“RIVERINE BIODIVERSITY” AND “ECO TOURISM DEVELOPMENT PLAN” FOR KATARNIAGHAT WILDLIFE SANCTUARY

: A case of Creative adaptive bio-reserve along Girwa river (Ghagra river) in Bahraich, Uttar Pradesh.

Thesis Submitted in Partial Fulfilment of the requirements for the award of the degree of

MASTERS IN PLANNING (URBAN PLANNING)

By

Versha Singh

1220152009

Under The Guidance of

Dr. Mohit Kumar Agarwal

SCHOOL OF ARCHITECTURE & PLANNING,
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2023-2024

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CERTIFICATE OF THESIS SUBMISSION FOR EVALUATION

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2. Enrollment No. :**11201520054**

3. Thesis title: **"RIVERINE BIODIVERSITY" AND "ECO TOURISM DEVELOPMENT PLAN" FOR KATARNIAGHAT WILDLIFE SANCTUARY: A case of Creative adaptive bio-reserve along Girwa river (Ghagra river) in Bahraich, Uttar Pradesh.**

4. Degree for which the thesis is submitted: **Masters in Planning (Urban Planning)**

5. Faculty of the University to which the thesis is submitted
   School of Architecture and Planning

6. Thesis Preparation Guide was referred to for preparing the thesis. ☐ YES ☐ NO

7. Specifications regarding thesis format have been closely followed. ☐ YES ☐ NO

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9. The thesis has been prepared without resorting to plagiarism. ☐ YES ☐ NO

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(To be submitted in duplicate)

1. Name : **Versha Singh**

2. Enrollment No. : **11201520054**

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(Signature of the Candidate)

Name:……...…….

Roll No: …….

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ACKNOWLEDGEMENTS

I would like to express my deepest gratitude to everyone who has helped me complete my Master's thesis in Planning (Urban Planning) Your support and encouragement have been vital in my academic journey.

First and foremost, I am immensely grateful to my thesis guide, Dr. Mohit Kumar Agarwal. His guidance, expertise, and support throughout this research have been crucial in shaping my work. His continuous encouragement, insightful feedback, and patience have been a great source of inspiration for me.

I also want to thank my parents, Shri Gajendra Bahadur Singh and Mrs. Kusum. Their constant belief in my abilities, unwavering encouragement, and emotional support has been instrumental in completing this thesis. Their wisdom and guidance have motivated me to strive for excellence.

Additionally, I would like to express my gratitude to my friends and loved ones. Their unwavering support, understanding, and encouragement have given me the strength and motivation to overcome challenges and persevere. Their presence has brought joy, laughter, and comfort during the demanding times of thesis work.

Lastly, I want to thank all the individuals who have directly or indirectly contributed to my growth as a researcher and planner. Your collective efforts have played an integral role in shaping my academic and personal development.

To everyone mentioned above and to those not mentioned individually but who have been part of my journey, please accept my heartfelt gratitude for your support, guidance, and encouragement. This thesis would not have been possible without each and every one of you. Thank you for being a part of this significant milestone in my academic life.

Lastly I would Like to dedicate my thesis to My Husband “ Late Shri Ajay Chauhan”.

(Versha Singh)

UNDERTAKING

I Ms. Versha Singh, the author of the thesis titled "RIVERINE BIODIVERSITY" AND "ECO TOURISM DEVELOPMENT PLAN" FOR KATARNIAGHAT WILDLIFE SANCTUARY: A case of Creative adaptive bio-reserve along Girwa river (Ghagra river) in Bahