASSESSING WOMEN'S EMPOWERMENT IN A LOCAL CONTEXT (ULUBERIA SUBDIVISION, DISTRICT HOWRAH, WEST BENGAL): IMPLICATIONS FOR SOCIO -ECONOMIC DEVELOPMENT

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ABSTRACT

Women's empowerment is a crucial topic for the socio-economic development of any nation. The adage "a good and educated mother always gives society a good child" underscores the importance of empowering women for the broader benefit of society. Empowering women is essential for achieving gender balance and enabling women to make autonomous choices and control their livelihoods at home, in society, and at the workplace. It favors women's rights and autonomy. It's a talked-about or silent world-wide movement trying to create a better world for women where they are valued, respected, and given the same opportunities as men, and this seeking or trying situation must be started in every family. When men and women equally contribute to building up society, proper socio-economic progress will take place in the right way.

To measure women's empowerment, indicators such as literacy rates, access to quality education, decision-making power within households, economic ability, freedom of movement, political participation, freedom from gender bias, media exposure, and improvements in the healthcare system are essential. This paper explores the status of women's empowerment in a specific rural region, the Uluberia Subdivision of District Howrah in India, reflecting the broader state and societal conditions. Utilizing primary and secondary surveys and statistical data analysis, the study concludes that only 24% of women experience empowerment within their family lives, while the majority face significant challenges.

Keywords: economic empowerment, education, pseudo-empowerment, sex ratio, women empowerment.

Introduction

The statement "One is not born, but rather becomes a woman" (Beauvoir, 1953) encapsulates the idea that gender identity is shaped by social and cultural factors rather than being innate. Simone de Beauvoir, in her seminal work "The Second Sex," delves into the construction of

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femininity and the societal expectations imposed upon women. Her analysis has become a cornerstone of feminist theory, underscoring the social and cultural construction of gender roles and advocating for women's self-awareness and agency to define their identities and destinies. This foundational understanding aligns with the proverbial wisdom that "a good and educated mother always gives society a good child," highlighting the essential role of women in shaping future generations.

Statement of the Problem

Women's empowerment is a critical issue that intersects with various aspects of socio-economic development. Historically, women have faced significant barriers to achieving equal status with men, particularly in patriarchal societies where gender roles are rigidly defined. Despite various efforts and legislative measures aimed at empowering women, a significant number of women in India, especially in rural areas, still lack the autonomy to make independent choices and control their livelihoods. This situation persists despite notable progress over the years. The disparity in women's empowerment between India and Western countries is stark, with Indian women continuing to face considerable challenges in achieving equality with men in many aspects of life.

This paper examines the status of women's empowerment in a predominantly rural area (Uluberia Subdivision of District Howrah, West Bengal) of India, analyzing how various socio-economic factors influence women's ability to make autonomous choices and participate equally in all spheres of life. And it will happen one day: "Feminism is for everyone" (Hooks, 2000).

Previous Works

UNESCO's definition of women's empowerment emphasizes the enhancement of women's ability to act independently, make their own decisions, and access opportunities and resources on an equal footing with men. This concept of empowerment is rooted in the idea that women should have the same ability as men to participate in all aspects of life—social, economic, political, and cultural. To promote this vision, UNESCO launched the "Participation Programme" in 1953, which aimed to empower women by focusing on their roles in education, science, culture, and communication.

Historically, many societies were matriarchal. In his book 'From Volga to Ganga', Rahula Sankrityayana (1947) illustrated that early global societies were predominantly matriarchal when men were primarily food collectors and women provided essential sustenance, thus commanding respect. The uncertainty of daily support made women invaluable, as they could provide substitute nourishment, thereby earning men's respect as vital resources. Additionally, men, as food collectors who had to contend with wild animals, were essential for their strength,

and women, as food providers, were central to societal sustainability. However, with the advent of civilization and economic progress, societal roles shifted, leading to a decline in women's societal freedom.

Anthropologist Gimbutas Marija (1991), argued that many ancient societies were matriarchal or matrifocal, where women held central roles in social and religious life. Gimbutas discusses the central roles of women in these early societies, "attributing to them the status of life-givers and cultural bearers". Gimbutas posited that, these societies were more peaceful and egalitarian, with women's roles as life-givers and nurturers being revered. She stated that "in these societies, women were seen as the bearers of culture, responsible for the continuity of the community through their roles in agriculture, healing, and the arts."

In the Indian context, women's status has fluctuated dramatically over the centuries. During the Rig Vedic period, women were highly respected and enjoyed considerable freedom. They were revered as mothers and guardians, playing significant roles within the household. Prominent female intellectuals like Gargi, Maitreyi, Ghosha, Lopamudra, Vishwabara, and Bacha were recognized as philosophers and sages. However, post-Rig Vedic society saw a steady decline in women's status. A significant number of women lack the autonomy to make their own choices and control their livelihoods within their homes, society, or workplaces. The situation was so dire that it necessitated specific laws during the drafting of the Indian Constitution to protect women's rights. Despite various efforts and legislative measures aimed at empowering women, a significant number of women in India, especially in rural areas, still lack the autonomy to make independent choices and control their livelihoods.

Basham, A.L. (1954), noted that "women during this time could engage in intellectual pursuits, participate in philosophical debates, and be revered as scholars and sages. The significant role that women played in ancient Indian society, particularly in the realms of education and philosophy. Women had the opportunity to attain high levels of learning and were respected". For instance, female figures like Gargi and Maitreyi are well documented in Vedic texts as influential thinkers and philosophers.

However, as Indian society transitioned into the later Vedic and post-Vedic periods, the status of women began to decline. Historian Uma Chakravarti (1993) in her essay, "Beyond the Altekarian Paradigm: Towards a New Understanding of Gender Relations in Early Indian History", analyzed this shift, noting that the advent of more patriarchal social structures and the codification of laws in texts like the Manusmriti significantly curtailed women's rights and freedoms. Chakravarti (1993) argued that "this period saw the institutionalization of patriarchal norms that reduced women's autonomy and confined them to more domestic roles."

Despite modern legislative efforts to address these historical inequalities, many women in India, particularly in rural areas, continue to face significant barriers to empowerment. Reports

from the United Nations Development Programme (UNDP) highlight that although there has been progress in areas such as education and political participation, structural inequalities still persist, limiting women's ability to make independent choices and control their economic and social lives.

The journey towards women's empowerment in India, therefore, reflects a complex interplay of historical reverence, societal regression, and ongoing struggles for equality. It underscores the need for sustained efforts to address both the historical legacies of inequality and the contemporary challenges that women face in achieving true empowerment.

Research Gap

While there have been numerous studies on women's empowerment in India, there is a lack of focused research on the specific dynamics of rural areas and small towns like Uluberia. Previous works have broadly covered urban and metropolitan contexts, often overlooking the unique challenges and progress in smaller, predominantly rural regions. This gap necessitates a detailed examination of these areas to understand the local nuances of women's empowerment.

Purpose of the Study

This study aims to examine the status of women's empowerment in a specific region of India on a micro-level, reflecting broader state and national situations. The focus is on a predominantly rural area, the Uluberia Subdivision of District Howrah of the state of West Bengal, including the municipal town of Uluberia and 53 census towns. This agriculturally developed region, characterized by a male-dominated society with nearly equal proportions of Hindu and Muslim populations, provides a microcosm to study the progress and challenges in women's empowerment.

Significance of the Study

The significance of this study lies in its potential to shed light on the specific challenges and progress of women's empowerment in a rural Indian context. By focusing on Uluberia and its surrounding towns, the research aims to provide insights into the effectiveness of educational, economic, social, and political initiatives aimed at empowering women. Understanding these local dynamics can inform more targeted policies and interventions, contributing to the broader goal of achieving gender equality and enhancing women's agency and autonomy across India.

This paper will explore the previous and current status of women's empowerment in Uluberia, examining educational advancements, employment opportunities, and political participation. Despite progress, the region remains largely patriarchal, reflecting broader trends in India. The

findings aim to contribute to the discourse on women's empowerment, offering a localized perspective that can inform broader strategies and policies.

Study Area

The study focuses on a rural region with one municipal town, Uluberia, and 53 census towns. The area is agriculturally developed and male-dominated, with nearly equal Hindu and Muslim populations.

This is located in the nine Community Development (CD) blocks of the Uluberia Subdivision in the Howrah district of West Bengal, India. Howrah district is divided into two subdivisions: Howrah Sadar and Uluberia. The Uluberia Subdivision extends geographically from $22^{\circ}12'$ N latitude in the south to $22^{\circ}48'$ N latitude in the north. At its northernmost point, it starts from the Udaynarayanpur block ($22^{\circ}48'$ N) and stretches to the southernmost point at the Shyampur block ($22^{\circ}12'$ N), where the Damodar River meets the Hooghly River. The longitudinal extent of the study area ranges from $87^{\circ}50'$ E to $88^{\circ}10'$ E.

The Uluberia Subdivision is bounded by the Rupnarayan River to the west and the Hooghly River to the east, with the Damodar River intersecting the subdivision in the middle. The nine blocks comprising the Uluberia Subdivision are Uluberia I, Uluberia II, Amta I, Amta II, Udaynarayanpur, Bagnan I, Bagnan II, Shyampur I, and Shyampur II. Additionally, Uluberia Municipality, part of the Kolkata Metropolitan Development Authority (KMDA) area, falls within this subdivision. The area is geographically a floodplain region and agriculturally advanced. It is notable for its industrial belts, which significantly contribute to the local economy.

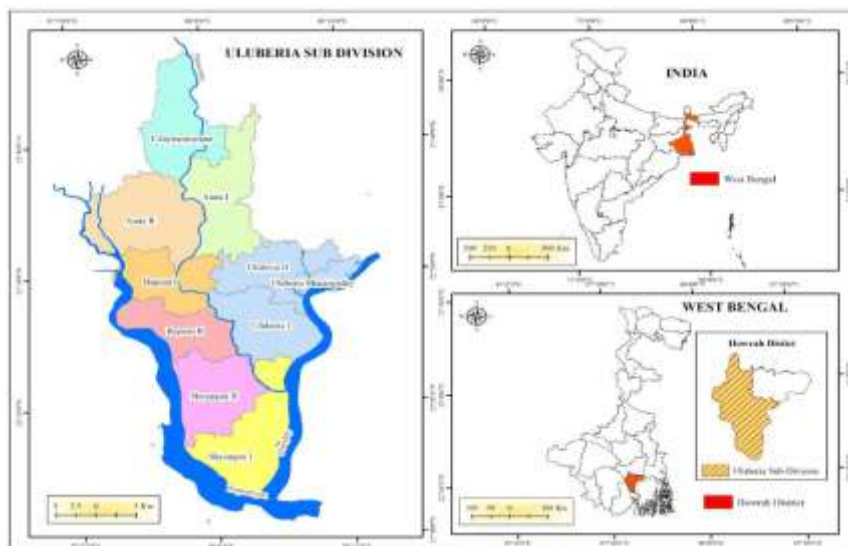


Figure 1 : Study area map : Map of Uluberia Subdivision

Aims and objectives

The aims and objectives of the paper on women's empowerment in a small region of a state, reflecting the broader societal situation, could be outlined as follows:

Aims

1. **Assess the Status of Women's Empowerment:** To evaluate the current status of women's empowerment within the selected region, providing insights into various aspects of their lives.
2. **Identify Key Challenges:** To identify the key challenges and barriers faced by women in achieving empowerment in their family, social, and economic lives.
3. **Measure empowerment using indicators:** To utilize specific indicators such as literacy rates, economic ability, political participation, and healthcare access to measure the level of empowerment among women.
4. **Reflect Broader Societal Trends:** To use findings from the small region to infer trends and conditions that may be applicable to the larger state and society as a whole.

Objectives

1. **Literacy and Education:** To analyze the literacy rate and access to quality education for girls and women, assessing its impact on their empowerment.
2. **Home-Making Decision Power:** To investigate the extent to which women have decision-making power within their households.
3. **Economic Empowerment:** To examine women's economic abilities, including their control over finances and access to economic opportunities.
4. **Freedom and Mobility:** To evaluate the level of freedom women have regarding movement, participation in politics, and exposure to media.
5. **Gender Bias:** To study the prevalence of gender bias and the availability and quality of healthcare services for women.
6. **Comparative Analysis:** To compare the status of women in the study area with other regions to highlight disparities and commonalities.
7. **Policy Recommendations:** To provide recommendations for policymakers and stakeholders based on the findings, aiming to enhance women's empowerment in the region and beyond.

By achieving these aims and objectives, the paper aims to contribute valuable knowledge and insights into the status of women's empowerment, thereby supporting efforts to create a more balanced and equitable society.

Hypotheses

- The hypothesis of the study is that women's empowerment in a specific rural region of India is limited, with only a small percentage of women experiencing empowerment within their family lives.
- The study posits that despite global movements and the recognized importance of women's empowerment for socio-economic development, significant challenges still exist that prevent the majority of women in this region from achieving empowerment.

Methodology

The study utilizes a mixed-methods approach, integrating both primary and secondary survey techniques, alongside statistical data analysis, to assess the status of women's empowerment. Key indicators such as literacy rates, economic capacity, and political participation are analyzed to measure progress.

Surveys and interviews were conducted with a representative sample of 100 women from the study region, selected based on age, occupation, and educational background. The sample was carefully chosen to ensure diversity and represent different demographics. These women were asked about their educational attainment, economic status, decision-making authority, and perceptions of gender bias. Statistical analysis was then applied to quantify and interpret the survey findings, offering a comprehensive view of the levels of women's empowerment in the region.

Women's Empowerment

Women's empowerment has emerged as a pivotal issue for the socio-economic development of nations worldwide. It is increasingly recognized as essential for achieving gender balance and fostering socio-economic progress.

Women's empowerment is a multifaceted concept discussed by various socialists in their work. An educated and empowered mother contributes significantly to society by nurturing capable children. Empowering women ensures a gender-balanced society where women can make independent choices and control their livelihoods, promoting their rights and autonomy. This worldwide movement aims to create a world where women are valued, respected, and given equal opportunities as men, starting within the family unit. When both men and women equally contribute to society, socio-economic progress is achieved.

The societal perception of women in India is fraught with contradictions. On one hand, women are venerated as goddesses, symbolizing power and purity. On the other hand, they are often subjected to subjugation and treated as second-class citizens, akin to slaves. This duality underscores the complex and inconsistent nature of gender relations in the country.

Women's empowerment in India is supported by various laws and initiatives aimed at enhancing gender equality and ensuring women's rights. Some key legislative measures include:

1. Protection of Women from Domestic Violence Act, 2005: This law aims to protect women from domestic violence and provides for civil remedies, including protection orders, residence orders, and monetary relief.

- **Sexual Harassment of Women at Workplace (Prevention, Prohibition, and Redressal) Act, 2013:**

- It mandates employers to create a safe working environment for women and establishes mechanisms for addressing complaints of sexual harassment at workplaces.

- **Maternity Benefit Act, 1961 (amended in 2017):**

- It regulates maternity leave and other maternity benefits for female employees, aiming to protect their employment during maternity and ensure their welfare.

- **Prohibition of Child Marriage Act, 2006:**

- This act prohibits the solemnization of child marriages and provides for the annulment of such marriages.

- **The Equal Remuneration Act, 1979,** mandates equal remuneration for equal work for both men and women.

- **Pre-Conception and Pre-Natal Diagnostic Techniques (Prohibition of Sex Selection Act, 1994)** regulates the use of pre-natal diagnostic techniques to prevent sex-selective abortions.

- All of these laws create a legal framework that applies uniformity across India, including the Uluberia Subdivision, to protect women's rights, ensure their safety, and promote gender equality in various aspects of life. Local authorities, law enforcement agencies, and community organizations play crucial roles in implementing and enforcing these laws effectively in smaller regions like Uluberia.

Economic Empowerment:

Table No 1 : Female employment in rural and urban areas of Uluberia Subdivision over an 8-year period .

Year	Rural	Urban	Total
2005	15.8	16.49	10.17
2013	19.69	11.62	13.65

Data Source: Economic Census 2005, 2013

The data shows a positive trend in female employment in both rural and urban areas between 2005 and 2013. Rural female employment increased from 15.81% to 19.69%, and urban female employment rose from 6.49% to 11.62%. The overall female employment in the Uluberia Subdivision grew from 10.17% to 13.65%.

Interpretation

The increase in rural female employment is significant, suggesting that rural areas may have had more opportunities or fewer socio-cultural barriers to women's participation in the workforce. The urban increase, although lower in percentage, is notable and indicates growing urban opportunities for women.

The overall increase from 10.17% to 13.65% indicates that more women are entering the workforce, which is a sign of improving economic empowerment.

Table No 2: Male and Female Main Workers in the Uluberia Subdivision Over Two Decades

Year	Main Male Workers	Main Female Workers
2001	499702	77228
2011	621360	128204

Data Source : Howrah District Census Handbook 2001 and 2011

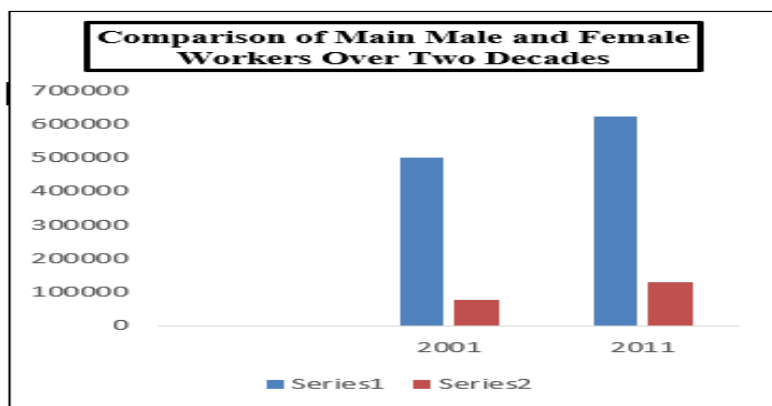


Figure 2 : Comparative Diagram of Main Workers of Uluberia Subdivision by Gender Over Two Decades

(Data Source : 2001 and 2011 census hand book of Howrah district)



Figure 3 and 4 : Unorganised Women workers of Uluberia Subdivision, village Dhandali , Shyampur II

Source : Field Survey, 2023

These pictures revealed that economic empowerment remains limited, with many women working in unskilled labor sectors. Efforts to enhance economic opportunities for women are essential for broader socio-economic progress.

Interpretation

1. Absolute Change Analysis

The absolute increase in the number of male workers is 121,658 (from 499,702 to 621,360), while for female workers, it is 50,976 (from 77,228 to 128,204).

Although the percentage increase is higher for women, the absolute number of additional male workers is significantly larger. This indicates that, while the rate of female workforce participation is increasing rapidly, the overall number of women entering the workforce is still much lower compared to men.

2. Ratio Analysis:

In 2001, the ratio of male to female workers was approximately 6.47:1 (499,702/77,228).

By 2011, this ratio had decreased to about 4.85:1 (621,360/128,204).

While the gap between male and female workers is narrowing, the workforce remains male-dominated. This ratio analysis helps to illustrate the persistence of gender disparity despite the faster growth rate of female workers.

3. Growth Rate Comparison:

To further analyze the trends, it is indicated that, annually, the number of female workers grew at more than double the rate of male workers, further confirming the faster integration of women into the workforce.

4. Proportional Analysis

In 2001, female workers represented approximately 13.4% of the total workforce (77,228 out of 576,930).

By 2011, this proportion had increased to about 17.1% (128,204 out of 749,564).

The increase in the proportion of female workers indicates that women's contribution to the workforce is becoming more significant, although they still represent less than a fifth of the total workforce.

5. Contextual Factors:

To fully understand the reasons behind these trends, it would be essential to consider other socio-economic factors such as educational attainment, socio-cultural norms, government

policies promoting female employment, and the types of industries that have seen growth in the region.

Additionally, an analysis of part-time vs. full-time work, the nature of the work (e.g., skilled vs. unskilled), and wage disparities could provide deeper insights into the quality and impact of female workforce participation. Maximum females engage in unorganized sectors like tailoring, factory workers, self-help group workers, and some females engage in organized sectors like nusse teaching, et cetera. The male population is dominant in the organized sector.

6. Projection Analysis:

If these trends were to continue, projections could be made for the next decade. This would help to estimate when gender parity might be achieved or if the growth rate of female workers might level off due to structural constraints in the labor market.

While the initial interpretation based on percentage growth offers valuable insights, a more thorough statistical analysis reveals a complex picture. The growth in female workers is promising, yet the absolute numbers and persistent gender disparity suggest that much work remains to be done to achieve gender equality in the workforce.

Table No 3 : Financial Decision-making Women Data Table of a Small Area in Shyampur II Block

Age	Earning Women and making decisions with own money	Earning but not making decisions with money
> & = 30	56	44
< & = 30	55	45

Data Source : Primary Survey in Dhandali Village on 50 families, Shyampur II block

This analysis is based on primary survey data collected from 50 families in Dhandali Village, Shyampur II block. The focus is on understanding the financial decision-making autonomy of earning women, particularly how it varies with age. The data is divided into two age groups: women aged 30 and above (≥ 30), and women below 30 years of age (< 30). The close percentages suggest that traditional gender roles and societal norms in Dhandali Village might equally influence women of different age groups in terms of financial decision-making. Both younger and older women may face similar challenges and societal pressures when it comes to handling their own earnings. Only 24% of women reported having significant decision-making power within their families. This highlights the ongoing struggle for autonomy and equality in domestic settings.

Education

Table No 4 : Gender-wise Literacy Rates by Blocks of Uluberia Subdivision

Name of the Blocks & municipality	Male literate 2001	Male literate 2011	Female literate 2001	Female literate 2011	% of male & female literacy in 2001	% of male & female literacy in 2011
Uluberia Subdivision	649958	785272	491223	663454	81.15 &64.88	85.14 &75.68
Uluberia I	60056	77603	45832	66330	76.36 &60.56	81.88 & 72.75
Uluberia II	54473	70052	40319	59476	76.28 &60.38	82.67 & 73.23
Amta I	73766	87960	56137	73587	82.82 & 65.57	86.18 &74.06
Amta II	70358	82341	51543	67837	82.78 & 64.78	87.20 &75.93
Udaynarayanpur	64155	76012	48300	62606	82.09 &65.54	96.74 &75.41
Bagnan I	70609	88531	55560	75991	83.28 &68.81	88.16 &79.80
Bagnan II	54442	65023	41252	55019	72.21 &67.02	86.83 &78.05
Shyampur I	65468	78240	49495	66200	81.12&63. 79	95.65 &73.75
Shyampur II	63178	75504	48131	63702	84.25 & 66.32	85.18 &75.57
Uluberia (M)	73453	84006	54654	72706	79.38 & 65.62	83.66 & 76.21

Data Source : Howrah District Census hand book 2001 & 2011

The data table clearly illustrates a significant disparity between male and female literacy rates over the past two decades, although there is a noticeable trend towards improvement. In examining the data for the entire subdivision, the gender literacy gap was 16.27% in 2001. By 2011, this gap had decreased to 9.46%. This indicates a substantial and rapid improvement in female literacy rates, which is a positive indicator for the enhancement of social status and

gender equity in the region. However, despite the improvement in women's literacy rates, disparities remain. Access to quality education is crucial for empowering women and enabling them to participate fully in society.

Sex ratio

In India, proper women's empowerment is a questionable issue. In this small subdivision, the data table shows a disproportionate sex ratio where the female population is comparatively lower than the male population. And this scenario is not only applicable for this small region of the country; it is applicable all over India. This data also reveals that their social status is not even the same as that of men in all aspects. Even now, a boy child is much more adorable than a girl child in many families. But nowadays, society is in an advanced stage, so all-time girl children are not neglected; it varies from family to family.

Comparative Sex Ratio Chart of Uluberia Subdivision in Relation to Howrah District and West Bengal State

Table No 5 : Comparison of the sex ratio over the last two decades.

Year	Sex ratio of Uluberia Subdivision	Sex ratio of District Howrah	Sex ratio of the State West Bengal
2001	947	906	934
2011	951	939	950

Data Source : Census data of Howrah district 2001 and 2011

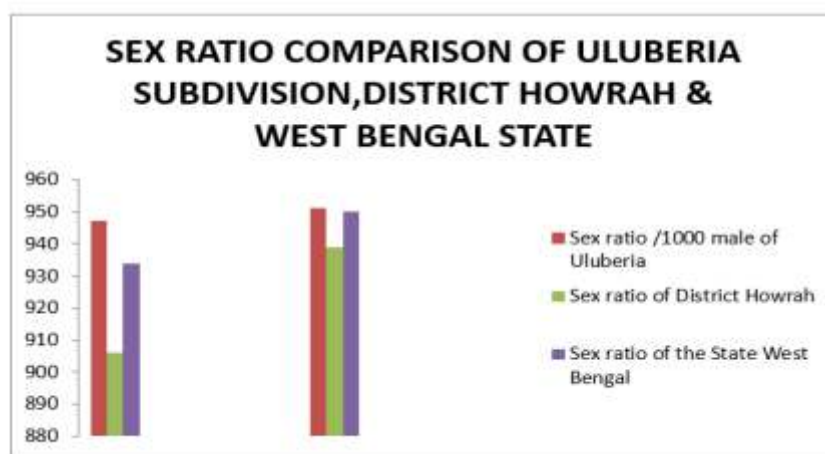


Figure 5 : Comparative Sex Ratio Diagram of Uluberia Subdivision

(Data Source : Census data of Howrah district 2001 and 2011)

By examining the data presented in Table 4 and Figure 5, we observe that the sex ratio of this Subdivision exceeds both the district and state sex ratios. In 2001, the state of West Bengal had a sex ratio of 934, while the Howrah district's sex ratio was 906, notably lower than the state average. Contrarily, this Subdivision recorded a sex ratio of 947, surpassing both the district and state figures. In 2011, the sex ratio for West Bengal improved to 950, whereas the Howrah district's ratio remained lower at 939. Nonetheless, this Subdivision continued to demonstrate a higher sex ratio of 951, exceeding the state average. These trends indicate a positive trajectory, suggesting that the sex ratio in this Subdivision is progressively improving and may eventually achieve parity.

Rural Urban Sex Ratio of Two decades

Table No 6: Comparison of Sex Ratios in Rural and Urban Areas of Uluberia Subdivision

Year of Census Report	Total Rural Male Population	Total rural Female Population	The Sex ratio on total rural population (/ 1000 male)	Total Urban Male Population	Total Urban Female Population	The Sex ratio on total urban population (/1000 male)
2001	791151 51.01%	753760 48.79%	953	132493 52.20%	121313 47.80%	916
2011	731603 51.27%	695492 48.73%	951	312872 51.16%	298718 48.84%	955

Data Source : District Statistical Handbook, Howrah, 2017

By comparing the data in Table 2, we can see that the sex ratio of rural areas is far better than that of urban areas in this subdivision in the census year 2001. Again, there are two amazing facts in the 2011 census data: the rural female sex ratio is less than in 2001 in rural areas, and the sex ratio of urban females in the 2011 census report has developed much more than in the 2001 census report .

The unequal sex ratio is indicative of the broader social challenges faced by women, who often experience inferior social status compared to men. The preference for male children persists in many families, contributing to the marginalization of female children. Although advancements in societal attitudes have been observed, leading to improved treatment of girl children in some families, these changes are not uniformly experienced across all demographics.

Social Empowerment

Women's empowerment is essential for the socio-economic development of any nation. This case study focuses on Uluberia Subdivision, Howrah, West Bengal, to explore the current state of women's empowerment in this region, which can serve as a reflection of broader societal trends.

From the above information and data sources reveal that social empowerment of women in the Uluberia subdivision of India entails a multifaceted approach that includes enhancing educational opportunities, economic participation, healthcare access, political involvement, and challenging patriarchal norms. Uluberia, characterized by its predominantly rural setting, presents unique challenges and opportunities for women's empowerment. While there are positive trends in women's economic and educational empowerment in Uluberia Subdivision, significant challenges remain. Achieving true gender equality requires a multifaceted approach that includes policy support, educational improvements, and shifts in societal attitudes. With continued efforts, it is possible to create a more balanced and equitable society where women are empowered to make independent choices and contribute meaningfully to socio-economic development.

Strategies for Implementation

Government Initiatives: Collaborating with government bodies to implement policies and programs that support women's empowerment. Ensuring effective execution of existing schemes like Beti Bachao Beti Padhao, Mahila Shakti Kendra, and others tailored to local needs.

Non-Governmental Organizations (NGOs): Partnering with NGOs that have a strong presence in the region to implement empowerment programs, provide training, and raise awareness.

Public-Private Partnerships: Leveraging public-private partnerships to create economic opportunities and improve infrastructure in education and healthcare.

Local Leadership: Involving local leaders and influencers in promoting and supporting women's empowerment initiatives. Their endorsement can significantly enhance community acceptance and participation.

Employment Opportunities: Creating job opportunities in various sectors, including agriculture, small-scale industries, and service sectors. Encouraging women's participation in self-help groups (SHGs) and cooperatives can foster economic independence.

Access to Financial Services: Facilitating women's access to banking services, credit, and microfinance. Financial literacy programs can help women manage their finances better and invest in their futures.

Healthcare Access: Improving access to healthcare services, particularly maternal and child health and reproductive health services, and addressing malnutrition. Establishing more healthcare facilities and mobile health units can help reach remote areas.

Health Education: Promoting health education to raise awareness about hygiene, nutrition, and preventive healthcare measures.

Political Participation and Representation: Encouraging women's active participation in local governance, including Panchayati Raj Institutions (PRIs). Training programs can prepare women to take on leadership roles and effectively contribute to decision-making processes.

Community Engagement: Engaging men and boys in discussions and initiatives to promote gender equality, ensuring that empowerment efforts are inclusive and sustainable.

Participation of Women in Political Campaigns at the Time of Election



Figure 6 : Active Participation of Local Women in Politics.

Problem and prospect

"The Master's Tools Will never Dismantle the Master's House " (Lorde , 1984) the particular essay expresses the limitations of using the existing systems and tools of oppression to achieve liberation and social justice .Empowerment is not just individuals self- assertion but collective action and solidarity by woman .

Women's empowerment in India as well as in this small Subdivision remains a critical issue, marked by significant disparities in gender equality. Analysis of demographic data from this region and the other portion of the country highlights a consistently disproportionate sex ratio, with the female population notably lower than that of the male population. This trend is reflective of deep-rooted societal biases and is not confined to isolated areas but is prevalent across the nation. Broader Implications

Socio-Economic Factors

Education and Skills The increase in female employment may be linked to improved access to education and vocational training for women.

Cultural Shifts: Changing societal norms and attitudes towards women working, particularly in rural areas, could be contributing to this positive trend.

Economic Policies: Government initiatives aimed at promoting female employment and economic participation might have played a role.

Efforts to address these issues require a multifaceted approach, encompassing policy interventions, educational reforms, and cultural shifts. By fostering an environment that promotes gender equality and challenges entrenched stereotypes, India can move towards true women's empowerment, ensuring that women enjoy equal rights and opportunities in all aspects of life.

Challenges

Pseudo Empowerment: The increase in female employment numbers does not necessarily translate into meaningful economic empowerment due to the lack of focus on the quality of employment and wage equality.

Persistent Inequality: Despite the improvements, the substantial gap between male and female workers indicates that gender inequality in employment remains a challenge.

Quality of Employment: The data does not provide insights into the quality of employment, wage equality, or the types of jobs women are entering, which are crucial factors for true economic empowerment.

Future Directions

Policy Recommendations: A continued focus on policies that promote female education, skill development, and access to diverse job opportunities is essential.

Addressing Barriers: Tackling socio-cultural barriers, providing childcare support, and ensuring safe work environments can further enhance women's economic participation.

The literacy data for the subdivision shows that female education levels are unsatisfactory, with no area reaching an 80% literacy rate for women. To improve the quality of employment, there is a pressing need to enhance female education in the region. Higher education levels among women would likely lead to better job opportunities and improved employment quality.

Systemic Barriers: Persistent socio-cultural and economic barriers continue to impede true gender equality in the workforce.

Need for Holistic Approaches: Addressing gender inequality requires comprehensive strategies that integrate policy interventions, educational reforms, and cultural shifts.

Conclusion

The analysis of employment rates, gender-based literacy, and sex ratios in Uluberia Subdivision reveals a positive trajectory in female employment, indicative of advancing economic empowerment for women. The data shows significant progress, with female participation in the workforce increasing notably over the years. This improvement underscores the potential for further economic development and gender equality in the region.

However, despite these gains, the persistent gender gap in employment highlights ongoing challenges. There is a critical need for deeper insights into the quality of employment available to women, including wage parity and the types of occupations they enter. Additionally, addressing women's access to healthcare, including health insurance, is essential for achieving true economic empowerment. Ensuring women have comprehensive health coverage will support their overall well-being, enabling them to participate more fully in the workforce.

To sustain and enhance these advancements, a holistic approach is necessary. This approach must integrate improvements in education, shifts in cultural norms, supportive economic policies, and robust healthcare systems. By removing barriers to women's full participation in society and promoting gender equality across all spheres, significant progress can be made.

The findings emphasize the importance of concerted efforts from policymakers, civil society, and communities to create an environment where women are valued, respected, and empowered. This includes ensuring access to quality healthcare and health insurance for women. Such an environment will enable women to contribute meaningfully to their families and societies.

Looking forward, the vision for India is one where the two wings of society—men and women—are equally strong, enabling an enjoyable and prosperous journey for civilization. The ongoing empowerment of women in Uluberia Subdivision, supported by improved healthcare access, serves as a beacon of hope for achieving this balanced and equitable society.

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RURAL-URBAN TRANSFORMATION DUE TO DEVELOPMENT OF SPECIAL ECONOMIC ZONES (SEZs): A CASE STUDY OF GAUTAM BUDDHA NAGAR, DISTRICT, U.P

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ABSTRACT

Special economic zone (SEZ) is a geographically delimited area and generally physically secured with inherent benefit of location. SEZs are useful for the socio-economic development of a country; it started in 1999 in India. At present there are 415 formally approved SEZ units in India, and among them 205 are operational and out of 205, there are 8 SEZs in Gautam Buddha Nagar district of U.P. SEZ has several impacts in a particular area like employment generation in non-primary activities, infrastructural development, urbanizations and growth in GDP and per capita income etc. So it has been tried to examine these impacts in Gautam Buddha Nagar. The study is based on the data collected from the District Census handbook, Department of Industry and Commerce and Statistical Abstract of U.P for 2001 and 2015. To analyze the block wise change in level of urbanization fifteen variables related to driving urban force, urban economic base and urban infrastructure are selected thereafter, Z score technique is applied to transform scores into standard score. Composite values of these standard scores of each variable are used to show the level of urbanization and their variation between 2001 and 2015. The study shows that Composite Z score (CZs) value is highest in Bisrakh (0.94) followed by Dadri (0.51), Jewar (-0.50) and Dankaur (-0.87) in 2001 but in 2015 CZs is highest in Dadri (3.59) followed by Bisrakh (2.21), Dankaur (-1.62) and Jewar (-2.05) which shows that there is a block wise shift in level of urbanization. Besides this there is a rise in GDP of about 259%, per capita income increased by 173.06%, number of towns increased from 9 to 13, and contribution of tertiary sector in GDP increased from 13% to 33% between 2001 and 2015. This shows that SEZ has a significant positive impact in the region.

Keywords: Tertiary Sector, Rural-urban transformation, Special economic zone, Urbanization.

Introduction

Rural-urban transformation is a process of comprehensive societal change whereby rural societies diversify their economies and reduce their reliance on agriculture; become dependent on distant places to trade and to acquire goods, services, and ideas and move from dispersed villages to towns and small and medium cities (Berdegue J, Rosada T & Bebbington A, 2014).

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According to the census of India (2011), 31.16% of the population lives in urban areas contrary to 11.4% in 1901 (Datta P, 2012). According to a survey by the UN State of the World Population report in 2007, by 2030, 40.76% of the country's population is expected to reside in urban areas. With a high rate of urbanization significant changes have taken place. For better lifestyle, employment, education etc. people from rural areas migrated to the urban area. So in this process rural-urban linkages took place (Pawan, 2016). Rural-urban linkages made people from rural areas tempted to have lifestyles like urban areas and in this process started to follow the urban culture and lifestyle. So major concern in the present situation is that not only are cities growing in number but rural communities are adopting urban culture, no longer are rural communities retaining their unique rural culture. Rural people are following the material culture of urban people (Pundir R S and Singh K, 2001).

Special economic zones (SEZs) play a significant role in the phenomena of rural-urban transformation. There is a need for a large patch of land for the development of SEZs. So on large scale land is needed to be acquired. In India total land area is 29, 73,190 sq km of that 16, 20,338 sq km is under agriculture. The share of the agriculture area in the total area is 54.5 %. For the development of proposed SEZs (formally and principle approved SEZs) approximately 2061 sq km area was allotted i.e. not more than 0.12 % of the total agricultural land in India (Ministry of Agriculture, 2006).

In India development of SEZs is an urban phenomenon; they are generally located adjacent to mega cities, for example Noida SEZs is located in the National Capital Region of Delhi (Sahoo P, 2015). SEZs in India are able to provide better reach towards technological development, better connection with the help of transport, improved education services and also change the economic structure of rural areas as a large number of people engage into non-primary activities. Because of the above said development there is easy movement of people, goods and services and also penetration of waste and pollution and blurring the boundaries between urban and rural areas (Tacoli C, McGranahan G & Satterthwaite D, 2015).

The latest schemes & incentives provided by the Govt. of India & State Government and the initiatives taken by Noida, Greater Noida & Yamuna expressway Industrial Development Authority for infrastructural and industrial development in the district such as Infrastructural & Investment Policy 2012, Infotech Park, Biotech park, Exposition Mart, Yamuna Expressway, Noida-Greater Noida Expressway, Delhi – Mumbai Industrial Corridor etc. will boost the industrial growth in the District especially for micro, small & medium enterprises. Thus it has a high potential of phenomena of rural-urban transformation. So, the main objective behind this paper is i) to analyze the block-wise level of urbanization ii) to analyze the welfare status of the district iii) to analyze block-level rural-urban transformation of Gautam Buddha District.

Study area

Gautam Buddha Nagar district is located in the north-western part of the state of Uttar Pradesh, in the vicinity of India's capital New Delhi. It is a newly created district which emerged in the year 1997 from portions of Bulandshahr & Ghaziabad districts. Geographical coordinate point of the study area is $28^{\circ}34'N$ and $77^{\circ}55'E$. According to the district brochure of Gautam Buddha Nagar (AAP 2008-09), the district has a geographical area of 1442 km with headquarters in the industrial city of Greater Noida. It has three Tehsils and four developmental blocks viz. Birsakh, Dadri, and Dankaur & Jewar. The district is bounded by Ghaziabad District to the North, Bulandshahr district to the East and Aligarh District to the South. The Yamuna River separates the district from Haryana State and Delhi to the West. As per 2011 census the total population of the Gautam Buddha Nagar district is recorded as 1,648,115 and the population density is 1,286 persons per sq. km. Within the total population of the study area, the total number of male population is 890,214 and 757,901 are females. The sex ratio in the district is 851 females per 1000 males. The population growth rate is 37.11% and average literacy rate is 80.12%. The rural and urban population is 40.88% and 59.12% respectively. The study area is also a vigorous and significant one within the state of Uttar Pradesh in terms of economic activities. Agriculture is the dominant economic activity in this district. However, due to fast industrialization land size under cultivation is decreasing rapidly. The availability of land for agriculture has tremendously decreased due to acquisition of land for the Noida Special Economic Zone (NSEZ) and Yamuna ExpressWay. The district has potential to become India's one of the most industrialized and developed districts and able to sustain large population and also accelerate phenomena of rural-urban transformation.

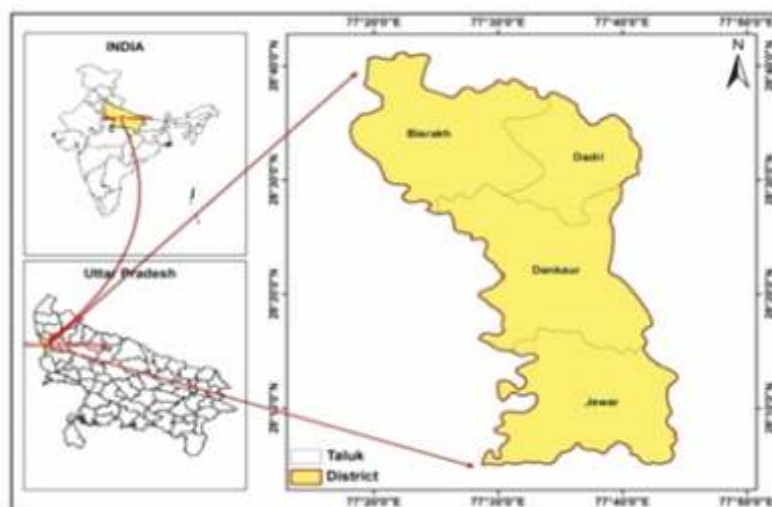


Figure 1: Study Area

Database and methodology

The data used for the analysis of rural-urban transformation has been collected from secondary sources including the District census handbook of Gautam Buddha Nagar for 2001, statistical abstract of Gautam Buddha Nagar district for 2001 and 2015, State Planning Institute, Economics and Statistics Division, Uttar Pradesh. Physical transformation is analyzed on the basis of simple tabular analysis of block-wise land use data. Simple change analysis is done to see the physical transformation of the district. To analyze the block wise change in level of urbanization fifteen variables are selected and Z score technique is applied to transform them into comparable units using equation 1. Composite values of these variables are used to show the level of urbanization and their variation between 2001 and 2015 using equation 2. These variables are shown in Table 4 with their description. Economic transformation is calculated by using the district level GDP, BPL and workforce participation data.

$$Z = \frac{X - x}{SD} \dots \dots \dots \text{equation 1}$$

Where,

Z= Standard score

X=Original values of the score

x = Mean of variables

SD= Standard deviation of variables

The Z-score of each indicator is added block-wise to find composite Z-score(s).

$$CZS = \sum Z_{ij} \dots \dots \dots \text{equation 2}$$

Where,

CZS denotes composite Z-scores

Z_{ij} indicates the sum of Z-scores of indicators j in block i.

The level of urbanization is supported by other indicators of rural urban transformation like population growth, agriculture inputs, change in urban agglomeration or towns, poverty, sectoral share in GDP and per capita income. These data are collected from statistical abstract of U.P, Department of Commerce and industries.

Result and discussion

Physical transformation (2001-2015)

Physical transformation from rural to urban mainly depicts the transformation of agriculture into non-agriculture areas. The Food and Agriculture Organization (FAO) identifies three

broad 'stages' of physical transformation from rural to urban which is reflected in the form of changes in the composition of rural land use (Cartetto et al., 2007). The first stage of physical transformation is linked to agriculture when the workforce is concentrated mainly on agriculture in rural areas. At this stage, the people mainly engaged in agriculture and non-farm activity is limited and concentrated in the countryside with little dependence on rural-urban linkages. The second stage is associated with rural areas where a lower share of households directly depends on agriculture with greater rural-urban linkages. The third stage witnesses the maturing of trends that emerge in the second stage, with stronger links to the urban sector. In this stage a large part of agricultural land is converted into non-agricultural land.

So to see the physical transformation of the G B Nagar block-wise area under different agricultural and non-agricultural activities is shown in table 1 and table 2 for 2001 and 2015 respectively. In 2001 area under net sown class was highest among all land use classes in each block and also at district level. Net sown area is highest in Jewar block which is agriculture dominated area and lowest in Bistrakh block. Reason behind the lowest net sown area in Bistrakh block is that Bistrakh is an urban dominated area located near Delhi and Noida is largest city of this block. Non- agricultural land is also highest in Bistrakh block with 18.4% land followed by Dadri with 16.6% land.

In 2015 also net sown area was highest in Jewar (68.90%) and lowest in Bistrakh (21.2%). Non-agriculture land is highest in Bistrakh (43.10%) and lowest in Dankaur (3.5%). Study shows that in G B Nagar during 2001 and 2015 there is very high loss (61.12%) in the area under net sown area. But there is an increase in area under present fallow land, non-agricultural land, forest and other fallow land (table 3).

Table 1 : Block wise distribution of land use (2001) (in hectares)

S. No	Block	Net sown area	Forest	Barren Cultivable waste Land	Present fallow Land	Other Fallow land	Barren & uncultivable land	Non-agriculture use	Pasture	Bush, forest & garden	Total
1	Dankaur	45322	82	2636	2918	1662	1193	5284	344	744	60185
2	Jewar	39286	117	278	2231	768	1324	3482	38	430	47954
3	Bistrakh	28083	114	838	2834	3852	592	8392	123	638	45466
4	Dadri	23586	82	765	2026	1864	1092	5990	169	485	36059
5	Total	136277	395	4517	10009	8146	4201	23148	674	2297	189664

Source: Sankhiki Patrika, G B Nagar, U.P (2001)

Table 2 : Block wise distribution of land use (2015) (in hectares)

S. No	Block	Net sown area	Forest	Barren Cultivable waste Land	Present fallow Land	Other Fallow land	Barren & uncultivable land	Non-agriculture use	Pasture	Bush, forest & garden	Total
1	Dankaur	12269	513	613	3087	1761	102	10165	200	117	28827
2	Jewar	19921	300	490	3782	1615	280	2251	51	183	28873
3	Bisrakh	8150	1190	10	8455	3368	473	16571	147	25	38389
4	Dadri	12638	0	712	4872	2193	752	6725	123	60	28075
5	Total	52978	2003	1825	20196	8937	1607	35712	521	385	124164

Source: Sankhiki Patrika, G B Nagar, U.P (2015)

Table 3 : Change in land use (2001-2015) (in percent)

S. No	Block	Net sown area	Forest	Barren cultivated	Present fallow land	Other fallow land	Barren & Uncultivated	Non-agriculture	Pastures	Bush, forest & garden
1	Dankaur	-72.93	525.61	-76.75	5.79	5.96	-91.45	92.37	-41.86	-84.27
2	Jewar	-49.29	156.41	76.26	69.52	110.29	-78.85	-35.35	34.21	-57.44
3	Bisrakh	-70.98	943.86	-98.81	198.34	-12.56	-20.10	97.46	19.51	-96.08
4	Dadri	-46.42	-100.0	-6.93	140.47	17.65	-31.14	12.27	-27.22	-87.63
5	Total	-61.12	407.09	-59.60	101.78	9.71	-61.75	54.28	-22.70	-83.24

Source: Sankhiki Patrika, G B Nagar, U.P (2001 & 2015)

Change in Level of urbanization and social transformation

There is rapid growth in urbanization in the district because of its proximity to NCT of Delhi, establishment of planned industrial estates, discouragement of establishment of large industries inside Delhi (Mohan, Rakesh & Dasgupta S (2005). In the present study three indicators are used to measure the level of urbanization viz. driving urban force, urban economic base and urban infrastructure. Growth in urban population, increase in the number of towns and their distribution are the most important indicators of driving urban force. There is also a close relation between urbanization and urban economic base. In the present condition industrialization and economic development are pre required conditions for urbanization. People move from subsistence agricultural practice or primary activity towards non-primary activity. Structural change in the economy causes urbanization and it is a common phenomena in developing countries, where urban centers act as a growth engines and nucleus of innovation and knowledge (Sharma N.K, 2009). Cities like Noida are already developed as a hub of

multinational firms and IT industries. Besides this Energy and Power utility companies such as Reliance Infrastructure, NTPC Limited, Tata Power, Gas Authority of India Limited, Indian Oil Corporation, Bharat Heavy Electricals Limited have their corporate offices in Noida. For the analysis of urban economic base three variables are used as shown in table 4.

Urbanization acts as a focus point for the restructuring of the whole economy as it regulates and modifies the sectoral composition of output, income and employment. Progress of the urban area is based on the progress of its economy and the development of industries which is based on available resources and infrastructure in the district. Infrastructure development is a prerequisite to form a base for any type of development whether it is social, economic or regional. There is a significant role of the means of communications in accelerating industrialization. Fast means of communication helps in provision of fast movement of finished items to the markets and of the raw materials to the production units. The Noida-Greater Noida Expressway is perched to become a dependent urban pocket in Noida with high-quality infrastructure. This 23 km long corridor has attracted real estate investors and buyers with its good infrastructure facilities and connectivity to the other regions of NCR.

Table 4 : Variables of level of urbanization

S. No	Variables/ Indicators	Description
Driving urban force		
1	X1	Percent of urban population to total population
2	X2	Percent of urban population to rural population
3	X3	Increase in urban population
4	X4	Number of towns per 100 sq km of total area
5	X5	Number of towns per 100 sq km of urban area
6	X6	Percent of household in urban area
7	X7	Percent of total literate to total population
Urban economic base		
8	X8	Percent of male workers to the total urban population
9	X9	Percent of urban workers to total workers
10	X10	Percent of factory workers to total workers
Urban infrastructure		
11	X11	Total road length per 100 sq km of total area
12	X12	Number of banks per 100 sq km of total area
13	X13	Number of banks per 1000 of population
14	X14	Number of hospitals per 100 sq km of total area
15	X15	Number of hospital beds per 1000 population

Block-wise different indicators of level of urbanization are shown in table 5 and table 6 for 2001 and 2015 respectively. Level of urbanization is calculated for both the year 2001 and 2015. Study shows that in 2001 driving urban force indices was highest in Bistrakh (1.49) followed by Jewar (-0.35), Dankaur (-0.47) and Dadri (-0.67). At the same time, the level of urban economic base is highest in Bistrakh (2.95) followed by Dadri (-0.05), Dankaur (-0.52) and Jewar (-2.38). In terms of urban infrastructure Bistrakh block is at the lowest position (-3.62). Urban infrastructure is lowest in Bistrakh because the total population of Bistrakh is highest among all blocks and facilities like banks and hospital beds are calculated in terms of per thousand populations. Whereas overall level of urbanization is highest in Bistrakh (0.94) followed by Dadri (0.51), Jewar (-0.50) and Dankaur (-0.87) table 7. Nevertheless despite being lowest in terms of urban infrastructure it is on top among four blocks in terms of overall level of urbanization in 2001. The main reason behind the high level of urbanization in Bistrakh Block is its proximity to Delhi which makes it a favorable location for all types of activities related to investments, development of residential societies by builders, establishment of corporate offices and MNCs etc.

In 2015 driving urban force was highest in Bistrakh (1.45) followed by Dadri (-0.12), Dankaur (-0.35) and Jewar (-0.83) whereas, urban economic base is highest in Dadri (1.49) earlier than it was in Bistrakh in 2001. Besides this in respect of urban infrastructure Dadri stands at top (2.35), followed by Dankaur (-0.62). Overall in 2015 the level of urbanization is highest in Dadri (3.59) followed by Bistrakh (0.21). Between 2001 and 2015 there was a wise shift in the level of urbanization. In 2015 the level of urbanization was highest in Dadri block which was in Bistrakh in 2001. Because the population in Bistrakh is greater than Dadri, the value of indicators calculated on the basis of per head population like number of towns per thousand of population is lower in Bistrakh than Dadri.

The Pearson correlation technique is used to show the association of urbanization with urban driving force, urban economic base and urban infrastructure and it was found that there is a medium degree of positive correlation between level of urbanization and driving urban force (figure 2). There is a high degree of positive correlation between urban economic base and urban infrastructure with level of urbanization (figure 3 & 4).

Table 5 : Spatial variations in indicators of level of urbanization (2001)

S. No	Block	Driving urban force						Urban economic base						Urban Infrastructure				
		X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15		
1	Bisarakh	1.50	1.50	N.A	-0.35	1.50	1.50	1.39	1.50	1.50	-0.06	-0.85	-1.03	-1.60	0.61	-0.82		
2	Dadri	-0.50	-0.50	N.A	-1.23	-0.50	-0.50	0.06	-0.50	-0.50	0.95	1.34	-0.42	-0.78	0.96	-0.08		
3	Dankaur	-0.50	-0.50	N.A	0.39	-0.50	-0.50	-0.62	-0.50	-0.50	0.47	-0.68	1.31	1.16	-1.28	-0.58		
4	Jewar	-0.50	-0.50	N.A	1.17	-0.50	-0.50	-0.83	-0.50	-0.50	-1.38	0.19	0.15	0.44	-0.26	1.51		

Source: District Census Handbook (2001), Statistical Abstract (2001 & 2015)

Table 6 : Spatial variations in indicators of level of urbanization (2015)

S. No	Block	Driving urban force						Urban economic base						Urban infrastructure				
		X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15		
1	Bisarakh	1.35	1.49	1.50	1.39	-0.51	1.33	1.35	-0.49	1.33	-1.19	0.42	0.03	-1.77	1.39	-0.99		
2	Dadri	-0.70	-0.57	-0.50	-0.29	1.49	-0.70	-0.20	1.49	-0.72	0.41	0.96	1.16	0.94	-0.29	-0.51		
3	Dankaur	0.16	-0.34	-0.50	-1.02	-0.37	0.21	-0.07	-0.38	0.20	-0.36	0.00	0.10	0.05	-1.02	0.15		
4	Jewar	-0.81	-0.59	-0.50	-0.08	-0.61	-0.84	-1.07	-0.62	-0.82	1.13	-1.38	-1.29	0.06	-0.08	1.43		

Source: District Census Handbook (2001), Statistical Abstract (2001 & 2015)

Table 7 : Change in level of urbanization (2001-2015)

S. No	Block	2001					2015				
		Driving urban force	Urban economic base	Urban infrastructure	Composite Z Score	Driving urban force	Urban economic base	Urban infrastructure	Composite Z Score		
1	Bisarakh	1.49	2.95	-3.62	0.94	1.45	-0.44	-0.82	0.21		
2	Dadri	-0.67	-0.05	1.10	0.51	-0.27	1.49	2.35	3.59		
3	Dankaur	-0.47	-0.52	0.00	-0.87	-0.35	-0.67	-0.62	-1.62		
4	Jewar	-0.35	-2.38	2.10	-0.50	-0.83	-0.38	-1.16	-2.35		

Source: District Census Handbook (2001), Statistical Abstract (2001 & 2015)

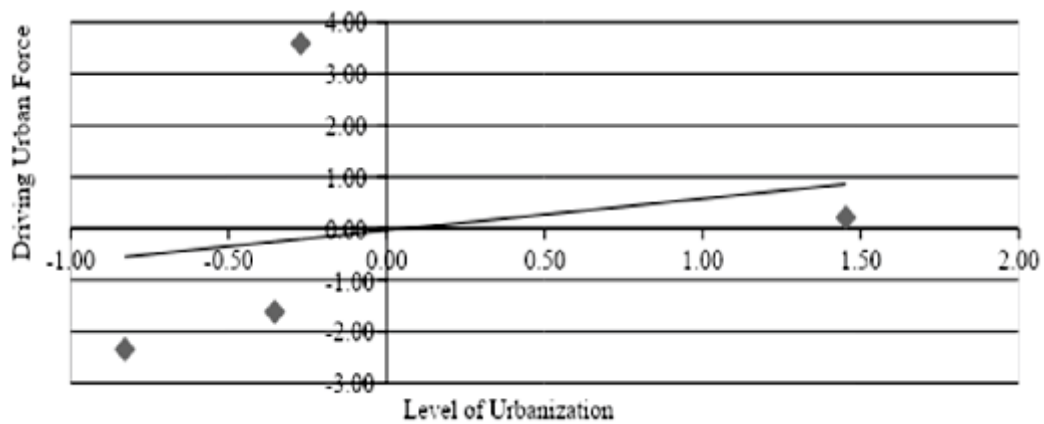


Figure 2 : Driving Urban Force and Level of Urbanization

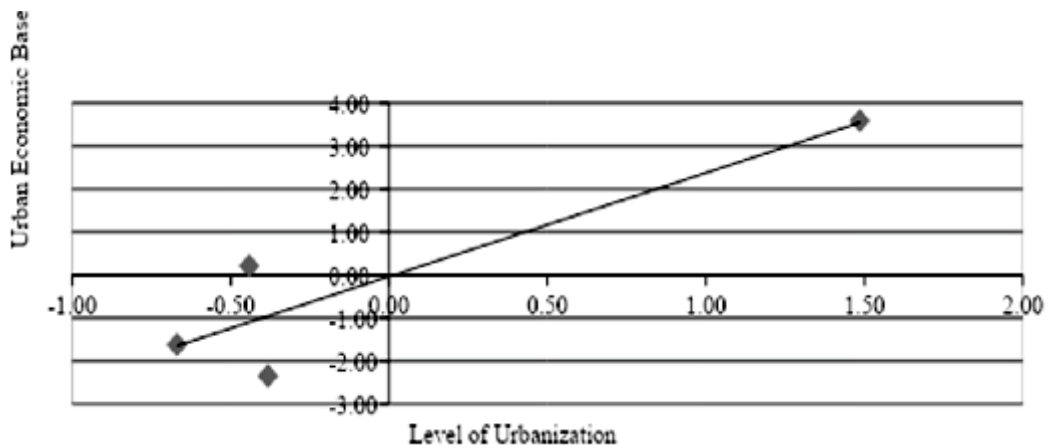


Figure 3 : Urban Economic Base and Level of Urbanization

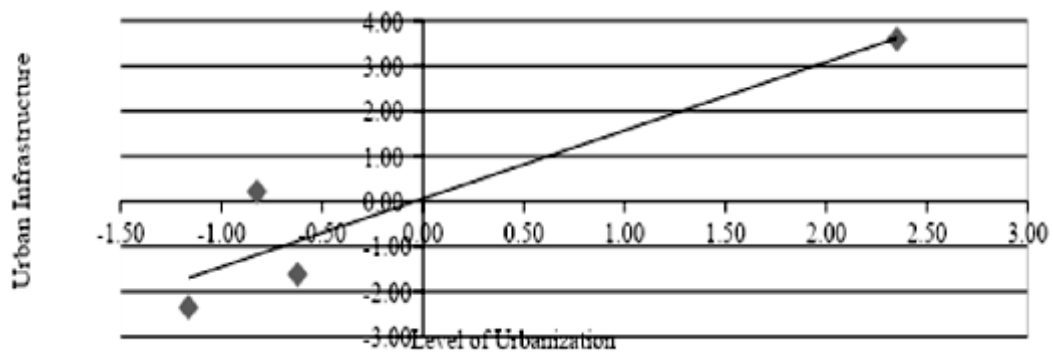


Figure 4 : Urban Infrastructure and Level of Urbanization

Economic transformation

Economic indicators like growth of Gross Domestic Products (GDP) at constant price, Share of economic sector in GDP, Work force participation rate, agriculture and non agriculture enterprises, per capita expenditure on food and non-food items are displayed at district level to know the economic transformation of the study area.

Gross Domestic Product (GDP)

There is significant economic transformation in Gautam Buddha Nagar where there is about 560 % increase in GDP between 2000 and 2014 from 4508.62 Crore to 29735.60 Crore (table 8). Because part of Delhi NCR Gautam Buddha Nagar has become a favorable place for high foreign direct investments, for setting up of SEZs, for private investments and finally these features help in a stable macroeconomic environment and strong export growth.

Table 8 : Growths of GDP of Gautam Buddha Nagar (2000-2014)

S. No	Year	GDP in Rs. Crore	Growth rate (%)
1	1999-00	4508.62	-
2	2000-01	4569.47	1.35
3	2001-02	4677.26	2.36
4	2002-03	4571.72	-2.26
5	2003-04	4984.51	9.03
6	2004-05	6050.27	21.38
7	2005-06	6608.23	9.22
8	2006-2007	8301.00	25.62
9	2013-2014	29735.60	258.22

Source: State Planning Institute, Economics and Statistics Division, Uttar Pradesh

Share of economic sector in GDP

Study shows that in G B Nagar from 2001 to 2013 the secondary sector plays the most important role in GDP. But between this duration structural changes in the economic sector of Gautam Buddha Nagar take place. It is seen in the study that there is a decrease in contribution of the primary sector in GDP and increase in secondary and tertiary sectors. In 2001 the share of the primary sector in GDP was 11% and about 75 % share of secondary and 13 % share of tertiary sectors. But between 2001 and 2005 there was a decline in share of primary and secondary sector with about 3 % and 17 % and an increase in share of tertiary sector with about

20% increases. Between 2005 and 2013 also the share of primary sector decreased (3%) and share of secondary sector increased (4%) but there is little increase in tertiary sector (1%) (table 9).

Table 9 : Share of economic sector in GDP

S. No	Sector	Sector wise GDP			% Share in GDP			Change (2001-2013)
		2001	2005	2013	2001	2005	2013	
1	Primary	746.04	731.18	1505.03	11.98	8.81	5.061	-6.93
2	Secondary	4645.59	4813.39	18312.64	74.65	57.99	61.58	-13.06
3	Tertiary	831.7	2756.43	9917.92	13.36	33.20	33.35	19.99
4	Total	6223.33	8301	29735.6	100	100	100	

Source: State Planning Institute, Economics and Statistics Division, Uttar Pradesh

Welfare trends

Population below poverty line (BPL), per capita income, number of enterprises, work participation rate and per capita expenditure on food and non-food items and total per capita expenditure are used to show the welfare trend of Gautam Buddha Nagar. It is seen in the study that there is a decrease in the number of households below the poverty line in 2001 to 2011 from 105100 people to 23205 people. So there is about 78% decrease in BPL Household. There is about a 173 % increase in per capita income at current prices and about 52% increase in the number of enterprises. Workforce participation increased with 4.2%, where male workforce and female workforce participation increased with 3.2% and 5.7% respectively. According to the Report of the Expert Group to Review the Methodology for Measurement of Poverty (2014), Per capita expenditure decided for BPL is 972 and 1407 Rs. in rural and urban areas respectively in India. In Gautam Buddha Nagar per capita income is 1221.4 in rural area and 3766.82 in urban area which is significantly higher than the decided limit of BPL (table 10).

Table 10 : Indicators of welfare trend of Gautam Buddha Nagar

S. No	Years	BPL House-hold	Per capita Income	No. of enterprises	Workforce participation (%)			Per capita Expenditure on food and non-food items (Rs)					
					Male	Female	Total	Rural			Urban		
								Food	Non-food	Total	Food	Non-food	Total
1	2001	105100	45148	47464	46.6	10.9	30.3	N.A	N.A	N.A	N.A	N.A	N.A
2	2011	23205	123283	72049	49.8	16.6	34.5	766.29	455.1	1221.4	1107.33	2659.49	3766.82
3	Change (%)	77.92	173.06	51.80	3.2	5.7	4.2						

Source: State Planning Institute, Economics and Statistics Division, Uttar Pradesh

Discussion

The main objectives of SEZs policy is to create employment opportunities for introducing better facility, to improve lifestyle of rural area and develop industrial corridor of manufacturers and service sector, provide sustainable rural development in agriculture most particularly to farmers, poor people and landless people, to get employment opportunities, to increase income sources directly and indirectly (Desai N, 2006). Overall attitude towards the SEZs project is to develop import-export services thereby attracting foreign investors. The government provide such types of infrastructural facility for Special Economic Zone (SEZs) projects in order to start manufacturing units, to develop industrial sector and increase foreign direct investment for sustainable economic development to the backward region and rural area and thereby provide better facility through road, transportation, water, electricity, communication facility, health facility, education, and generation of employment opportunities (Ramananda M.S & Pandian V.A, 2012).

Rural-urban transformation has been defined in many different ways, but largely as a 'process of comprehensive societal change driven by global and homogenizing forces that interact with localized structures, institutions, and actors to produce uneven patterns and outcomes of development' (Cartetto et al., 2007). It has also been described as a 'process whereby the sharp economic, social, and cultural differences between rural and urban gradually blur and bleed into each other along a continuous gradient' (Tacoli C, McGranahan G & Satterthwaite D, 2015). Criteria used to define a process of rural- urban transformation include diversification of rural economies, increased dependence on more distant places to trade goods, access to services and ideas, movement to towns and small/medium cities, and cultural assimilation into large urban areas (Glaeser E, 2011). The focus when talking about rural-urban transformation has tended to be on migration of rural people to cities moving away from agriculture, when there are actually many other factors at play, which contribute to changing rural and urban realities.

So, all above discussed phenomena noticed in the Gautam Buddha Nagar district of U.P. The 1990s saw huge growth in the Indian economy and additional migration to the capital city Delhi exceeded planning estimates. At the outskirts of Delhi, a large amount of land was reclaimed from the River Yamuna flood plain to construct a city for about half a million population widely known as New Okhla Industrial Development Area (NOIDA, popularly known as Noida). As a planned expansion, Noida's infrastructure and utilities were carefully laid out. It was developed to accommodate additional population growth of Delhi for 20–25 years. But, with the massive influx to Delhi, it became overloaded in just 15 years. It is one of the largest planned industrial townships of Asia, and symbolizes harmony between human habitat and industrial enterprise in India (Singh R.B & Singh S, 2011). So after that greater

Noida developed to accommodate the additional population and fulfill the rising demand of residential colonies. So in this study also it is found that there is rural-urban transformation in Gautam Buddha Nagar district where there is about 78% decrease in BPL Household. There is about a 173 % increase in per capita income at current prices and about 52% increase in the number of enterprises. Workforce participation increased with 4.2%, where male workforce and female workforce participation increased with 3.2% and 5.7% respectively.

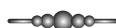
Conclusion

Rural India is experiencing rapid transformation in terms of physical, social and economic terms. Physical transformation means transformation in terms of land use, for instance transformation of agricultural land into non-agriculture. Social transformation means transformation in terms of standard of living, availability of basic infrastructure. Economic transformation means change in sectoral workforce participation. So, the main focus of the study is the analysis of change in physical, social and economic transformation in Gautam Buddha Nagar district and finally to analyze the phenomena of rural-urban transformation of the district. It is found from the analysis that from last decade Gautam Buddha Nagar has maintained a high economic growth rate, high rate of urbanization and a shifting pattern in the contribution of the economic sector into the GDP of the district. Level of urbanization has also increased between said periods. Number of towns increased from 9 to 13 and percent of urban population increased from about 40% to about 60%. Gross Domestic Product of the district rose by about 259 % between 2001 and 2015. Contribution of tertiary activities in the GDP of the district is growing between 2001 and 2015 from 13 to 33%. There is an increase of about 52% in the number of enterprises. Per capita income increased 173.06% between 2001 and 2015. So from the above discussed information we can conclude that phenomena of rural-urban transformation are very significant in the case of Gautam Buddha Nagar.

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REMOTE SENSING-BASED ACREAGE ESTIMATION OF BANANA CULTIVATION IN BARABANKI DISTRICT, UTTAR PRADESH

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ABSTRACT

India is a major contributor to global horticulture, with banana cultivation being a significant part of its agricultural GDP. This study focuses on accurately estimating banana acreage in Barabanki district, Uttar Pradesh, using Sentinel-2 satellite imagery and unsupervised classification methods. Barabanki, situated in the Middle Ganga Plain, has fertile soils from rivers like Ghaghra and Gomti, making it ideal for banana farming. Sentinel-2A and 2B satellite data from October 2020, optimal for banana cultivation, were processed using ERDAS Imagine and ArcGIS software. The analysis involved masking non-crop areas and using the ISODATA algorithm for unsupervised classification, producing 80 spectral classes. Ground truth data from August 2021 validated the classification. Six land use/land cover categories, including banana crops, were identified, and block-wise acreage was estimated using ArcGIS's spatial analyst tool. The study achieved high classification accuracy, confirmed by calculating the overall accuracy and Kappa coefficient. The findings demonstrate the effectiveness of remote sensing and machine learning in agricultural assessments. This research provides valuable insights for agricultural planning, crop monitoring, and decision-making, particularly in optimizing land use and enhancing crop management. Moreover, the study highlights the utility of Sentinel-2 imagery for large-scale horticultural assessments, contributing to more accurate crop estimation models and informed agricultural policies in Uttar Pradesh and beyond.

Keywords: Remote Sensing, Sentinel-2 Imagery, Normalized Difference Vegetation Index (NDVI), Geospatial Analysis, Crop Acreage Estimation, Land Use Land Cover (LULC) Mapping

Introduction

In India, fruits and vegetables contain about 90% of the total agricultural production. India is in the second position in the production of fruits and vegetables all over the world and for many

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horticultural crops, namely banana, mango, cashew nut, papaya, areca nut, potatoes, and okra India is a top producer. In India, the total area under horticulture crops was 23.69 million ha. and total production was 283 million tons in 2015-16. Systematic and efficient management of existing crops and bringing more of the country's land under horticultural crops to increase overall horticulture crop production, a database is required for planning and decision-making. Remote sensing is a proven tool that can play an important role in achieving this goal (Hussain et al., 2023). Remote sensing technology is useful in the estimation of crop inventory of main horticultural crops, analysis of site suitability analysis for expansion, disease detection and accurate horticulture planning (Usha and Singh, 2013). Typical methods include the use of high-resolution temporary intermediate data for the identification of crops of interest and similar collateral information, soil, water, weather, infrastructure, etc.

Various ways in remote sensing may be used to detect and delineate individual plant crowns across all species, with local maximum filter (LMF), template matching (TM), watershed segmentation, and GEOBIA being some of the most frequent and well-established. For the recognition of individual plant tops, machine learning, specifically deep learning approaches based on neural networks, is rapidly being used (Ray et al., 2016). There are other neural network models available; however, the CNN approach is the most popular and commonly used. The use of CNN for individual crown detection has advantages since it can use big datasets to give flexible detection under different environmental variables like lighting and morphological changes, reporting high success and exceeding many other methods (Parihar and Oza, 2006; Ray and Neetu, 2017). The required processing power and initial supervised training, which can be time-consuming because it is typically an iterative process, are disadvantages of CNN approaches compared to well-established non-machine learning alternatives. Although other deep learning approaches are often used and better suited for more complex tasks, CNN is the best solution for crown object detection. The required processing power and initial supervised training, which can be time-consuming because it is typically an iterative process, are disadvantages of CNN approaches compared to well-established non-machine learning alternatives (Panigrahy and Manjunath, 2009). Although other deep learning options exist and are frequently used and suited for sophisticated tasks with relevant additional complexity, CNN provides an appropriate model for crown object detection that is well suited for the detection of spectral and spatial features that indicate plant crowns due to its detection mechanism.

Banana is the fourth most important food crop in the world after rice, wheat and corn in terms of total production. The scientific name of Banana is *Musa acuminata* and *Musa Balbisiana*, belonging to the Musaceae family. It is also an important source of trade and income. In India, banana production accounts for 2.8 percent of agricultural GDP. Bananas are a popular fruit because of their low price and high nutritional value. Banana is a rich source of carbohydrates and rich in vitamins A, C and B6 and is a good source of potassium, phosphorus, calcium and

magnesium and are a great source of fiber as well. The fruit is easy to digest, and low in fat and cholesterol. Patients with high blood pressure, arthritis, ulcers, gastroenteritis and kidney disorders are recommended. Bananas also have many applications including the production of alcohol, starch and animal feed; can be used medicinally, as fiber or as a source of leaves and to make banana bread, banana chips, baby food and food processing. Banana plants reproduce asexually from the underground stem. Bananas are a perennial plant that grows fast and can be harvested all year round.

Banana is a tropical crop, and a warm climate is ideal for the cultivation of bananas, temperature between 15°C - 35°C and a relative humidity of 75-85%, banana planting is successful in areas with high rainfall. The deep and rich loamy soil with a pH between 6.5 -7.5 is preferred for banana cultivation. The banana soil should be well drained, well fertilized and moist. The soil rich in organic matter with high nitrogen content, adequate phosphorus level and plenty of potash which is neither very acidic nor very alkaline is suitable for bananas (Singh et al., 2016).

Bananas are produced in about 135 countries and territories in tropical and subtropical regions. India was the largest producer of bananas in 2019. India produced 26.02% of the total banana production of the world which is 30.5 million tons. The top 5 countries are India, China, Indonesia, Brazil, and Ecuador. They make up 53.94% of total Production. India produced approximately 304.7 tons of bananas from acreage of 8.6 lakh acres during the 2017-18 seasons. The major banana-producing states are Andhra Pradesh, Gujrat, Maharashtra, Tamil Nadu, Uttar Pradesh, Karnataka, Madhya Pradesh, Bihar, West Bengal and Kerala. The main areas of Uttar Pradesh where bananas are grown on large scale are Sidharthnagar, Basti, SantKabirnagar, Maharajganj, Kushinagar, Faizabad, Barabanki, Sultanpur, Lucknow, Sitapur, Kaushambi, Allahabad. Uttar Pradesh has an acreage of about 67.4 thousand hectares under banana plantations and produces about 30.8 tons of bananas annually.

Several banana varieties are recommended according to the climatic conditions of our country such as Grand Naine (G-9), Basrai, Dwarf, Green Bark, Salbhog, Alpan, Robusta, Moon, Nendran and Puvan etc. the variety of banana which is mainly grown in Uttar Pradesh is Grand Naine (G-9). It is an internationally popular variety. It is a tall and high-yielding plant with a cylindrical long bunch. On average it produces a mass of 25 kg and can grow to 32-35 kg, and 8-10 hands with 200-220 fruits/mass. Fruit length is 15-21 cm and width 12-13 cm.

Banana planting is typically done using two methods: the pit method and the drainage method. In North India, planting occurs from July to August, while in South India, it can be done at any time except during summer, and in other regions from February to May. Tall banana varieties are planted at a spacing of 3x3 meters, whereas smaller varieties are spaced 2x2 meters apart (Nishant et al. 2016). This study aims to estimate the acreage of banana crops in various

blocks of Barabanki district, namely Dewa, Banki, Harakh, Siddhaur, Masauli, Fatehpur, Haidergarh, Dariyabad, Suratganj, Pure Dalai, Nindura, Trivediganj, and Ramnagar. Additionally, it seeks to identify the most suitable period for acquiring satellite data to ensure accurate banana crop inventory.

Study Area

Barabanki district is one of the five districts of Faizabad division (officially Ayodhya division), in the central Awadh region of Uttar Pradesh, India. Barabanki city is the administrative headquarters of Barabanki district. The total area of Barabanki district is 3891.5 Sq. Km. It has a population of 2,673,581, with a population density of 686.50 per square kilometre (1,778.0/sq mi). Barabanki district is situated between 27°19' and 26°30' north latitude, and 80°05' and 81°51' east longitude; it runs in a south-easterly direction, confined by the nearly parallel streams of the Ghaghara and Gomti. The extreme length of the district from east to west may be taken at 92 km (57 mi), and the extreme breadth at 93 km (58 mi); the total area is about 3,900 km² (1,504 sq mi). It borders seven other districts of Uttar Pradesh. With its most northern point, it shares borders with the Sitapur district, while its north-eastern boundary is defined by the Ghagra, beyond which lie the districts of Bahraich district and Gonda district. Its eastern border is shared with Faizabad district, and the Gomti forms a natural boundary to the south, dividing it from the Amethi district. On the west, it adjoins the Lucknow district. Barabanki district stretches out in a level plain interspersed with numerous lakes and marshes. In the upper part of the district the soil is sandy, while in the lower part it is clay and produces finer crops. The district is fed by the rivers Ghaghra (forming the northern boundary), Gomti (flowing through the middle of the district), Kalyani and Rait and their tributaries, for the major part of the year. [4] Some rivers dry out in the summer and become flooded during the rainy season. The changing course of the river Ghagra alters the land area of the district. Figure 1 shows a location map of the study area.

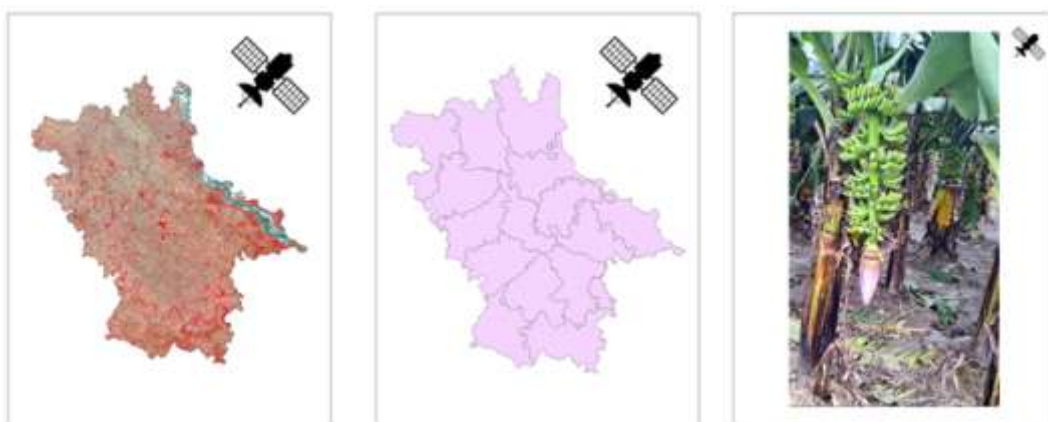


Figure 1 : Location Map of the study area.

Data Used & Methodology

Data Used

In this study, we have used sentinel-2A and 2B satellite data from different dates in October 2020 because it is the ideal time (October- November) for banana planting/ cultivation. Sentinel- 2 data have a temporal resolution of 10 days. Sentinel 2 satellite data have a total of 13 bands (443- 2190nm) of which 4 bands have a spatial resolution of 10 m, 6 bands have a spatial resolution of 20m and 3 bands have a spatial resolution of 60m. Table 1 shows satellite data used in this study as well as Table 2 shows ancillary data used for the study.

Table 1: Dataset Used in this study

S. No	Satellite data	Sensor	Scene ID	Acquisition date	Source
11.	Sentinel-2B	MSI	T44RMQ	30-oct-2020	USGS Earth Explorer
12.	Sentinel-2B	MSI	T44RMR	30-oct-2020	USGS Earth Explorer
13.	Sentinel-2B	MSI	T44RNQ	30-oct-2020	USGS Earth Explorer
14.	Sentinel-2B	MSI	T44RNR	30-oct-2020	USGS Earth Explorer

Table 2 : Ancillary data

S.No	Data	Source
1.	District boundary of Barabanki	RSAC- Lucknow
3.	Block boundary	RSAC- Lucknow

Collection of Ground Truth

Ground truth refers to complete information collection about the location. the ground truth data and image data together relate to real features, phenomena and materials on the ground. In the post-digitally classified image, it helps to determine the accuracy of digital classification performed by the digital image processing software and therefore minimize error in the classification. Fieldwork was carried out on 4 August 2021. During the fieldwork ground truth data collection was carried out for banana crops in the Nawabganj tehsil, Barabanki. Ground truth data have been collected using an application called as Map Pad. With the help of the map pad area occupied by the banana marked on the satellite image in the form of polygon then these polygons are exported in the form of shape file.

Methodology**Downloading, importing mosaicking of the data**

Firstly, open the USGS Earth Explorer site. Then log in my account then downloads the sentinel-2 data of 30 October of 2020 for the study area. After this extract the downloaded date. To import the data, open Erdas Imagine go to the raster tab in click on layer stack. Layer stack bands 2, 3, 4, 8 out of a total 13 bands and save the layer stack image. Bands 2, 3, 4, and 8 have a spatial resolution of 10m. In the same way, import all the data. After importing the data mosaic all 4 scenes of the same date. After mosaicking the subset, the study area from the mosaic image.

Preparation of masks

Mask for settlements, canals, water bodies and other crops like mango and paddy have been created from the satellite image by the process of digitisation in ESRI ArcGIS software.

Unsupervised classification

In unsupervised classification pixels are not classified on the basis of any prior information. In this classification large number of random data points are examined and classified into different classes on the basis of intrinsic properties of the data points. In this classification by the process of automatic identification, image pixels are assigned to spectral grouping (Hebbar et al. 2014, Roy et al. 2018). Using the ISODATA unsupervised classification algorithm, sentinel-2 data was classified into 80 classes then the area occupied by the banana was extracted from it with high accuracy. In this study unsupervised classification will be done according to their spectral signature and their area statistics will be generated using image processing / Arc GIS software. The unsupervised classification based on ground truth information will be performed. In unsupervised classification, satellite data will be examined for various land use/land cover categories. different categories of land use/land cover will be identified and coincide with crops ground truth marked on the satellite image. Classified outputs will be checked for its accuracy and the results modified for any discrepancy observed. Classified data then recode into 6 land use/land cover classes namely water body, settlements, fallow, orchards, other crops and bananas.

Block-wise Acreage Estimation of Banana

Banana crop acreage estimation was carried out using ArcGIS. In Arc GIS we have used spatial analyst tool Zonal. In zonal we used to calculate geometry to calculate the area. for block-wise area estimation first we have subset blocks from the classified image of Barabanki district using block boundary then calculate the area using the Zonal tool.

Accuracy Assessment

Accuracy Assessment of the digital classification of various classes was carried out in the Arc GIS tool. For accuracy assessment, we have taken a total of 40 random samples of all the classes. First, we create a shape file for the sample points then convert these points to the raster. after this, we combine the point-to-raster file with the classified image and then export the attribute table of the combined raster in dBASE table format. After this, we create a pivot table from the exported table and then copy this pivot table in Excel. then in excel, we calculated, producer accuracy and user accuracy, overall accuracy and kappa coefficient to determine the accuracy of the classification.

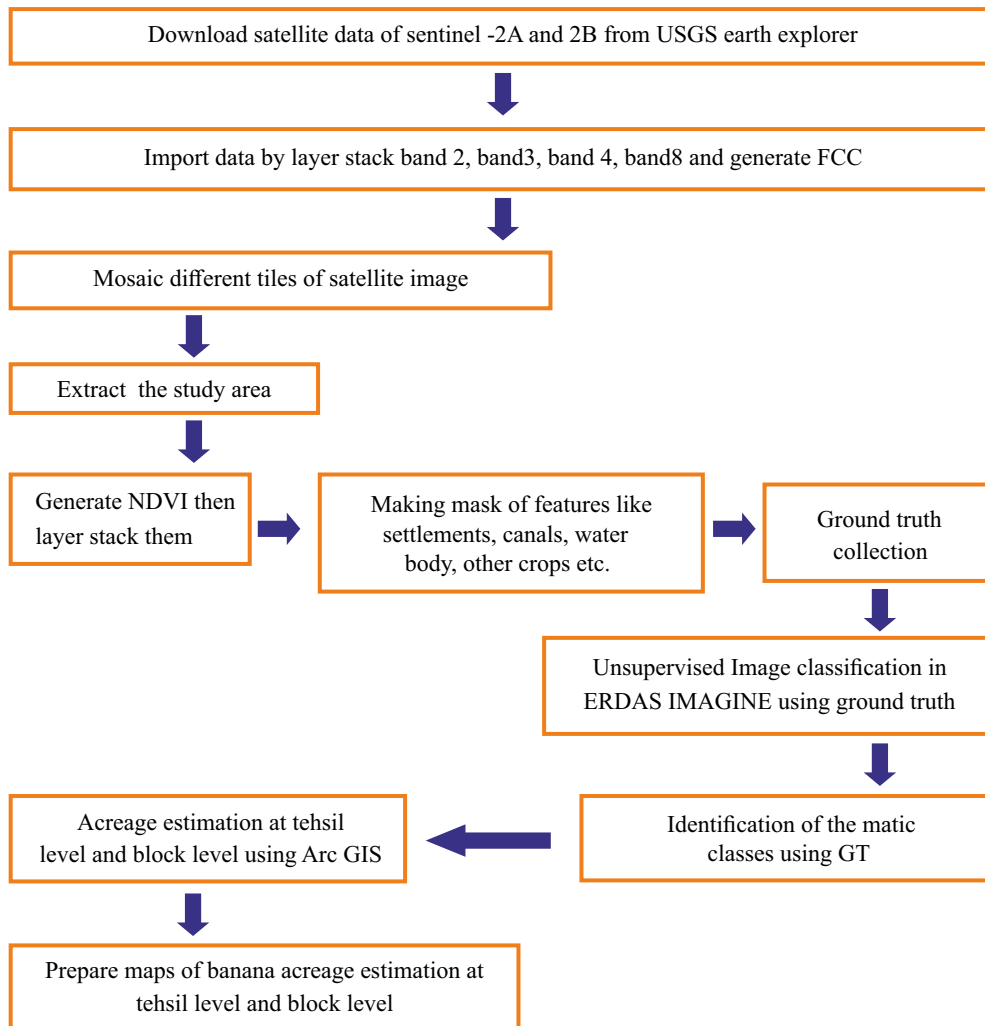


Figure 2 :Flow diagram of methodology for Banana Acreage Estimation

Result and Discussion

Banana Crop Discrimination

Crop identification and discrimination using satellite data is based on the fact that individual crop has their unique spectral signature shown in Figure 3. Spectral reflectance of a particular crop shows absorption due to chlorophyll in the visible range and high reflectance in near-infrared region due to inter-cellular structure of leaves. Identification and discrimination of banana crops from other land use and land cover have been carried out by the digital unsupervised classification. All classes of land use and land cover have distinct spectral responses. The spectral response of banana crops and other land cover classes is shown in the figure. 3 classes have been identified by the unsupervised classification viz. banana, other crop, water body, settlement, fallow, and orchard.

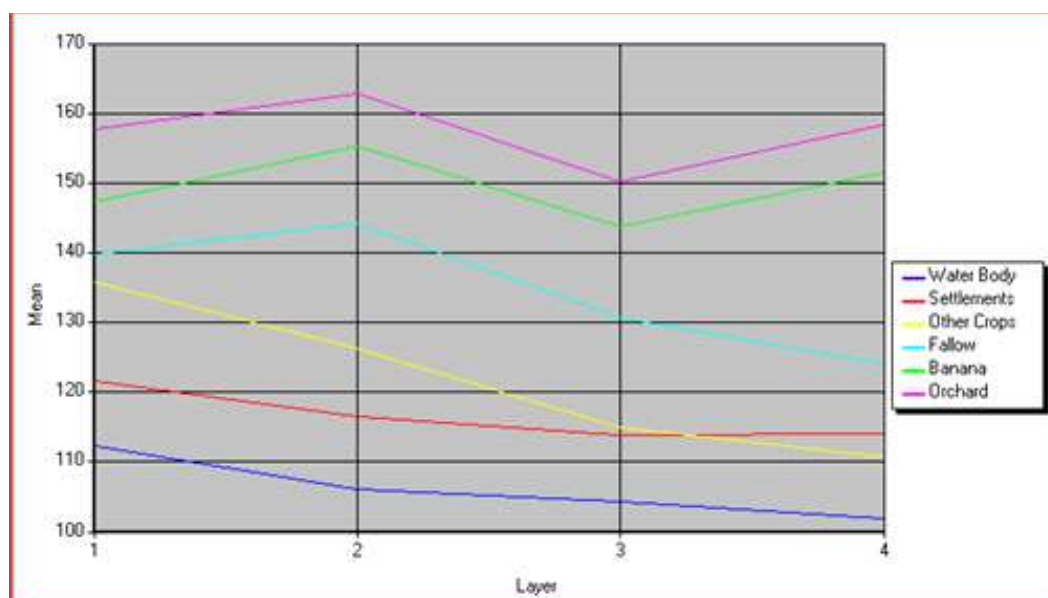


Figure 3 : Spectral Signature Curve of Various Classes

Banana Acreage Estimation

Banana is the dominating horticulture crop in the study area. Crop acreage estimation and discrimination are carried out by the digital unsupervised classification using ISODATA clustering. The total acreage estimation of banana crops in all five blocks is 20699.86.1 hectares. The digitally classified image of crop acreage estimation is of the study area shown in figure 4 (a-c). Statistics of banana crops and other land use classes obtained are shown in Table 3.

Table 3 : Statistics of Banana Crop and Other Land Use Classes

Land use classes	Area (ha)	%
Water body	350.55	0.42
Other crop	20464.6	24.69
Settlement	14849.6	17.92
Fallow	15936.1	19.23
Orchard	731.54	0.88
Banana	20699.86	36.86
Total	59672.25	100

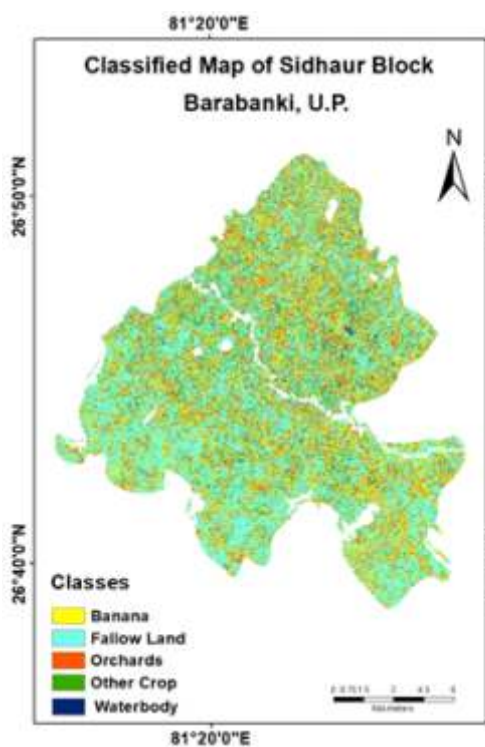


Figure 4 : (a) Classified Map of Sidhaur Block.

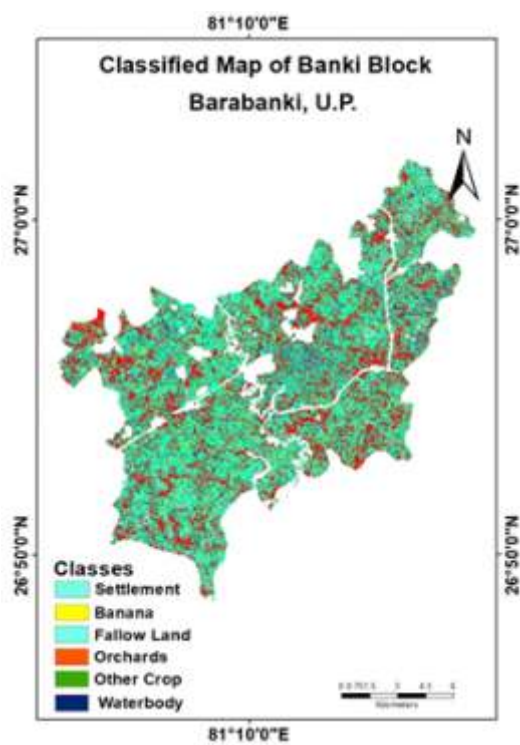


Figure 4 : (b) Classified Map of Banki Block.

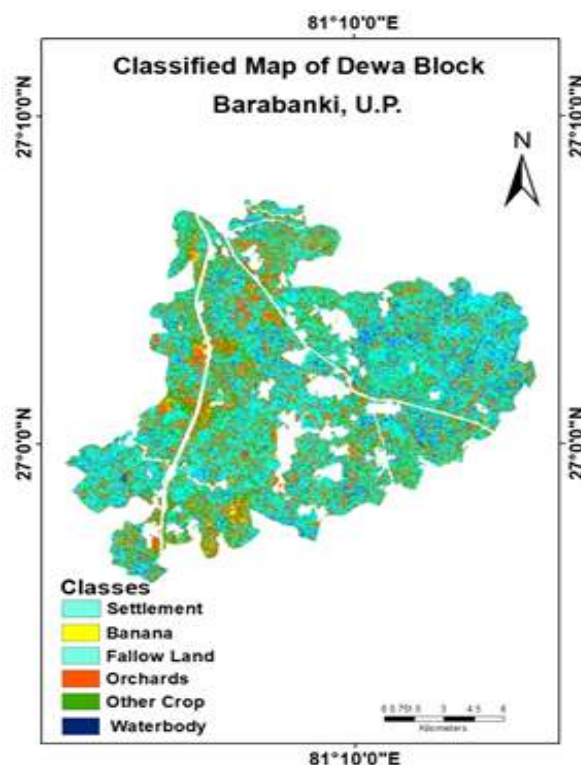


Figure 4 : (c) Classified Map of Dewa Block

Acreage estimation of the banana crop is maximum in Harakh block of Nawabganj Tehsil i.e. 8337.68 hectares and minimum in Masauli block i.e. 6822.69 hectares. In Dewa block acreage estimation of banana is 8221.85 hectares and in Bankiblock acreage estimation of banana is 7142.19 hectares. Blockwise acreage estimation is given in the Table 4.

Table 4:Block wise acreage estimation of Banana

Block name	Crop inventory (ha)
Harakh	8337.68
Dewa	845.85
Banki	1327.19
Masauli	6822.69
Sidhaur	3366.45
Total	20699.86

Accuracy Assessment of the classification of banana

The accuracy assessment of the banana crop classification aimed to evaluate the reliability of the unsupervised classification results. The classification achieved an overall accuracy of 79.17%, indicating that a majority of the land use and land cover types were correctly identified in the satellite imagery. For the banana crop specifically, the user accuracy was 85%, meaning that out of the samples classified as banana, 85% were correctly classified as such. The producer accuracy, which measures the proportion of actual banana areas correctly classified by the model, was 87.18%. This reflects the effectiveness of the classification process in correctly identifying banana crop areas from the ground truth data. These metrics demonstrate that the model performed well in distinguishing banana crops from other land cover types, such as water bodies, settlements, and other crops. The high producer and user accuracy percentages indicate that the unsupervised classification method used in this study was effective, with minimal misclassification. The overall accuracy of 79.17% further confirms the robustness of the methodology, providing confidence in the results. Minor errors in classification did not significantly affect the overall findings, but there remains potential to enhance accuracy further in future studies by integrating advanced classification algorithms or utilizing a larger set of ground truth data.

CLASS	New_Shapef1	New_Shapef2	New_Shapef3	New_Shapef4	New_Shapef5	New_Shapef6	GT
water	7	1	0	0	40	0	48
other crop	24	0	0	0	0	0	24
setelement	0	11	4	4	0	4	23
fallow	1	14	21	25	0	2	63
orchards	8	8	15	12	0	0	43
banana	0	5	0	0	0	34	39
Total	40	39	40	41	40	40	240

$$\text{User Accuracy for Banana} = 34/40 * 100 = 85\%$$

$$\text{Producer Accuracy for Banana} = 34/39 * 100 = 87.17\%$$

Discussions

This study demonstrates the effective application of Sentinel-2 satellite data for estimating banana crop acreage across the Barabanki district of Uttar Pradesh using the ISODATA unsupervised classification technique. Sentinel-2A and 2B satellites, with a temporal resolution of 10 days and multiple spectral bands, enabled detailed crop discrimination during

the ideal planting season of October 2020. By leveraging high-resolution bands (10 meters), the classification accurately distinguished banana crops from other land cover types. The methodology involved downloading, mosaicking, and layer stacking the satellite images, followed by creating masks for non-crop areas to refine the classification (Vimal et al., 2021). Ground truth data collected during fieldwork were crucial for validating the classification, ensuring that the spectral data represented real-world conditions. This process, supported by the spectral signatures of banana crops, provided reliable results for agricultural mapping (Doymaz et al., 2010).

The study successfully identified six land use/land cover categories: water bodies, settlements, fallow land, orchards, other crops, and banana crops. Block-wise banana acreage estimation revealed significant variation in cultivation across the district. Harakh block had the highest banana acreage at 8337.68 hectares, while Masauli had the lowest at 6822.69 hectares. These variations reflect regional factors influencing crop distribution, such as soil quality, water availability, and local agricultural practices (Neteler et al., 2011). The spatial analyst tool in ArcGIS was used to estimate the area under cultivation, and the study provides critical data for optimizing resource allocation, improving banana crop management, and supporting decision-making at the local and regional levels (Liu et al., 2011).

Accuracy assessment confirmed the robustness of the classification, with a producer accuracy of 87.18%, user accuracy of 85%, and an overall classification accuracy of 79.17%. These metrics validate the method's effectiveness in distinguishing banana crops from other land covers. The combination of remote sensing with field-verified ground truth data proved to be a powerful tool for large-scale agricultural assessments, offering a cost-effective and scalable approach. The accuracy assessment, particularly the Kappa coefficient, showed strong agreement between the classified image and actual conditions, further establishing the reliability of the classification results (Usman et al., 2014). This approach highlights the potential for ongoing use of satellite data in monitoring crop health and distribution.

Future work could focus on enhancing the methodology by incorporating machine learning algorithms such as random forests or support vector machines for more refined classification. Additionally, multi-temporal analysis using satellite imagery could track crop growth stages and shifts in banana cultivation over time, allowing for improved crop forecasting and decision-making. This study sets the foundation for applying similar techniques to other crops and regions, contributing to precision agriculture and informed agricultural policy-making. Expanding this research could also involve integrating environmental and socioeconomic variables to better understand the drivers of agricultural land use changes. This would further support sustainable agricultural practices and enhance the resilience of the banana farming sector against climate and market fluctuations.

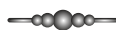
Conclusion

This study successfully employed Sentinel-2 satellite data and unsupervised classification techniques to estimate banana crop acreage across various blocks in Barabanki district, Uttar Pradesh. By leveraging the spectral resolution of Sentinel-2A and 2B satellites, the ISODATA algorithm provided an accurate classification of six land use and land cover categories, with a specific focus on banana cultivation. The block-wise analysis revealed significant spatial variations in banana acreage, with Harakh block showing the highest cultivation area. The classification's overall accuracy of 79.17% and a Kappa coefficient indicating strong reliability validate the methodology as an effective approach for agricultural mapping. The findings of this research are valuable for agricultural planning, crop monitoring, and resource management. By providing detailed spatial data on banana crop distribution, the study supports informed decision-making for local authorities and farmers, particularly in optimizing land use and improving crop management strategies. The use of remote sensing technology, coupled with ground truth validation, has demonstrated a scalable and cost-effective solution for large-scale agricultural assessments. Looking ahead, this study opens avenues for further refinement of crop estimation models. Future research could integrate advanced machine learning techniques for higher classification accuracy and explore multi-temporal satellite data for dynamic crop monitoring. Expanding the scope of this work to include environmental and socioeconomic variables could also provide deeper insights into the factors driving agricultural land use changes. Ultimately, this study contributes to the growing body of research on remote sensing in agriculture, underscoring its potential to enhance precision farming and supporting sustainable agricultural practices in India.

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AN INITIATIVE FOR RURAL REVITALIZATION IN BIHAR: DEVELOPMENT OF RURAL AREAS AS A TOURIST DESTINATION

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ABSTRACT

Bihar is an agrarian state and a major spiritual, heritage and cultural tourist destination. Primary sector in Bihar has the second highest growth rate after the tertiary sector. Rural areas are growing but have less income than other states in India. It is facing the challenge of low revenue and unemployment due to lack of proper infrastructure, market and storage facilities, low production, irregularity of rainfall, flood or drought like situation every year, decrease in land size, lack of interest in farming by youths, migration, etc. Farmers are switching to other occupations or migrating to other cities or states. In the industrial sector, the tourism sector is in second place after agro-based industries. Between 2016 and 2017, there has been a growth of 13.4 percent in the arrival of tourists. More encouragingly, the growth rate of foreign tourists' arrival was 7.1 percent. But during COVID-19 period, there was a decline in tourist flow in the state as people were avoiding crowded tourist destinations in fear of infection. In recent years, people are in search of green, less crowded and tranquil places where they can rejuvenate, enjoy and spend premium time with their family and friends. This interest provides a perfect opportunity to develop Bihar's rural areas as an ideal tourist destination because Bihar has a unique combination of rich history, culture, knowledge, fertile soil, variety of agro-products and water resources. Rural tourism can showcase the rural life, art, culture and heritage along with helping the local community economically and socially. Therefore, if the primary and secondary sectors can be merged, it will be a great source of revenue and employment. To check rural-urban migration and increase rural economy, a combination of agriculture, small scale industries and local culture with tourism is the need of the hour. This paper has been written with the objective to outline the prospects of rural tourism and find the ideal places for its development in Bihar. Second objective is to assess the issues and challenges associated with its development and infer a plan or design for its development on a pilot project basis for achieving rural economic independence, sustainability and social responsibility for preserving the environment. Both primary and secondary data were used. Adequate interpretation and analysis have been done to reach the conclusion.

Keywords: Agrarian, agro-products, COVID-19, heritage, migration, rural tourism.

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Introduction

Agriculture is the backbone of Bihar's economy as it incorporates 77% of the workforce and generates nearly 24.84 percent of the State Domestic Product (Agriculture Department, Government of Bihar, 2011-12). Self-sufficient in cereal crops, the state has decreasing production in other crops due to shrinking cultivation area and adverse climatic conditions, like drought and floods. But these adverse conditions can be overcome to some extent. There is tremendous scope for income generation, by improving productivity and developing another source of income. In the current years, when people are in search of green, less crowded and tranquil places, the rural areas of Bihar can provide an ideal opportunity to promote rural tourism. It can also help the government to revive the economy and its environment conservation programs like 'Jal, Jeevan and Hariyali'.

Tourism gave people the opportunity for recreation and rejuvenation to become physically and mentally fit and healthy. When people move to rural areas for a minimum period of 24 hours to a maximum of 6 months for leisure, it is known as rural tourism. It is a new concept of alternative tourism which helps the local community economically and socially. According to Nagarjuna and Chandrashekara (2014), rural tourism is multi-faceted and may entail farm/agricultural tourism, cultural tourism, nature tourism, adventure tourism, and eco-tourism. Rural tourism takes place in non-urban settings usually in countryside, offering an elixir to counter tension and urbanization syndrome to the weary, stressed-out tourists from both within as well as foreign countries to help them relax and rediscover their roots (Kapur Shikha, 2016). Rural tourism development in the state will increase the local income, generate employment, encourage the small and household industry and spur infrastructural development while preserving and nurturing the essence of rural community life. This will also check the heavy migration of the rural population and the immense pressure on urban resources.

The Ministry of Tourism has launched the Swadesh Darshan Scheme for the integrated development of theme-based tourist circuits and tourism infrastructure in Bihar and Kerala at a cost of Rs 125 crore under the Rural Circuit (Financial Express, 2020). The objectives of this scheme include creating employment through active involvement of local communities and promoting community-based development and a pro-poor tourism approach. Under the Shyama Prasad Mukherji Rurban Mission (SPMRM), 300 clusters are being developed across 28 States and 8 Union Territories. Therefore, under the Swadesh Darshan Scheme where the countryside is gaining importance as a 'Rurban Village', a project has been sanctioned in Bihar during FY 2017-18 for the development of Bhitiharwa -Chandrahia -Turkaulia amounting to Rs 44.65 crore. But which other villages are ideal for the development of rural tourism in Bihar is not clear. There are also many challenges in the development of rural tourism in the state.

There is a total of 45103 villages in 38 districts of Bihar where 77% of the population is engaged in agriculture directly or indirectly (Bihar State Profile, Government of Bihar, 2024). Bihar, as an imperial, religious and heritage state, is already an important tourist destination on both international and domestic levels. Rural tourism has a wide scope in this agrarian state. Ginwal Richa and Kumar Daleep (2022) recommended that rural people should be motivated to develop rural tourism and that those incentives can be provided to them but at the same time with a condition to preserve the environment. Therefore, rural areas near famous tourist spots can be developed as tourist destinations for rural revitalization.

Study Area

Bihar, a part of the ancient and famous Magadh, Mithila and Anga Kingdom, was the cradle of Buddhism, Jainism, Republicanism, Ahimsa, and environment conservation and the centre of the Golden Age of India. In ancient times, Bihar was the synonym of knowledge, imperial power and culture. Bihar word came from the Sanskrit and Pali word 'Vihara' which means 'Abode' of Buddhist Monks (Sinha, U.P. and Kumar Swargesh, 2012). Located between 24°-20'-10"N and 27°-31'-15"N latitude and 83°-19'-50"E and 88°-17'-40" E longitude, its average elevation is 173 feet. Covering an area of 94,163 sq. kms. in the Middle Gangetic Plain, it comprises 10,40,99,452 (2011) population, 38 districts and a density of 1106 persons per square km (Bihar State Profile, Government of Bihar, 2024).



Figure 1 : The Tourist Map of Bihar

Source: Bihar Tourism: Destination Maps, Department of Tourism, Government of Bihar

Objectives

1. The first objective of this paper is to outline the prospects of rural tourism and find the ideal locations for its development in Bihar.
2. The second objective is to assess the issues and challenges associated with the development of rural regions near to major tourist destinations.
3. To infer a plan or design for the development of tourism on a pilot project basis for achieving rural economic independence, sustainability and social responsibility for preserving the environment.

Research Questions

1. How can rural tourism prosper in Bihar?
2. What are the probable areas suitable for the development of rural tourism clusters?
3. What measures can be taken to develop rural tourism?

Methodology

Some villages like Kundalpur, Telhara, Ghora Katora, Tutla Bhawani, Chainpur and villages near Vaishali, Nalanda, Rajgir, Gaya, Sasaram, etc. in Bihar were visited by the author previously and perceived them ideal for the development of rural tourism. As these were the locations near famous tourist places. Therefore, the present research has been conducted in the month of April, 2021 to find the prospects of rural tourism and other ideal locations for its development. For arriving at scientific valid statements, it is essential to examine the facts and figures by some standard approach and methods. A systematic micro-level approach and random purposive sampling method have been adopted for this research work. An online survey with the help of Google form has been done to collect the primary data as a physical survey was not feasible due to corona virus spread during this period. The author has collected primary data from 103 respondents. The respondents were those residing in Bihar irrespective of any district at least for the last 10 years. The majority of respondents were from Patna, Nalanda, Arrah and Rohtas districts. Secondary data was collected from the concerned Department of Tourism, Govt. of Bihar and its website to explain the facts.

How can rural tourism prosper in Bihar?

Bihar is an agrarian state with more than 45 thousand villages and hence has enormous potential for the development of new tourist sites, some of which are the latest craze like '*Ghora Katora*' in Rajgir. Many urban areas are sub-rural in nature. Mahatma Gandhi once said that the "True India resides in her villages" and he started his first independence campaign

Satyagraha from Champaran, a district of Bihar. Bihar is also very rich in food delicacies, arts and crafts, art is an villages, temples and monuments which await tourists in every part. Table number 1 shows the existing major tourist destinations developed by the Government of Bihar. Exceptional arts like Madhubani paintings and Sujni arts originate from the villages of Bihar. So far, there are seven important religious circuits developed by the Government of Bihar - Hindu, Buddhist, Islamic/Sufi, Ramayan, Gandhi, Jain and Sikh circuits.

Table 1 : The Major Existing Tourist Destinations in Bihar

Patna & Vaishali District	Gaya & Jehanabad District	Nalanda & Nawada District	Kaimur & Rohtas District	Bhagalpur, Munger & Jamui District	Madhepura, Sitamarhi & Darbhanga District	East & West Champaran District
Patan Devi and Agam Kuan Kumhrar ruins Stupa known as Chhoti Pahari & Panch Pahari Sufi Saint Makhdoom Yahya Maneri and Makhdoom - - - Sanjay Gandhi Jaivik Udyan Takhat Sri Har Mandir Sahib Golghar & Museums BulandiBagh Relic Stupa & Raja Vishal ka Garh at Vaishali	Caves in Barabar&Nagarjuni hills Vishnupad Temple Brahmayoni, Pretshila & Ramshila Hill Dungeshwari Hills Mahabodhi Temple (Bodhgaya) Sujata Garh Ancient mounds (Hasra Kol & Sobhnath) Carved rock Sculptures on KauwaDol Hill Ancient monolithic pillar/Lat	Ruins of Nalanda University Giriyaak Kakolat Waterfall Rajgir Jal Mandir, Pawapuri Jain temple Kundalpur Kakolat Waterfall Indrasal Cave Ancient mound, Bargaon GhoraKatora Hiuen Tsang Memorial	Rohtas Fort Sasaram Fort Sher Shah's tomb at Sasaram Tomb of Bakhtiar Khan Temple of Mundeswari Devi Kaimur Sanctuary Bhagwanpur Chainpur Manjhar Kund Dhuan Kund Telhar and Karkat Waterfall	Ancient Vikramashila Monastery Vikramshila Gangetic Dolphin Sanctuary Golgong Rock Temple BateshwarSthan Ajgaivinath Temple Mandar Hill Munger Fort Hot springs of Rishikund Kharagpur lake Nagi-Nakti Dam Bird Sanctuary Jain Mandir, Lachhuar Giddheshwar Temple Kali Mndir, Malaypur Bhimbandh	Ancient PachrukhiGarh of Raja Bali Navlakha Palace Museums & Darbhanga Fort Shyama Mai Temple Nargona Palace Anand Bagh Palace Ahalya Sthan KusheshwarAsthan Sita Kund, Urvija Kund, Janaki Sthan, Punaura Dham, HaleshwarAsthan, Manokamna Dham at Madhubani	Valmiki National Park Simeshwar Fort Kesaria Stupa Ashoka column at LauriyaNandangarh LauriyaAraraj Champaran Satyagraha Park & Gandhi Museum Bhikhna Thori Bhithiharwa Ashram

Source: Compiled from *List of Monuments of National Importance in Bihar* (https://en.wikipedia.org/wiki/List_of_Monuments_of_National_Importance_in_Bihar) and *Tourism in Bihar* (https://en.wikipedia.org/wiki/Tourism_in_Bihar).

According to the Bihar Tourism Annual Statistics Report (2005) also, countries with a sizeable Buddhist population accounted for almost 75 percent of the foreign tourists who visited Bihar in that year. Among the domestic tourists, 84.3 percent tourists were from Bihar itself. Almost

8 percent were from the neighboring states of Jharkhand and Uttar Pradesh. Tourists come to Bihar mainly in the winter season and avoid the scorching summer months. This rise can be also attributed to the Sonpur cattle fair, Vishnu puja and Pind-dan in Gaya and hot springs in Rajgir and Munger. This uneven flow of tourists creates seasonal jobs and so people have to rely on other occupations to earn the rest of the time.

Primary survey (Figure no. 2) also confirms that in the post-COVID period, people like to travel those places that are less crowded and surrounded by greenery and a feeling of tranquility which can be found in rural eco-tourist sites (52 percent) or wildlife sanctuaries (20 percent). 69 percent of respondents confirm that there is a vast possibility of developing rural areas as a tourist destination while 27 percent of respondents have negative responses.

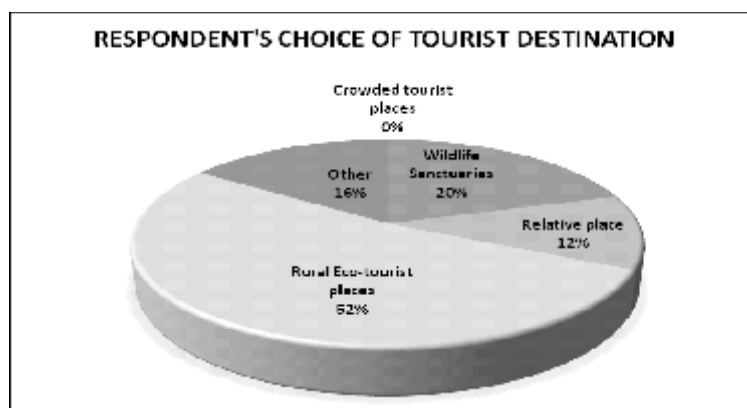


Figure 2 : Respondents choice of tourist destination and scope of rural tourism in Bihar

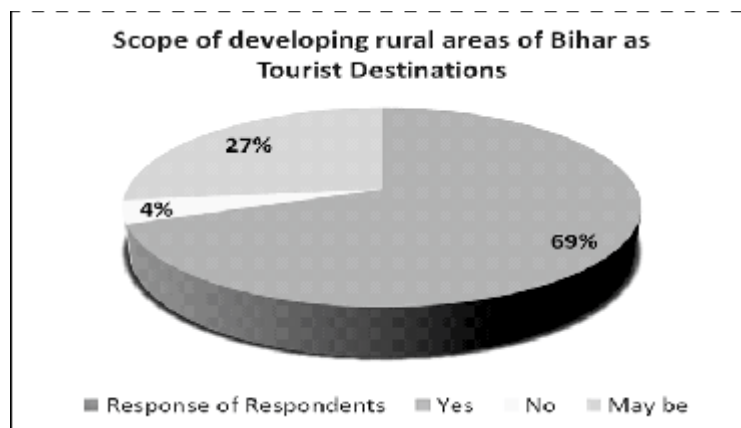


Figure 3 : Respondents on Developing Rural Areas

Data Source: Online survey done by the author with the help of google form, 2021, N=103

Therefore, the government is now focusing on niche areas of health tourism like yoga in Munger, thermal tourism in Munger and Rajgir, rural and eco-tourism in West Champaran, Kaimur, Rohtas, Nalanda, Gaya, Munger, Bhagalpur, Katihar, Darbhanga and Vaishali and food festivals. Government is also planning to promote many new and unexplored destinations for potential tourists and travelers but it is in its initial stage. Many rural areas are unexplored and neglected. Therefore, this research paper tries to outline the prospects of rural tourism and find the ideal locations for its development in the state. Few people like Girindranath Jha of Purnia district are trying in this direction by making home stays at their village and providing many agriculture related activities and village sports on their farms to promote rural tourism and empower their village.

Government Measures for Tourism Development

Central and state governments both are trying to develop rural areas as tourist destinations to help the local community, economy and environment. There are many schemes for promotion of rural tourism by the central government like Rural Tourism Infrastructure Development Component (part of Product Infrastructure Development for Destinations and Circuits – PIDDC – Scheme), Swadesh Darshan (Ministry of Tourism, Government of India, 2023), PRASHAD, SAATHI, Dekho Apna Desh, NIDHI and Domestic Promotion & Publicity including Hospitality (DPPH) for organizing local fairs, festivals, seminars, conventions, etc. Some villages were selected across the country for rural tourism development but few of them succeeded. Rural tourism in the state is in the infancy stage. The major constraint was the lack of participation of local people and lack of a focal theme around which that particular village can be promoted. Therefore, to succeed convergence of government schemes, the participation of local people and institutions, a proper implementation plan from the grassroots level with advertisement on social and print media is a must.

Bihar Government is trying to develop different circuits and identified a few major projects for the development of tourism but they all are in the urban areas. These projects include the development of a garden and theme park around Buddhist Stupas, tombs and excavated remains of ancient dynasties; consolidation and development of Lauriya Nandangarh, Goga Bill Bird Sanctuary and Kanwar Lake Bird Sanctuary; holistic healing cum rejuvenation centre at Sita Kund, Munger and Urban Haat at Madhubani and Bhagalpur. They focus on riverfront development and floating restaurants at Patna and Bhagalpur; tourist resorts at Manihari and Gandhi Circuit and upgradation of Nalanda, Rajgir, Gaya and Bodhgaya with world-class tourist infrastructure. Bhagalpur-Munger and Kaimur-Rohtas clusters should be developed in mission mode. There is only one project under Swadesh Darshan in East Champaran (Gandhi Circuit) for the development of rural areas as a tourist destination but it is an average project (Table number 2). Jammu and Kashmir had the maximum number of successful projects.

Therefore, for rural revitalization, some initiatives and projects from the government and innovative ideas with positive participation from the local people are very much needed.

Table 2 : State-wise performance of the rural tourism projects by the Central Government.

State	No. of Projects covered	No. of Successful Projects	No. of Average Projects	No. of Unsuccessful Projects
Total	107	41	33	33
Andhra Pradesh	5	2	3	
Arunachal Pradesh	3	3		
Assam	4		3	1
Bihar	1		1	
Chhattisgarh	5			5
Delhi	2	1	1	
Gujarat	4		2	2
Haryana	1		1	
Himachal Pradesh	3	1	2	
Jammu & Kashmir	8	7	1	
Karnataka	5	3	2	
Kerala	5	5		
Madhya Pradesh	4	1		3
Maharashtra	2	2		
Manipur	3	1		2
Meghalaya	2		1	1
Nagaland	5	3	2	
Orissa	7	1	1	5
Punjab	5	1	3	1
Rajasthan	3		1	2
Sikkim	1	1		
Tamil Nadu	8	4	2	2
Tripura	2	2		
Uttar Pradesh	3			3
Uttarakhand	11	3	5	3
West Bengal	5		2	3

Source: Evaluation cum Impact Study of Rural Tourism Projects - Final Report, Ministry of Tourism, Government of India.

Note: Ratings 4 & 5 are successful projects, 3 are average projects, and 1 & 2 are unsuccessful projects. 1 represented Failure, 2 represented Not Successful, 3 represented Average, 4 represented Moderately Successful, and 5 represented Highly Successful.

What measures can be taken to develop Rural Tourism?

In the initial period, those villages can be developed which are near already famous tourist places like Rajgir, Nalanda, Bodhgaya, Patna, etc. so that tourists who come to visit these places can stay at these villages in guest houses, mud houses or home stays in the natural environment and explore the nearby tourist spots as well as artisan villages. Rural areas near famous tourist places hold a unique combination of rural industries, farming lands, famous arts and handicrafts along with famous religious and cultural monuments. These villages will set an example when they succeed.

Therefore, to attract tourists, these areas should be made more adventurous with various activities, people friendly and safe with all modern facilities. Training of manpower and cooperation among related sectors and departments will also help. According to respondents, good infrastructure (9 percent), hygiene and sanitation (9 percent), adventure and sports facilities (2 percent), hospitality and network facilities (4 percent), friendly people and safety (1 percent) are essential facilities to promote rural tourism (Figure no. 4). 75 percent responded that all these facilities are important.

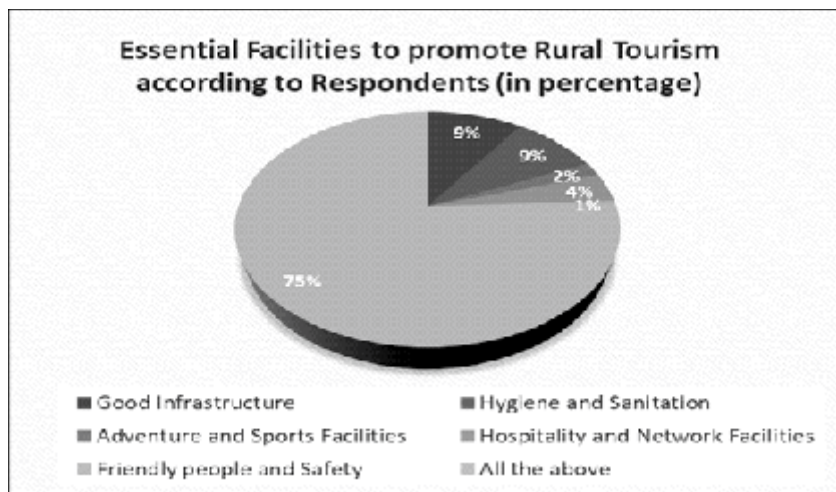


Figure 4: Essential Facilities to promote Rural-Tourism according to Respondents

Data Source: Online survey done by the author with the help of google form, 2021, N=103

To attract tourists, village resorts or home stays can be constructed or houses can be modified in traditional style, showcasing a beautiful sight with aesthetic local paintings on the walls with attached western bathrooms and modern amenities. Mud and tree houses are becoming famous as they remain cool in the summer, while warm in the winter. Traditional woven bed 'charpai' or wooden bed 'chauki' can be provided to sleep in the open under the stars. Tourists can watch

birds, walk by the green farmlands, learn farming practices, buy traditional products like Madhubani paintings, learn local cuisine and skills from the artisans and enjoy the serene beauty of the village.



Figure 5 : Examples for Village Resort



Figure 6 : Activities - Trekking and Boating

Image Source: Author's own collection, 2022-24

Tourists can perform activities like milking cows, clay pot making, tractor riding, cycling, visiting temples and craft centres, experiencing religious ceremonies, etc. It is most popular for the mangroves, agriculture, and prominent silk business. Various facets of silk saree weaving can keep the local folks involved. Tourists can also enjoy various cultural programs organized by eminent artists with national and international recognition at fairs organized by the government. Organic farming in the state can benefit both from tourism and the direct selling of organic food to tourists. Kedia village in Jamui came to light for its ecological farming. Villagers should be trained to welcome guests with warm hospitality and care.

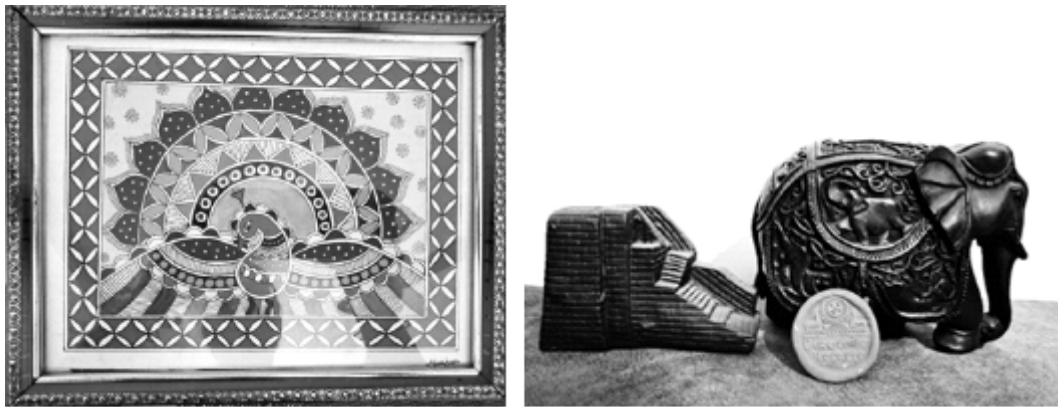


Figure 7 and 8 : Madhubani Art & Figurines made at Craft Centre near Hiuen Tsang Memorial Hall, Nalanda

Image Source: Author's own collection, 2022-24

To develop village tourism, Human Resource Development (HRD) can publicize the importance and attraction of rural tourism by organizing various events, by market research, statistics and overseas marketing and by developing tourism infrastructure. The government has also provided platforms like 'Saras Mela' and 'Bihar Diwas' for selling rural products and training local tourist guides by trained professionals. But there is a need for a platform that organizes and deals with home stays in rural areas of Bihar like Punjab and Kerala, where people from other countries come to experience the culture and place. It can be a startup idea for many youths. There are a lot of startups dealing with similar ideas. Event organizing companies can plan rural festivals and village games competitions like gillid and a, pitto, kancha, and kabaddi which can be made exciting enough to attract the urban audience to participate as tourists.





Figure 9 : Types of activities in Rural Tourist Places

Image Source: Author's own collection, 2022-24

There are several organizations both government and non-government which are involved in the promotion of rural tourism in India. These organizations are making their contribution by creating infrastructure, developing capacity, etc. These organizations include:

- Grass routes
- Rural tourism Network Enterprise RTNE
- DHAN Foundation
- Travel Another India
- Culture Aangan
- Ecospiti
- Village Ways
- Eco Login

Prospective Rural Tourism Clusters according to Respondents

Today, due to various digital medium and hush and rush of work pressure, many people want to find a few places where they can leave the crowd, work pressure and distractions and temptations of social media behind and soak up the simplicity of the moment while staying in the camps, traditional huts or home stays with family and friends. A rural tourist spot brings peace and tranquility to people, affects their senses and lifestyle, and provides them with the ideal place to rejuvenate and reconnect with nature. There are many sites of rural tourism near Rajgir, Nalanda, Munger, Bhagalpur, Bodhgaya, Gaya, Sasaram, Vaishali, Valmiki Nagar, Bettiah, Sitamarhi, Begusarai, Patna, etc. The establishment of ayurveda centres, yoga and wellness spas, thermal and aroma treatment centres, and mental healing and meditation centres can also promote tourism in the state.

Table number 3 clearly depicts the top villages ideal for the development of rural tourism according to respondents. They are villages near Nalanda ruins (16) and Rajgir (15), Pawapuri (11), Kedia (Jaivik Gram) (7), Telhara (7), Sitamarhi (6), Valmiki Nagar (6), Gaya (6), Bodhgaya (5), Mankudha (Paliganj) (5) and Vaishali (5). There are many other villages also which can be developed on the secondary stage, after completion and success of the first stage of rural tourism development. Table number 4 indicates these villages of secondary stage.

Table 3: Top villages ideal for the development of Rural Tourism in Bihar according to Respondents

District	Name of Villages	No. of Respondents
Nalanda	Villages near Nalanda ruins (Bargaon, Kundalpur) and Rajgir (Nepura, Giriyak, Ghora Katora), Telhara	38
Nawada	Pawapuri (Bhagwanpur, Shikarpur, Durgapur) & Kakolat	22
Gaya	Villages near Gaya & Bodh Gaya and Tenari	11
Jamui	Kedia (Jaivik Gram)	7
West Champaran	Villages near Valmiki Nagar	6
Sitamarhi	Sitamarhi	6
Patna	Mankudha (Paliganj)	5
Vaishali	Vaishali	5

Source: Online survey done by the author with the help of google form, 2021, N=103

Table 4: Other Villages ideal for the development of Rural Tourism in Bihar according to Respondents

District	Name of Villages	No. of Respondents
Patna	Dehri (Punpun), Patauna (Paliganj), Karauta, Taregna, Danapurdiara, Alawalpur, Daniyawan, Khusrupur, Alawalpur, Villages in the outskirts of Patna	19
Bhojpur	Bihya, Buxar, Ar rah, Bakhorapur, Tarari, Nonar, Nagri, Sahar, Jagdishpur	14
Gaya	Dumaria, Malah Bigha, Kurkihar, Bela, Gehlaur, Maranpur, Tekari, Wazirganj	12
Rohtas	Villages near Sasaram and Dehri -on-Sone, Tutla Bhawani, Suggikhoh, Gupta Dham, Nasriganj, Tilouthu	12
East Champaran	Motihari, Bettiah, Manguraha, Kesaria, Pakridayal	8
Nalanda	EkangarDih, Kundwa Par, Kundalpur, Asthawan, Ghanabigha, Chhittar Bigha	7
Munger	Bhimbandh Wildlife Sanctuary, Baba Mahendra Nath Mandir, Bankar, Mairwa Dham, Mairwa Gaon	6

Jamui	Gidheshwar, Lachhwar, Nagi-Nakti bird sanctuary, Mahadeo-Simeria, Simultala	5
West Champaran	Rampur, Bhitiharwa, Chankigarh, Gobardhana, Bagahi	5
Begusarai	Manjhaul (Kanwar lake), Sim ariya	5
Sitamarhi	Punaure (Janki Asthan), Panthpaker, HaleshwarAsthan	4
Nawada	Murhena, Rajauli, Baijnathpur, Khanwa	4
Vaishali	Mahua,Hajipur,Sultanpur, Lalganj	4
Madhubani	Madhubani, Shivipatti, Benipatti, Rajnagar	4
Bhagalpur	Bhagalpur, Gopalpur	3
Darbhangha	Jhanjharpur, Kewatgama Darbhanga	3
Katihar	Villages near Goga Bill Lake, Kursela, Lakshmipur	3
Samastipur	Morwara (ChilwaraChaur lake), Baidyanathpur,Chaita	3
Saran	Sonpur, Chirand	3
Bhabhua	Chainpur, Mundeshwari	2
Gopalganj	Hathua, Thawe	2
Jehanabad	Sultanpur, Dharnai (First fully solar -powered village)	2
Muzaffarpur	Madhuban, Rajkhand	2
Aurangabad	Deo	1
Banka	Banka	1
Purnia	Purnia	1
Siwan	Madhopur	1
Saharsa	Bangaon	1
Sheikhpura	Sohadi	1

Source: Online survey done by the author with the help of google form, 2021, N = 103

Major clusters for the development of Rural Tourism

The major clusters for the development of rural tourism based on respondent's answers are:

- 1. Bhagalpur-Munger Cluster:** Bhagalpur and Munger have significant potential for water-based tourism along the picturesque landscape of the River Gangesnear Vikramshila Gangetic Dolphin Sanctuary, Dolphin Eco Park and Bhimbandh Wildlife Sanctuary. They are protected areas for the endangered Gangetic dolphins, the National Aquatic Animal of India found mainly in River Ganga. Tourists can see them playing in the river water from the boat or steamer. This area can be developed as aquatic adventure tourism. Munger Fort, Chandika Asthan, Sita and Rishi Kund Hot Spring and Bihar School of Yoga, Pir Pahar, Bateshwar Hills, Mandar Hills and tussar silk weaving centres are the main attractions of this cluster. Villages of Maksuspur, Sandalpur, Tikarampur and Shankarpur near Munger and Saidpur, Rajpur, Mahadeopur, Champanagarand Bairiya near Bhagalpur are ideal for rural tourism development.

2. **Nawada-Nalanda Cluster:** Villages near cold Kakolat Waterfall which is surrounded by lush green vegetation in the Nawada district can be developed for rural tourism. A big fair is organized every year on the occasion of Chhat or Baisakhi Sankranti in this region. Nepura village is famous for its Tussar silk weaving and it is the place where Lord Buddha gave his sermon to his disciples. Villages near ancient Nalanda University ruins, Rajgir and Kundalpur, the birthplace of Jain Tirthankara Lord Mahavir, can also be developed. Hot Spring (Saptadhara and Brahma Kund) in Rajgir has the potential for the development of therapeutic/health tourism by using its mineral water and other elements of curative quality. Health resorts at these places can offer exotic oil massages, yoga, meditation, rejuvenation therapy, herbal baths, body-slimming, beauty care, intake of herbal tea and organically grown food cooked in medicinal herbs and spices for physical, mental and spiritual cleansing. Makhdum Kund has been identified for the establishment of a health resort. Ghora Katora, an eco-zone, attracts migratory birds from central Asia during winter. It has a statue of Lord Buddha in the centre of a lake, boating facilities, a cafeteria and guest rooms, a watch tower and ten pergolas for tourists.
3. **Patna-Vaishali Cluster:** It is famous for ancient monuments and ruins, temples, gurudwaras, mosques, trade fairs, Chhath Puja festival, amusement and water parks, science center, museums, planetariums, etc. There are three waterparks in and around Patna – Funtasia Waterpark at Sampatchak, Hungama World Waterpark near Bihta and Chhapaak Waterpark near Sukulpur Village(NH-30). Villages near these waterparks can be developed as they are in the proximity of the state capital, Patna. River cruise and floating restaurants in River Ganga, floating cottages and houseboats like Dal Lake of Srinagar, water sports, and recreational facilities like fishing, dolphin watching etc. will attract many tourists. The villages like Mankudha, Patauna, Karauta, Taregna, Danapur Diara, Alawalpur, etc. can be developed for rural tourism. Vaishali was the first republic and is famous for its stupas, Ashokan pillar and ruins of ancient forts. Villages adjacent to Vaishali are very green and ideal for rural tourism.
4. **Gaya-Bodhgaya Cluster:** Gaya attracts tourists from all over the world for Pinda dana ritual(for the moksha of the soul) in Falgu River and ancient Buddhist, Jain and Hindu heritage sites and monuments. Villages near Bodhgaya, where Lord Buddha is said to have attained enlightenment, can be benefited from foreign tourists. Barabar hill caves, Nagarjuni caves, Vishnu Temple (Kako) and the first solar village Dharnai in Jehanabad are ideal for rural tourism. Gautam Buddha Wildlife Sanctuary is ideal for nature lovers and bird watchers and can be developed as such.
5. **Darbhangha-Madhubani Cluster:** The world-famous folk paintings (Mithila paintings which originated about 2500 years ago in Mithila District) attract many tourists. Jitwarpur

and Ranti in Madhubani and Kalakriti in Darbhanga are major centres of Madhubani painting. Many villages in this cluster can be developed as rural tourist centres. The water-logged fourteen villages near Kusheshwar-Asthan (Lord Shiva temple) due to their greater ecological, faunal, floral, geomorphological and natural importance has already been declared as Kusheshwar-Asthan Bird Sanctuary under the Wild Life Protection Act 1972 (as amended up to 1991) (Darbhanga Tourism, Government of Bihar, 2024). Makranda, Newri (ruins of Raja Lorick's fortress), Raghapur (earthen mound/ruins known as Sheosingh-Garh), Saurath, Ahilya gram, Brahmpur, Kapileswar-Asthan, Uchaitha, Bhawanipur, etc. can be developed in this cluster.

6. **Kaimur-Rohtas Cluster:** Rivers and limestone caves in these districts are ideal for adventure cum rural tourism. Adventure sports have opened many offbeat destinations and new possibilities for tourism activities like mountaineering, rock climbing, trekking, hiking, river rafting, water games, paragliding, hot air ballooning, caving (cave exploration), camping, etc. This type of tourism is favored by a niche class of tourists. Promotion of various sports and construction of stadiums, practice grounds and sports complexes should be done by the government so that the youths of Bihar can build their future through games and sports. Every year sports competitions should be organized to promote this new type of tourism.

Kaimur Wildlife Sanctuary is the largest sanctuary in the state near Bhabhua in the Kaimur Range. Several waterfalls like Karkat Waterfall and Telhar Waterfall and lakes, including Anupam Lake can be developed as recreational and adventure tourism spot. It will attract lots of tourists as it is very near to the Bihar-Uttar Pradesh border. Migratory birds from Central Asia increase their beauty in winter. Waterfalls near Sasaram - Manjhar Kund and Dhuan Kund - are a pair of waterfalls utilized as a hydroelectricity source. Locals gather here on Raksha Bandhan but the rest of the time people fear visiting here due to its isolation and robbery. Therefore, the government has to provide more security and develop them as recreational and adventure tourist spots.

7. **Jamui cluster:** The Nagi Dam and Nakti Dam are two sanctuaries close to each other surrounded by rocky hillocks, formed by the damming of streams. It is the smallest bird sanctuary near Jhajha in Jamui District where bird watchers can identify a large variety of migratory birds. The dry moist and sal forest, mixed deciduous and thorn forest, animals and many species of terrestrial and aquatic birds present an ideal spot for eco-tourism. Kedia, the state's first 'organic' village, has made its name on the organic farming map of India and become a role model for its water conservation and management practices. Half the families in this village have switched to organic farming. NGOs, government agencies and officials from other districts have been visiting Kedia to learn about organic farming.

8. East and West Champaran cluster: East and West Champaran, nestled in the foothills of the Himalayas in the northwest of Bihar, is a fascinating tourist destination famed for its history, captivating landscapes and spiritual sites. From the historical significance of Lauria Areraj (an archaeological site), largest Buddhist Stupa located in Kesariya, Gandhi Ashram and Sangrahalaya, Bhitiharwa Ashram and Bettiah Fort to the serene beauty of Valmiki National Park, Udaipur Wildlife Sanctuary, SaraiyanMan Lake, Moti Lake and the Bank of Triveni (Rivers Gandak, Panchanand, and Sonaha), East and West Champaran is hidden gem waiting to be explored and has something for every tourist. A unique expanse of 26 hamlets and villages embedded in the Done area, forests of local tribes attract many tourists. East Champaran is known for its folk songs, Chhath Puja, Jhumari dance and a variety of cuisines. Tourists can plan a visit to East and West Champaran around the festive times of Makar Sankranti, Holi and Durga Puja, which are celebrated with much faith and enthusiasm.

Advantages of Rural Tourism in Bihar

There are certain advantages of the development of rural tourism in Bihar:

- Self-employment, women empowerment and increase in per capita income and foreign exchange.
- Regeneration of the region by increasing organic and non-organic production.
- Boosting small-scale industries, household industries and the service sector and expanding the complementary business and new business opportunities.
- Stop migration and concretization of green land (which will help groundwater recharge).
- Development of infrastructure, hospitality sector, education, healthcare, marketing, technological development and other facilities.
- Development of new skills and increase in social bonding, self-esteem, moral and knowledge.
- Preservation of local culture and tradition, heritage, environment, water bodies, green areas, wildlife, etc. (Sustainable Development)
- Increase in sales of arts and crafts, local cuisine, fruits, handloom and agricultural products.
- Feeling of well-being by tourists.

Disadvantages of Tourism

1. Environmental damages – accumulation of waste, disturbing the animals of sanctuaries, damages the vegetation, degradation of soil, water pollution, etc.
2. Structural damages
3. Cultural clash – Tourists may lack respect and that is not good for the locals.
4. Seasonal job creation and unequal development

Issues and challenges in the development of rural tourism in Bihar according to respondents

According to respondents, the major issues and challenges in the development of rural tourism in the state are:

1. Lack of financial support, education, good infrastructure, advanced market, refreshment facilities, hygiene and sanitation.
2. Lack of adventure and sports facilities, hospitality or accommodation with internet facilities, privacy, safety and friendly people.
3. Lack of skilled workers, accessibility and local transport problems, clean potable water and 24*7 electricity, ATM and credit card facilities.
4. Attitudinal behavior of locals, local problems and Business hurdles (Govt. regulations and shifting visa rules).
5. Slow pace of decision-making by Government, lack of futuristic vision and corruption and indifferent attitude of government and administration.
6. Lack of local involvement, trained tourist guide, proper communication and business skills.
7. Language problem and convincing of rural masses about the benefits of eco and rural tourism.
8. Inadequate marketing of tourism products and publicity amongst locals and security.
9. Stiff competition from other states like Maharashtra, Kerala, Rajasthan etc.
10. Environment concern, congestion/ crowd.
11. Low salaries, recruitment and non-availability of guides at reasonable prices.

There are many problems in the development of rural tourism in Bihar. The government is trying to increase its economy by bringing foreign exchange through the tourism sector. The major challenge is sustaining the local environment while developing the place for tourism and

providing better infrastructures to the tourists at the same time. The government has to promote Bihar's rural tourism in a good way in front of the country just like the Kutch Rann of Gujarat was done.

Suggestions by Respondents

The government can encourage rural tourism by starting it on a pilot project basis. These following ideas from respondents can be helpful:

1. Select those villages that have at least 3-4 combinations of farm tourism, eco-tourism, green/wilderness tourism, heritage tourism, cultural tourism or forest tourism.
2. Training of local women and youth. It needs trained personnel and a willing and enthusiastic workforce at every level.
3. Establish good hospitality centres with efficient communication, free internet services, good amenities, reasonable charging and transport facilities along with cleanliness, hygiene and tasty food and courteous staff.
4. Help centre with online booking and guide facility.
5. Local touring, cultural activities, water sports, yoga, aerial activities, village sports, hallmark events, hiking, horse or bullock cart riding, and adventurous activities will attract tourists.
6. Guided tours with special packages to ruins, forts, stupas, sanctuaries, archaeological sites, arts & cultural events etc. can attract more domestic and foreign tourists.
7. Tourist-friendly rules and regulations, good infrastructure and positive media coverage.
8. There is a need to unload luggage faster and transit people through immigration and customs lines more easily at airports and warm welcome on arrival.
9. The tourism sector has to work with other sectors and the airline industry to change attitudes and be less mercenary and more flexible.
10. The tourism industry has to protect tourists and lower the incidents of fraud and cybercrime.
11. Availability of financial capital to develop tourist attractions.
12. Marketing strategies and promotional programmes.
13. Enhancing and distributing the economic benefits of tourism.
14. Environmental protection - Destruction of Habitat and poaching should be stopped which are leading to the depletion of wildlife and forest.

Apart from the development of new tourist sites, it is essential to strengthen and enhance the existing tourist circuits. The tourism sector needs to turn part-time jobs into careers. The innovation in tourist sites and attractively packaged tours could unleash a new era in the tourism sector of the state.

Conclusion

The rich heritage of Bihar has provided world-class tourism resources, both natural as well as manmade, which include picturesque landscapes, wildlife sanctuaries and national parks, hot springs, cultural heritage sites and unique Mithila paintings. Many Buddhist and non-Buddhist destinations are world-famous and people visit every year. Apart from them, Bihar has many other ancient heritage sites, historical places, religious places, archaeological sites and forts which can be suitably renovated and opened up for tourism. There are also many eco-tourist places and thermal sites like Valmiki Nagar, Ghora Katora, Munger, Rajgir, Kaimur, Sasaram, etc. where people enjoy nature and its wonders. Bihar has enormous potential for the upgradation of existing tourist places and the development of rural tourism.

Villages in Bihar are dotted with luxuriant greenery. They can be developed under rural tourism where local delicacies, green environment, village games, ayurvedic treatment, local festivals, homestays, folk culture and rituals can attract tourists who are in search of peace, serenity, culture and lifestyle of village life where they can disconnect and rejuvenate with a real digital detox. Bihar as an agricultural state has huge potential for village tourism like Kerala and Rajasthan because many foreign tourists visit India to see the life in villages. Various fairs and festivals, dances, folk songs and arts, the food and cultural festivals exhibiting culinary delights and ethnic traditions can be properly marketed to give a major boost to rural tourism in the state.

But, the tourism potential of the state remains under-utilized. The lack of tourism infrastructure, security and safety measures for tourists affects the perception and tourism potential of the state which directly and indirectly curbs the growth of tourists. Therefore, there is a need to develop its strength as a major religious destination, promote the Buddhist circuit, leverage its rich cultural history and its strength in yoga to develop well-being centres and harness the huge potential of promoting rural tourism revolving around its rich tradition of art, craft and handloom to attract international and domestic tourists. Tourism has to provide 'surety', the interaction between security and safety, better infrastructure and good hospitality. The private sector and public sector will need to learn to interact and work not only with each other but with the media, local people and marketers. Rural tourism requires good and innovative marketing along with inspired and well-trained people to make people aware. Therefore, people and the government have to work together to increase the economy and employment in the state by developing the rural tourism sector.

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SUSTAINABLE AGRICULTURE IN THE CHANGING CLIMATE: WOMEN FARMERS AT THE FOREFRONT IN BIHAR

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ABSTRACT

Agriculture is the most important sector of Bihar's economy where women play a very important role right from seed to food in the kitchen. However, their participation is not recognized either by society or by the Government. Apart from the common problems like female land rights, institutional support, gender discrimination, credit facilities, etc., the women in Bihar face exclusive problems like large-scale male out migration due to non-profitable agricultural practices and unfavourable climate change in recent years(dbtagriculture.bihar.gov.in). Therefore, the women who have been taking care of their farms on behalf of male members for ages, are now confronting dual challenges-livelihood sustainability and adaption to climate change in the farming sector. Thus, the present work aims to show that the local knowledge of women is valuable and useful for the adaptation of smallholder agriculture to climate change. The objective is to show that women are not only victims of climate change but also part of the solution. In this sense, the paper intends to strengthen the recognition that a gender perspective adds value and important insights to the debate on climate change taking examples from Bihar.

Keywords: climate change, adaptation strategies, women, agriculture, sustainability.

Introduction

Climate change is not just a global threat, but it also poses a significant risk to the Indian state of Bihar, which has a vulnerable population of 2% of the world's total population (Govt. of Bihar, 2015). Erratic rainfall, extreme range temperature, falling groundwater level, drought, and flash floods have all impacted the state's developmental efforts, particularly in the agriculture sector. Agriculture is the most important economic sector in Bihar and employs millions of its population, which is sensitive to climate and dependent on it for their livelihood. The people of Bihar are highly vulnerable to the impacts of climate change, such as crop failure, debts, and forced rural-to-urban migration, leading to significant loss of farming lands and household responsibilities left behind for women (DST, 2019-20). The feminization of the agriculture sector is becoming more apparent in Bihar due to increasing rural-to-urban migration by men.

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This trend has led to an increasing number of women taking up multiple roles as cultivators, entrepreneurs, and labourers. Therefore, the women who have been taking care of their farms on behalf of male members for ages, are now confronting dual challenges- livelihood sustainability and adaption to climate change in the farming sector. Overall, this study aims to provide a comprehensive understanding of the impact of climate change on the agricultural sector of Bihar and the coping mechanisms employed by women in agriculture to mitigate its effects. The insights gained from this study will help inform policymakers and stakeholders in developing effective strategies to enhance the resilience of the agriculture sector in Bihar, particularly for women farmers.

Objective of the Study

The impact of climate change on Bihar's agricultural sector is a critical issue that needs urgent attention. Thus, this paper aims to closely observe the effects of climate change on agriculture in Bihar and understand the strategies women adopt to cope with these challenges. This study will shed light on the resilience and adaptability of women farmers in the face of changing climate conditions and the strategies they adopt to manage and mitigate the risks posed by climate change.

Methodology

Data Collection and Analysis: Reputable sources, including the India Meteorological Department (IMD) and other pertinent government databases, were used to gather historical meteorological data, with an emphasis on temperature and rainfall. The data, which covers several decades, offers a thorough picture of the region's long-term patterns in climatic variability. Utilising statistical methods, the gathered data was examined to find patterns and trends in the amount of rainfall and temperature over time. Temperature variations and seasonal and yearly rainfall variations were tracked using time-series analysis. To map and visualize the geographical distribution of these climate changes throughout the various districts of Bihar, Geographic Information System (GIS) techniques were also used.

Survey Design and Sample Selection: To track how climate change is affecting Bihar's agriculture, primary data is gathered through surveys, interviews, and case studies. To comprehend the wider effects of climate change on rural livelihoods, information on farm revenues, household food security, and resource accessibility was gathered in addition to crop yields and agricultural techniques.

Case Studies: Comprehensive case studies of different districts of Bihar were done to offer qualitative insights into the particular difficulties that farmers are facing as a result of climate change. Direct inspections of farming operations nearby city of Patna, casual farmer interviews, and the gathering of secondary data from literary sources including farm records and local climatic histories were all part of the case studies.

Focus Group Discussions (FGDs) : To learn more about the experiences and coping mechanisms of women farmers in various parts of Bihar in response to climate change, focus groups were arranged.



Figure 1 : Focus Group Discussion

Literature Review

Several studies have demonstrated that women play a crucial role in the agricultural sector, especially in developing countries like India, where they actively participate in all aspects of agricultural production, from planting to post-harvest activities (FAO, 2011). Nevertheless, the significant contributions of women in agriculture are frequently obscured by traditional gender roles that emphasize male involvement and decision-making, ultimately resulting in pervasive gender disparities (Agarwal, 2018). The migration of male workers to urban areas due to the unsustainability of small-scale farming has resulted in a feminization of agriculture, where women increasingly occupy roles traditionally held by men. However, this change has not been accompanied by equal access to resources or decision-making power. Women still confront substantial obstacles, including a lack of land ownership, limited credit access, and inadequate institutional backing (UN Women, 2020; Ghosh & Ghosh, 2022). Furthermore, female farmers frequently lack access to formal education and extension programs, which can contribute to their marginalization in the adoption of contemporary, climate-adaptive agricultural techniques (Singh et al., 2021). Research has indicated that gender disparities already exist, and that climate change makes them worse since women have less access to resources that may help them adjust to changing climatic circumstances (Mehtar et al., 2016). Rising temperatures, more frequent extreme weather events, and irregular rainfall in Bihar have put an additional burden on the agricultural sector, resulting in lower crop yields and greater food insecurity (Kumar et al., 2019). It has been acknowledged that women's traditional

knowledge and familiarity with the area are essential resources for climate change adaptation. Techniques for managing water, conserving soil, and diversifying crops are among the information that is frequently passed down through the generations (Shukla et al., 2020). Adopting sustainable techniques like organic farming, which lessens reliance on chemical inputs, and the System of Rice Intensification (SRI), which uses less water and seeds, has been spearheaded by women in Bihar (Singh et al., 2021).

Study area

Bihar is a state in eastern India. It is the third largest state by population, the 12th largest by area, and the 14th largest by GDP in 2021. Bihar borders Uttar Pradesh to its west, Nepal to the north, the northern part of West Bengal to the east, and Jharkhand to the south. The Bihar plain is split by the river Ganges, which flows from west to east. Bihar covers a total area of 94,163 km² (36,357 sq mi), with an average elevation above sea level of 173 feet (53 m).

Furthermore, the vast stretch of fertile Bihar Plain is divided by the Ganges River into two unequal parts –North Bihar and South Bihar. At the 2011 Census, Bihar was the third most populous state of India with a total population of 104,099,452. It was also India's most densely populated state, with 1,106 persons per square kilometer. The sex ratio was 1090 females per 1000 males in the year 2020. Bihar has had an urbanisation rate of 20%. Bihar has an adult literacy rate of 68.15% (78.5% for males and 57.8% for females) in 2020.



Figure 2 : State of Bihar, its location, and neighbouring states.

Source: <https://images.app.goo.gl>.

Status of Agriculture in Bihar

With a total land area of 93.60 lakh hectares, Bihar is home to 82.9 million people, translating to a population density of 880 people per square kilometre (Census 2001). The State's net sown area is 56.03 lakh hectares, compared to the gross sown area of 79.46 lakh hectares. In the State, there are around 1.04 crore land holdings, of which approximately 83% are marginal holdings that are less than one hectare (Table 1). Since over 90% of people live in rural regions, agriculture—which is the main driver of the rural economy—continues to function on the edges of both human enterprise and available land, with some of the lowest production levels in the nation. (Department of Agriculture, Gov. of Bihar)

Table 1 : Distribution of Holdings by Size Class in Bihar

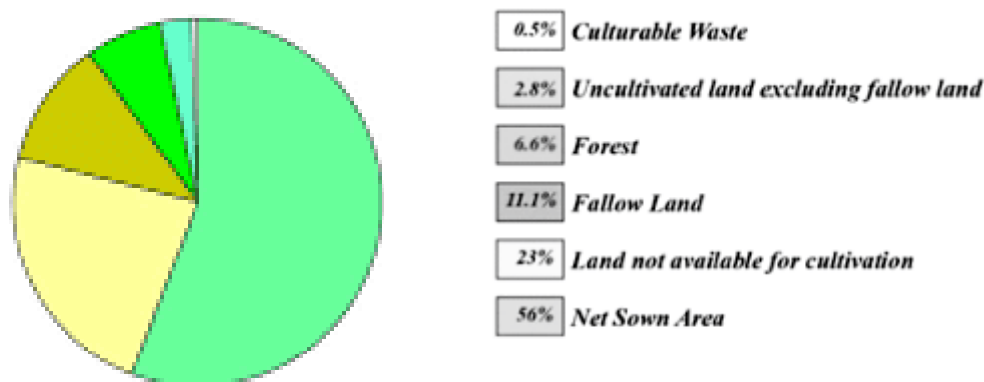
Categories of farmers	No. of holdings	Operational holdings. (in ha.)
Marginal (0-1)	86,45,932 (82.9%)	27,87,789 (40.8%)
Small (1-2 Ha.)	10,05,650 (9.6%)	13,00,667 (19.0%)
Semi medium (2-4 Ha.)	5,90,970 (5.7%)	15,82,279 (23.1%)
Medium (4-10 Ha.)	1,78,295 (1.7%)	9,75,355 (14.3%)
Large (10-above Ha.)	11,570 (0.1%)	1,93,760 (2.8%)
Total	1,04,32,417 (100%)	68,39,850 (100%)

Source : *Agricultural Census Division, Ministry of Agriculture, New Delhi.*

With its fertile land, abandoned water resources, and hard-working populace, Bihar has great potential to spearhead the nation's second green revolution. The state's economy is dominated by agriculture and related sectors, employing between 82 and 85% of the population who live in rural areas. Agriculture and animal husbandry are the primary sources of income for these people. Even though the state is now self-sufficient in producing food grains and pulses, Bihar's productivity in other crops is significantly lower than the national average.

Apart from agriculture, dairying is becoming one of the most significant industries in Bihar. Bihar has an abundance of water resources that may be used for inland fishing. Approximately 4.6 billion families in the state fish, and this industry has been expanding quickly. The next largest area in Bihar is approximately 57.6%, with a cropping intensity of 1.42. There is a significant amount of variance in the land use pattern between districts. This is because various districts are located in various agro climatic zones. Farmers in Bihar can grow a wide range of crops due to the fertile land and plentiful groundwater supplies. Apart from cereals and pulses

farmers in Bihar also produce oil seeds fiber fruits and vegetables for of late the farmers I have taken to floriculture because of the growing demand for flowers both from within and outside the state.



The Land Utilization in Bihar (2017-18)

Figure 3 : Shows land utilisation in Bihar.

Agriculture and Climate in Bihar

Bihar's agriculture is heavily reliant on the monsoon. Even though irrigation accounts for around 57% of the country's total farmed land, irrigation itself is heavily reliant on the monsoon since it uses a lot of surface water. Bihar has been divided into three agro-climatic zones: North-West Alluvial Plane (Zone 1), North-East Alluvial Plane (Zone 2), and South Alluvial Plane (Zone 3). The latter zone is further divided into two sub-zones, 3A and 3B, based on the soil quality and climate of the relevant areas (Table 2). Of the three zones, northeastern Zone 2 experiences the earliest arrival of monsoon and the biggest amount of rainfall. Out of the three zones, Zone 3 experiences the least quantity of monsoon rainfall and arrives last. Nearly thirty percent of the State's 45.67 lakh hectares of irrigated land are supplied by canal water. Given that the catchment regions of almost all of the state's major rivers are located outside of it, this emphasizes how dependent even irrigated lands are on the monsoon.

Unpredictable rainfall in recent years has hurt agriculture production. common floods and droughts have a significant negative impact on farm output. As a result of climate change, extreme weather events have become more common, which tends to damage the potential production of various crops. In the state, about 50% of the cultivated area is still rainforest.

Table 2 : Shows Agroclimatic zones and their important characteristics.

Agroclimatic Zones	Districts	soil	Main crops
Agroclimatic Zones-I	East Champaran, West Champaran, Motihari, Gopalganj, Siwan, Vaishali, Sheohar, Mujjafarpur, Samastipur, Sitamarhi, Madhubani, Darbhanga.	Medium acidic, heavy textured, sandy loam to clay.	Rice, Wheat, Maize, Arhar.
Agroclimatic Zones-II	Purnea, Katihar, Saharsa, Madhepura, Araria, Kishanganj, Saupal, Khagria, Begusarai	Light to medium textured, slightly acidic, sandy to silty loam.	Maize, mustard, Sugarcane, Jute.
Agroclimatic Zones-III	Patna, Gaya, Buxar, Jehanabad, Nawada, Nalanda, Rohtas, Bhojpur, Aurangabad, Kaimur, Banka, Munger, Jamui, Lakhisrai, Seikhpura, Bagalpur.	Old alluvial to sandy loam.	Rice, Gram, Wheat.



Figure 4: Agroclimatic Zones of Bihar;

Source: dbtagriculture.bihar.gov.in

The general climatic condition and climate change in Bihar

Bihar, located in the eastern part of India, experiences a diverse climate due to its large geographical area. The state's climatic conditions can be broadly classified into four seasons: summer, monsoon, post-monsoon, and winter. Bihar's climate, classified under the Köppen climate classification as Subtropical Monsoon (Cwa), is characterized by mild and dry winters and hot summers.

However, the state faces a multitude of challenges due to extreme weather conditions. The central government has identified 14 districts in Bihar that are particularly vulnerable to such weather events, including Araria, Kishanganj, Purnia, Jamui, Sheohar, Madhepura, East Champaran, Lakhisarai, Siwan, Sitamarhi, Khagaria, Gopalganj, Madhubani, and Buxar. (<https://dst.gov.in/document/reports/national-climate-vulnerability-assessment-report>).



Figure 5 : The general Climate of Bihar.
After DST, Govt. of India.

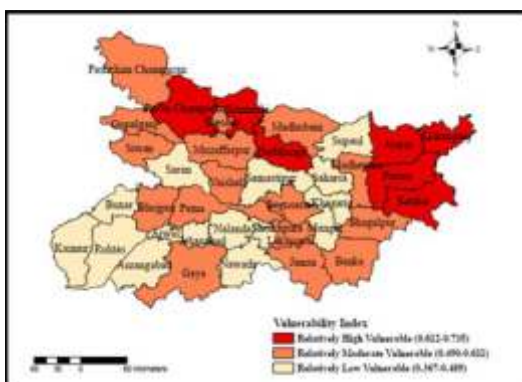


Figure 6: Climatic vulnerability assessment

Climate Change for Temperature in Bihar

Table 3.1 displays trends in the average annual maximum temperature calculated over 30 years (1990-2019) and the average annual temperature (T max) of the most recent 10-year period (2010-2019) over several Bihar stations. (Bihar Agroclimatic Atlas, 2021). For the study, data from ten stations were used, including Bhagalpur, Patna, Gaya, and Rohtas in zone III; at these stations, the average annual T max showed a decreasing trend, except Gaya, which is located in zone III B, where a significantly increasing trend was observed. These stations include Pusa, Muzaffarpur, Chhapra, and Motihari in zone Purina and Supaul in zone II. Of the ten sites, the average annual T max showed markedly declining trends in four of them (Pusa, Muzaffarpur, Chhapra, Supaul, and Rohtas), while Gaya exhibited an increasing trend. Upon comparing the 30-year average with the 10-year average (2009-2019), it was discovered that the current 10-year period across various stations has resulted in a **decline in the annual average t Max of between 0.1 and 1.1 degrees Celsius** annually. On the other hand, South Bihar's Gaya has

seen an annual rise of 0.1 degree Celsius. Figure 7 shows a graphical representation of the average T max fluctuation during the last 10 years as well as 30 years.

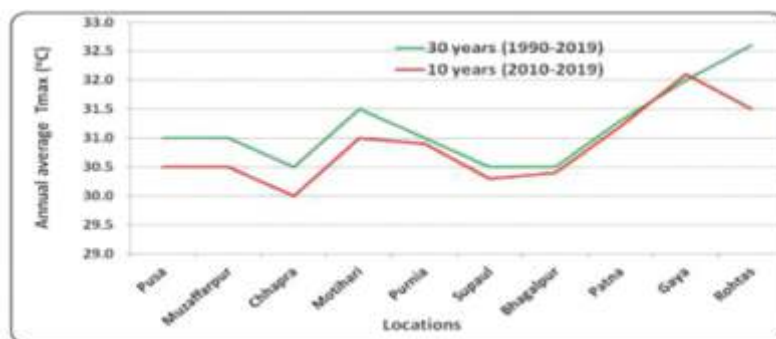


Figure 7 : Variation in annual average T max over 30 years (1990-2019) and 10 years (2010-2019) periods at different locations in Bihar.

Source: Agroclimatic atlas of Bihar, 2021, pg.159.

Except for Purnia and Gaya, where declining tendencies were noted, all stations showed a rising tendency for the average annual minimum temperature (T min). At Muzaffarpur, Supaul, and Patna, the minimum temperature exhibited markedly rising patterns. Regarding the shift in T min during the last ten years, all stations saw an increase of 0.1 to 0.7 degrees Celsius annually. Figure 8 presents a graphic comparison between the average annual minimum temperature for all stations over 30 years and the average obtained over a recent 10-year period. The comparison reveals a significant rise in the annual average minimum temperature in Bihar (Agroclimatic Atlas of Bihar, 2021).

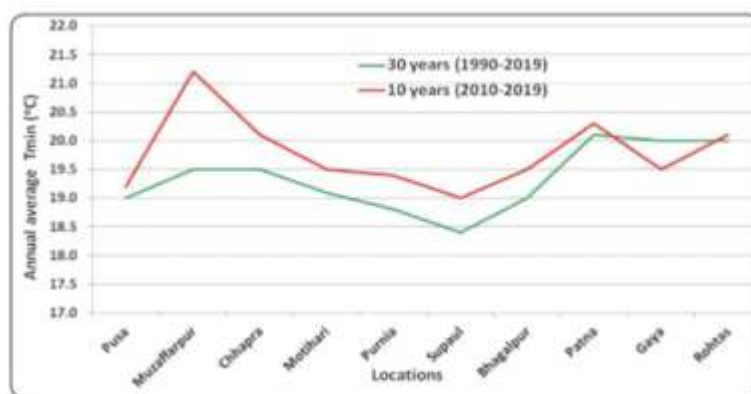


Figure 8 : Variation in annual average T min over 30 years (1990-2019) and 10 years (2010-2019) periods at different locations in Bihar.

Source: Agroclimatic atlas of Bihar, 2021, pg.160.

Climate Change for Annual Rainfall in Bihar

With the exception of Motahari (East Champaran), Supaul, and Patna, all stations exhibit declining trends in annual rainfall. For every site, there has been a noticeable drop in yearly rainfall during the last ten years (figure 9). Figure 9 presents the changes in annual rainfall during the last ten years concerning thirty years of data (1990-2019) for all stations in Bihar. It demonstrates a notable decline in the average annual rainfall at all stations in Bihar during the last ten years. (Bihar Agroclimatic Atlas, 2021).

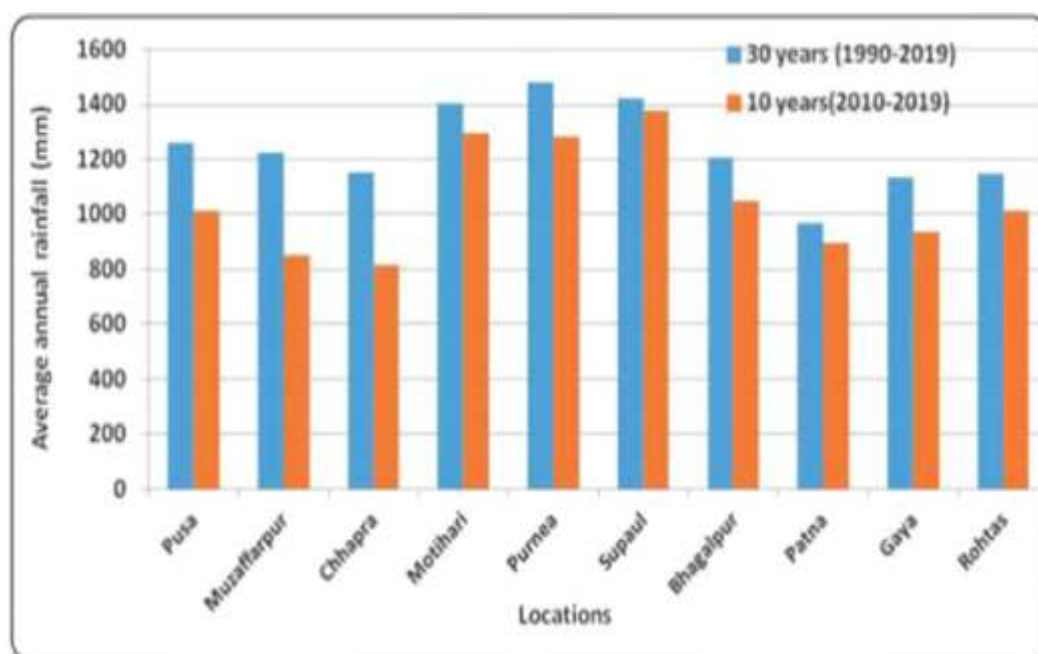


Figure 9 : Variation in annual average annual rainfall over 30 years (1990-2019) and 10 years (2009-2019) periods at different locations in Bihar.

Source: Agroclimatic atlas of Bihar, 2021, pg.160

Flood in Bihar

Over a decade (2010-2020), the northern region of Bihar faced a considerable flood risk, with a significant 73.63% of its geographical area being prone to inundation. The impact of floods varied during this period, affecting a fluctuating number of districts each year, ranging from 9 to 25. This recurrent threat of severe flooding highlights the need for comprehensive flood management strategies and measures to safeguard communities and mitigate the potential damage to lives and livelihoods in the region.



Figure 10 : Flood hazard map of Bihar. Source: Agroclimatic atlas of Bihar, 2021,

Drought conditions

Approximately 33 percent of the state of Bihar experiences an annual rainfall of less than 750 mm, primarily affecting the southern region. This meteorological condition renders the southern part of Bihar particularly susceptible to the harsh impacts of drought. This situation is most pronounced in the districts situated within the Magadha region of the state. Regrettably, these districts have gained a reputation for being inherently prone to drought, given their historical pattern of recurring water scarcity and agricultural challenges. (Kumar, Bhushan, Roy, B. ; 2016).



Figure 11 : Drought-affected areas of Bihar.

Source: Agroclimatic atlas of Bihar, 2021, pg.189.

Climate Change and Its Impact on The Agriculture Sector

The escalating impacts of climate change introduce a cascade of both direct and indirect consequences that significantly impact crop production and food security, particularly in economies heavily reliant on agriculture, such as Bihar. The northern region of Bihar, encompassing a substantial 56 percent of the state's area, is particularly susceptible to various risks, with approximately one-third of this area enduring annual floods. Throughout 1998 to 2019, the state has borne the brunt of 10 high-intensity floods (in 1998, 2004, 2007, 2008, 2012, 2013, 2016, 2017, 2018, and 2019), inflicting substantial damage upon the overall economy and hampering developmental progress. (Sinha, et.al 2021)

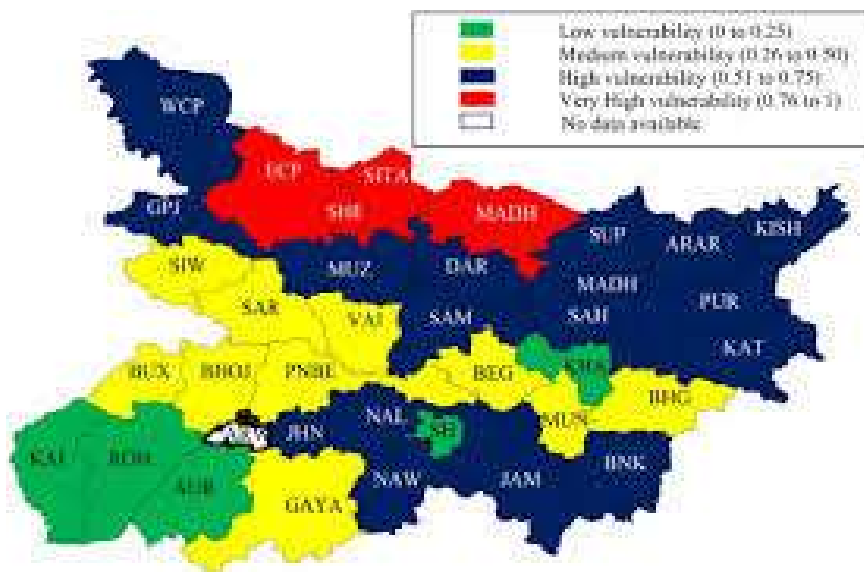


Figure 12 : Vulnerability of agriculture to climate change in Bihar.

Source: Sinha, et.al 2021

Likewise, a concerning scenario unfolds across Bihar as nearly 19 to 21 districts consistently grapple with agricultural drought on an annual basis. This distressing situation is exacerbated by the fact that five of these districts are categorized as severely drought-affected areas, as highlighted in a 2021 report from the Indian Council of Agricultural Research (ICAR). This prevailing vulnerability to hydro-meteorological natural disasters has plunged many communities into tragic conditions.

As a direct consequence, a significant number of labourers have been compelled to migrate beyond the state's borders, largely due to the uncertainties surrounding employment opportunities within agricultural activities. This migration trend underscores the critical socio-

economic repercussions that arise from the intertwined factors of climate-induced challenges, environmental volatility, and the resultant disruptions to traditional livelihoods.

Agriculture and The Role of Women In Bihar

According to the Economic Survey of 2017-18, the dynamics of rural-to-urban migration by men in Bihar have led to a transformative shift in the agricultural landscape, resulting in the 'feminization' of the agriculture sector. This phenomenon is characterized by a notable rise in the number of women taking on diverse roles as cultivators, entrepreneurs, and labourers within the sector. However, despite this increasing engagement, the disparity in land ownership remains stark, with women holding a mere 13.31% of the land as opposed to 87.27% by men in Bihar.(Agarwal, B.,2018).

Table 3 : Share of agricultural workers in the total workforce

Year	Particulars	Workforce (lakh)	Agricultural workforce (lakh)	Gender-wise participation in total workforce(in %)	Participation of the agricultural workforce inthe total workforce (%)
2001.	total	279.74	134.22	100.00	47.98
	female	74.91	46.87	26.87	16.57
	male	204.83	128.16	73.22	45.18
2011	total	347.25	95.37	100.00	27.46
	Female	95.28	21.64	27.44	6.23
	male	252.22	73.73	72.56	21.23

Source: Bihar census Table 2001 & 2011

The Census of 2011 reveals that women constitute a significant proportion of the agricultural workforce, accounting for 27.44%of the total. Their involvement extends beyond the core agricultural activities and encompasses a range of allied sectors such as cattle management, dairying, beekeeping, goat rearing, mushroom production, and poultry farming. This multifaceted contribution underscores the indispensable role that women play in ensuring the sustainability and prosperity of the agricultural domain. (FAO, 2011)

In the context of Bihar, the situation presents a unique and intricate set of circumstances. With men increasingly migrating to urban centers, women are confronted with the dual responsibility of managing both households and farms. This scenario is further compounded by the challenges posed by recent climate change, which has exerted pressure on agricultural practices and necessitated adaptive strategies (Singh et al., 2021).

Adaption Strategies in Agriculture by Women In Bihar; case studies

Various studies have underscored the challenges faced by women in agriculture, including issues related to female land rights, lack of institutional support, gender-based discrimination, and limited access to credit facilities. (UN Women, 2020; Ghosh & Ghosh, 2022). The impact of climate change further exacerbates these existing challenges, amplifying the vulnerabilities of women whose livelihoods hinge on agricultural activities.

Across Bihar, insightful case studies have shed light on the resilience of women in agriculture, as they employ indigenous knowledge-based adaptive strategies to effectively navigate the complexities of climate change. Notable examples include:

1. **Utilization of Local Seeds and Crops:** In areas like Muzaffarpur in the Vaishali district, (Ganguly et.al, 2014) women farmers have adopted a strategic approach by using locally adapted seeds and crops that can withstand extreme weather conditions such as heat, drought, cold, or flooding, (Ganguly et.al, 2014). This practice ensures that agricultural production remains resilient, even when faced with unpredictable climatic shifts. SHG functions through its regular meetings, disseminates awareness, and works as an institution.

2.



Figure 13 : Feminisation of Agriculture in Bihar.

Source: Google Images.

3. **Diversification of Production:** In Lakhisarai, women have implemented a diversification strategy in their agricultural production. (FAN, 2022) By cultivating a variety of crops instead of relying solely on one or two major crops, they reduce the risk of complete crop loss due to unfavourable weather conditions. This approach safeguards their livelihoods against the uncertainties of climate-induced disruptions.

4. **Traditional Plant-Based Protection:** In Nawada, women have ingeniously incorporated the use of local plants and herbs to protect and treat their crops and animals against pests and diseases (Kumar, 2019). This indigenous knowledge-driven method helps mitigate losses caused by climate-related challenges while utilizing sustainable and eco-friendly practices.



Figure 14 : Women actively engaged in farming activities in Bihar.

Source: field survey.

5. **Adaptive Timing of Planting:** In areas like Katihar and Darbhanga, women farmers have observed the changing rainfall patterns and delayed monsoons, prompting them to adjust their planting and sowing schedules accordingly. (Mohan, 2019). By postponing these activities until rains are more reliable, they minimize the risk of crop failure due to inadequate water availability.



Figure 15 : Women farmers at the field in Darbhanga are adapting to climate change scenarios

Source: timesofindia. indiatimes.com

6. **Agroforestry systems:** The agricultural systems exhibit a high degree of diversification, characterized by strategic employment of crop rotations, mixed cropping practices, and the integration of trees or bushes into the farming landscape. Notably, some regions such

as Vaishali and Samastipur (Pandey, et al 2019) showcase agroforestry systems, further enhancing the multifaceted nature of these practices.

7. **Presence of leguminous crops:** A common thread running through these diverse systems is the prominent presence of leguminous crops, frequently incorporated as essential components of the farming system. These crops, which serve as valuable sources of food, are widely cultivated, contributing to the sustenance of local communities. Notably, regions like Gaya and parts of southern Bihar boast a rich array of local seeds, reflecting the region's agricultural diversity and heritage.
8. **Absence of synthetic fertilizers and biocides:** A remarkable facet of these farming systems is the minimal use or absence of synthetic fertilizers and biocides (Mandal, 2013). This trend, as observed in Purnia, underscores a commitment to sustainable practices that prioritize environmental and ecosystem well-being. Instead, farmers in areas such as Jamui, Nalanda, Samastipur, Vaishali, and Nawada choose to employ organic resources like manure and compost as fertilizers, ensuring the preservation of soil fertility in the long term.



Figure 16 : Use of biofertilizer by women farmers.

Source: vikalpsangam.org

9. **Low external input systems:** It is noteworthy that women play a pivotal role in nurturing and enhancing diversified low external input systems. Low external input (LEI) agriculture is a farming practice that uses minimal external inputs like pesticides, synthetic fertilizers, and fossil fuels, (Ahmad et al, 2018) Their active involvement is driven by the tangible benefits these systems offer, particularly in terms of providing a diverse range of food for their families. Importantly, these systems are not reliant on substantial financial resources, making them accessible and viable options for sustenance and livelihoods.

This indigenous approach to agriculture demonstrates a harmonious relationship with the environment while fulfilling the needs of local communities. The utilization of traditional practices, diverse crops, and organic input shigh lights a commitment to sustainable and resilient farming, a crucial factor in adapting to changing climate conditions. Acknowledging and strengthening these systems can contribute significantly to enhancing food security, preserving agro biodiversity, and empowering women in Bihar's agricultural landscape.

Conclusion

In conclusion, this study emphasizes the indispensable role of women farmers in Bihar, who are navigating the dual challenges of climate change and the feminization of agriculture due to large-scale male out migration. Women are not just passive victims of these changes but are actively contributing to the sustainability of agriculture through innovative and indigenous strategies. Their practices, such as crop diversification, agroforestry, and the use of drought-resistant local seeds, are vital for building resilience in an agricultural sector heavily impacted by unpredictable climate patterns. Despite their significant contributions, women continue to face systemic barriers, including limited land rights, lack of access to formal credit, and insufficient institutional support, which hinder their full potential in leading climate adaptation efforts.

The study emphasizes the need for comprehensive, gender-sensitive policies that acknowledge and promote the role of women in agriculture. Empowering women with better access to resources, training, and decision-making opportunities can significantly enhance Bihar's agricultural resilience. Recognizing women's local knowledge and integrating it into broader climate adaptation strategies will not only support sustainable agriculture but also contribute to improved food security and livelihoods for rural communities in Bihar.

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TEMPORAL CHANGE IN VEGETATION COVER AND ITS IMPACT ON CLIMATE: A CASE STUDY OF MITHILA REGION

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ABSTRACT

Change in the Earth's surface temperature over millions of years is a continuous process. The five-ice ages of the earth give ample proof of the same. But in the recent past, the temperature of earth's surface has changed at a rapid rate in a very short geological time, leading to global warming. The current study tries to evaluate the changing pattern of vegetation in the Mithila Region and its subsequent impact on the climate of the area. The study involves the estimate the temporal changes in Vegetation cover of the Indian portion of the Mithila region (study area) which spreads in the state of Bihar and Jharkhand (Bhusan.S, 2022), using NDVI & EVI of the study area. Two seasons of a year is taken (April & October) for two decades. The result shows that there is no marked change in the vegetation pattern of the study area, though seasonal variation is very well pronounced. The study clearly shows that this region has not contributed much to the greenhouse gases.

Keywords: Temporal change, Green House gases, Ice-age, Geological time, Global Warming, Vegetation Cover.

Introduction

Vegetation of an area has a noticeable impact on the temporal and spatial distribution of climate, hydrology, environment, etc. (Boelman et al., 2003; Ponce-Campos et al., 2013). Climate change mainly temperature and precipitation change and human activities which alters the landscape have been regarded as the two driving factors for vegetation change (Wang et al., 2015; Zheng et al., 2019). As per the IPCC report (Intergovernmental Panel on Climate Change), the global mean surface temperature increased by 0.65 °C to 1.06 °C during 1880–2012 (IPCC, 1999; 2007). The continuous global warming will lead to a great impact on vegetation, thereby affecting earth's system (Gao et al., 2016; Field et al., 2014; Sun et al., 2015). In order to assess how will the vegetation cover change under future global warming scenarios, it is essential to investigate the sensitivity of vegetation cover to climate change. A close association of vegetation cover to temperature and precipitation change has been founded by numerous studies (Fabricante et al., 2009; Ning et al., 2015; Orain et al., 2015; Piao

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et al., 2004; Yu and Hu, 2013). Changing vegetation cover alters the radiative and non-radiative properties of the surface. The result of competing biophysical processes on Earth's surface energy balance varies spatially and seasonally, and can lead to warming or cooling depending on the specific vegetation change and background climate (Duveiller et al., 2018). The spectral reflectance of individual leaves or needles is controlled by a number of factors, the most important of which are absorption by photosynthetic pigments and water. The diffused spectral reflectance caused by internal scattering and peculiar reflectance caused by leaf surface. The shape of the reflectance in visible region ($0.4\ \mu\text{m} - 0.7\ \mu\text{m}$) is based on the composition and concentration of the photosynthetic segments, chlorophyll and the carotenoids. Leaf reflectance in the near infrared region ($0.7\ \mu\text{m} - 1.3\ \mu\text{m}$) is mainly due to the internal structure of the leaf, the number of air spaces and their arrangement. The reflectance in the near infrared and middle infrared ($1.3\ \mu\text{m} - 3\ \mu\text{m}$) are the effect of absorption by leaf water content, and biochemical constituent of leaves. It can be observed that the spectral signature or spectral reflectance curves of dry and deciduous tree leaves are similar in nature and hence the wavelength region of ($1.0\ \mu\text{m} - 2.5\ \mu\text{m}$) electro – magnetic spectrum is more appropriate for estimating canopy biochemistry of forest cover. The reflectance of leaf varies with variation of stress factors like air pollution, the presence of heavy metals, the drought conditions, environmental and physiological factors, the concentration of pigments, water, and chemicals in leaves and maturity of the leaves. Variation in leaf or needle spectral reflectance will also occur from species to species as the spectral reflectance of broad leaf species is different to those of coniferous leaf (Reddy, 2013).

Remote Sensing, GIS and GPS play vital role in mapping of existing forest resource information at a particular period of time. The multi-spectral data obtained from remote sensing satellites like Landsat, IRS, SPOT, IKONOS have been used to study forest features either by visual interpretation or by processing digital data using digital computers (Reddy M. Anji, 2013). In this article, we investigate the change in vegetation across the Mithila region using satellite-derived LST datasets from EOS-Terra and EOS-Aqua Moderate-resolution Imaging Spectro radiometer (MODIS) instruments during the period 2001-2022. Aboard Terra flies a sensor called the Moderate-resolution Imaging Spectro radiometer, that greatly improves scientists' ability to measure plant growth on a global scale. Briefly, MODIS provides moderate spatial resolution (up to 250-meter resolution), while also matching AVHRR's almost-daily global cover and exceeding its spectral resolution. The present study tries to estimate the temporal changes in Vegetation cover with the help of Satellite Image of the Mithila region (study area) which spreads in the state of Bihar and Jharkhand (Bhusan.S 2022). To measure the changes in the vegetation cover NDVI & EVI of the study area are calculated in GIS environment. Two seasons of a year is taken (April & October) for two decades. Satellite Imageries are used to collect the vegetation data and the data is processed in (ARC GIS 10.1).

Study Area

Mithila is a cultural region covering Nepal, Bihar and parts of Jharkhand (Thakur Deepesh Kumar, 2022; Bhushan.S., 2022). The present study only deals with the cultural region within Indian territory, covering the state of Bihar and Jharkhand (Fig. 1).

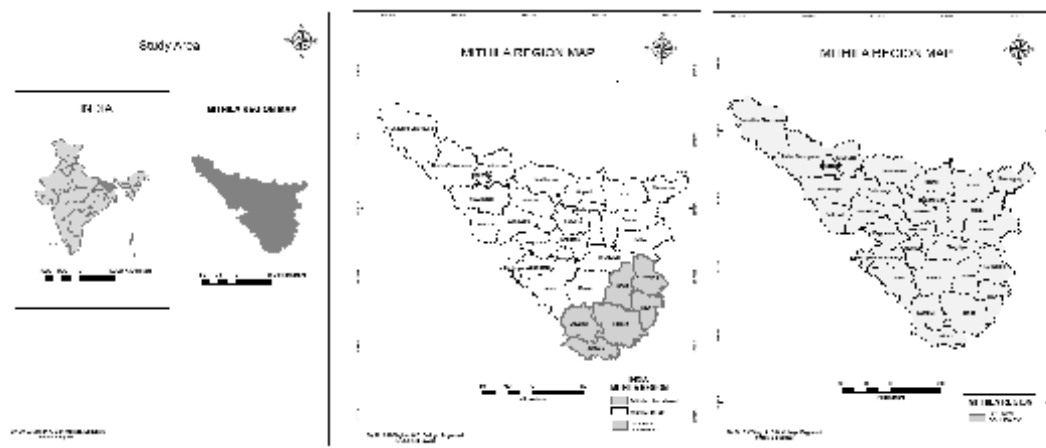


Figure 1 : Study Area

Methodology

MODIS data was used to calculate the Normalized Difference Vegetation Index (NDVI) and Enhanced Vegetation Index (EVI). The data was collected for the month of April and October. Data from October 2001 to April 2022 has been taken with a gap of 10 years interval. The data collected was processed in Arc GIS 10.1 software. The Area of Interest (AOI) from the satellite image was extracted to represent the study area. Interpretation of the map was done by comparing the values of NDVI and EVI for the given months and year.

Normalized Difference Vegetation Index (NDVI)

Nearly all satellite Vegetation Indices employ this difference formula to quantify the density of plant growth on the Earth - near-infrared radiation minus visible radiation divided by near-infrared radiation plus visible radiation. The result of this formula is called the Normalized Difference Vegetation Index (NDVI). Written mathematically, the formula is:

$$NDVI = (NIR - VIS) / (NIR + VIS)$$

Calculations of NDVI for a given pixel always result in a number that ranges from minus one (-1) to plus one (+1); however, no green leaves give a value close to zero. A zero means no vegetation and close to +1 (0.8 - 0.9) indicates the highest possible density of green leaves.

Enhanced Vegetation Index (EVI)

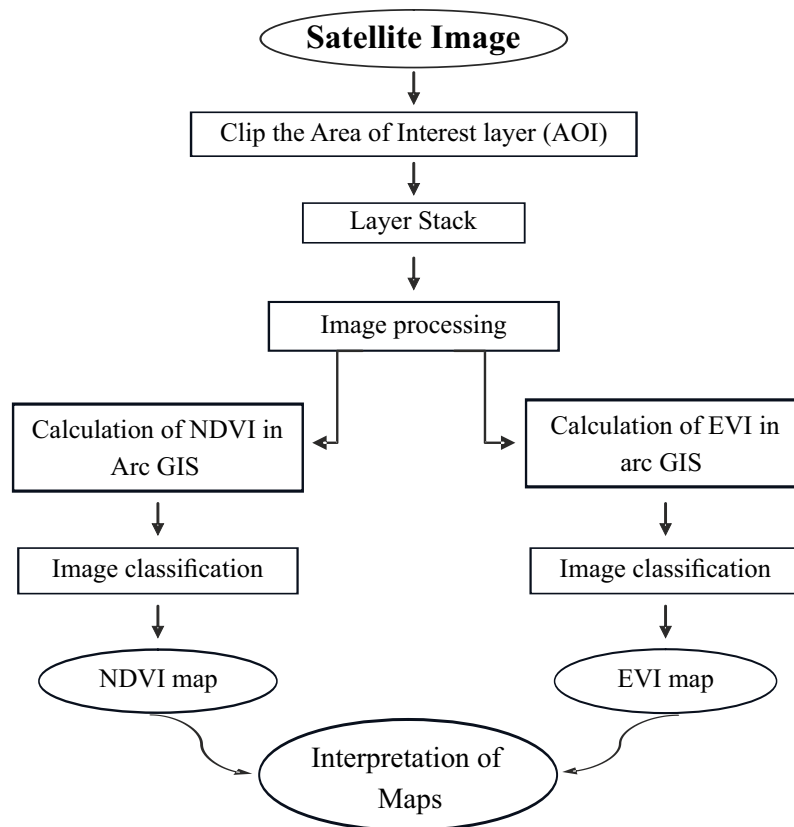
While the EVI is calculated similarly to NDVI, it corrects for some distortions in the reflected light caused by the particles in the air as well as the ground cover below the vegetation.

EVI is similar to Normalized Difference Vegetation Index (NDVI) and can be used to quantify vegetation greenness. However, EVI corrects for some atmospheric conditions and canopy background noise and is more sensitive in areas with dense vegetation. It incorporates an "L" value to adjust for canopy background, "C" values as coefficients for atmospheric resistance, and values from the blue band (B). These enhancements allow for index calculation as a ratio between the R and NIR values, while reducing the background noise, atmospheric noise, and saturation in most cases.

$$\text{EVI} = G * ((\text{NIR} - \text{R}) / (\text{NIR} + \text{C1} * \text{R} - \text{C2} * \text{B} + \text{L}))$$

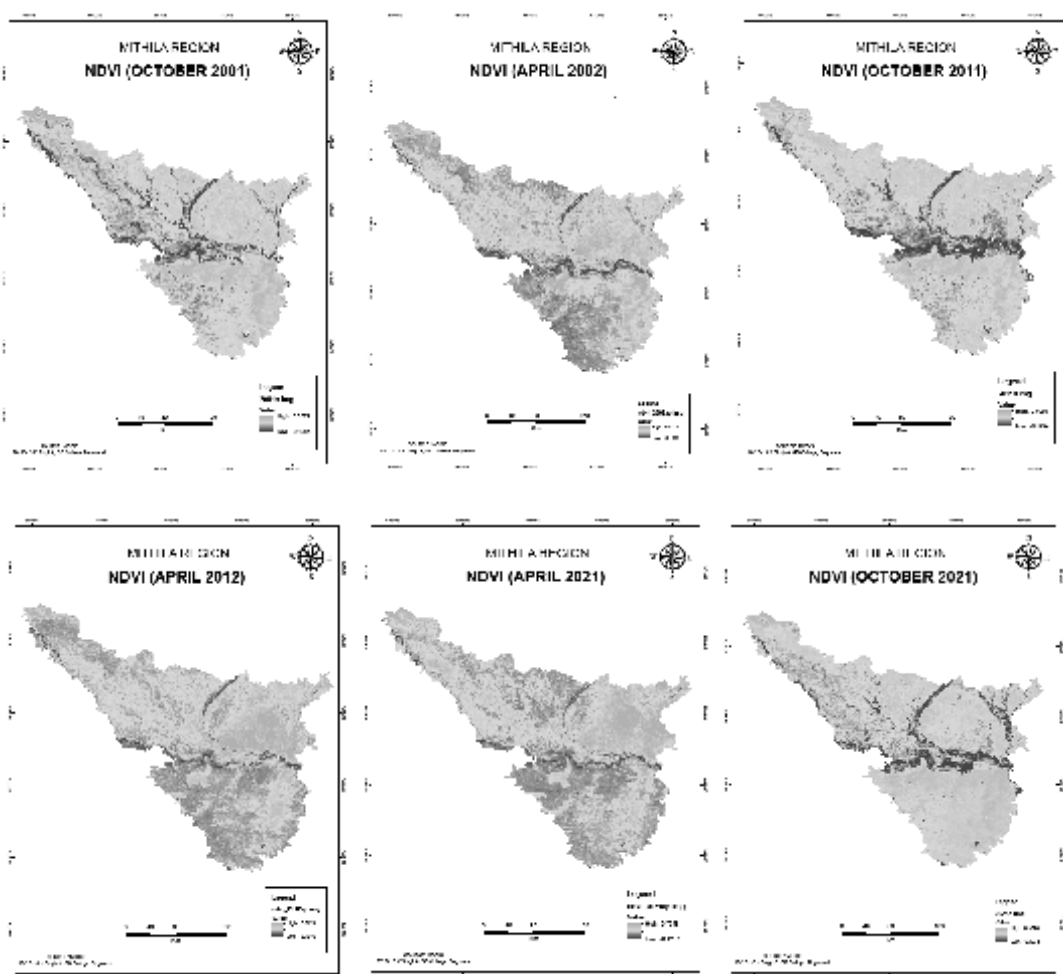
G-The coefficients adopted in the EVI algorithm are, L=1, C1=6, C2=7.5, and G (gain factor)=2.5.

Flow diagram of Methodology



Result & Discussion

Comparison of the NDVI of October and April shows that the NDVI in the month of October is on the higher side, but the concentration of area covered by thick vegetation is higher in the month of April than in the month of October. One important aspect about the Mithila region is that it receives heavy rainfall in the monsoon season (June to September) where as drought condition prevail in the month of April and agriculture is possible only in the area which has irrigation facility. In the month of October large area under water can be seen and this is because in the area under study river at filled with water due to the heavy monsoon rainfall. Comparing the image of October 2001 and 2021 it can be inferred that the area under wetlands have been reduced and the area under crop land has increased (Fig. 2). This indicates a diminishing trend in wetlands in the area.



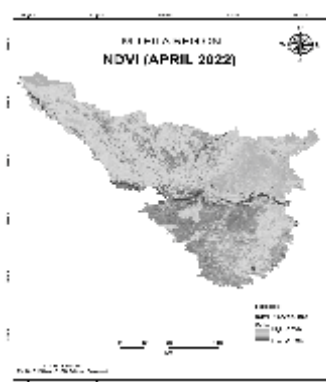


Figure 2 : NDVI Map extracted from the Satellite Image for the month of April (2002, 2012, 2021 & 2022) and October (2001, 2011& 2021)

The NDVI of Mithila region for the month of October in the year 2001 to 2021 shows marked change in the wetland area and the area under wetlands is comparatively well spread in the year 2011 followed by the year 2021. In the year 2001 the amount of water seems to be less indicating a rather less than normal monsoon. When comparing the area under cropped land the map clearly shows vast area under crop in the year 2021 specially in the southern part of the region which mainly comprises the region of Jharkhand and southern Bihar. Comparing the map of 2001 to that of 2011, area under vegetation seems to be less and it might be mainly due to above normal monsoon rainfall, though the inference should be verified with the help of average monsoon precipitation data of the year 2001 and 2011. From the maps of October, no much conclusion can be derived between the year 2001 and 2011 but during the year 2021 marked change in the land use can be inferred and this indicates a rapid increase in the area under cropped land (Fig. 3).

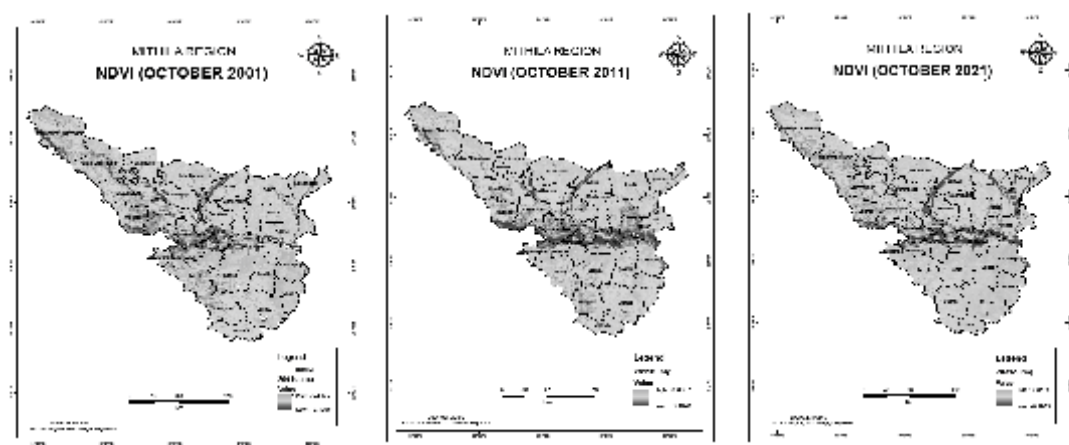


Figure 3 : District wise NDVI Map of October (2001, 2011& 2021)

Comparing the NDVI for the month of April it can be easily inferred that the area under cultivation over the years in the month of April has been diminishing but the intensity of cultivation in some area has been on the rise especially in the Purnia, Katihar and Araria districts of Bihar, while the intensity has decreased in Sahibganj, Pakur and Dumka districts in Jharkhand. This indicates a marked shift in the land use of these areas. No remarkable changes in the land use have been noticed in the area (Fig. 4). But it can be concluded that though the area under vegetation has marked changes in some districts of the region but the area under wetlands shows decline and the land is put to other uses.

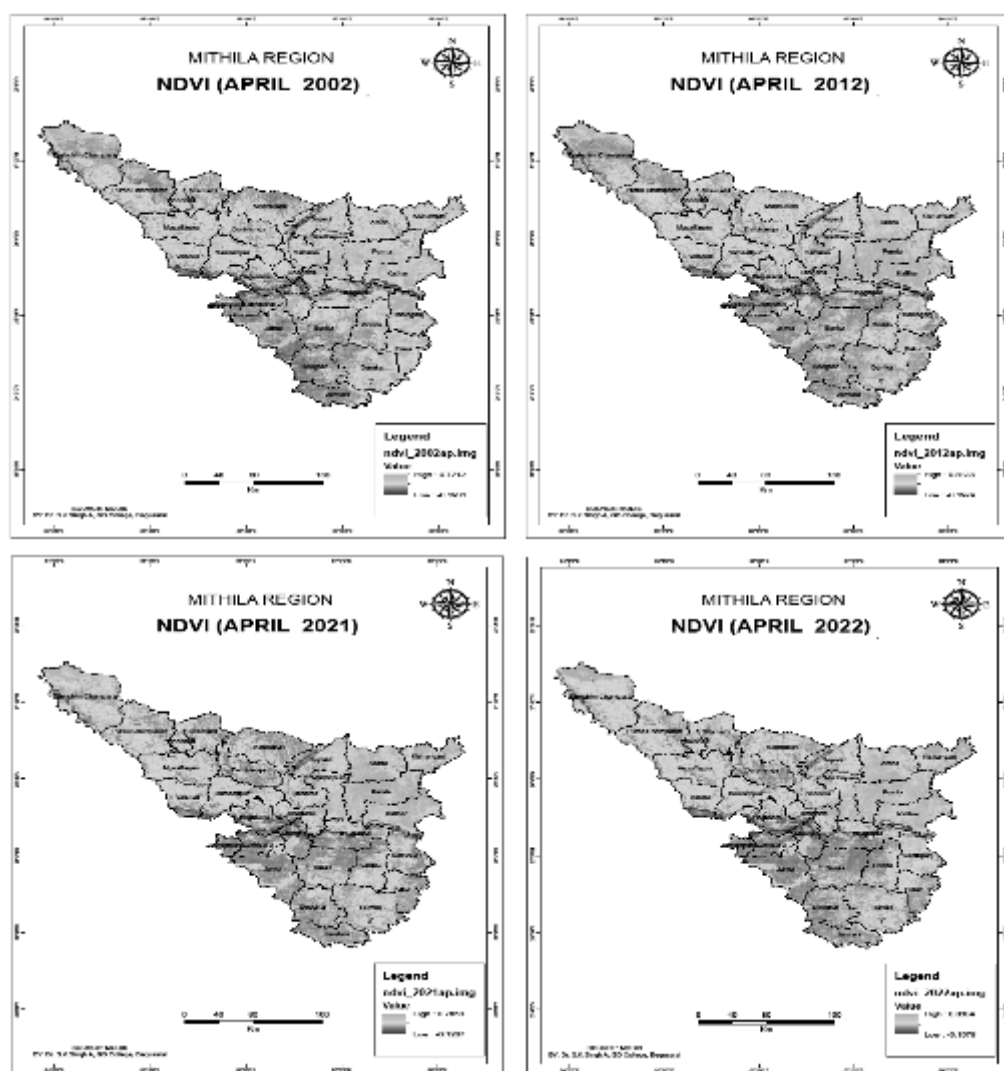


Figure 4 : District wise NDVI Map of April (2002, 2012, 2021 & 2022)

EVI has some advantages over NDVI but the trends shown in the NDVI of the area under investigation is more or less similar. The area under intense cropped land seems to decrease in the month of October from 2001 to 2021 but the area under cropped land seems to increase when compared with that of 2001 and 2021 (Fig. 5). EVI of the study area also suggests a trend in diminishing wetlands and increase in the cropped area.

The EVI for the month of April seems to show the same trend as that of the NDVI, but a clear trend in intensity of cropped area can be seen in Katihar, Purnea and south Madhepura and Paschim Champaran (Fig. 6,7 &8). One of the important changes which is noticed in the EVI image is a rapid increase in the area under vegetation and intensity of vegetation in the Araria and Kishangang districts of Bihar.

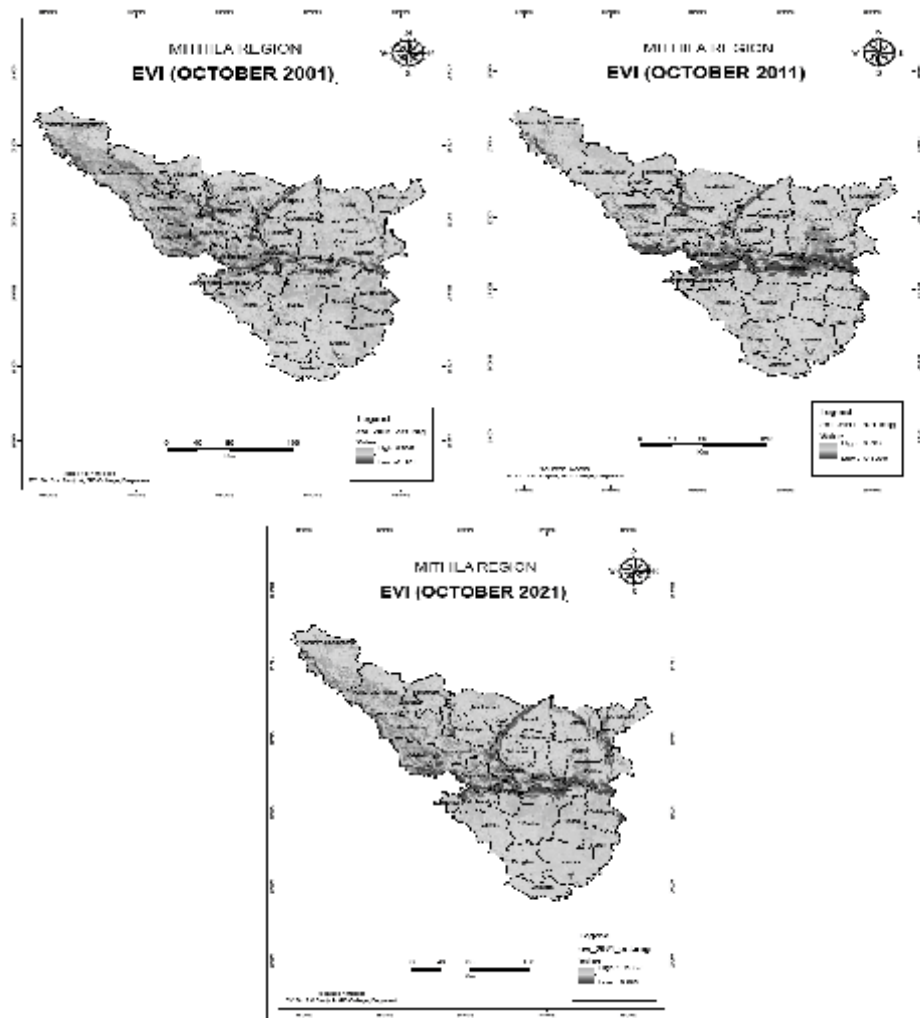


Figure 5 : District wise EVI Map of October (2001,2011 &2021)

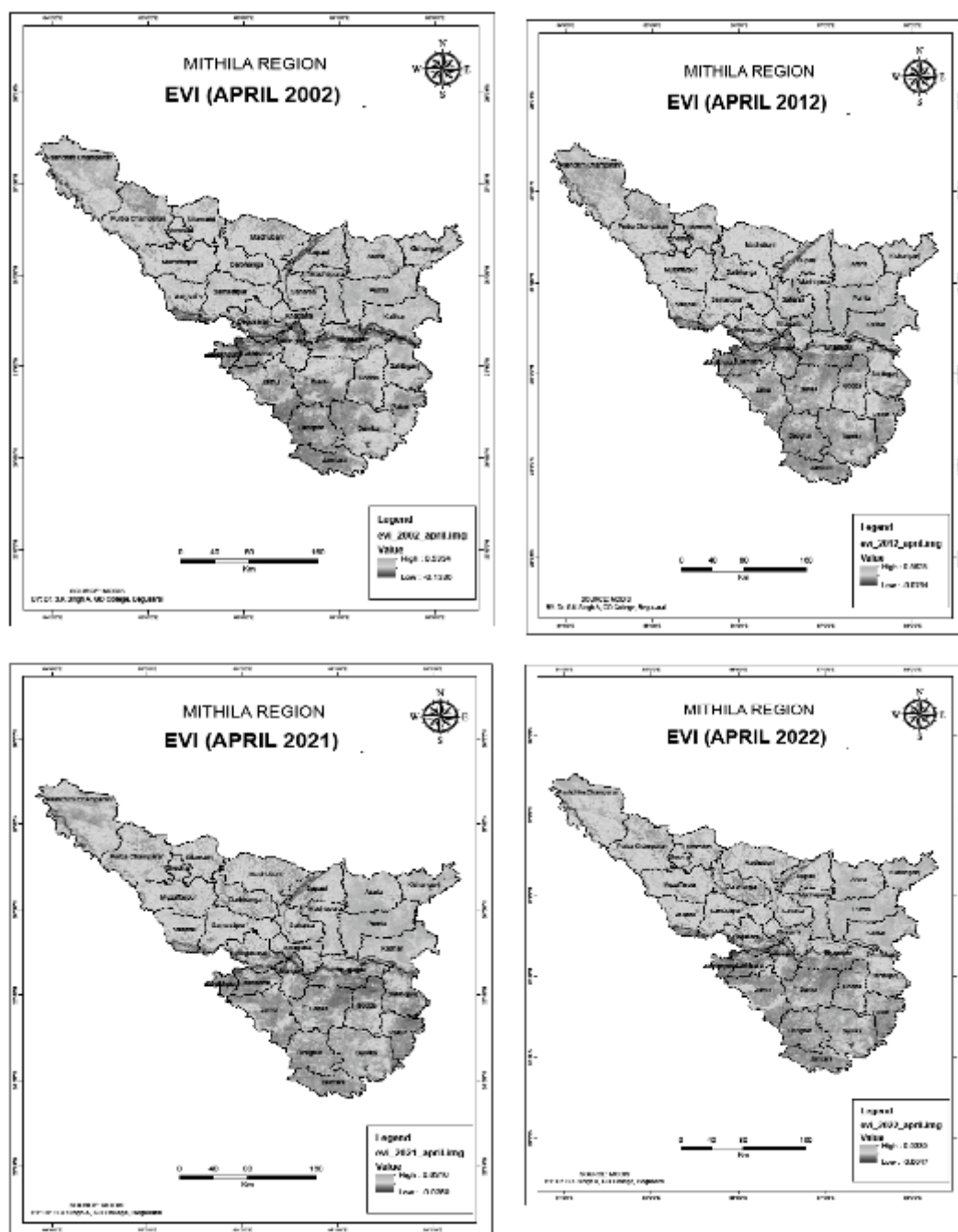


Figure 6 : Map showing district wise EVI of April (2002, 2012, 2021 & 2022)

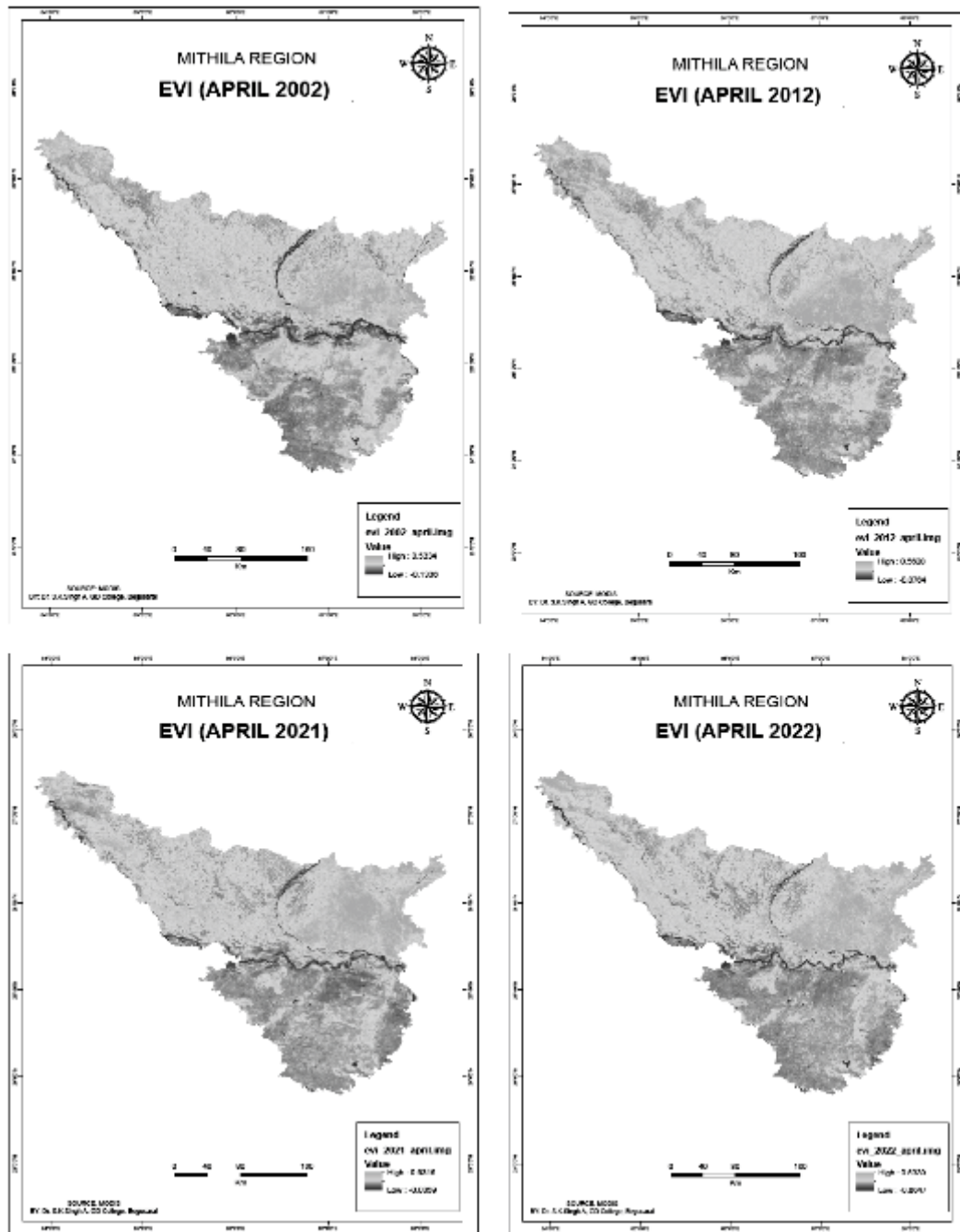


Figure 7 : Generalize EVI map of the study area of April (2002,2012,2021 & 2022)

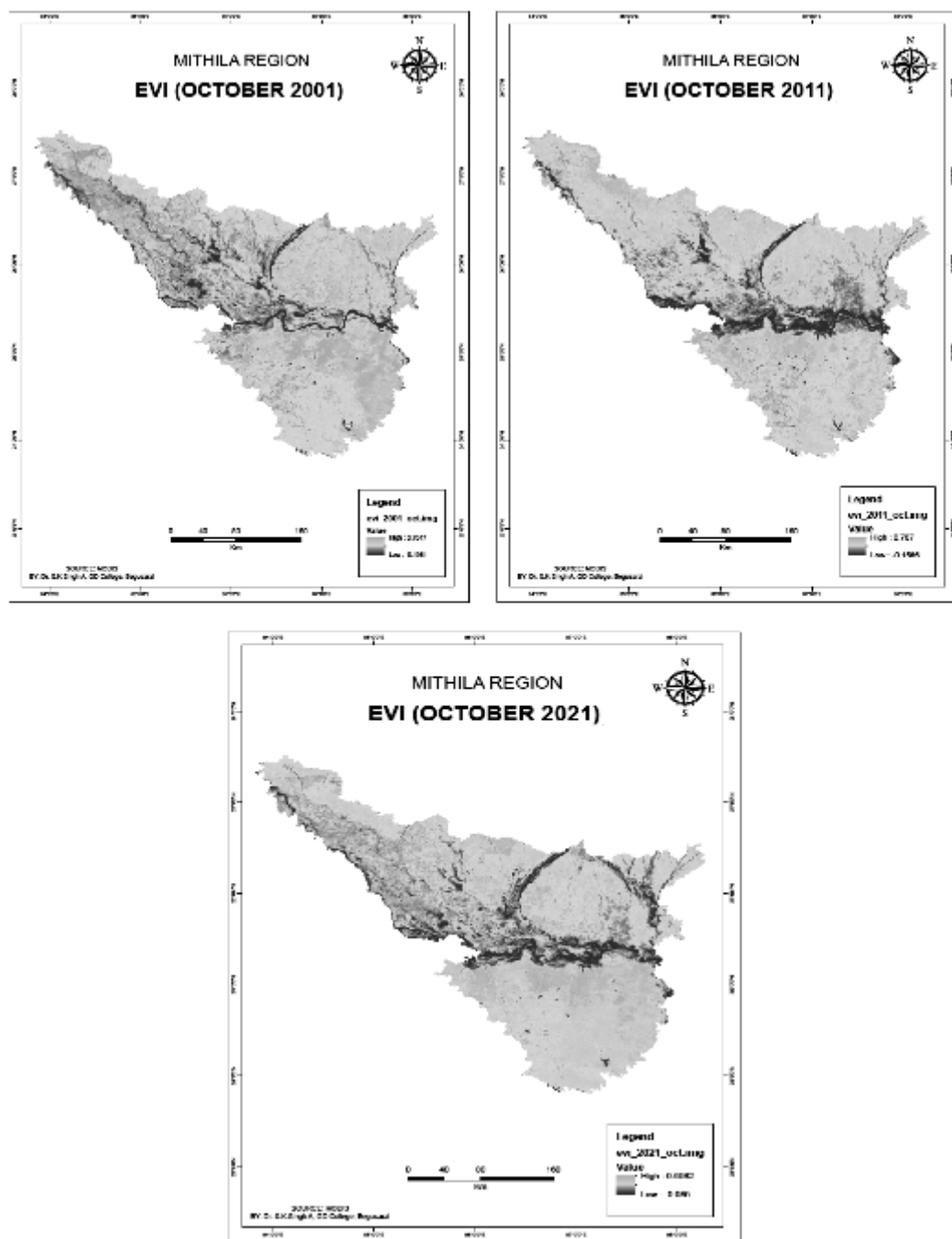


Figure 8 : Generalize EVI map of the study area of October (2001,2011,2021 & 2021)

Conclusion

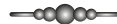
The NDVI and EVI for the months of October and April from 2001 to 2022 show changes in the land use of the study area wherein wetlands are being replaced by cropped land. The NDVI of April 2002 shows thick vegetation in northern part of Paschim Champaran and Sahibganj districts. Some parts of Purnea, southern parts of Madhepura, northern Khagaria, western parts of Munger, Palamu and eastern Dumka districts have thick to moderate vegetation though it is not spread evenly. Other parts of the study area have moderate to light vegetation. In April 2012, the concentration of vegetation increases in Purnea, Katihar and southern Madhepura districts whereas it seems to have diminished in other parts of the study area. In April 2021 and 2022, thick vegetation is seen in Purnea, Katihar, Araria and Kishanganj district. Vegetation in Paschim Champaran does not seem to have major changes. In other parts of the study area vegetation seems to have decreased when compared with previous decade. The NDVI of October 2001 shows thick vegetation in the south eastern part of the study area comprising the districts of Sahibganj, Godda, Palamu, parts of southern Bhagalpur, northern Banka, parts of eastern Dumka, southern Munger, Lakhisarai and western Jamui district. In October 2011, an increase in vegetations is found in East Champaran and Madhubani districts, whereas there is a decline in south eastern part of the study area. In October 2021, overall vegetation has increased in the southern part of the study area where as in other parts it is more or less similar to that of the previous decade. The EVI of the study area shows the same trend as that of the NDVI for all years and seasons. The intensity of agriculture seems to increase in the area under investigation. But not alarming change has been seen in the land use of the Mithila region. Thus, we can safely conclude that the loss in wetlands in the study area is compensated by vegetation which is a result of increase in area as well of intensity of agriculture in the Mithila region. This study only depends on satellite image and no land truth verification has been done. Comparison of data with that of monsoon rainfall has also not been made. This particular research provides opportunities to the budding researchers to validate the inferences of the study and either support or reject the conclusions of this report based only on NDVI and EVI.

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EXPLORING THE TOURISM OPPORTUNITIES SURROUNDING MANSAR WETLAND IN THE UDHAMPUR DISTRICT OF JAMMU : A CASE STUDY OF PEOPLE'S PERCEPTIONS

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ABSTRACT

Tourism is a temporary activity in which individuals visit different locations with the goal of returning after their visit is completed. The major share of Jammu and Kashmir's economy is tourism, and Mansar wetland has the potential to rise as a leading tourist destination, because of its scenic beauty and natural serenity. But despite its natural significance it fails to attract tourists. This paper tries to analyse its reasons and study the existing tourism infrastructure and its socio-economic impact on the local communities. The present study is based on the primary data collected through primary field survey with the help of structured questionnaire. And purposive sampling has been used to collect the data. The majority of tourists are dissatisfied with the existing infrastructure at Mansar Lake, on the other hand the local communities agree that this lake created employment opportunities for them.

Key words: Mansar Wetland, Tourism, Tourist Destination, Infrastructure, Socio-Economic Impact, Employment Opportunities.

Introduction

Tourism, derived from the Greek word "tornos" is a transient activity that ends at its starting point, similar to traveling in circles without reaching anywhere. It is driven by the need for humans to disconnect from work and enjoy valuable time with loved ones. The various reasons for travel may include religious or pilgrimage-related travel, health-related travel, heritage travel, rural travel, business travel, and leisure travel. Media, dramas, and films often influence people to travel to places depicted in media, dramas, and films. The World Travel and Tourism Council's (WTTC-2019) report highlights the importance of tourism in solving a nation's economic issues and enhancing its importance as a national strategy. A tourism nation seeks to

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strengthen its economy through tourism, offering benefits such as regional revitalization, economic growth, and employment generation.

Tourists in India are drawn to various destinations, such as national parks, lakes, rivers, waterfalls, temples, rich cultural legacy and beautiful landscapes. India also attracts medical and religious tourism, where spirituality and religious pilgrimage are significant. Shinde's research emphasizes the significance of religion in influencing tourists' experiences and behaviours, emphasizing the necessity of allowing unambiguous religious expression in tourist environments.

Jammu and Kashmir has a lot to offer tourists, including valleys, parks, lakes and other natural features. These could include well-known tourist spots like Patnitop, Pahalgam, Baderwah, Srinagar and others. Additionally, there are religious tourism destinations like Mata Vaishno Devi and the Amarnath Temple. Similarly, Mansar Lake is also one of such tourism cum religious place in district Samba to visit. However, relatively few individuals are aware of this location. Therefore, it is essential to explore the opportunities of tourism at Mansar Lake.

Statement of the Problem

Mansar Lake, located in the Samba district of Jammu and Kashmir, is a captivating natural place enveloped by a dense pine forest. This picturesque lake stands out not only for its breathtaking natural beauty but also for its significant religious and cultural importance, drawing visitors for both spiritual and recreational purposes. Despite its potential to be a major tourist attraction, Mansar Lake remains relatively under explored and underutilized, with only a modest number of visitors making their way to this serene destination. The reasons behind this limited influx of tourists can be attributed to its geographical location and the general lack of widespread awareness about the lake's offerings. Consequently, there is an urgent need to undertake a comprehensive study to delve into various aspects of tourism at Mansar Lake. This study aims to analyze the patterns of visitor flow, seasonal variations in tourist numbers, the primary motivations behind visits, the geographical origins of the tourists, and their overall satisfaction levels with their experience at the lake. By understanding these facets, the research will provide valuable insights into the current state of tourism at Mansar Lake and identify opportunities for enhancing its appeal and accessibility. This investigation represents the first systematic effort to explore the tourism potential of Mansar Lake, offering a foundational framework for future initiatives aimed at promoting and developing this hidden gem into a prominent tourist destination. Through this research, we hope to highlight the untapped tourism opportunities at Mansar Lake and propose strategic measures to attract a larger and more diverse group of visitors, thereby contributing to the socio-economic development of the region and preserving the lake's natural and cultural heritage.

Literature Review

For the present study literature is reviewed under the following sub themes:

1. Tourism Infrastructural and Management Strategies

Infrastructure is more broadly defined as the facilities—physical, legal, environmental, and psychological—that help make tourism-related goods pleasurable, dependable, and sustainable (Khadaroo and Seetanah in: Jafari and Xiao, 2016). Determining tourist infrastructure, however, is difficult since these ideas are broad and revolutionary, and their application is frequently constrained by national regulations and personal perceptions. There is no precisely defined "tourism" infrastructure as the tourist sector is not a single business (Dwyer et al. 2010). According to Hansen (1965) and Mera (1973), infrastructure is the outcome of both social and economic overhead capital. Social capital improves human capital through public services like public health and education, while economic capital supports productive activities like building highways, streets, and bridges. While recreational amenities enhance daily living and need to be available to both locals and tourists, infrastructure establishes the groundwork for growth (Bell et al. 2007; Lewinson, 2001). These amenities include sports centers, water parks, hiking and trekking routes, and swimming pools (Hadzik and Grabara, 2014; Heldt, 2010). All components that support and encourage the growth of tourism are included in the wide category of tourist infrastructure (Swarbrooke and Horner, 2001). Although the majority of tourism infrastructure is utilized by locals, it does contain amenities that visitors use from the point of departure to the point of return (Lohmann and Netto, 2017). (Fourie and Santana-Gallego, 2011; Hadzik and Gabara, 2014). The development of recreational amenities and tourist infrastructure is related to the growth of tourism (Heath, 1992; UNWTO, 2007; Sharpley, 2009). Infrastructure and amenities have a major impact on destination competitiveness once they are created (Crouch and Ritchie, 1999; Murphy et al., 2000). In certain instances, they even make tourist services feasible. They also boost the effectiveness of privately generated and supplied tourism services (Sakai in: Dwyer and Forsyth, 2006). Research on facilities and infrastructure has been impacted by the rise of sustainability, with an emphasis on the connection between tourism development and transportation infrastructure (Khadaroo and Seetanah, 2007; Khadaroo and Seetanah, 2008; Albalade et al. 2017; Rehman Khan et al. 2017) as well as the management of sustainable destinations (Phillips and Jones, 2006; Currie and Falconer, 2014). Similarly, Goyal (2018) highlights that the United Nations World Tourism Organization (UNWTO) defined sustainable tourism in 1988 as managing resources to fulfil economic, social, and aesthetic needs while preserving cultural integrity, ecological processes, biodiversity, and life support systems. Rema et al., (2023) discusses how ecotourism, which involves opening natural reserved areas to tourism, impacts ecology, culture, and economy, often unsustainably. Therefore, from the above literature it is clear that infrastructural and management strategies are crucial for sustainable tourism development.

2. Socio Economic Impacts of Tourism:

Effective environmental management, local community involvement, and the promotion and enhancement of natural and cultural ecosystems are the cornerstones of sustainable tourism

development (Myburgh & Saayman, 2002). The consequences of tourism are often divided into three categories: socio-cultural, environmental, and economic. Financial flows, tax revenues, employment rates, and environmental changes are common metrics used to quantify the effects of tourism on the environment (Buultjens, 2005). However, because socio-cultural influences are intangible, they are more complicated. Changes in social interactions, values, attitudes, and lifestyles are among the socio-cultural effects of tourism (Page et al., 2002; Douglas et al., 2001; Fredline et al., 2003; Sims & D'Mello, 2005). Fostering understanding between residents and visitors, protecting cultural heritage, and enhancing social welfare and infrastructure are just a few of the positive effects (Ogorelc, 2009; Archer et al., 2005; Murray, 2009). According to Murray (2009), Tourism has the potential to foster the growth of infrastructure, improve safety and security, aid in the preservation of culture, and open up new opportunities. On the other hand, tourism may also have detrimental socio-cultural effects, such as altering traditional lifestyles, raising crime rates, and upsetting local norms (Rogerson, 2000; Tsundoda & Mendilinger, 2009). There may be cultural conflict when visitors disregard local values (Stohr, 1990; Zaaier & Sara, 1993; Demaziere & Wilson, 1996). Notable economic effects of tourism include boosting economic growth, providing foreign exchange revenue, and opening up job possibilities (Gee et al., 1997; Liu & Var, 1986; Dogan, 1989). But tourism may also have detrimental repercussions on the economy, such over reliance on the industry, high consumer costs, and jobs that aren't sustainable or don't pay enough (Kreag, 2001; Haralambopoulos & Pizam, 1996; Liu & Var, 1986; Tomoko & Samuel, 2009). Small and medium-sized businesses (SMEs) in the areas of lodging, food and beverage services, transportation, and crafts are all aided by tourism (Phoummasak, Kongmanila & Changchun, 2014). These businesses, which were frequently founded within the previous five years, serve both domestic and foreign tourists and support regional economic growth.

Therefore, it can be said that while host communities gain a great deal from tourism, there are drawbacks that must be taken into account in order to promote sustainable development. To strike a balance between economic benefits and socio-cultural and environmental concerns, it is necessary to continuously assess the views of the community and the real effects of tourism.

Significance of study

- This study will help us to analyse the level of development and impact of Mansar Lake in the district of Samba.
- This study will help us to analyse the impact of human activities on this lake by which we can formulate the policies for its conservation and management.
- It will help us to analyse the current tourism infrastructure and point out the needs for developing its tourism.
- It will assess the policies and regulations formed by the government for the development of this lake.

Study Area

Mansar Lake, located in the Udhampur district of Jammu and Kashmir, is a popular tourist destination with attractions like Chichi Mata Mandir, Mansar Lake and other attractions. The lake is situated at an altitude of 1,259 feet above sea level and is connected to other parts of the country by buses on the National Highway (NH1-A). It is also a Ramsar site and is situated about 22 kilometres from Samba on the Samba-Udhampur Road. The lake's significance and religious values are more well-known than its aesthetic appeal. Hindu pilgrims visit the lake as a sacred place for blessings and it is a popular boating spot with attractions like swings, game zones and camel rides. The lake supports 207 different species of algae, seven different species of fish and fifteen different species of waterfowl and many people depend on it for their livelihood.

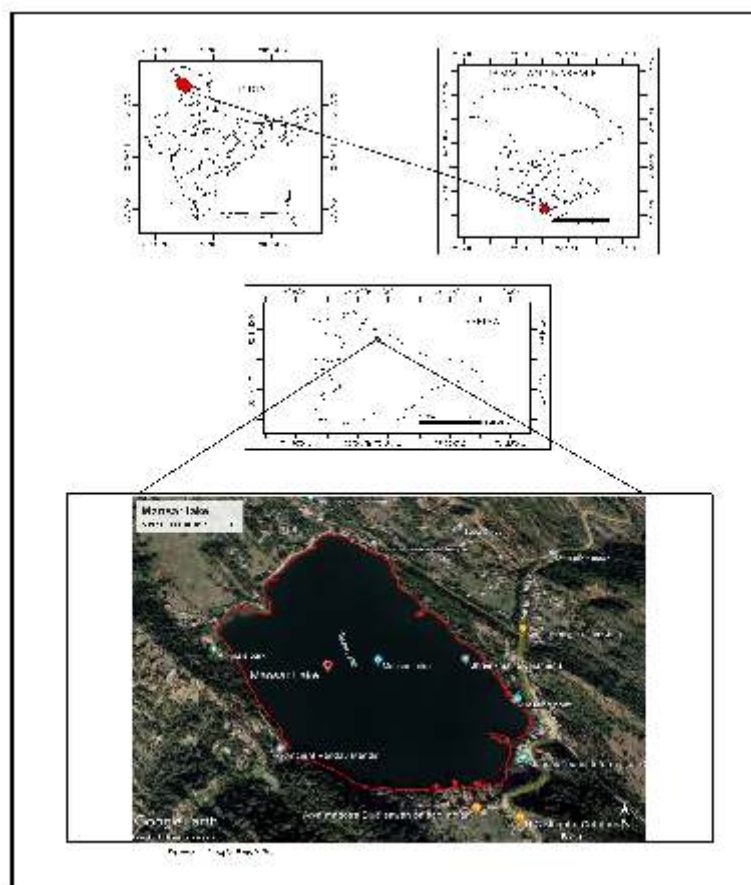


Figure 1 : Location of StudyArea

Source: DCHB and Department of Tourism, Jammu and Kashmir, 2023.

Research Objectives

The present paper will work on following objectives:

1. To evaluate the existing tourism infrastructure, management strategies and potential for tourism development at Mansar Wetland.
2. To analyse the socio-economic impacts of tourism on local communities surrounding Mansar Wetland.
3. To put forward the recommendations for the upliftment of tourism at Mansar Wetland.

Research Questions

1. How does the infrastructure for tourism support or hinder the development of tourism in the Samba District?
2. What are the socio-economic impacts of tourism on the local communities surrounding Mansar Wetland?
3. How do government policies and regulations influence tourism development in the Samba District, particularly around Mansar Wetland?

Research Methodology

The present study primary based on the primary data collected through field survey with the help of structured questionnaire by using purposive sampling. A total of 75 responses have been collected through field survey. For the research objective 1, 50 responses are collected from visitors and for the research objective 2, 25 responses are collected from local people. After the data collection it has been processed and analyzed thoroughly on Likert scale. Results have been displayed through tables, bar graph, pie chart and GIS based maps.

Results and Discussions

General Introduction about the Visitors

For the research objective 1, a total of 50 visitors were surveyed out of which 35 were males and 15 were females. Their Age structure ranged from below 18 to above 60. And they follow different professions like Student, Government employ, private job etc. as shown above. Around 30% of the visitors were private employs and government employs were 10%. This lake is popular among students. Many schools and colleges visit this lake as school trips and picnics.

Arrival of the visitors from different parts of India

Figure 2, given below shows that among these visitors, 60% were local and were from Jammu and Kashmir, and 40% were from Punjab. From J&K, most of the visitors were from Samba

Geographical Perspective

district itself, then from Jammu and Udhampur and others were from Kathua, Rajouri and Reasi. From Punjab, visitors were from Jalandhar, Pathankot and Mohali. Their spatial diffusion can be depicted as:

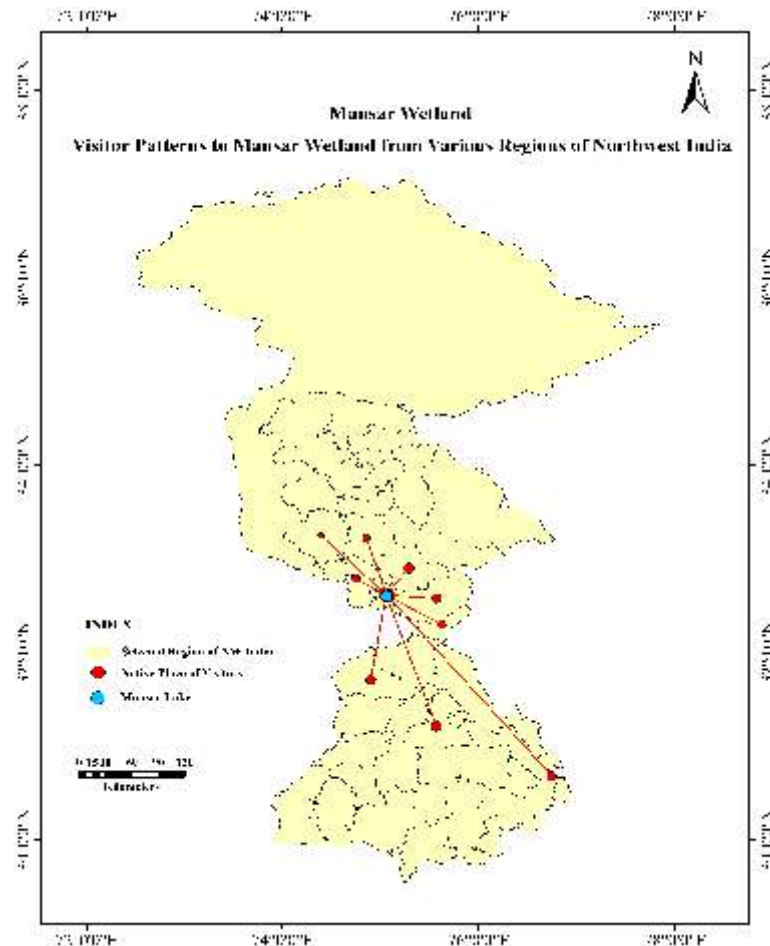


Figure 2 : Mansar Wetland :Visitor Arrival from Different Parts of NW Region of India

Source: DCHB and Department of Tourism, Jammu and Kashmir, 2023 and Primary Field Survey, 2024.

Mode of knowledge about this place and purpose of visit

It was also asked to these tourist show they learned about the very existence of this lake. In response, (figure 3, shows that) the majority of respondents cited family and relatives. As many people visit this lake with their families to perform their religious traditions and customs.

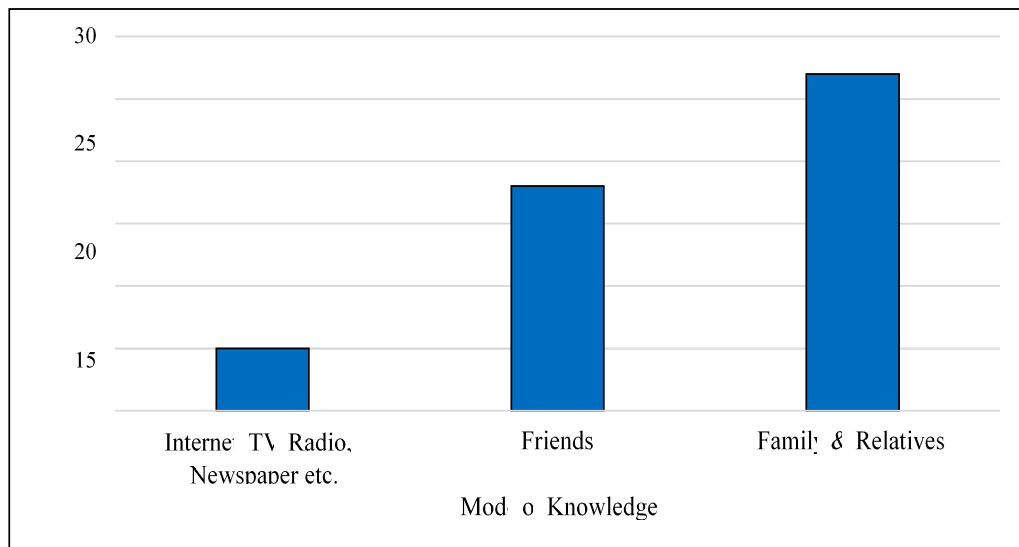


Figure 3 : No. of Visitor

Mansar Wetland: Mode of Knowledge about this place (Visitors' perception)

Source: Primary Field Survey, 2024.

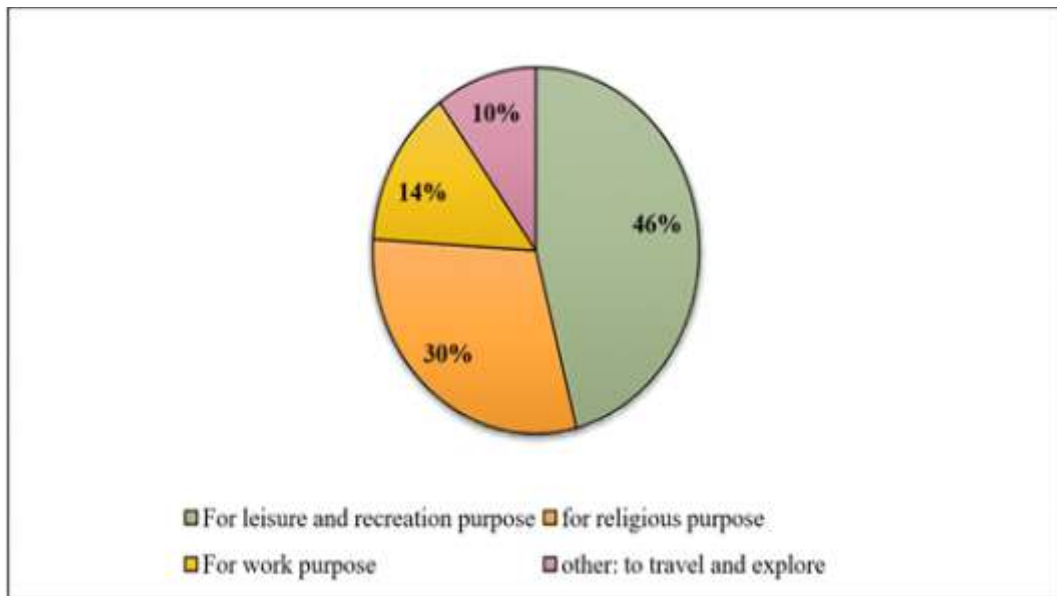


Figure 4 : Mansar Wetland : Purpose of Visit of Visitors

Source: Primary Field survey, 2024.

Mansar Wetland is famous for its religious significance and it is further demonstrated by the results of asking visitors why they stopped by there and the figure 4 shows that the majority of respondents stated their purpose for visiting Mansar wetland is leisure and recreation as well as religious purposes.

Status of Cleanliness and Maintenance of Mansar Wetland

Figure 5 shows that more than 50% of the visitors believed that the cleanliness and maintenance of Mansar Lake is poor or average. Some people also suggested that the cleanliness level is very poor and is becoming a major reason for the death of the fishes in this lake. This clearly shows the peoples' dissatisfaction towards the cleanliness and sanitary conditions of Mansar Wetland.

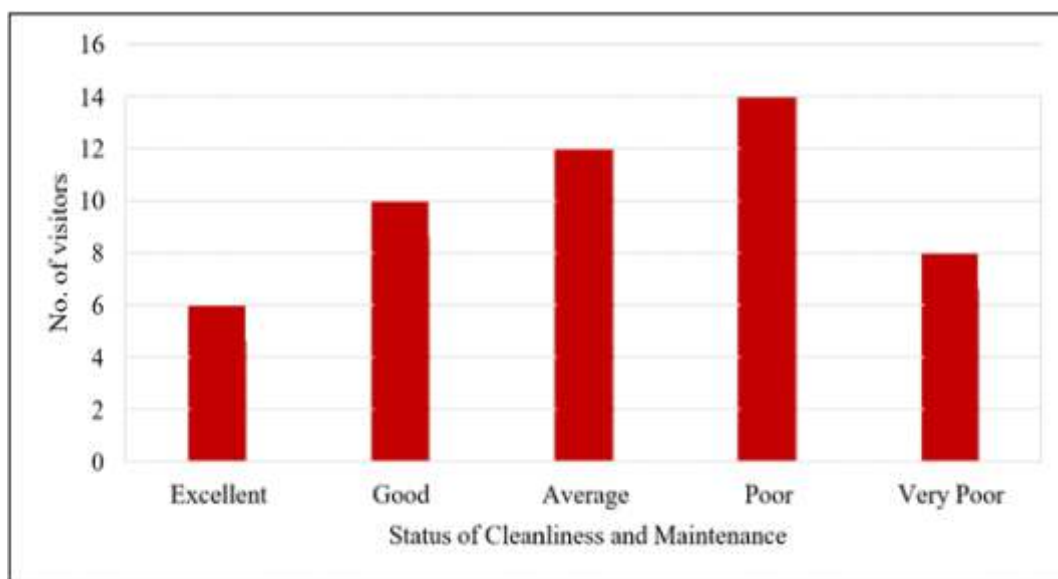


Figure : 5

Mansar Wetland : Status of Cleanliness and Maintenance of Mansar Wetland (Visitors Perception)

Source: Primary Field survey, 2024.

One can observe large heaps of plastic was eat different spots around the lake (figure 6 and 7), which is dangerous for the animals which tends to eat it from the garbage. Additionally, there are also enormous piles of plastic water bottles. Its circumference also contains just four restrooms, three of which are locked and only one of which is operational. Although it is strictly prohibited to feed fish in this area, people nevertheless feed fish "flour." Their motivations are religious. They consider these fish to be "devi," and they feel obligated to feed them.



Figure : 6

Mansar Wetland : Plastic waste and Garbage around the lake

Source : Primary Field survey, 2024.



Figure : 7

Mansar Wetland : Man selling "Flour" to feed fishes and dump of plastic bottles.

Source : Primary Field survey, 2024.

Status of existing tourism infrastructure

The survey result shows that around 36% of the people rated the existing tourism infrastructure as average. 14% people believed that it is excellent whereas 12% rated it as very poor (figure 8)

and 9). This shows that the existing tourism infrastructure can be improved and it will help to increase tourism activities in this lake.



Figure : 8
Mansar Wetland : Current Infrastructure

Source: Primary Field survey, 2024.

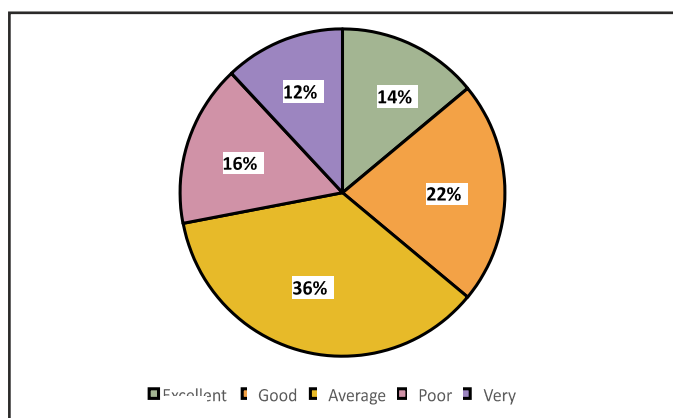


Figure : 9

Mansar Wetland : Status of existing tourism infrastructure (Visitors Perception)

Source: Primary Field survey, 2024.

Satisfaction level of visitors at Mansar Wetland

The satisfaction level of the visitors has also been studied. People were asked whether they are satisfied or not from the services provided here like washrooms, eating places, sitting places,

rides etc. and the figure 10 shows that most of the people answered that they are satisfied but it needs to be improved or they are not much satisfied. This clearly shows that people are not happy with the current management of this wetland.

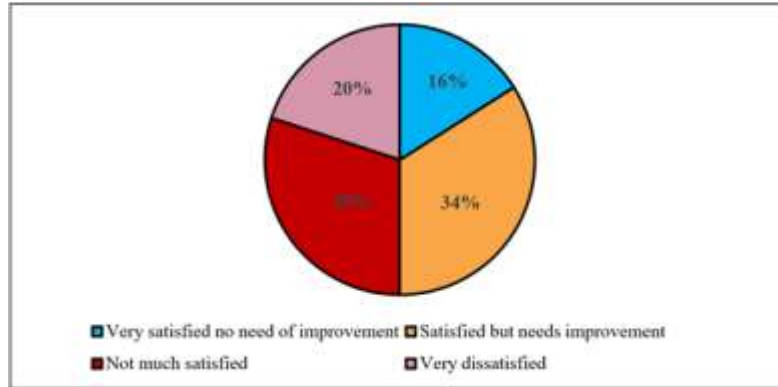


Figure : 10

Mansar Wetland : Satisfaction level of Visitors with Current Infrastructure

Source: Primary Field survey, 2024.

Scope of Improvement in services at Mansar Wetland

People were asked what improvements or additions they would like to see in the facilities surrounding Mansar wetland to enhance the tourism experience.

Level of Satisfaction	No. of Visitor	Percentage
Improved sign age and information board	3	6
Better restroom facilities	6	12
Enhanced picnic areas with seating and shade	13	26
Introduction of guided tours or educational programs	4	8
Master Plan for the Lake	10	20
Improve drainage system and roads	5	10
Cleanliness	7	14
Quality Restaurants	2	4
Total	50	100

Figure:11

Mansar Wetland : Scope of Improvement in Services at Mansar Wetland (Visitors Perception)

Source: Primary Field Survey, 2024.

The above figure 11, shows that most of the people demanded enhanced picnic areas with seating and shade. Some people suggested that the Master plan should be implemented which is on hold from the last 20 years. There is also the need of improving better restroom facilities, improved signage and information boards, introduction of guided tours or educational programs, cleanliness and quality restaurants.

Importance of Sustainable Tourism Practices for Preservation of Mansar Wetland

The result of the primary survey through the figure 12 shows that Around 80% of the visitors believed that sustainable tourism practices are important for the preservation of Mansar Wetland. This clearly indicates that it is the urgent need of Mansar wetland to improve the tourism by improving the existing tourism infrastructure and management.

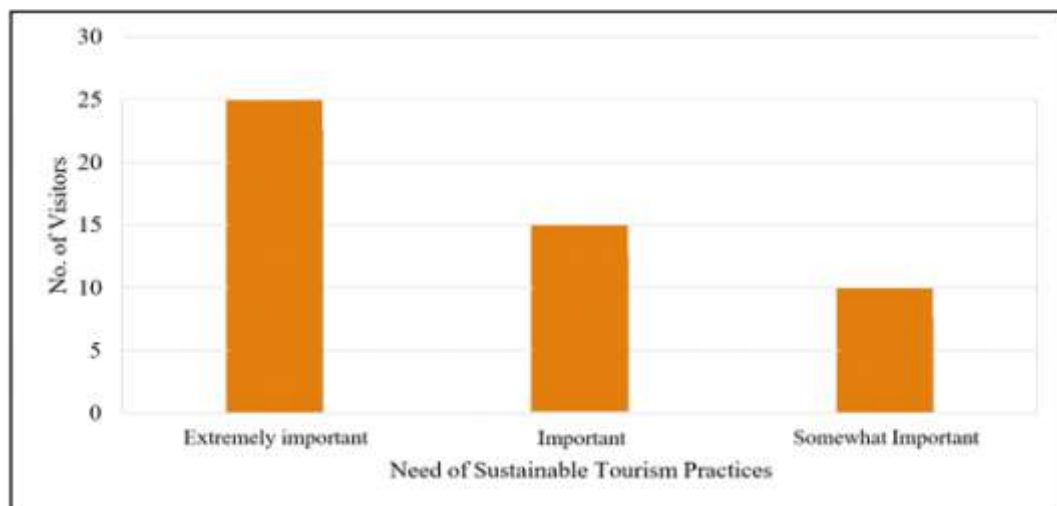


Figure:12

Mansar Wetland: Importance of Sustainable Tourism Practices for Preservation of Mansar Wetland

Source: Primary Field Survey, 2024.

The major challenges that hinder the development of tourism of this area is lack of implementation of the government programs. The locals keep complaining that the government does nothing to improve tourism in Mansar Lake. Whereas the government is working on improving the infrastructure as well as conserving the natural environment. In November 2020, the Union Minister of State for Development of North Eastern Region inaugurated the Mansar Lake Development Plan in Jammu, with the objective to attract 20 lakh

tourists annually which would cost Rs. 200 crores. But on the other hand, the locals are frustrated and they demand results. It has been 4 years and there is no development till date. The local people claim that there is corruption which is hindering the development of this area. Due to this reason, they refuse to cooperate with the government. Also, no proper guide is available for the tourists who can provide detailed information about this area to the tourists. People also complaint that there is no cleanliness. Additionally, there is no proper management. It lacks amenities like restrooms and lack of awareness and publicity of this place. There is also the pressure of over population of f ishes in a small lake due to feeding which disrupts the delicate food chain.



Figure :13

Mansar Wetland: Interaction with Local People

Source: Primary Field Survey, 2024.

Effect of Wetland on The Local Community (local People's Perception)

The survey result through the figure 14 (A) shows that ten respondents suggested it has a positive impact, whereas fifteen out of the twenty-five believed its impact is very positive. It follows that every one of the twenty-five respondents felt that the tourism industry around this lake improves the quality of life for the locals. This shows the importance of this lake and the urgent need to improve its tourism infrastructure in order to elevate this lake as a leading tourist destination.

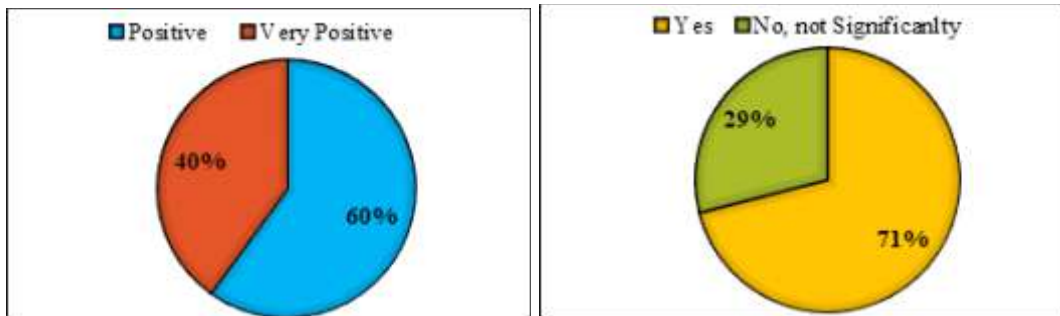


Figure:14 (local People's Perception)

A) Mansar Wetland: Effect of Wetland on the Local Community

B) Mansar Wetland: Job Creation for Local Community due to Tourism

Source : Primary Field Survey, 2024.

Job Creation for Local Community due to Tourism (local People's Perception)

Figure; 14 (B) and 15 shows that more than 70% of the local people who were surveyed were of the opinion that the tourism of this lake leads to job creation for the local people.



Figure : 15

Mansar Wetland : Local shops, Maggi point and Kulcha's

Source: Primary Field Survey, 2024.

The remaining people are of the view that it doesn't create jobs significantly. This clarifies that people are getting jobs due to the emerging needs created by tourism in this area.

Effect on Standard of living due to Tourism

Each and every person being surveyed agreed to the point that the standard of living of local people have been improved due to tourism of this lake. This indicates unanimous agreement among the respondents that tourism has had a positive impact on the standard of living of the local community around Mansar Lake. It suggests that the economic benefits brought by tourism, such as job creation, increased income, and infrastructure development, are widely recognized and valued by those surveyed.

Influence of Tourism on Local Culture and Traditions

From the Ground survey it has been noted that (figure 16 (A)) more than 70% of the people argued that tourism has a positive influence of tourism on local traditions and culture. Some people also believes that it has a negative influence. This suggests that a majority of the respondents perceive tourism as having a positive influence on the local cultures and traditions of Mansar Lake. However, it's important to note that there is a significant minority who hold the opposite view.

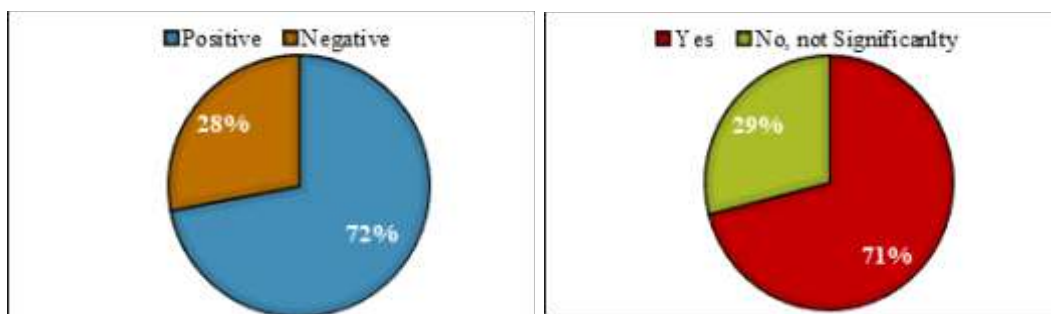


Figure : 16 (Local People's Perception)

A) Mansar Wetland: Influence of Tourism
on Local Culture and Traditions

B) Mansar Wetland: Income
Enhancement due to Tourism

Source: Primary Field Survey, 2024.

Income Enhancement due to Tourism

The primary survey result shows that (figure 16 (B)) 71% of people agree that tourism has increased locals' incomes while the other 29 % of those surveyed think that tourism has somewhat raised locals' incomes. The data indicates that a considerable proportion of the surveyed individuals believe that tourism has a positive effect on local residents' income, with a majority indicating that the increase is substantial. A minority does, however, also hold the opinion that although tourism has raised income, but some people may not be as affected as others.

Effect of Tourism on the Availability and Affordability of basic Necessities

Figure 17 shows the effect of tourism on the availability and affordability of basic necessities and it has been found that out of the 25 respondents, 17 felt that tourism has increased the affordability and accessibility of necessities, 5 claimed that tourism had no effect and 3 respondents claimed that the accessibility and cost of necessities have decreased due to tourism.

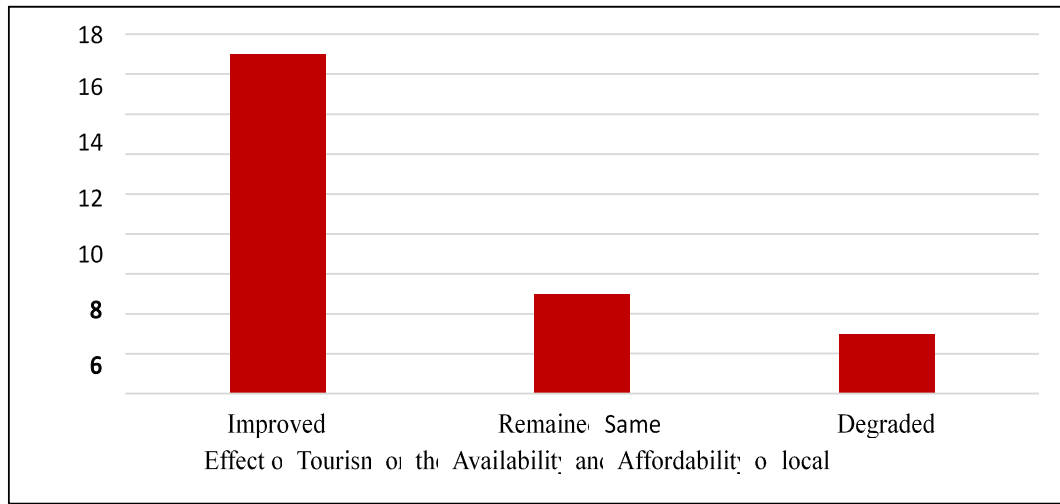


Figure:17

Mansar Wetland : Effect of Tourism on the Availability and Affordability of basic Necessities (Local People's Perception)

Source : Primary Field Survey, 2024

This indicates that a substantial majority of the participant should the view that tourism positively influences the accessibility and cost of basic necessities with in the local community. A smaller minority, on the other hand, think that tourism has either had no impact at all or has worsened the situation.

Sustainability of the current tourism model in terms of benefiting local communities According to the results of primary survey (figure 18) 32% of respondents, the Mansar Wetland's current tourism model is very sustainable in terms of helping the community, 48% of respondents, the current tourism model helps local communities in a some what sustainable way and 20% of respondents think that the existing tourism model cannot continue to help local communities. With regard to the advantages it offers to near by communities, this data provides in sight into how sustainable the current tourism model at Mansar Wetland is thought to be.

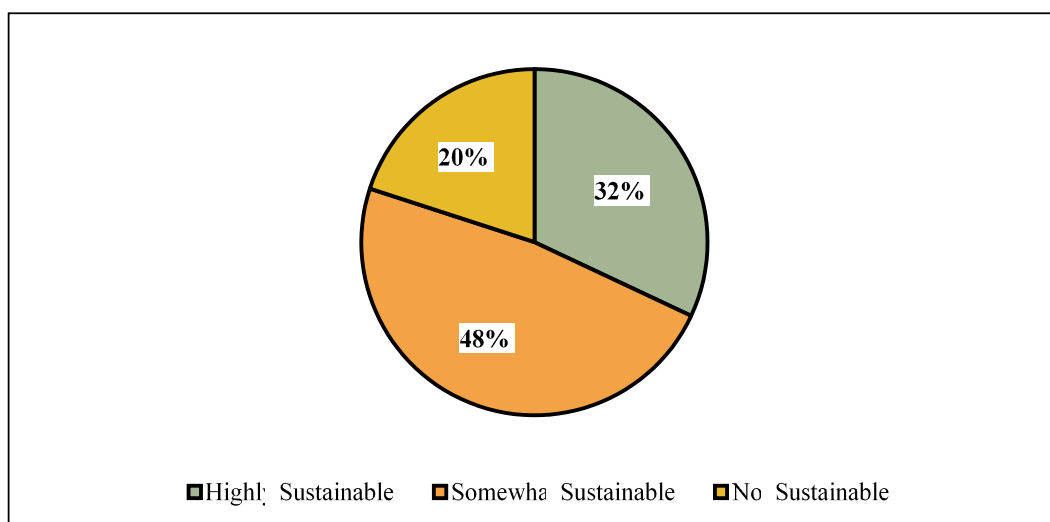


Figure:18

Mansar Wetland : Sustainability of the current tourism model in terms of benefiting local communities (local People's Perception)

Source: Primary Field Survey, 2024.

Community Involvement in Tourism Planning and Decision Making

From the primary field survey, it has been observed that around 64% of respondents agreed that there should be greater community participation in Mansar Wetland tourism planning and decision-making, 28% of respondents indicated that it might depend on the situation and 8% of respondents said asking locals is not necessary. This clearly shows that the local people should be involved in planning to solve their problems at grass-root level.

Overall Socio-Economic Impact of Tourism on Local Communities

The below given figure 19, shows the overall socio-economic impact of tourism on local communities and it shows that out of 25 respondents, 11 encountered that tourism has a very positive socio-economic overall impact on the local communities surrounding Mansar Wetland, 5 respondents felt it has generally positive socio-economic impact, 6 respondents claimed that there is no overall socio-economic impact of tourism on the community and 3 respondents claimed that there is a generally negative socio-economic impact of tourism on nearby communities.

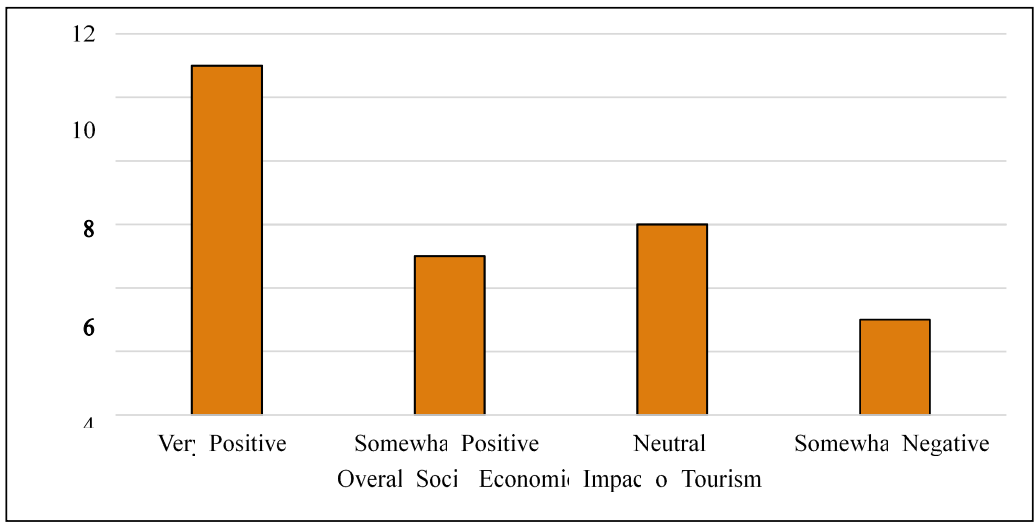


Figure : 19 No. of Visitors

**Mansar Wetland: Overall Socio- Economic Impact of Tourism on Local Communities
(Local People's Perception)**

Source: Primary Field Survey, 2024.

This data provides as pot light on the differing opinions regarding the socio-economic effects of tourism on the surrounding communities of Mansar Wetland. Although some of the respondents think the impact is positive, others think it's neutral or even negative.

Conclusion

To put it briefly, it can be argued that Mansar Lake, a popular tourist destination, needs to improve its infrastructure and management to attract more visitors. Despite its numerous attractions, over 50% of visitors believe the lake's cleanliness and maintenance are poor, leading to fish deaths. The lake is filled with plastic water bottles and has only four restrooms, three of which are not operational. Visitors' express satisfaction with the services provided but want improvements to enhance the tourism experience. Some suggestions may include implementing the Master plan, improving restroom facilities, signage, information boards, guided tours, cleanliness, and quality restaurants. Sustainable tourism practices are crucial for the preservation of Mansar Wetland. Locals complain about corruption and lack of proper guidance, and the lake faces overpopulation of fish due to feeding, disrupting the delicate food chain. A survey reveals that tourism positively impacts the quality of life for locals around Mansar Lake, with over 70% believing it leads to job creation and improved standard of living. However, a significant minority believes tourism has negatively impacted local traditions and culture. To address local problems, greater community participation in tourism planning and

decision-making is necessary. Out of 25 respondents, 11 found tourism to have a positive socioeconomic impact on local communities, while 5 felt it had a generally positive impact. Therefore, to improve tourism at Mansar Lake, several recommendations can be implemented.

- Firstly, there is a need for infrastructure improvements, including upgrading restroom facilities, installing signage, and providing information boards for visitor convenience. Developing accommodation options would encourage longer stay and increase tourism revenue.
- Secondly, environmental conservation efforts are crucial, with measures such as regular cleanup drives and waste management initiatives necessary to address pollution. Raising visitor awareness about the lake's ecological importance and promoting responsible tourism practices can further contribute to preservation efforts.
- Thirdly, enhancing the visitor experience through guided tours, educational programs, and recreational activities like birdwatching and eco-friendly boating can attract a broader range of visitors. Community involvement in tourism planning ensures that local voices are heard, and their interests are considered.
- Additionally, preserving and promoting local traditions and cultural heritage through festivals and cultural exchanges enriches the visitor experience while fostering community pride. Implementing sustainable tourism practices, improving infrastructure, and launching targeted marketing campaigns to promote Mansar Lake as a tourist destination are essential steps toward realizing its tourism potential.
- By incorporating these recommendations, Mansar Lake can emerge as a thriving tourist destination, benefiting both visitors and the local community while preserving its natural and cultural treasures for future generations.

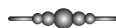
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UNVEILING THE PROSPECTS AND OPPORTUNITIES FOR VILLAGE TOURISM IN DARBHANGA DISTRICT OF BIHAR

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ABSTRACT

Village tourism is an emerging sector with great promise for driving economic and social development in communities. India is just starting to explore this type of tourism, which is centered on natural settings and offers an in-depth look at rural life, culture, arts, and heritage. This form of tourism benefits local communities in several ways: it boosts the local economy through tourist spending and creates job opportunities within the sector. In developing countries, the growth of tourism raises concerns about environmental sustainability, highlighting the need to protect natural resources. Village tourism also offers an immersive experience, allowing visitors to engage with local residents, participate in their everyday activities, and gain a deep understanding of their traditional lifestyles. As this type of tourism grows, it provides a unique opportunity for tourists to connect with the essence of rural communities. This paper aims to explore the potential, opportunities, and sustainability of rural and village tourism in the Darbhanga district of Bihar, focusing on the benefits it offers to both tourists and local communities.

Keywords: Tourism, prospects, rural tourism, village tourism, rural development, sustainability

Introduction

In recent years, there has been a growing recognition of tourism's role in promoting rural development. With 69% of India's population residing in rural areas and over 6.5 million villages spread across the country, rural tourism presents an enormous opportunity for economic growth and cultural preservation. India's diverse landscapes, ranging from deserts and mountains to fertile plains and picturesque coastlines, make it an ideal destination for rural tourism. The country's rich cultural heritage—marked by its traditions, varied lifestyles, artistic expressions, and vibrant festivals—adds a unique dimension to this form of tourism, drawing both domestic and international visitors. Rural tourism is often defined as an

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“authentic countryside experience,” offering visitors a wide array of attractions and activities set within rural and agricultural environments. Over time, this segment of tourism has evolved in response to growing awareness of cultural heritage, environmental concerns, and increased accessibility. The aim of rural tourism today is not only to provide a meaningful, immersive experience for tourists but also to create sustainable economic opportunities in rural areas. This includes employment in various roles, such as guides, hospitality workers, drivers, and chefs, all of which contribute to rural economic upliftment. The Ministry of Tourism in India emphasizes that rural tourism should showcase rural life, culture, and heritage in a way that supports local communities, fosters meaningful tourist-resident interactions, and contributes to the local economy. Rural tourism encompasses a wide range of activities including agricultural tourism, cultural and heritage tourism, nature-based tourism, adventure tourism, and eco-tourism. Successful examples of rural tourism initiatives can be seen in Kerala's backwaters, Karnataka's forested regions, and Tamil Nadu's temple towns.

More than just farm visits, rural tourism offers a broad spectrum of experiences, such as nature getaways, eco-tourism, trekking, mountaineering, horseback riding, extreme sports, and health-focused retreats. It also includes opportunities for cultural and heritage exploration, educational excursions, and, in certain regions, ethnic tourism. A key component of rural tourism is agri-tourism, where visitors can engage with active farms or agricultural ventures, either for recreation or educational purposes, and sometimes even to participate in farming activities. This engagement provides tourists with a direct connection to rural life while offering farmers an additional source of income.

Tourism as a whole is typically divided into two main categories: 'mass' tourism and 'alternative' tourism. According to Mieczkowski (1995, as cited in Wearing, 2001), these two categories exist on opposite ends of a spectrum. Numerous scholars, including Lane (1994), Page and Getz (1997), and Swarbrooke (1996), have outlined the essential characteristics of rural tourism, which include its setting in authentic rural areas characterized by traditional communities, customs, and ways of life. These rural destinations offer peaceful environments, expansive natural landscapes, and the opportunity for tourists to immerse themselves in the rural way of life. Activities are typically managed at the community level, with direct economic benefits flowing to the local population, ensuring that rural tourism remains a tool for local empowerment and sustainable development.

As India's tourism industry continues to grow, rural tourism presents a significant avenue for addressing rural-urban economic disparities, preserving cultural heritage, and promoting sustainable tourism practices. By strategically developing and promoting rural tourism, India has the potential to create long-lasting economic and social benefits for its rural communities.

In the fiscal year 2017-18, the Ministry of Tourism approved a project in Bihar called "Development of Bhitiharwa-Chandrahia-Turkaulia," with a funding of Rs 44.65 crore. To motivate similar endeavors, the ministry also created a National Tourism Award for the 'Best Rural/Agri/Plantation Tourism Projects.' Additionally, the Shyama Prasad Mukherji Rurban Mission (SPMRM) aims to develop village clusters that maintain rural community values while providing key urban amenities, focusing on equity and inclusion.

Study Objectives

1. To cater information about rural tourism and decipher its various classes with respect to Darbhanga.
2. To present brief of the driving forces and benefits of rural tourism.
3. To identify potential for rural tourism in Darbhanga district.

Research Questions

1. What is the concept of rural tourism?
2. What factors contribute to the development of rural tourism in Darbhanga?
3. What challenges and opportunities exist in rural tourism in Darbhanga?
4. What measures are crucial for the success of rural tourism and rural development?

Study Approach and Scope

This study draws on existing research from websites and documents, covering not just Darbhanga but also rural tourism development across various regions in India. It explores different types of rural tourism, the factors contributing to its success, its benefits, and the elements that foster its growth. The study has highlighted the potential advantages of promoting agri-tourism from an agricultural standpoint. Although Darbhanga district has the potential for rural tourism, it lacks established rural tourism centers, which limits the empowerment of skilled artisans in the area due to insufficient training in packaging and presentation.

Research Methodology

This paper uses secondary data from various sources, including research papers, news articles, and websites. It utilizes a qualitative research approach, integrating insights gained from on-site visits to tourist locations and conversations with local entrepreneurs, residents, and tourists. Around 500 people were contacted at various locations in Darbhanga and point

connecting Darbhanga to neighbouring towns and state capital. The following sections discuss the overview of the Darbhanga district, its socio-cultural richness, and the historic treasure embedded in the folklore of the Darbhanga city and surrounding areas vis-à-vis potential aspects of rural tourism in this region. The subsequent sections discuss the important places of social, and religious interest in Darbhanga to promote rural tourism. The following section also throws light on the significance of handicrafts and folk arts, including the famous Mithila paintings. Furthermore, rural tourism and its various types have been defined. Moreover, the multiple challenges & opportunities in rural tourism and how they can be synced to create Darbhanga as a major tourist hotspot for rural tourism has been explained.

District Overview

This district is located in the northern Bihar Plain as well as the northern part of Bihar state. It shares its boundary with Sitamarhi and Madhubani to the north, Samastipur to the south, Saharsa and Supaul to the east, and Muzaffarpur to the west. The district comprises 18 C.D. Blocks and is organized into three sub-divisions: Darbhanga Sadar, Benipur, and Biraul, with Darbhanga being the only urban center. There are 1247 villages within the district. The name of the district is derived from Darbhanga, the district headquarters, which is believed to have been founded by someone named Darbhangi Khan, though there is limited information about him. Another theory proposes that "Darbhanga" might have originated from "Dwar Banga" or "Dar-I-Banga," meaning "the gateway to Bengal." However, this theory is not entirely accurate as the historical boundary between Bengal and Bihar has always been located further east. Despite this, the region is thought to have cultural and linguistic links to Bengal.

Darbhangha's Significance: Darbhanga holds an important place within North Bihar, lying at the heart of Mithilanchal which is a fertile alluvial region. It was an ancient city within Mithila, an ancient cultural area of North India located between the lower Himalayan range and the Ganges River. The northern edge of this region borders Nepal, while the Gandak and Kosi rivers define its western and eastern limits, respectively. Darbhanga is well-known for its production of 'Makhana' (foxnuts) and is distinguished by its rich historical and cultural heritage, making it a key tourist destination. The city is home to notable attractions such as forts, palaces, and various structures erected by Maharaja Kameshwar Singh. Important sites include Lalit Narayan Mithila University and Kameshwar Singh Darbhanga Sanskrit University, along with prominent temples like Shyama Mandir, Madhweshwar Mandir, and Manokamna Mandir, which are hubs of learning, wisdom, and spirituality. Moreover, landmarks such as Khankah Samarkandia, Jama Masjid, Mirja Khan Talab, Three Church, and Gurudwara represent unity and religious diversity.

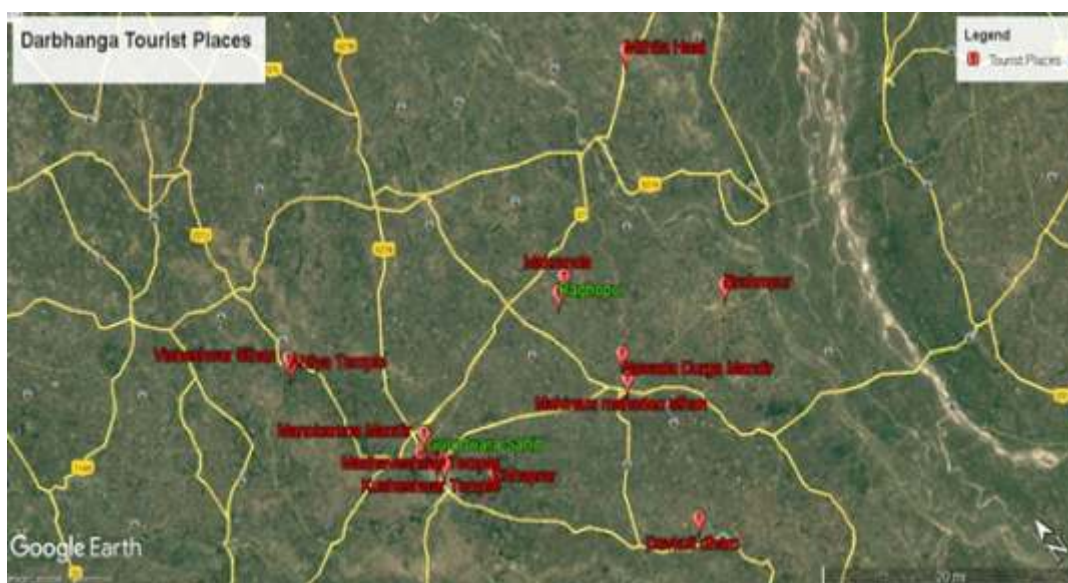


Figure 1 : Satellite View of Study Area

Source: <https://darbhanga.nic.in>

The city's illustrious past continues to influence its contemporary character, reinforcing its role as a center of literature, culture, justice, and philosophy. The Maithili language, spoken here, is celebrated for its melodious quality and attracts scholars. Darbhanga is also known for its trade in fish, mangoes, and makhana. It hosts significant educational institutions, including Chandradhari Mithila College, Medical College, Women's College, and Engineering School. Additionally, the district features numerous rural areas with considerable potential for developing rural tourism, rooted in history, culture, and religion, which could significantly boost the local economy.

Places of social, religious interest to promote rural tourism

- a. **Ahilya Sthan:** Ahilya Sthan is a prominent historical shrine located roughly 3 kilometers south of Kamtaul Railway Station in the Jale Block of Darbhanga. This site is renowned for its connection to the Ramayana, where it is said that during his journey to Janakpur, Lord Rama's foot touched a stone that miraculously turned into a woman named Ahilya. Ahilya had been turned into stone by a curse from her husband, Gautam Rishi. The temple is dedicated to Ahilya, the wife of Gautam Rishi. Every year, large fairs are held to celebrate Ramnavami in the Hindi month of Chaitra and Vivah Panchami in Margashirsha. The village also hosts various other temples and mosques. The location has been marked in the map of Darbhanga given above with a *black cross* in the Jale block.

- b. Brahmpur:** Located about 8 kilometers from Kamtaul and 19 kilometers southeast of Jogiara, the village of Brahmpur is well-known for the Gautam Kund and a temple dedicated to Gautam Rishi, which are close to each other. According to ancient legends, Lord Brahma manifested at this location to meet Gautam Rishi following the incident where Lord Indra and Chandrama had infringed upon Ahilya's purity. The village's name is linked to this important event. The Gautam Kund is believed to have been created by Lord Brahma, who struck the ground with seven arrows to form the tank, providing Gautam Rishi with a local place to bathe rather than having to travel a long distance to the Ganga. Brahmpur serves as a rail hub in the Jale block and also features a Khadi Gramodyog center and store. It functions as the rail access point for those visiting Ahilya Sthan and Gautam Sthan. This location also has been marked in the map of Darbhanga given above with a *black cross* in the Jale block. This rural tourist spot also comes under Jale block of Darbhanga.
- c. Chhaprar:** Situated in the Bahadurpur block, this village is about 10 kilometers from the district headquarters. It features a temple dedicated to Lord Mahadeva, located along the banks of the Kamla river. This temple is a central attraction for fairs that take place during the Kartik and Maghi Purnima festivals. The location has been marked in the map of Darbhanga given above with a *black cross* in the Bahadurpur block.
- d. Dekulidham:** Dekulidham, situated in the Biraul block, is renowned for its magnificent temple dedicated to Bhagwan Shiva. Every weekend, numerous devotees gather at the site, and a major annual fair is held in celebration of Mahashivaratri. The location has been marked in the map of Darbhanga given above with a black cross in the Biraul block.
- e. Kusheshwar-asthan:** Kusheshwar-asthan is recognized for its substantial religious importance and is situated about 16 kilometers east of Singhia and 22 kilometers northeast of Hasanpur Road railway station, along the Samastipur-Khagaria Branch line of the North Eastern Railway. The temple dedicated to Lord Shiva, known as Kusheshwarasthan, is renowned, and worshippers visit the site throughout the year. The origins of this temple are believed to date back to ancient times. Additionally, the wetlands encompassing fourteen villages in the Kusheshwarasthan block, covering an area of 7019 acres and 75 decimals, have been designated as the Kusheshwarasthan Bird Sanctuary under the Wild Life Protection Act of 1972 (as amended up to 1991) due to their ecological, faunal, floral, geomorphological, and natural significance. The sanctuary is frequented by migratory birds from various countries, contributing to its rich biodiversity. The location has been marked in the map of Darbhanga given above with a black cross in the Kusheshwar asthan block.

- f. Catholic Church:** Holy Rosary Church, established in 1891, is located one kilometer north of Darbhanga Railway Station. After the earthquake of 1897, the church was reconstructed. Prayer gatherings are held every Friday, and Christmas festivities are observed from December 25th to 31st. Additionally, Anand Mela is celebrated annually on October 7th. It is present in the district headquarter in Darbhanga.
- g. Handicraft and Folk Arts, including Mithila Paintings:** Mithila paintings are recognized as a unique art form, distinguished by their elaborate line work and bright, colorful patterns. Mud walls and verandas are adorned with these paintings, which are altered to reflect different celebrations, deities, ceremonies, and family events. Some prominent examples include:
1. **Sujni:** Similar to crafts like bedspreads and wall hangings, Sujni is a popular form of art.
 2. **Sikki:** This craft involves making articles from the tall and attractive Sikki grass found abundantly in North Bihar. The coiling technique, using a needle called Takua, is employed to create various items.
 3. **Inlay Work:** Inlay work incorporates different materials like metal, ivory, and wood chips of various grains and tints to achieve unique effects.
 4. **Natural-Origin Paintings:** These paintings, created with primary colors from natural sources, adorn paper and cloth and are often used during mythological and religious events.
- h. Mithila Haat:** Located at Arariya Sangram, Jhanjharpur near Darbhanga in Madhubani district of Bihar, *Mithila Haat* is an epitome of rural tourism, blending the vibrant heritage and natural beauty of Mithilanchal with modern amenities. Developed by the Bihar State Tourism Development Corporation (BSTDC), this enchanting theme-based park serves as a cultural and culinary showcase of the Mithila region, making it a must-visit destination for travelers seeking an authentic experience. At the heart of Mithila Haat lies a lush landscape, home to over 500 trees, offering visitors a serene environment that highlights the natural splendor of rural Bihar. The *Craft Bazar*, with its 50+ shops, immerses guests in the region's rich artisanal traditions, displaying intricate textiles, handmade artifacts, and folk art, all of which reflect Mithilanchal's deep-rooted cultural legacy. For those wishing to extend their stay, Mithila Haat boasts a premium resort, allowing guests to enjoy rural hospitality while surrounded by the park's tranquil atmosphere. The resort also features a well-equipped banquet hall, perfect for hosting events and celebrations amidst nature's beauty. Mithila Haat's *Live Kitchen* is a unique culinary attraction, where skilled chefs prepare authentic Mithila cuisine using traditional recipes passed down through generations. Visitors can witness the live preparation of local delicacies, offering a sensory

journey through the flavours of Mithilanchal. Adding to the experience, Mithila Haat offers a serene boating facility, allowing guests to glide through tranquil waters while taking in the scenic surroundings. The amphitheatre is another highlight, where vibrant cultural performances bring to life the colorful traditions and dynamic arts of Mithila, offering an authentic rural cultural immersion. For families, the *Kids Play Zone* ensures children enjoy an interactive and educational experience. With engaging activities designed to entertain and inspire, young visitors can explore the magic of Mithila's heritage in a fun, playful environment. *Mithila Haat* is more than a tourist attraction; it is a celebration of Mithila's traditions, offering visitors a deep connection to the region's heritage, art, and cuisine, making it a significant contributor to rural tourism near Darbhanga. The location has been marked in the map of Madhubani district that is adjacent to Darbhanga given above with a black cross.

What is Rural/Village Tourism?

Rural tourism covers a broad spectrum of attractions and activities situated in non-urban, often farming areas. It is characterized by vast open areas, limited tourism development, and opportunities for visitors to engage directly with agricultural or natural surroundings. Genuine rural tourism should ideally satisfy the following conditions:

- Located in rural areas.
- Functionally rural, emphasizing the unique aspects of rural life, such as small-scale enterprises, natural surroundings, heritage, traditional societies, and practices.
- Small in scale, including buildings and settlements, typically community-controlled and developed for long-term local betterment.
- Rooted in tradition, growing organically, and deeply connected with local communities.

Types of Rural Tourism: Rural tourism can be categorized into several types:

1. **Heritage Tourism:** This involves travelling to experience places and activities representing the past, such as historical sites and cultural heritage.
2. **Nature-Based Tourism/Ecotourism:** Visitors explore natural areas to appreciate the scenery, including plant and wildlife. It can be passive (observation-focused) or active (participating in outdoor activities).
3. **Agri-Tourism:** Involves visiting working farms, agricultural, horticultural, or agribusiness operations for enjoyment, education, or participation in farm activities. It includes farmers' markets, petting farms, and more.

Table 2 : State-wise performance of the rural tourism projects by the Central Government.

State	Number of Projects Covered	Number of Successful Projects	Number of Average Projects	Number of Unsuccessful Projects
Total	107	41	33	33
Andhra Pradesh	5	2	3	
Arunachal Pradesh	3	3		
Assam	4		3	1
Bihar	1		1	
Chhattisgarh	5			5
Delhi	2	1	1	
Gujarat	4		2	2
Haryana	1		1	
Himachal Pradesh	3	1	2	
Jammu Kashmir	8	7	1	
Karnataka	5	3	2	
Kerala	5	5		
Madhya Pradesh	4	1		3
Maharashtra	2	2		
Manipur	3	1		2
Meghalaya	2		1	1
Nagaland	5	3	2	
Odisha	7	1	1	5
Punjab	5	1	3	1
Rajasthan	3		1	2
Sikkim	1	1		
Tamil Nadu	8	4	2	2
Tripura	2	2		

Source: Evaluation cum Impact Study of Rural Tourism Projects - Final Report, Ministry of Tourism, Government of India.

Note : Ratings 4 & 5 are successful projects, 3 are average products, and 1 & 2 are unsuccessful projects. 1 represented Failure, 2 represented Not Successful, 3 represented Average, 4 represented moderately successful and 5 represented Highly Successful

The above table depicts the state wise performance of the rural tourism projects. The evaluation of the rural tourism projects has brought to the fore the exact picture of the scheme and also the projects which are successful in intertwining the interest of rural craftsmen and beneficiaries with that of tourism and has helped in improvement of conditions in the lives of the rural populace. The study has also brought to the fore the projects which has not been successful in the same and also the roadblocks and challenges that the projects face. Out of the total 107 projects, 41 projects have been successful, 33 projects have performed averagely and the rest 33 projects have been unsuccessful in attaining the objectives. The following chart depicts the share of successful, average and unsuccessful projects out of the total 107 rural tourism projects evaluated. Please note that moderately, successful and highly successful projects have been merged and labeled as “successful”, failure and not successful projects have been merged and labeled as “unsuccessful”.

The historic built environment stands to gain in two major ways from rural tourism. Firstly, admission fees are now charged at many historic sites to support the maintenance of their structures, gardens, and surrounding landscapes. Secondly, certain historical buildings have become outdated due to evolving circumstances. Churches may have lost their congregations, castles their strategic importance, farm buildings their compatibility with modern machinery, railway stations their trains, and canal warehouses their barge traffic. Often, the tourism industry is able to creatively and profitably repurpose these obsolete structures, transforming them into attractions on their own.

In the Indian context, despite a strong intent to advance and promote rural tourism, difficulties in the successful implementation of such schemes have been observed. According to a 2012 study by the Ministry of Tourism, Government of India, only 41 sites were found to have successfully implemented rural tourism initiatives. Conversely, 33 sites were categorized as "Average," and 33 were labeled as "Failure" (refer to table). Various factors leading to the unsuccessful outcomes of these rural tourism initiatives across different sites were identified, with a notable issue being the lack of engagement and interest from local communities in the projects.

Challenges & Opportunities in Rural Tourism in Darbhanga:

Rural areas are typically home to a predominantly impoverished population. Many residents, who live below the poverty line, are often reluctant to display their culture and heritage to tourists due to a lack of understanding about the benefits of rural tourism. Numerous obstacles,

such as remote locations, inadequate transportation, poor infrastructure, limited lodging options, unreliable electricity, and communication problems, prevent many rural sites from attracting tourists, despite their substantial tourism potential. The heavy and frequent traffic jams near Donar chowk, Beta chowk, Balbhadrapur, Laheriasarai, Bela more chowk, Tower chowk and many damaged roads with encroachment area is a major threat for the development of rural tourism. The infrastructure issues like dearth of flyovers, high rate of pollution, frequent communal incidents in religious processions, law and order problems, narrow and meandering roads and limited healthcare facilities with respect to large population is a major issue. However, pollution control measures, community awareness and enactment of stringent laws with swift and fast development can ensure huge opportunities in Darbhanga. Recently AIIMS Darbhanga has been proposed and is under construction and shall meet the state of the art medical requirements and healthcare facilities.

What Contributes to the Success of Rural Tourism in Darbhanga?

To establish a site into a flourishing rural tourism destination instead of simply a temporary stop, it is important to create organized networks and collaborative partnerships including both public and private sector players. Community involvement is secret to its success. Now in Ranipur, Basdeopur Darbhanga ICAR RCER Research Centre for Makhana, Darbhanga has been established and new start ups are coming up to promote the rural crop and inviting people to purchase this highly nutritious crop foxnut or Makhana from various parts of Bihar and India. And now that Mithila Makhana has received a Geographical Indication designation, it is poised to expand internationally as well. A large business boom and the emergence of makhana billionaires are being anticipated by many in Bihar. The Government of India has committed more than Rs 6,800 crore to support makhana producers, with a target of 10,000 farmer-producer organizations by 2027–2028. Darbhanga was also chosen by PM for makhana farming as part of the innovative “One District, One Product” program.

Proximity to Accessible Markets or Gateways for Darbhanga

Rural tourism destinations must be easily accessible via road, rail and air for potential tourists through various transportation systems. The Amas-Darbhangha Expressway - This 230-kilometer expressway will connect Darbhanga to Aurangabad, Gaya, and Patna. It is expected to be completed soon. The Darbhanga airport is fully functional and has been upgraded to handle more flights after becoming operational. A new IT Park complex and a new medical college is proposed to be built in Darbhanga. The railway station in Darbhanga has a heavy traffic and it connects the city to major other cities in Bihar and India as well. Darbhanga is connected to many national highways like NH 105, NH 57, NH 119 which could be very helpful to promote tourism.

Product Development (Tourism Planning, Infrastructure, and Activities) in Darbhanga

This involves the planning of tourism development in detail, the investment in tourism-related infrastructure, and the provision of a range of activities designed to suit various visitor preferences. The development of rural tourism infrastructure is to be supported through the offering of technical aid, the promotion and facilitation of initiatives, and the execution of economic impact evaluations. The new tourism policy for Darbhanga by both central and state governments is the need of the hour.

Establishment of Visitor Centres at various locations in Darbhanga

Rural communities should have 'May I Help You' centres where visitors can gather information about local attractions, activities, accommodations, and seek guidance from knowledgeable individuals known to the area. Such centres can be established at locations such as Rambag Colony Rd, Mansaar Colony, Darbhanga for tourist coming at Darbhanga fort, Station Rd, Bhatiyaridsarai for Chandradhari Museum, Bera chowk bus stop for Kushweshwar Sthan, Kathalbari near LNMU campus and Sundarpur, Darbhanga where large numbers of tourists arrive.

Collaborative Partnerships and Cultural Heritage Welcome Centres in Darbhanga

To optimize rural tourism marketing strategies, it is essential to establish and leverage potential partnerships within the cultural and heritage sectors. These collaborations can improve the visitor experience by offering additional services such as guidance and increasing awareness about rural tourism sites and historical or cultural events, thereby distinguishing them from other destinations. Nargona Palace is another key heritage site in Darbhanga, known for its architectural grandeur and connection to the royal family. It's a major tourist attraction for those interested in the region's history. A collaborative center here could offer deeper insights into the history of Mithila rulers, host cultural exhibitions, and present folk performances like Maithili music and dance. Ahilya sthan near Kamtaul in district of Darbhanga is linked to the mythological story of Ahilya from the Ramayana, and welcome centres here can attract visitors interested in India's ancient epics and mythology

Conclusion

This research paper has provided a comprehensive insight for rural tourism in Darbhanga district of Bihar, focusing specifically on the major tourist attractions where there is huge potential. Around 500 people were contacted at various locations in Darbhanga and point connecting Darbhanga to neighbouring towns and state capital as well as both primary and secondary observations have been utilised in this manuscript. By deciphering the various

categories—such as eco-tourism, cultural tourism, and agro-tourism—the paper has demonstrated how Darbhanga's rich cultural heritage and natural resources position it as an ideal location for rural tourism development.

In examining Darbhanga's potential, this paper identifies significant opportunities for tourism development. The district's rich tradition of Maithili art, music, and its unique festivals, coupled with its agricultural resources and scenic landscapes, provide a strong foundation for rural tourism. However, realizing this potential requires addressing key challenges such as inadequate infrastructure, limited accessibility, and a lack of coordinated policy implementation. This study contributes valuable insights into the potential for rural tourism in Darbhanga, setting the stage for further research and policy initiatives that can leverage rural tourism as a catalyst for regional development.

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BOOK -REVIEW

Title of the Book	: Chotanagpur Highlands : A Study in Jharkhand Applied Geography
Name of the Author	: Kamla Prasad
No. of Collected Research Papers	: 27
No. of Pages	: 324
Publisher	: Rajesh Publication, New Delhi - 110002
Year of Publication	: 2023
Price	: Rs. 995/-

The above stated book is an important contribution in the field of Applied geomorphology by Dr. Kamla Prasad, former Head, Dept. of Geography, V. B. University, Hazaribag. Dr. Prasad's persona is of high repute and that is clearly evident when we go through the pages of this book. Infact, the book is the collection of such research papers authored by Kamla Prasad which are already published in some leading Journals of Geography and allied disciplines. A few of them are presented with Dr. Nageshwar Prasad who was Professor of Geography, University of Burdwan, West Bengal. Dr. Nageshwar Prasad was Ph.D. research work supervisor of Dr. Kamla Prasad and Dr. Nageshwar Prasad himself has accepted in the 'Foreword' of this book that the entire credit of presenting the research paper with my name goes to Dr. Kamla Prasad who conducted intensive field study and there after, the research papers are presented.

Dr. Nageshwar Prasad has openly acknowledged Dr. Kamla Prasad for showing his geneority towards his teacher. This must be taken as classical example of teacher-taught relationship. Looking into the views of Dr. Nageshwar Prasad, I am confident that Dr. Kamla Prasad has the perfect academic command over all collected research papers. There has been many work on the geomorphological aspects of Chotanagpur Plateau. Prof. S.C. Chatterjee, Dr. R. P. Singh and Dr. E. Ahmad have pioneer work on the evolution, structure, geological complexities and the topographical characteristic of Chotanagpur Highlands.

However, there has not been found any recognisable work on Chotanagpur Highlands in the field of applied geomorphology. Applied Geomorphology addresses the functional viability and applicability of geomorphic features in context of environment, mineral economy, climate, mineral resources, accessibily development, traditional and modern economy, urban growth and the growth of built-up areas, water resources and many other aspects which are within the ambit of sustainable development and human welfare.

The 21st century geography is rapidly emerging as a discipline where micro-area study would provide meaningful and pragmatic conclusions. Such conclusions have immense importance so far as the planning, welfare and development are concerned. Several research paper of this book, particularly related to river basins are highly viable so far as the sustainable development is concerned. One research paper is written in Hindi language. It is found justifiable as its contents are relevant. The language of the book is very simple and impressive, sentences are short structured. There are well drawn maps, Tables, plates etc. to support the applied logics of the theme.

Although the book is welcome, short comings can not be ignored. The book is a contribution in the field of applied geomorphology but no research paper of this book has even used the word applied geomorphology. There is no contextual collaboration with conceptual frame of the core them, i.e applied geomorphology. There is no research paper which justifies the heading of the book.

It would have given a better research syndrom to this book provided the book was started with a chapter where the Chotanagpur Highlands was defined and its distinct geomorphological contents were explained in the applied geomorphological perspective. Again all regions of Chotanagpur Highlands are not covered in the book. Kolhan highlands, Rajmahal highlands, Chaibasa plain are not covered. Rohtas plateau, Hazaribag Plateau and Palamu region have received more coverage in this book.

In spite of some shortcomings, the collected research papers give a privilege to researchers to study Chotanagpur Highlands with several references without turning many pages and many Journals. This book must be taken as an important Indian contribution in the field of applied geomorphology. I am confident that the author would go into the points raised in this review whenever the next edition of the book is published.

R. B. P. Singh
Professor of Geography (Retd.)
Patna University

GENERAL SECRETARY REPORT

**On the Auspicious Occasion of the XXV Annual Conference and National Seminar
of**

The Association of Geographers, Bihar and Jharkhand

October 27-28, 2024

Department of Geography, Patna University, Patna, Bihar

Hon'ble President, Chief Guest, Guest of Honour and Keynote Speaker of today's inaugural Session of 25th Annual Conference cum National Seminar, Dignitaries on the dias, Fellow delegates, Life and Annual Members of the Association, Invited Guests, Students, Media Persons, Ladies and Gentlemen.

I am standing before you to present my Third General Secretary report of the overall activities of the association. It is a matter of great privilege and honour for me to present this report on the occasion of the 25th Annual Conference cum National Seminar under the auspices of the Association of Geographers, Bihar and Jharkhand, which is being attended by a large number of distinguished scholars and researchers, not only from different parts of the states of Bihar and Jharkhand but also from other Indian States and again not only from Geography but also from other branches of knowledge.

Dear fellow members, our association has now become twenty five years old and this year we are celebrating Silver Jubilee year of the Association. This is also Silver Jubilee conference and the journal "Geographical Perspective" is also named as "Silver Jubilee Volume". During these periods, the Association itself has been strengthened in respect of life members, financial position and infrastructure facilities. These have been possible due to the participation by the Post-graduate Departments and Departments of Geography of Colleges of different universities to give an active support in the functioning of the association. These activities helped in increasing our life members to more than 1460. There has been an increase of about 150 members in the last year. There has also been an increase in the number of institutional and annual members.

Dear fellow members, I am happy to inform you that our financial position is also considerably sound. This year also the balance sheet of the account of the Association has been certified by the Chartered Accountant and the Treasurer will present the balance sheet in the General Body Meeting. Our fixed deposit is Rs. 14,23,070/- till 31st March, 2024 The infrastructural facilities of the Association has also improved much during the last few years. Website has been launched and email address of the Association created. We are communicating well with such a large number of members through the website and email of the Association as well as through social media. All relevant information are now available on the website, through the email and Whatsapp social media.

It is our pleasure to inform you that Prof D.P. Singh, our former President has launched an academic programme under the name of Founders and Makers of Modern Geography in India. The 54th episode of this online lecture series is just completed. This programme has received warm response from the Indian sub continent. Now series of Edited Volumes (Books) are in process of publication, covering lectures delivered on the theme. Prof D.P. Singh, Director, Researches of IERAD became Convener of the South Asia Geographers Association (SAGA).

Our journal 'Geographical Perspective' is successful in getting the global recognition by getting indexed in 'J-Gate' which is an international data base of journals. UGC-CARE listing of this journal is in process and we hope to get enlisting in next year. The journal is successful in attracting papers of the scholars from different universities of the country.

Various Department of Geography of the Universities of Bihar and Jharkhand are promoting the subjects by organizing seminars, symposiums, extra – mural lectures, workshop, invited lectures and other academic activities throughout the year. A special lecture was delivered by Prof. P. Saptarshi of Savitri Bai Phule University, Pune, Maharashtra on the occasion of International Day for Disaster Risk Reduction in the Seminar hall of Patna College, Patna University. Prof. Md. Nazim, HOD Geography, Patna University delivered a special invited lecture on the topic 'Significance and Testing of the hypothesis in the Department of Geography, Shibli National P.G. College, Azamgarh, U.P. on October 1, 2023. A Refresher Course in Geography and Geology, Patna University from January 18 to Feb, 02, 2024 on 'Disaster Management and Climate Change Adaption'. A special invited lecture on 'Climate Change and Human Migration was delivered on January 22, 2024 Prof. V.N.P. Sinha former HOD of Geography, Patna University to mark the platinum Jubilee Celebration.

A Special invited lecture of Prof. Salahuddin Qureshi, Ex-chairperson, Department of Geography, AMU, Aligarh and President NAGI was held on 25.04.2024 on the topic 'Revisiting Issues of Climate Change and the Remedial Measures', on the occasion of Silver Jubilee Formation Day of the Association of Geographers, Bihar and Jharkhand. The Department of Geography, Patna University hosted its 'Alumni Jubilee Celebration of the department. Prof. K.C. Sinha, V.C., Patna University inaugurated the event in which more than 150 alumni from various batches and from all over the country attended. P. G. Department of Geography, Patliputra University organized 'Ek Ped Maa ke Naam campaign' A plantation activity in the premise of College of Commerce, Arts & Science on July 17, 2024.

The International Geographical Union (IGU) appointed Dr Gaurav Sikka of A. N. College, Patna as the Chair of International Geographical Union Commission for Young and Early Career Geographers for (2024–2028). Dr Sikka supported the Bihar State Higher Education Council Government of Bihar in Planning, strategy and identification of focus districts for implementing the Prime Minister Uchhtar Shiksha Abhiyan (PM-USHA) in Bihar from 2024 onwards. Dr Sikka presented a research paper entitled “Rural Young Woman achieving

sustainability and cultural gains through Jeevika self help groups in Bihar, India” at 35th International Geographical Congress of IGU hosted by Dublin City University, Dublin Ireland on 24-30 August, 2024. Dr. Vinita Parasad, HOD of geography, A N College, Patna edited a book entitled “Environment solidarity and Defiance” published by Rajesh Publication, New Delhi in 2024. The P.G. Department of Geography, A. N. College organized special lecture on “Harness Geospatial Technology for Efficient Natural Resource management” on September 20, 2024. The Department of Geography, College of Commerce, Arts and Science, Patliputra University organized ICSSR sponsored workshop on “Homeless and Intervention of Deendayal Antyodaya Yojana National Urban Livelihood Mission (Day-NULM): Achievements and Challenges on March to 4, 2024.

Dr. Pintu Kumar, Assistant Professor of Geography, Magadh University Bodh Gaya has been appointed on the Co-ordinator, Nodal Centre of IIRS-ISRO Outreach Programme for e-Learning Course under LMS by IIRS, Dehradun from February 20, 2024. Dr. Kumar also awarded with the Excellence Award-2024 for innovation and Research by Hon'ble Vice Chancellor of Magadh University, Bodh-Gaya.

The P.G. Department of Geography, LNMU, Darbhanga has organized GIS –Day' in collaboration with ESRI on November 15, 2023. Dr. Manu Raj Sharma, Assistant Professor of Geography was appointed as co-ordinator for monitoring of Automatic Weather station in collaboration with India Meteorological Department, Patna. The P.G Department has celebrated 'Earth Day' on April 22, 2024 and 'World Environment Day' on June 5, 2024. Dr. Anuranjan has delivered a lecture on 'Agriculture and Food Security' at VSJ College, Rajnagar, Madhubani on October, 2023.

The P.G. Department of Geography, BNMU, Madhepura took the initiative to raise concern for the degrading current state of environment around the Madhepura Town by celebrating the World Environment Day on June 6, 2024. The PG Department of Geography BRA Bihar University, Muzaffarpur has organized a National webinar in collaboration with Government Degree College, Bagha, West Champaran and Karim City College, Jamshedpur on Climate Change and Environmental Degradation: Causes and Impact and Environmental Degradation on April 22, 2024. Two Minor Research Projects of ICSSR have been initiated one led by Dr. Shirin Hayat, Assistant Professor and other led by Dr. Ida Ella Seema Kerketta, Assistant professor of P.G. Department of Geography, BRA Bihar University, Muzaffarpur. Dr. Anirudh Kumar, Head of the Department of Geography TM Bhagalpur presented a paper entitled “Exploring Climate Change Impact on Rural Livelihood & Adaptation Strategies: Reflection from Marginalized Communities in India” in International seminar organized by Bihar Agriculture University Sabaur, Bhagalpur. The P.G. Department of Geography, V.B. University Hazaribag, has organized a Seminar on “Planet vs Plastic”. The Department in collaboration with 'Vasudha Kalyan' NGO has organized a plastic cleaning programme in Eco-sensitive Canary hill area.

In addition to above facts, Geography departments of different universities and colleges several academic activities like Seminar, Symposium, Workshop invited lecture, Poster exhibition etc. both off-line as well as on-line. Several guest faculties and regular teachers have joined respective Geography departments of Bihar and Jharkhand. A large no. of PG teachers have also joined in +2 School in Bihar. We seize this occasion to congratulate them and also request them to associate themselves with the Association to carry it forward and to make it an association of new generation geographers. I am sorry to state that due to shortage of time, achievements of several geographers of Bihar and Jharkhand in the fields of book writing, receiving awards, attending national and international seminars, getting promotion, etc. are not being presented here. I on behalf of the association congratulate them and wish to have a bright future. Most of them are mentioned in the Departmental news of the Universities of Bihar and Jharkhand.

I, as a General Secretary of the Association request all those life members who have not furnished their email or contact number kindly submit the same to the office of the Association. You are also requested to be a regular follower of our website for any kind of information. All newly recruited teachers in Geography are specially requested to come forward to become actively associated with the Association. Your association will give a new generational move to the Association.

At the end I once again express my sincere thanks to all of you for your kind co-operation and support in running the Association. I am sure that our bond to work together will promote the cause of Geography and we shall succeed in establishing Geography as an indispensable subject in coming years. We need to work academically on challenging issues in a systematic and scientific way so that stakeholders in the field of planning and development may not be able to ignore the importance of Geography.

I hope that your two-day stay at historic town of Patna will be academically very fruitful. At the end, I owe my deep sense of gratitude to the organizers specially convener and organizing secretary of this conference who have provided all kinds of facilities satisfactorily.

Thanking you all once again.

Jai Bihar, Jai Jharkhand, Jai Bhoogol.



(Dr. Manoj Kumar Sinha)

General Secretary, AGBJ
email: agbj2003@gmail.com

THE ASSOCIATION OF GEOGRAPHERS BIHAR & JHARKHAND

DEPARTMENTAL NEWS

PATNA UNIVERSITY, PATNA

1. Prof. (Dr.) Md. Nazim, Head, Department of Geography, Patna University, delivered a special invited lecture on the topic '**Significance and Testing of the Hypothesis**' in the postgraduate Department of Geography, Shibli National P.G. College, Azamgarh, U.P on 01.10.2023
2. **Special lecture on International Day for Disaster Risk Reduction**
A special lecture was organised on 13.10.2023 on the topic “**International Day for Disaster Risk Reduction**” by Prof. Praveen Saptarshi, Former Head, Department of Environmental Sciences, Savitri Bai Phule Pune University, Pune in the Seminar Hall of Patna College, Patna. Program was organised by P.G. Department of Geography in collaboration with Patna College and AGBJ, Patna. The program was started with the welcome address of the Head, Department of Geography, Professor Mohammad Nazim, Dr. Manoj Kumar Sinha, Head, Department of Geography, Patna College proposed the vote of thanks. A large number of students, teachers and scholars participated in the program.
3. **Celebration of National Unity Day**
The National Unity Day was celebrated in Department of Geography, Patna University on 31.10.2023. All the teachers, scholars and staff members as well students were present on this occasion and all took pledge to keep unity of the nation. The Head of the department Professor Mohammad Nazim made all the teachers and students took pledge for National Unity.
4. Dr. Debjani Sarkar Ghose published an article on the 'Impact of Alcohol Prohibition in Bihar: A Case Study of Patna Municipal Corporation' in Geographical Perspective, by Association of Geographers Bihar and Jharkhand in October 2023, Vol. 24, pp 16-31.
5. Prof. Md Nazim, Head Department of Geography, Patna University, attended and presided a technical session of 24th annual conference and national seminar of the Association of Geographers, Bihar and Jharkhand (AGBJ) which was held in Ranchi University, Ranchi on 4th and 5th November 2023. Dr. Vivek Kumar, a Guest Faculty of

Department of Geography also attended the seminar and presented a research paper on Impact of Rural Service Centers on changing patterns of Crop Cultivation: A Micro Level Study of Chhotki Math Center of Jahanabad District, Bihar.

6. Swachh Bharat Abhiyaan

The Swachh Bharat Abhiyaan in context of AECC- I Course was organized by the students of M.A semester-I, Session: 2023-2025 in the Department of Geography from 11.30 am to 2.30 pm on 07.11.2023. Besides students, all the teachers and scholars also took part in cleaning the class rooms, seminar hall, Laboratory as well as the premises of the department.

7. Dr. Vivek Kumar and Dr. Akhtar Abid Ali, Guest Faculties of the Department of Geography attended Two Day National Workshop on the topic National Education Policy 2020: Model Curriculum and Content in Geography organized by Central University of South Bihar, Gaya and Vidya Bharti Uchcha Shiksha Sansthan in collaboration with Indian Council of Social Science Research (ICSSR), Ministry of Education, Government of Bihar on 10th -11th December.

8. Parent- Teachers Meet

Parent- Teachers Meet of the students of M.A. Semester-1, Session: 2023-2025 was held on 12.12.2023 at 11.30 am in the Seminar Hall of the department under the aegis of “Platinum Jubilee Celebration” of Department of Geography, Patna University to discuss the students progress and solution to their academic problems. Professor Mohammad Nazim, the head of the department along with all the teachers were present in the meet and discussed the problem of attendance, progress and participation in other academic activities.

9. Condolence Meeting of Professor R.N.P. Sinha and Professor B. Thakur

A condolence meeting of teachers, research scholars, students and staff members of Department of Geography, Patna University and Patna College was held in the memory of the sad demise of Professor B. Thakur and Prof. R.N.P. Sinha. The meeting was organised in the Seminar Hall of the department on 10th of January, 2024 at 2:30 pm to pay homage to the departed soul. Both were the alumni and teachers of the department. We pray to almighty that their souls may rest in peace and also pray to provide strength to the family to bear the loss.

10. Logo Release Ceremony of Platinum Jubilee Celebration

Release of Logo for Platinum Jubilee Celebration of Department of Geography, Patna University, Patna was held on 16.01.2024 at 3:00 pm. It was released by Prof. K.C.

Sinha, the Honorable Vice Chancellor, Patna University. The function was held in the Seminar Hall of the department in which many senior and reputed teachers as Prof. R.B.P. Singh, Prof. K.N. Paswan, Prof. Sanjay Kumar Sinha and Prof. Mohammad Nazim, Head of the Department had participated.

11. Refresher Course in Geography and Geology

A Refresher Course in Geography and Geology was organized in the Department of Geography and Geology from 18.01.2024 to 02.02.2024 on the focal theme “**Disaster Management & Climate Change Adaptation**”. Prof. (Dr.) Md. Nazim, Head, Department of Geography, and Prof. (Dr.) Anil Kumar, Head, Department of Geology were the co-ordinators of the Refresher Course. Teachers of Geography and Geology from different universities of Bihar had participated in the course.

12. Special Invited Lecture on “Climate Change and Human Migration”

The Special Invited Lecture on “Climate Change and Human Migration” was held today on 22.01.2024 at 12:00 Noon in the Seminar Hall of the department to mark the starting of Platinum Jubilee Celebration after release of the logo on 16.01.2024. Prof. Md. Nazim, Head, Department of Geography welcomed the Guest speaker Prof. V.N.P. Sinha and other faculty members of the department as well as from other universities of Bihar.

- 13.** Prof. Md Nazim, Head Department of Geography, Patna University has delivered a special invited lecture on the **Concept and Testing of Hypothesis** in Ph.D Coursework of University Department of Geography, B.R.A, Bihar University, Muzaffarpur on 01.02.2024

14. Special Invited Lecture on “Overview of Central Ground Water of India”

The Special Invited Lecture on “Overview of Central Ground Water of India” was held today on 02.02.2024 at 10:30 am in the Seminar hall of the department as a series of events to mark the Platinum Jubilee Celebration of the department. The lecture was delivered by Dr. Alok Kumar Sinha, Scientist-D, Central Ground water Board, MER, Patna.

- 15.** Dr. Debjani Sarkar Ghose delivered a lecture on **Urbanization and Climate Change** on 22nd January 2024 as a resource person in the Refreshers' Course organized by the Department of Geography and Geology from 18th January to 2nd February 2024.

- 16.** Dr. Vivek Kumar, Guest Faculty Department of Geography published a research paper on the topic “Impact of Rural Service Centers on Changing Patterns of Chhotkimath

Center of Jehanabad District, Bihar (2001-2021) in Periodic Research, Vol-XII, issue III, February 2024.

17. Fresher's cum Farewell Programme

A Fresher's cum Farewell Function by the students of M.A. Semester-IV has been organised today on 08.02.2024 at 11:30 am in the Seminar Hall of the department. The students of M.A. Semester II and M.A. Semester IV participated the function in large number. Prof. Md. Nazim, Head of the department, attended the function along with other faculties of the department.

18. Poster Making Competition on “Natural Disaster and its Management”

A Poster Making Competition on “**Natural Disaster and its Management**” was organised in the Department of Geography, Patna University on 22.02.2024 at 12:30 pm in the Seminar Hall and Room No. 32 on the occasion of Platinum Jubilee Celebration of the department. The students of M.A. in Geography, Semester II and Semester IV participated in the competition.

19. Alumni Meet

The Department of Geography, Patna University hosted its 'Alumni Meet' on March 10, 2024 on the occasion of Platinum Jubilee Celebration of the department. Prof. K. C. Sinha, Hon'ble Vice Chancellor, Patna University inaugurated the event and Prof. Mohammad Nazim, Head of the Department welcomed the alumni. Large number of alumni from various batches and from all over the country attended the meet, shared their experiences and interacted with their batch mates and teachers. The senior most alumni attended the meet were Prof. L.N. Ram, Prof. V.N.P. Sinha, Prof. R.B.P. Singh and Shri Rajvardhan Sharma. A commemorative “Alumni Diary” containing details of the department and brief profile of the alumni was released on this occasion. The Meet also provided a platform for current students to interact with the alumni and attaining valuable insights for their career opportunities.

20. Condolence Meeting of Manish Kumar 'Badal' (M.A. Sem. IV, Session 2022-2024)

A condolence meeting of teachers, research scholars, students and staff members of Department of Geography, Patna University was held on 11.03.2024 at 12:00 Noon in the Seminar Hall. The meeting was organised in the memory of sad demise of our very promising student Manish Kumar 'Badal', a student of M.A. Semester IV, to pay homage to the departed soul. All the persons present in the meeting prayed to provide strength to the family to bear the great loss and the departed soul may rest in peace.

21. Dr. Debjani Sarkar Ghose delivered an invited lecture on 'Climate Change and its Impact on Human Health in Bihar with special reference to Smart City Patna' in the regional

workshop on CHARISMA: Climate Health Risk Management in India Dissemination and Impact, organized by Ashoka University, New Delhi and ADRI, Patna on 5th March 2024.

22. Parent -Teachers Meet

A Parent-Teachers Meet was organised for the students of M.A. Semester IV, Session 2022-2024 and M.A. Semester II, Session 2023-2025 in the Department of Geography, Patna University on 19.04.2024 to discuss student's progress and solution to their academic problems. Professor Mohammad Nazim, the Head of the department along with all other teachers was present in the meet and discussed the problem of attendance, progress and participation in other academic activities.

23. Quiz Competition on “Our Earth and Environment”

A Quiz Competition on “Our Earth and Environment” was organised in the Seminar Hall of the department on 22.04.2024 at 12:30 pm in which large number of students from M.A. Semester II and M.A. Semester IV participated. All the teachers of the department were present on this occasion. The Competition was organised on the occasion of Earth Day and as a series of events to mark the Platinum Jubilee Celebration of Department of Geography, Patna University, Patna.

24. One day National Symposium on “Climate Change and Agrarian Practices in India”

A One Day National Symposium on “Climate Change and Agrarian Practices in India” was organised on 25th April 2024 in Department of Geography, Patna University. Teachers, students and research scholar from different institutions actively participated in the event. Prof. Salahuddin Qureshi, Ex-chairperson, Department of Geography, A.M.U. Aligarh and President, NAGI, 2024 and Prof. Ram Pravesh Yadav, former Head, Department of Geography, BRABU, Muzaffarpur were the resource persons of the technical sessions. The event was very fruitful and it has shown new directions towards the field of research. Professor Md. Nazim, Head, Department of Geography was the convener and Dr. Debjani Sarkar Ghose was the organising secretary of the symposium. A large number of teachers and scholars from Bihar and other states participated in the symposium.

25. 25th Foundation Day Lecture of AGBJ on “Revisiting Issues of Climate Change and the Remedial Measures”

A Special Invited Lecture of **Prof. Salahuddin Qureshi**, Ex-chairperson, Department of Geography, A.M.U. Aligarh and President, NAGI, 2024 was held on 25.04.2024 on the topic “Revisiting Issues of Climate Change and the Remedial Measures” on the

occasion of Silver Jubilee Foundation Day of Association of Geographers, Bihar and Jharkhand (AGBJ). The said foundation day lecture was organised in the Seminar Hall of Department of Geography, Patna University, Patna. Prof. Mohammad Nazim, Head of the Department welcomed the Guest Speaker and other geographers present and felicitated Prof. Qureshi with a shawl and a plant on this occasion. Professor Manoj Kumar Sinha, Head, Department of Geography, Patna College presented the vote of thanks.

26. Plantation Drive

The Department of Geography, Patna University organized a “Plantation Drive” in collaboration with Sanjay Gandhi Biological Park on 16.07.2024 at 2:30 p.m. The Plantation Drive had carried on in the campus of the department under the series of events to mark its Platinum Jubilee Celebration.

27. Anti-ragging Awareness Week

An anti-ragging awareness week was organized in the Department of Geography, Patna University from 12.8.2024 to 18.8.2024.

- 28.** Dr. Perna Bharti, Guest Faculty Department of Geography, Patna University presented a paper on the topic “Spatio- Temporal Analysis of the Changing Electoral Culture of Women in Bihar” at the 35th International Geographical Congress, on 24-30 August 2024, organized by Dublin City University, Dublin, Ireland.

29. Climate Change and Safe Drinking Water

Prof. Nupur Bose, Former Head, Department of Geography, A. N. College, Patliputra University, Patna has delivered an invited Special Lecture on “Climate Change and Safe Drinking Water” on 29.08.2024 (Thursday) at 12:00 PM in the Seminar Hall of the Department of Geography, Patna University, Patna.

- 30.** Dr. Debjani Sarkar Ghose has presented a paper on “Climate Change and Threat to Vector Born Diseases and Heat Stress in Bihar and Co-Chaired a Technical Session on Climate at 8th National Association of Geographers, India (NAGI) on 23-25 September 2024, organized by the Department of Geography, Kazi Nazrul University, Asansol, West Bengal, India.

PATLIPUTRA UNIVERSITY, PATNA

A. UNIVERSITY DEPARTMENT OF GEOGRAPHY:-

1. Dr. Manoj Kumar, Head, University Department of Geography, departed to his heavenly abode on 08/02/2024 due to prolonged health issues.
2. Dr. Anoop Kumar Singh was appointed as Head, University Department of Geography on 21/02/2024.
3. Following three research papers of Dr. Anoop Kumar Singh was Published:
 - a) “Achieving the Sustainable Development Goals (SDGs) in the Samastipur district of Bihar: Challenges and Opportunities” Journal: MANVIKI, Volume: XV, Edition: July-December 2023, ISSN: 0975-7880.
 - b) “Importance of Education for Sustainable Development in Samastipur District, Bihar, India” Journal: International Journal for Multidisciplinary Research (IJFMR), Volume: 6, Issue: Edition: July-August 2024 E-ISSN: 2582-2160.
 - c) Journal name: -Regional Symbiosis, ISSN 0972-2041, Entitled “Evolution of Crop-Based Economy from River Shifting and Geo special Relations in the Kosi Basin, Bihar, India”.
 - d) “ग्रामीण-पर्यावरणीय पर्यटन: मधुबनी में विकास के संभावित नए आयाम” Journal: JIGYASA, Volume: 16 September 2023 No. III, ISSN: 0974-764
 - e) “मधुबनी में ग्रामीण पर्यावरणीय पर्यटन और समावेशी विकास” Journal: VAICHARIKI, Volume: 14, Issue I, March 2024, ISSN: 2249-8907
4. “Ek Ped Maa Ke Naam Campaign”- plantation activity conducted by departmental students in the College of Commerce Arts and Science Campus on July 17th, 2024

B. A. N. COLLEGE, PATNA

Research Paper Publication

1. **Dr Vinita Prasad:** Article titled “**Role of Traditional and Indigenous Knowledge in Disaster Risk Management.**” Book- Indigenous Knowledge and Disaster Risk Reduction: Insight Towards Perception, Response, Adaption and Sustainability. Published in Pg. no.19-34, 2023, Disaster Risk Reduction, ISBN 978-3-031-26142-8, ISSN-2196-4114.

2. **Dr Vinita Prasad:** Article titled “**Perception and Response regarding Urban Sustainability: A Case Study of Patna Municipal Corporation Area.**” Published in “International Journal of research and analytical reviews (IJRAR), (E- ISSN: 2348 – 1269), Volume 11, Issue 1 March'2024.
3. **Dr Vinita Prasad:** Article titled “**Impact of Climate Change on Urban Environment: A case Study of Patna Municipal Corporation Area.**” Published in MANAVAKI, An International, Peer Reviewed and Refereed Research Journal of Humanities & Social Sciences, (ISSN: 0975 – 7880) July-December'2024.
4. **Dr Vinita Prasad:** Article titled “**Impact of growing population and changing land use pattern on urban ecology: A study of Patna Planning Area**”, An International, Peer Reviewed and Refereed Research Journal of Humanities & Social Sciences, (ISSN: 0975 – 7880) January-June, December'2024.
5. **Dr Vinita Prasad:** Article titled “**Dynamics of Population and Land Use towards Sustainable Development in Patna Planning Area**”, published in International Journal for Research in Applied Science & Engineering Technology (IJRASET) (ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538, Volume 12 Issue III Mar 2024.
6. **Dr Vinita Prasad:** Article titled “**Siwan Jeele Mai Madhya Purva kedeshomai Prvas Janit Rozgar keAwaser ka Vikash: ek BhogolikAdhyaan**”. Published in “International Journal of research and analytical reviews (IJRAR), (E- ISSN: 2348 – 1269), September 2024, Volume 11, Issue 3.
7. **Dr Vinita Prasad:** Article titled “**Dimensions of Urban Green, Blue and Brown: A Case Study of Patna Municipal Corporation.**” Published in, Book- Urban Ecosystem and Sustainable Development, Pg. 125-138,2023, Rajesh Publication, New Delhi, ISBN 978-93-91139-76-6.
8. **Dr Vinita Prasad:** Published edited book titled “**Environmental Solidarity and Defiance**”. Edited by Dr. Vinita Prasad, ISBN- 978-93-91139-62-9, Rajesh Publication, New Delhi.
9. **Dr Bhawana Nigam:** Article titled “**An Analysis of Climate Change and Sustainable Development Programs in Bihar.**” Published in International Center for Scientific Research and Development (International Journal) Pg. no.01-14, Volume 01, Issue 01 (2023) ISSN: 2583-6722 (Online)
10. **Dr Bhawana Nigam:** Article titled “**Role of Traditional and Indigenous Knowledge in Disaster Risk Management.**” Book- Indigenous Knowledge and Disaster Risk Reduction: Insight Towards Perception, Response, Adaption and Sustainability.

Published in Pg. no.19-34, 2023, Disaster Risk Reduction, ISBN 978-3-031-26142-8, ISSN-2196-4114.

11. **Dr Bhawana Nigam:** Article titled “**Social, Economic and Environmental Impacts of Urban Sprawl: A Case Study of Patna Urban Agglomeration.**” Published in , Book- Urban Ecosystem and Sustainable Development, Pg. 125-138,2023, Rajesh Publication, New Delhi, ISBN 978-93-91139-76-6.
12. **Dr Gaurav Sikka:** Article titled “Site Suitability Analysis for Municipal Solid Waste Management System in Ranchi City using AHP: A Multi-Criteria Decision Approach, **Environmental Quality Management**, Aug'2024 Vol. 34, Issue 1, e22312, Wiley, New York

Faculty Achievements

1. **Dr Gaurav Sikka:** The International Geographical Union appointed Dr. Gaurav Sikka as the Chair of the *International Geographical Union Commission for Young & Early Career Geographers (2024-2028)*
2. **Dr. Gaurav Sikka** supported the Bihar State Higher Education Council, Govt. of Bihar in planning, strategy and identification of Focus Districts for implementing the Prime Minister Uchhatar Shiksha Abhiyan (PM-USHA) in Bihar from 2024 onwards.

Paper Presentation

1. **Dr. Gaurav Sikka** presented research paper entitled “**Rural Young Women Achieving Sustainability and Cultural Gains Through Jeevika Self-Help Groups In Bihar, India**” at 35th International Geographical Congress of International Geographical Union (IGU) hosted by Dublin City University, Dublin, Ireland 24-30 August 2024. Dr. Sikka received **IGU Travel Grant and Registration Fees Waiver** to participate in 35th International Geographical Congress, Dublin, Ireland.

Workshop/Training

1. **Dr. Gaurav Sikka** completed Refresher Course in Geography with grade A+ from UGC-MMTC DDU Gorakhpur, University from 30 January 2020- 12 February 2024.

Invited Lecture/Resource Person

1. **Dr Vinita Prasad:** Delivered a special lecture on th topic of “**Environment, Climate Change and consciousness**” on 29th January 2024 at two days National Seminar at B D College, Patna.
2. **Dr Vinita Prasad:** Delivered a Special online lecture on “Gandhian Approach to rural Development”, at P G department of Geography, Maharaja College, VKSU, Ara.

3. **Dr Bhawana Nigam:** Delivered a lecture, on the topic “**Transforming Deserts: Global and Indian Initiatives in Desertification Mitigation and Land Restoration**”. On the occasion of World Environment Day at the Bihar State Productive Council.
4. **Dr. Gaurav Sikka:** Resource Person at 22nd Faculty Induction Programme organized by UGC-MMTTC Ranchi University on 16-03-2024.
5. **Dr. Gaurav Sikka:** Delivered an invited lecture as a Resource Person at ICSSR Capacity Building Workshop for PhD Research Scholars, A.N. Sinha Institute for Social Studies, 11 March 2024.
6. **Dr. Gaurav Sikka:** Delivered an invited lecture as resource person on “**Collecting, Analyzing and Sharing Qualitative Research Data**” at National Seminar organized by S.U. College, Hilsa, Patliputra University on 14th September 2023.

Student Activity 2024

1. 12 July 2024: Induction meet with UG SEM-1 (2024-28)

An induction meeting was organized for students of UG SEM-1, session 2024-28. The students were acquainted the syllabus, internal assessment exams, practical files, and other rules and regulations of the college.



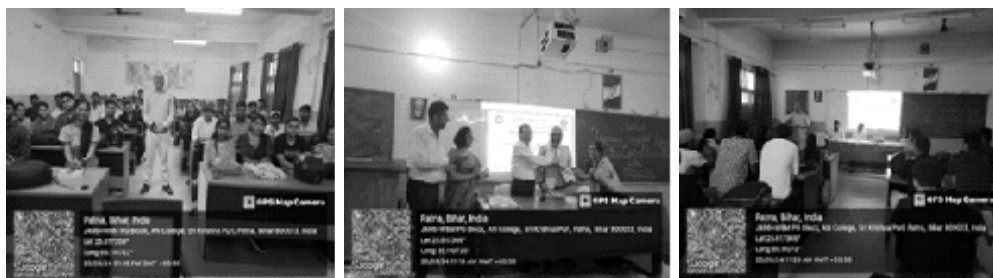
2. 15 July 2024: poster and slogan competition

On the occasion of World Population Day, the department organized a poster and slogan competition on the topic of population resources. Prof. K. Veena, Department of Economics and Dr Henna Tabassum, Department of Sociology were invited as judges. They appreciated the hard work done by the students and declared the winners. organized by the department.



3. 20 September 2024: special lecture by Dr Suraj Kumar Singh

The geography department organised a special lecture on “Harness Geospatial Technology for Efficient Natural Resource Management” on 20th September. The chief speaker Dr Suraj Kumar Singh from the Center of Climate Change and Water Resource, S. G. V. University, Jaipur, Rajasthan gave a lecture on “The importance of Geospatial Techniques such as Remote Sensing and GIS” helps in Finding solutions regarding any Natural phenomena. The Principal, Prof. Praveen Kumar, and all the faculty members were present on the occasion.



C. College of Commerce Arts and Science, Department of Geography:-

Departmental Activities:

1. Teachers Day Celebration in the department by students on September 5 th , 2024.
2. Induction Meet organized for newly admitted undergraduate students' session 2024-2028 on July 15th , 2024
3. “Ek Ped Maa Ke Naam Campaign”- plantation activity conducted by departmental students in the college campus on July 17 th , 2024
4. GIS Lab Exposure visits was conducted by Secondary Students of Delhi Public School (DPS) Patna, under SSR Activity on April 6 th , 2024.

Dr. Rashmi Ranjana

1. Presented a paper entitled “Dengue Fever outbreak associated with rain and water logging in selected parts of Patna” in XXIV Annual Conference & National Seminar; Organized on the theme of 'Climatic Vulnerability: Challenges to Physical Landscape and Human Response' by Association of Geographers Bihar & Jharkhand (AGBJ);& University Department of Geography, Ranchi University, Ranchi on November 4 th - 5 th , 2023.

2. Published a Chapter entitled “Impact of Environmental Pollution on the Health of Workers engaged in Informal Economy: A Case Study of Patna Metropolitan City” in the edited book on Urban Dynamics, Environment and Health – An International Perspective edited by Braj Raj Kumar Sinha. Sahay, A., & Ranjana, R. (2024). Impact of Environmental Pollution on the Health of Workers Engaged in Informal Economy: A Case Study of Patna Metropolitan City. In Urban Dynamics, Environment and Health: An International Perspective (pp. 391-411). Singapore: Springer Nature Singapore.

Dr. Vidya Yadav

- I. Working on the project on edited book as an editor entitled “The Built Environment and Public Health in India - Opportunities, Challenges, and Future Pathways” in the book series on New Frontiers in Regional Science: Asian Perspectives in Springer Nature Singapore Pvt. Ltd.
- II. Coordinate & Organized Ten Days 'Research Methodology Workshop' from 20th September to 1st October, 2024.
- III. Delivered a lecture on World Population Day, July 11th, 2024 on the topic of “Sedentary Lifestyle: A potential Risk for Growing Urban Population” at Maharaja College, Ara, Bihar.
- IV. Organized an ICSSR Sponsored Dissemination Workshop and Discussion on Homeless and Intervention of Deendayal Antyodaya Yojana National Urban Livelihood Mission (DAY-NULM): Achievements & Challenges” on March 4th, 2024.
- V. Completed 'UGC-MMTTC Refresher Course' in Geography & Geology Organized in Patna University, Patna.
- VI. Media Coverage of Research Work entitled “What causes loneliness among household heads: a study based in primary setting in Mumbai, India” in “Down to Earth”.
- VII. Participated in Round Table Discussion on “Child's Rights and SDGs in Bihar organized by Govt. of Bihar and UNICEF” on December 8th, 2023
- VIII. Presented Paper entitled “Assessment of Green Jobs in India: Harnessing Potential for Sustainable Future” in XXIV Annual Conference & National Seminar; Organized on the theme of 'Climatic Vulnerability: Challenges to Physical Landscape and Human Response' by Association of Geographers Bihar & Jharkhand (AGBJ) & University Department of Geography, Ranchi University, Ranchi on November 4th - 5th, 2023.

- IX. Got Project on “Assessment of Deendayal Antyodaya Yojana (DAY) Utilization by Urban Homeless: A study in the selected areas of Bihar” funded by ICSSR, New Delhi during the period August 28th, 2023 to April 25th, 2024.

D. Ram Krishna Dwarika College, Patna, Department of Geography.

1. World Photography day was celebrated in the Department from 14-19 August 2023.
2. International Ozone Day was celebrated on 16th September, 2023.
3. National Wetlands Day was celebrated on 2nd February, 2024.

E. Nalanda College, Bihar Sharif (Nalanda) Department of Geography.

1. A talk was given by Dr. Krishnanand, co-founder Geoecologist on the topic “Natural Disaster and Sustainable Development. on 22.07.2023.
2. A Survey Camp was organized on 12.10.2023 for P.G. Sem. III student.
3. A talk was given by Dr. Vidya Yadav, Assistant Professor, COCAS on the occasion of Savitribai Phule Jayanti on 04.01.2024.
4. Indoor Plantation drive by organized on World Ozone Day on 14.09.2024.

B.R.A. BIHAR UNIVERSITY, MUZAFFARPUR

News Updates :-

1. **Dr. Shirin Hayat** has joined the University Department of Geography as an Assistant Professor. Previously serving at S.R.A.P. College, Bara Chakia, Dr. Hayat officially became part of the department on February 21, 2023. Her extensive expertise and dedication to the field will undoubtedly enhance the department's academic endeavors.
2. **Prof.(Dr.) Rupa Kumari** transferred from M.D.D.M. College and joined the department on May 22, 2023. At present she is head in charge of the department because of kidney transplant surgery of the head Prof. (Dr.) Md. Jafar Imam.
3. **Prof.(Dr.) Pramod Kumar** also joined the University Department of Geography on May 22, 2023, coming from R.D.S. College.
4. **Dr. Ida Ella Seema Kerketta** transferred from MDDM College and became a part of the University Department of Geography on May 22, 2023. Her academic background and commitment to teaching make her a valuable addition to the department.
5. The department would also like to honor **Professor Dr. Ram Pravesh Yadav**, the former Head of the Department, who superannuated on July 31, 2023. Dr. Yadav's distinguished leadership and service to the department have left a lasting legacy, and he will be greatly missed.

Seminar and Webinar Updates :-

The University Department of Geography at B.R.A. Bihar University, Muzaffarpur, has been actively engaged in a series of seminars and webinars to promote academic growth and awareness on pressing environmental issues. Below is a summary of the recent activities:

1. **National Webinar on Climate Change and Environmental Degradation**
In collaboration with Government Degree College, Bagaha (West Champaran), and Karim City College, Jamshedpur (Jharkhand), the department hosted a national webinar on April 22, 2024, addressing "Climate Change and Environmental Degradation: Causes and Impacts." Participants examined the global consequences of climate change and ways to combat environmental degradation.
2. **Career Counseling**
A career counseling was held on April 30, 2024, with over 100 students participating. The session provided guidance on career opportunities in geography, emphasizing the growing need for expertise in environmental studies and geo spatial technologies.

3. Webinar on Environmental Pollution and Human Health

A one-day webinar was conducted by the department on the topic “Environmental Pollution and Its Impact on Human Health.” On May 4, 2024, This event highlighted the detrimental effects of pollution on public health and discussed potential mitigation strategies.

4. Seminar on Climate Change: Causes and Consequences

On May 6, 2024, the department organized a one-day seminar titled “Climatic Changes: Causes and Consequences – Current Perspectives.” The seminar discussed the contemporary challenges posed by climate change and proposed actionable solutions to minimize its effects.

Research Projects Initiated by Department Faculty

The faculty of the University Department of Geography, B.R.A. Bihar University, Muzaffarpur, have undertaken important research projects that explore socio-economic and geographical issues. Below are two notable projects currently in progress:

1. शोध परियोजना का शीर्षक (Title of the Project) मुजफ्फरपुर में मुस्लिम महिलाओं की आर्थिक भागीदारी और आजीविका रणनीतियाँ: एक भौगोलिक दृष्टिकोण

(Economic Participation and Livelihood Strategies of Muslim Women in Muzaffarpur: A Geographical Perspective)

This minor research project is being led by **Dr. Shirin Hayat**. The study focuses on analyzing the economic participation of Muslim women in Muzaffarpur and understanding the livelihood strategies they adopt. It aims to explore the socio-economic challenges and opportunities faced by these women from a geographical viewpoint.

2. शोध परियोजना का शीर्षक (Title of the Project) सिमडेगा जिला में खड़िया जनजाति का अस्तित्व संकट में: एक भौगोलिक अध्ययन

(Existential Crisis of the Kharia Tribe in Simdega District: A Geographical Study) **Dr. Ida Ella Seema Kerketta** is leading this significant project, which examines the existential challenges faced by the Kharia tribe in the Simdega district. The research aims to investigate the factors leading to their declining population and cultural erosion, with a geographical perspective on their living conditions, resources, and societal integration.

MAGADH UNIVERSITY, BODHGAYA

1. Special Lecture Series

- A special lecture was organised by the Department under the aegis of IQAC on August 03, 2024 on the topic “Challenges and Solutions of Environment Education through Awareness, Skill Development and People Participation”. The Guest Speaker was Prof. K.P. Goswami from Department of Geography, Institute of Science, Banaras Hindu University, Varanasi.
- A special lecture was organised by the Department under the aegis of IQAC on September 09, 2024 on the topic “Urbanisation and Development: A threat to Global Climate Change”. The Guest Speaker was Prof. Atiqur Rahman from Department of Geography, Faculty of Natural Sciences, Jamia Milia Islamia, New Delhi.

2. Publications of Faculty Members

- Dr. Meenakshi Prasad published a joint paper with Dr. D.C. Verma titled “Socio-Economic Determinants of Household Size: A Spatial Analysis of Bihar” in *Geographical Perspective*, Vol. 24, pp 80-96, ISSN – 0970-809X (Peer Reviewed)
- Dr. Maushami published a research paper titled “Impact of Air Pollutants on the Maternal Health in the Coal Mining Areas of Dakra Region, Ranchi District, Jharkhand (India): A Case Study” in the *International Journal of Research and Analytics Reviews (IJRAR)*, April, Vol. 11, Issue 2, pp. 829-838, 2024, ISSN No. 2348-1269 (Open Access, Peer Reviewed)
- Mr. Rakesh Kumar published a research paper co-authored with Prof. Veerendra Kumar titled “Spatiotemporal Variations in Child Undernutrition in Bihar: A District Level Analysis” in the *Int. J. Geogr. Geol. Environ.*, 2024;6(1):01-09, ISSN:2706-7483, DOI: <https://doi.org/10.22271/27067483.2024.v6.i1a.193>
- Dr. Meenakshi Prasad published a book chapter co-authored with D.C. Verma and Janardan K. Yadav titled *Walking in Bodh Gaya: A Gendered Approach to the Analysis of Sustainable Tourism Policies*. In: Walker, T., Demir, E., Machnik-Kekesi, G., Kelly, V. (eds) *Sustainable Tourism: Frameworks, Practices, and Innovative Solutions* (pp 277–299). Palgrave Macmillan (Springer Nature), Cham. https://doi.org/10.1007/978-3-031-43528-7_13

- Dr. Meenakshi Prasad & Dr. Maushami, published a research paper co-authored with Dr. Neeraj Raj titled “Tourism Infrastructure in Bihar” in the International Journal of Novel Research and Development (IJNRD), Vol. 9, Issue 8, August 2024, ISSN No. 2456-4184 (Open Access, Peer Reviewed)

3. Seminars/ Conferences/ Workshops/ Refresher Courses attended by Faculty Members

- Dr. Pintu Kumar participated in the XXIV Annual Conference & National Seminar of AGBJ organised by the University Department of Geography and IQAC, Ranchi University, Ranchi on 4th & 5th November, 2024 and presented two research papers titled “Land-use Pattern and Peri-Urban Development in Bodh Gaya, Bihar” and “Uruvela Gaon se Vaishvik Bodh Gaya Parivartan Mein Paristhitik Tantra ka Bhaugolik Adhyan”.
- Dr. Meenakshi Prasad attended and successfully completed the NEP 2020 Orientation and Sensitization Programme under Malaviya Mission Teacher Training Programme (MM-TTP) of University Grants Commission (UGC) organised by UGC-Malaviya Mission Teacher Training Centre, Patna University, Patna from 01.11.2023 to 11.11.2023.
- Mr. Rakesh Kumar participated in the 45th Indian Geography Congress and International Conference of the National Association of Geographers, India (NAGI) organised by Department of Geography, Savitribai Phule Pune University (SPPU), Pune from 14.12.2023 to 16.12.2023 and presented a paper titled “A Geographical Analysis of the Status of Child Undernutrition and Nutrition- Sensitive Government Initiatives in Bihar”.
- Dr. Pintu Kumar attended a NEP-2020 Orientation and Sensitisation Programme organised by MMTTP, JNU New Delhi from 11-20 December 2023.
- Dr. Pintu Kumar participated in the International Seminar on ‘Mindfulness – The Way of Conflict Resolution’ organised on the auspicious occasion of Buddha Mahotsava 2024 on 20th January 2024
- Dr. Meenakshi Prasad successfully completed the UGC- sponsored ‘Refresher Course in Geography and Geology’ organised by Malaviya Mission Teacher Training Centre (MMTTC), Patna University, Patna from 18.01.2024 to 02.02.2024.

Geographical Perspective

- Dr. Pintu Kumar successfully completed the ‘16th Refresher Course in Geography’ organised by MMTTC, DDU, Gorakhpur from 30.01.2024 to 12.02.2024
- Dr. Maushami attended a NEP-2020 Orientation and Sensitisation Programme organised by UGC-MMTTC, Shri Mata Vaishno Devi University, Katra, Jammu and Kashmir from January 22-31, 2024
- Dr. Maushami attended a Five-Day online workshop on ‘Geo-spatial Analysis using Google Earth Engine’ organised by Department of Space, Government of India, IIRS Dehradun and ISRO from February 19-23, 2024.
- Dr. Meenakshi Prasad participated in The Deccan Geographical Society of India (DGSi) XVIII International Conference on “Urbanization and Climate Change: Strategies for Sustainable Cities Through Geospatial Technologies organized by The Department of Geography, Osmania University, Hyderabad, Telangana State from March 5-7, 2024 and presented a joint paper with Dr. Neeraj Raj and Dr. Maushami titled “Tourism Infrastructure in Bihar”.
- Dr. Meenakshi Prasad participated in The Deccan Geographical Society of India (DGSi) XVIII International Conference on “Urbanization and Climate Change: Strategies for Sustainable Cities Through Geospatial Technologies organized by The Department of Geography, Osmania University, Hyderabad, Telangana State from March 5-7, 2024 and presented a joint paper with Dr. D.S. Singh and F. Rahman titled “A Study on the Conservation Status of Vedis – The Cultural Heritage of Gaya Using Geospatial Techniques”.
- Mr. Rakesh Kumar attended a NEP 2020 Orientation and Sensitization Programme organised by MMTTC, Patna University, Patna from 19.04.2024 to 30.04.2024
- Dr. Pintu Kumar participated in the National Seminar on ‘The Direction and Challenges of Modern Society: Desired Response Swami Vivekananda’ jointly organised by Department of Sociology and Geography, Central University of H.P,
- Dharamshala in collaboration with ICSSR, New Delhi and MAKAIAS, Kolkata from 09-11 June 2024 and presented a research paper titled ‘Vivekananda’s Vision for Socio-Cultural and Spiritual Realisation in Nation’s Building
- Dr. Maushami successfully completed Two Weeks online Refresher Course on “Research Methodology and Data Analytics” organised by MMTTC, University of Hyderabad from 1st to 13th July, 2024

- Dr. Meenakshi Prasad successfully participated in a Two Day Seminar on the topic ‘Uses of Technical Terminology’ organised by Commission for Scientific and Technical Terminology, Ministry of Education, Government of India in collaboration with the P.G. Department of Physics, Magadh University, Bodh Gaya
- Mr. Rakesh Kumar successfully participated in a Two Day Seminar on the topic ‘Uses of Technical Terminology’ organised by Commission for Scientific and Technical Terminology, Ministry of Education, Government of India in collaboration with the P.G. Department of Physics, Magadh University, Bodh Gaya

4. Other Achievements of Faculty Members:

- Dr. Pintu Kumar has been appointed as the co-ordinator, Nodal Centre of IIRS-ISRO Outreach Programme for e-learning course under LMS, by IIRS Dehradun from 20th February 2024
- Dr. Pintu Kumar has been awarded an ICSSR Research Project titled “Socio-economic Changes around Buddhist Circuit in Bihar and its impact on Livelihoods of Scheduled Castes vide File No. ICSSR/RPD/MN/2023-24/SC/95
- Dr. Pintu Kumar was awarded with the Excellence Award 2024 for Innovation and Research by Hon’ble Vice-Chancellor, Magadh University on March 01, 2024

5. Induction Programme for the students of Ph.D. Course work

An induction programme for the students of Ph.D. Course work 2021 was organised on September 26, 2024. All the faculty members and the research scholars were present on the occasion. It marked the commencement of the classes of Ph.D. course work.

LALIT NARAYAN MITHILA UNIVERSITY

Administrative Activities

1. Dr Vinay Nath Jha, Superannuated from the active University service on 31 Aug. 2024
2. Dr. Anuranjan, took charge of Head, University Department of Geography, L N M U., Darbhanga on 1st Sept., 2024.

Departmental Activities:

- i. Earth Day Celebration on 22nd April 2024, Guest Speaker, Prof. P. C. Mishra, Dean Social Science, L. N. Mithila University, Darbhanga & Dr. Pankaj Kumar, Delhi School of Economics, Delhi
- ii. World Environmental Day 05th June 2024, Chief Guest on this occasion, Prof. P.N. Mishra, Dean Science, Prof. T. Jha Achal, former HOD & Prof. S. Jamil, Former Hod, Univ. Dept. of Botany, L. N. Mithila University, Darbhanga.
- iii. Invited lecture on Animal cruelty dated 13th Jan. , 2024, Guest Speaker was Mr Sujit Choudhary, Chairman of Janchetna Abhiyan .
- iv. Invited Lecture on the topic of Understanding Electoral Systems and Making Informed Choices in India's Parliamentary Democracy, dated 6th March, 2024, Chief Speaker was Dr. Ashish Bariyar.
- v. Department celebrated World Natural Democracy Day on 31.07.2024 having Keynote Speaker, Prof. Vidyanath Jha, Ex. Principal, M.L.S.M. College, Prof. Rudra Kant Amar, HOD, Philosophy, Prof. Manju Rai, HOD English, L.N.M.U., Darbhanga.
- vi. A National Seminar was organised in the Department on Irregularity in Monsoonal rain, causes and consequences. Keynote Speaker: Prof. T Jha Achal, Chief Guest: Prof. K.K.L. Das.
- vii. Celebration of GIS Day 2023 on the theme in collaboration with ESRI on 15 November, 2023. Dr. Manu Raj Sharma was the coordinator of the event.
- viii. Installation of Automatic Weather Station in collaboration with India Meteorological Department, Patna. Dr. Manu Raj Sharma was appointed as coordinator.
- ix. Collaboration of the University Department of Geography with the National Institute of Disaster Management (NIDM) on 20 August 2024. Dr. Manu Raj Sharma was appointed as coordinator.

- x. Successful organisation of various courses on 'Remote Sensing and GIS' in collaboration with the Indian Institute of Remote Sensing (IIRS-ISRO) during 2023-2024. Dr. Manu Raj Sharma was the coordinator of this programme.

Faculty Achievements

Dr. Anuranjan

Publication in Journals

- i. Anuranjan & Prity Priya , 2023. “Biodiversity Vulnerability And Management , A case study of K. Asthan Darbhanga.” Madhya Bharti , Vol.-84, PP:-98-103 .
- ii. Anuranjan & Prity Priya , 2023 . “Study of survey collection and evaluation of water chestnut and makhana in Darbhanga, Bihar.” History Research Journal, Vol.-29 , PP:-224 -228.
- iii. Anuranjan & Pappu Kumar , 2024 . “Begusarai Janpad me Linganupat and saksharta me sah sambhandh” , International Journal of advance and applied research , Vol.-11 , PP:-336-342.
- iv. Das, Parimal & Anuranjan , 2024. “Present Livelihood status of rural households in khayerasole block of Birbhum district, W.B.” , Ravindra Bharti university Journal of Economics. Vol.-28, PP:-167-178.
- v. Kumar Pappu & Anuranjan , 2024. “Pramukh Prakritik Aapdayein and prabandhan, Begusarai Sadar prakhand ke sandarbh me” , SAMPRESHAN , Vol.-17, PP:-395-404.
- vi. Kshipra & Anuranjan , 2024. “Mapping and monitoring of wetland farming in Madhubani district of Bihar” , THE DECCAN GEOGRAPHER , Vol.-62 no.7, PP:-111-126.

Invited Lecture & Attending Conferences:-

- i. Delivered an invited Lecture on Research Design, Thesis Writing & Synopsis writing, at University department of Geography, BRAB University, Muzaffarpur, Bihar.
- ii. Delivered an invited lecture on Agriculture & Food Security at VSJ College , Rajnagar, Madhubani, Oct.2023.
- iii. Presented Paper on Climatic vulnerability & Sustainable development of agriculture in flood prone Darbhanga at Ranchi University ,Ranchi, in 24th AGBJ , Nov.2023.

Dr. Manu Raj Sharma

Publications in Journals

- i. Das, S. K., S. Priya, and **M. R. Sharma**. 2024. Determinants and Spatial Patterns of Out-migration from Madhubani District: A case study of BISFI, India. *Indian Journal of Spatial Science* 15 (2):94–98.
- ii. Das, S. K., and **Sharma, M.R.** 2024. Mapping long-term Transformation of Wetlands and Annual Rainfall Variability in Madhubani District (1975-2022). *Current World Environment* 19 (1): 251–268.
- iii. **Sharma, M. R.**, and S. Priya. **2023**. Long-Term Assessment of Precipitation Behaviour in Bihar (1901-2021): Patterns, Trends and Observed Variability. *Current World Environment* 18 (2): 662-673.
- iv. **Sharma, M. R.**, & Chandel, V. B. S. **2023**. Objective climate classification of Himachal Pradesh and Punjab: A clustering based approach. *Transactions of the Institute of Indian Geographers*, 45(1), 127–140.
- v. **Sharma M.R.** **2023**. An exploration of regional songs of politics and political campaigns: A case study of Bihar Legislative Assembly Elections 2020. *Bhairavi*. 25: 256-262. ISSN- 0975-5217.
- vi. Chandel, V.B.S., **Sharma, M.R.** 2024. Climate Change and Weather Extremes in Tourist Towns: Challenges for Livelihood in Himachal Pradesh, India. In: Singh, A.L., Jamal, S., Ahmad, W.S. (eds) *Climate Change, Vulnerabilities and Adaptation*. Springer, Cham. https://doi.org/10.1007/978-3-031-49642-4_4

Invited Lectures / Resource Person / Attended Conferences

- i. “Markers of Climate Change: Unraveling Precipitation Extremes in Himachal Pradesh and Punjab, India” in National Seminar, Central University of South Bihar, Gaya, Bihar during 8-10 April 2024.
- ii. “Fundamental of computers windows and printer | 2- Computer /Mobile क्षेत्रे BHIM, UPI, ATM आत्यादद अनुप्रयोगाणां (Apps) पररचयः | “ A Pre-PhD lecture at Kameshwar Singh Darbhanga Sanskrit University, Darbhanga, 28 November 2023.

Other Achievements

- I. Appointed as coordinator for monitoring of Automatic Weather Station in collaboration with India Meteorological Department, Patna.

- ii. Appointed as coordinator for academic exchange with the National Institute of Disaster Management (NIDM) on 20 August 2024.
- iii. Served as coordinator for the successful organisation of various courses on 'Remote Sensing and GIS' in collaboration with the Indian Institute of Remote Sensing (IIRS-ISRO) during 2023-2024.
- iv. Contribution to translation services in the Maithili language provided to the India Meteorological Department (IMD) for the lightning alert app Damini (2023).

Dr. R Shikha

- i. Participated in UGC-sponsored Refresher Course at Deen Dayal Upadhyay University in Gorakhpur from January 30 to February 12, 2024.
- ii. Participated in the NEP 2020 Orientation and Sensitization Programme organized by the Malviya Mission Teacher Training Programme at Central University of South Bihar from September 6-14, 2024.
- iii. Contribution as Organizing Secretary for the Debate and Poster-making Competition held on Earth Day at L.N. Mithila University on April 22, 2023.
- iv. Participated in the Two-Day National Workshop on National Education Policy and ICSSR conducted by Central University of South Bihar on December 10-11, 2023.

Dr. Sunil Kumar Singh A.

- i. Bhavya and Sunil, 2024. Gender inequality in education sector : A review, Urban India , Vol.-44 issue 1 , PP:-12-18.
- ii. Singh Sunil & Rashmi Sikha, 2024 . Biodiversity of Pallibaranai ecosystem, Chennai, Geo-vision, Vol.-9-10, PP:-53-59.
- iii. Participated in UGC Sponsored Refresher Course in Geography and environmental studies at Jamia Milia Islamia , New Delhi. From 26 Oct. To 8 Nov. , 2023.
- iv. Participated in NEP 2020 Orientation and Sensitisation programme organised by MMTT Program at Central University of S. Bihar, Gaya. From 23-31 Jan., 2024.
- v. Attended National Workshop on National Education policy 2020, Modal Curriculum and content in Geography at Central University of S. Bihar, Gaya in Dec. 2023.
- vi. Participated in UGC - MMTTC short term program on Yoga , Meditation and Stress management from University of Calicut Kerala from 24 Sept. to 30 Sept. 2024.

Events held in the Department:

1. Celebration of GIS Day 23, November 2023



2. Educational Trip to Rajgir-Nalanda October 2023



3. Installation of Automatic Weather Station at LNMU, in collaboration with IMD, Patna



4. Celebration of World Environment Day



T. M. BHAGALPUR UNIVERSITY, BHAGALPUR

Publication

1. Roy, Subham Kumar & **Kumar Aniruddh** 'Assessment of Urban Dynamics- A case Study on Behrampore Municipality and its Surroundings, West Bengal, India' *Revue Roumaine De Geographie/Romanian Journal of Geography* ,68,.(1), p.75-87,2024, Bucuresti.(UGC Care Indexed)
2. Kumari Shivangi & **Kumar Aniruddh** Changing Pattern of Occupational structure in Katihar District: A Geographical Analysis' *International Journal of Creative Research Thoughts*, Vol. 12, Issue 2, p.28-36,February 2024.(Peer Reviewed)
3. Kumari Shivangi & **Kumar Aniruddh** 'Role of Migration in Social Change: With Special Reference to Katihar District ,Bihar', *Journal of Emerging Technologies and Innovative research (JETIR)*Vol. 11, (Peer Reviewed)
4. Roy, Subham Kumar , Mondal chumkil , Karim Masud, Ghosh Sanatan and **Kumar Aniruddh**, 'Utilizing GIS and Remote sensing for soil Loss estimation in Kopai River Basin: an application of the RUSLE model , **Springer**, 10 April 2024. (UGC Care Indexed)
5. **Kumar, Aniruddh** & Dubey, Ajeet Kumar 'A Study on the Impact of Seasonal Changes in Soil Fertility on Agricultural Outcomes With Special Reference to District Bhagalpur, Bihar' *Journal of Foundational Research*,ISSN:2395-5635, Volume XXXII, No.2, 2024 (UGC Care Indexed)
6. Kumari, Sonam & Kumar, Prashant Problems and prospects of the powerloom industry: A study of Champanagar, Bhagalpur city, Bihar', *National Geographical Journal of India*, Vol. 69, No. 3. .(Peer Reviewed)

Conferences/Seminars/Training Organised and Participated

Dr. Aniruddh Kumar

1. XXIVth Annual Conference and National Seminar, University Department of Geographu, Ranchi University, Ranchi on Climatic Vulnerability : Challenges to physical Landscape and Human Response 4th and 5th Novemver 2023, Paper Presented Entitled 'भागलपुर जिला (बिहार) में जलवायु परिवर्तन का कृषि पर प्रभाव'.
2. International seminar, Agriculture University, Sabour on Empowering Agriculture & Rural Economy: A Journey of Rural Development from Independence to Amrit Kaal (EAR- 2024, 13-14 June).Presented Paper entitled "*Exploring Climate Change Impact on Rural Livelihoods & Adaptation Strategies: Reflections from marginalized communities in India*"

3. 8th National Association of Geographers, India (NAGI) International Seminar on Geography for a Sustainable Future: Land Water Climate and Society Interface, Held at Dept. of Geography, Kazi NaZrul University, Asansol West Bengal, September 23-25, 2024, Paper Presented Entitled '*Identification of Urban Microclimate : A Case Study on Rurban Region Of Berhampore Municipality, West Bengal, India*'.

Dr. Prashant Kumar

1. Paper entitled “जलवायु परिवर्तन के संदर्भ में मोटे अनाज का वर्तमान परिपेक्ष में महत्व एवं उपयोगित” presented in XXIV annual conference & national seminar, Ranchi on Climate Vulnerability: Challenges to Physical Landscape and Human Response (04-05 November, 2023) Dept. of Geography, Ranchi University, Ranchi.
2. 8th National Association of Geographers, India (NAGI) International Seminar on Geography for a Sustainable Future: Land Water Climate and Society Interface, Held at Dept. of Geography, Kazi NaZrul University, Asansol West Bengal, September 23-25, 2024, Paper Presented Entitled '*Identification of Urban Microclimate : A Case Study on Rurban Region Of Berhampore Municipality, West Bengal, India*'

BHUPENDRA NARAYAN MANDAL UNIVERSITY, MADHEPURA**Departmental News for the Period: Oct./2023-Sept./2024**

1. Dr. Mithilesh Kumar Singh (Associate Prof.) took the appointment on 24/02/2024 as the succeeding Head of the Geography Department after completion of three years tenure of Dr. Ganesh Prasad.
2. The Earth Day was celebrated on 22/04/2024 in the department under the chairmanship of Dr. Mithilesh Kumar Singh where participants shared their valuable insights on the global theme Planet versus Plastics and the students from Semester-II and Semester-IV pledged willingly to adopt to the measures in ensuring safety of life and guarding the sustainability of environment unequivocally. The interactions on this global theme assisted in laying the imperatives for collaborative efforts to restore ecosystems, address climate change and safeguard biodiversity with greater urgency and policy initiatives.
3. On the lines of the United Nations Environment Programme (UNEP), this department took the initiative to raise concerns for the degrading current state of environment around the Madhepura town by celebrating the World Environment Day on 05/06/2024. The programme provided ample chance to the participants to develop a platform where local to regional ascertainment of environmental degradation can be made and vital solutions to the raised issues can be confronted with community participation. The in-house resource persons floated the general idea of "Go green, breathe clean. Stop polluting the environment. Save our planet. Think before you trash it" among everyone present in the scene.
4. With all warm wishes and heartfelt felicitations, the department bid farewell to our esteemed and erudite faculty Dr. Ganesh Prasad on 30/06/2024 on his superannuation from the University Services. His passion for teaching and style of dedicated delivery has won admirations of many over the years and so on.

VINOBA BHAVE UNIVERSITY, HAZARIBAG

- **Seminar on “World Earth Day” (22 April 2024):**

On the occasion of the World Earth Day the Department had organised a seminar on the theme “**Planet v/s Plastic**”, in which Dr. Saurabh Chandra (DFO, Hazaribag East) and Dr. Avinash Kumar (Assistant Professor, Dept. of Botany, VBU) participated and delivered lectures as experts. Students from PG department of Geography, VBU and UG/PG different college of Hazaribag participated in the different competition like painting, speech, essay and poem/singing.

- **2 June 2024 Environment cleaning Program**

Dept. has organised a Plastic cleaning program in Eco-sensitive Canary Hill that is known as lungs of Hazaribag, in collaboration with Vasudha Kalyan (NGO).

- **Seminar on “World Environment Day” (5 June 2024):**

On the occasion of the World Environment Day the Department had organised a seminar on the theme “**Increasing Temperature and its Impact on Human Life**”. Geography teachers from different colleges of Hazaribag placed their views on Global Warming and its mitigation. Written question and answer round quiz were held in which students from dept. of geography, VBU and different colleges had participated.

- **Teacher-Parent Meeting (PTM) (18 July 2024):**

As a healthy academic activity Department had organised a **Teacher-Parent Meeting** on **18 July 2024** in the department where parents shared their suggestion for improvement of academic activities in the department.

- **Study Tour:**

Educational Tour is an important part of Geographical study, Department had organised a One day tour to **Netarhat and Lodh Waterfall, Latehar** from **9 February 2024 to 11 February 2024**.

NILAMBER - PITAMBER UNIVERSITY, PALAMU (JHARKHAND)

Superannuation: One (1) faculty member.

Dr. Indrajeet Prasad, Assistant Professor & In-charge HOD, superannuation on 31st January, 2024

Post his superannuation, Dr Arvind Sinha, Assistant Professor is currently the In-charge HOD.

Publications of faculty:

Kundan Kumar (Assistant Professor) published Medical Tourism of Indian Diaspora “backhome” RESEARCH REVIEW Vol-09, No.-05 on 15th May, 2024

Conference& Seminar attended by Faculty

Kundan Kumar (Assistant Professor) presented research paper at XXIV Annual Conference & National Seminar - Association of Geographers Bihar & Jharkhand (AGBJ) on November 4 & 5, 2023.

Ph. D. Degree Awarded

(From October, 2023 to September, 2024)

Patna University, Patna

Sl. No.	Name of Scholar	Topic of Thesis	Name of Supervisor
1.	Shipra Soni	"Imapct of Flood on the Landscape of North Bihar : A Study in Applied Geomorphology"	Dr. R.B.P. Singh
2.	Jarnail Singh	“मधेपुरा जिला में अनुसूचित जाति की सामाजिक, आर्थिक दशा में परिवर्तन (1971-2011): एक भौगोलिक अध्ययन”	Prof. (Dr.) K. N. Paswan
3.	Ranjita Kumari	“मुस्लिम महिलाओं के शैक्षणिक स्तर एवं व्यावसायिक प्रारूप में परिवर्तन : फुलवारीशरीफ़ प्रखण्ड का एक भौगोलिक अध्ययन”	Prof. (Dr.) Ravi Kiran Sharma
4.	Ravindra Kumar Prakash	“बिहार के भागलपुर जिला में खाद्यान्न उत्पादन एवं कृषि भूमि की वहन क्षमता: एक भौगोलिक विश्लेषण (1991-2011)”	Prof. (Dr.) Anuradha Sahay
5.	Anna Emiliya Fernandes	"Quality of Life of South Indian Migrants in Patna Municipal Corporation Area".	Dr. Sister Maria Rashmi A.C.

B.R.A. Bihar University, Muzaffarpur

S.N.	Name of Scholar	Topic of Thesis	Name of Supervisor
1	Smriti Kumari	The Dynamics Charecterstics of population and Settlement of Saran District, Bihar	Prof. (Dr.) Rupa Kumari, HOD, Deptt. of Geog. MDDM College, Muz.
2	Pankaj Kumar	Evaluation Devlopment and Planning of Motihari Town : A geographical Study	Dr. Ram Pravesh Yadav, EX-Head Univ. Deptt. of Geog. B.R.A.B.U., Muz.
3	Ram Nandan Ray	A Geographical Study of Water, Forest & Land : A Case Study of SanthalParganas	Dr. Pramod Kumar, Head, Deppt. of Geog., RDS College, Muz.
4	Sunil Kumar	Patna : A Geographical Study in Urban Dynamics	Prof. (Dr.) Surendra Pd. Sinha, Ex-Principal, RDS College, Muz.
5	Bushra Parween	Urban Development of motihari Town and Planning for future : A Geographical Analysis	Dr. Ram Naresh Sharan, Head, Deptt. of Geog., B.R.A.B.U., Muz.
6	Amzad Ali Ahmad	Dynamics of Agriculture in Koch-Bihar District	Dr. Ram Pravesh Yadav, EX-Head Univ. Deptt. of Geog. B.R.A.B.U., Muz.
7	Sanjeet Kumar	जनसंसाधन विकास का भौगोलिक अध्ययन: मधुबनी जिला के सन्दर्भ में।	Dr. Ram Naresh Sharan, Ex-HOD, Septt. Of Geog. M.S.M. SamtaCollge, Jandaha
8	Priyambada Bharti	A Geographical Analysis of Changing Pattern in Samastipur District	Dr.Arun Kumar, Assist. Prof. Deptt. of Geog. N.N. College, Singhara
9	Md. Anzar Ahmad	सीतामढ़ी में जनसांख्यिकी गत्यात्मकता का भौगोलिक अध्ययन	Dr. Murari Singh, Deptt. of Geog. Z.A. Islamia College, Siwan
10	Arjun Singh	गोपालगंज जिला में कृषि - विकास तथा रोजगार प्रबंधन का भौगोलिक अध्ययन	Dr. Rameshwar Pd. Singh, Deptt. of Geog., A.B.S. College, Lalganj, B.R.A.B.U., Muz.

Tilkamanjhi Bhagalpur University, Bhagalpur

S.N.	Name of Scholar	Topic of Thesis	Name of Supervisor
1	Shivangi Kumari	जनसंख्या गत्यात्मकता एवं उसका प्रभाव: कटिहार जिला बिहार के संदर्भ में एक भौगोलिक विश्लेषण	Dr. Aniruddh Kumar
2	Santosh Kumar Suman	जनसंख्या वृद्धि प्रवृत्ति एवं प्रतिरूप तथा जनसंख्या शिक्षा की प्रसंगिकता : भागलपुर जिला (बिहार) के सन्दर्भ में भौगोलिक विश्लेषण	Prof. Sharat Chandra Mandal
3	Namrata	Socio- Economic Conditions of Scheduled Tribes : A Geographical Analysis with reference to Dumka District, Jharkhand	Prof. S. K. Jha
4	Kabita Kumari	सामाजिक आर्थिक विकास पर साक्षरता एवं शिक्षा का प्रभाव : भागलपुर जिला बिहार के संदर्भ में एक भौगोलिक विश्लेषण	Prof. Sharat Chandra Mandal
5	Rajnish Kumari	Assessment of Population Pressure on the Land : A Case Study of Nawada District Bihar	Prof. S. K. Jha
6	Jitu Rajbonshi	Impact of Environmental Changes on Human Life in Palashbari Revenue Circle, Kamrup District Assam : A Geographical Analysis	Prof. S. N. Pandey
7	Abid Ahmed	Sustainable Agriculture Development in Dakshin Dinajpur District, West Bengal : A Geographical Analysis	Dr. U. S. Pandit

Vinoba Bhave University, Hazaribag

Sl. No.	Name of Scholar	Topic of Thesis	Name of Supervisor
1.	Dr. Bandhan Oraon	चूरचू ब्लॉक में जनजातीय समुदाय के शैक्षिक विकास को प्रभावित करने वाले सामाजिक और आर्थिक कारकों की भूमिका का भौगोलिक विश्लेषण''	Dr. S.K. Singh

Jai Prakash University, Chapra

Sl. No.	Name of Scholar	Topic of Thesis	Name of Supervisor
1.	Mrs. Rubi Kumari	पिछड़े क्षेत्र में सतत् विकास की योजनाएँ : गोपालगंज जिला का एक भौगोलिक अध्ययन	Prof. Sanjay Kumar, HOD, Rajendra College, Chapra
2.	Mr. Vikash Kumar Pandey	पिछड़े क्षेत्र में सतत् विकास की योजनाएँ : गोपालगंज जिला का एक भौगोलिक अध्ययन	Prof. Usha Singh P.G. Department of Geography, Chapra
3.	Mrs. Prabhat Kumar	Planning & Process for Poverty Eradication : A Geographical Analysis of Rohtas District	Dr. Kalim Gaffar Mian, Z.A.I. College, Siwan
4.	Mrs. Rupali Amit	पश्चिमी चम्पारण जिला में संसाधनों का मूल्यांकन एवं प्रादेशिक नियोजन : एक भौगोलिक अध्ययन	Prof. Shree Kamal Jee, N.L.S. College Daudur, Sarai

Lalit Narayan Mithila University

Sl. No.	Name of Scholar	Topic of Thesis	Name of Supervisor
1	Pankaj Kumar Mahto	मिथिलांचल की सांस्कृतिक विरासत: एक भौगोलिक अध्ययन	Dr. V. Nath Jha
2	Sunil Kumar	मुजफ्फरपुर नगर की समस्याएं एवं प्रबंधन	Dr. V. Nath Jha
3	Abdul Gaffar	A Geographical Study of Correlation of Demography & Change in Population	Dr. D. Prasad Singh
4	Sandeep Jha	A Geo-ecological analysis of Vector Borne Disease in Bihar .	Dr. Anuranjan
5	Pankaj Sahni	बदलते कृषि स्वरूप का सामाजिक: आर्थिक दशा पर प्रभाव: उजियारपुर प्रखंड के संदर्भ में।	Dr. K. K. Mishra

Bhupendra Narayan Mandal University, Madhepura

Sl. No.	Name of Scholar	Topic of Thesis	Name of Supervisor
1	Shri Devendra Kumar Dinkar	Impact of Geographical Environment on Nature and Function of Urban Centres in North Eastern Bihar	Dr. V. Nath Jha

Magadh University, Bodhgaya

S. No.	Name of Research Scholar	Topic of Thesis	Name of Supervisor
1.	Dev Prakash	Geographical Analysis and Cartographic Representation of Gandhian Movements and Relevance of Gandhism in Planning for Sustainable Development.	Dr. Devendra Pd. Singh
2.	Arvind Kumar	उत्तरी छोटानागपुर पठार की बिरहोर जनजाति का सामाजिक एवं आर्थिक परिवर्तन: एक भौगोलिक अध्ययन	Dr. Basudeo Prasad
3.	Neha Bharti	उत्तर बिहार के कृषि आधारित उद्योगों की समस्याएँ एवं संभावनाएँ: एक भौगोलिक अध्ययन	Dr. Hiralal Singh
4.	Sanjay Kumar Sinha	शेखपुरा जिला के कृषि में सब्जी उत्पादन की अहम भूमिका एवं इसमें नवाचार की संभावनाएँ: एक भौगोलिक अध्ययन	Dr. Anoop Kumar Singh
5.	Md. Parwez	परिवहन भूगोल: जहानाबाद शहर का एक अध्ययन	Dr. Rashmi
6.	Suraj Prakash	बिहार के चुनावों का भौगोलिक विश्लेषण	Dr. Devendra Pd. Singh
7.	Rabindra Paswan	बिहार राज्य के पूर्वी एवं पश्चिमी चम्पारण जिला के संसाधनों की भौगोलिक समीक्षा	Dr. Devendra Pd. Singh
8.	Ruby Kumari	Problems and Solutions of Slums of Patna Urban Area: A Geographical Study	Dr. Devendra Pd. Singh
9.	Nandlal Singh	पटना जिला के गंगा दियारा क्षेत्र के सतत् विकास के नियोजनार्थ बाढ़ रूपी आपदा का प्रबंधन: एक भौगोलिक अध्ययन	Dr. Devendra Pd. Singh
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4.	Magadh Univ. Bodh Gaya	Prof. L. N. Ram	Prof. L. N. Ram	Prof. M. Prasad	Prof. R. B. P. Singh	Prof. D. P. Singh	16-17 March, 2002	3rd Annual Conference
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6.	T. M. Bhagalpur Univ., Bhagalpur	Prof. V. N. P. Sinha	Prof. V. N. P. Sinha	Prof. R. B. Mandal	Prof. R. B. P. Singh	Prof. D. P. Singh	18-19 Oct., 2004	5th Annual Conference
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11.	Magadh University Both Gaya	Prof. N. Sharma	Prof. N. Sharma	Prof. Rana Pratap	Prof. K. N. Paswan	Dr. Md. Ataullah	6 - 7 Dec., 2008	10th Annual Conference
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 - d. Patel, S.B. and Singh, S.B. (2016), 'Changing course of river Ganga and its impact on human settlement between Mirzapur and Saidpur', *The Geographer*. Vol. 63, No.1. pp. 36-43.
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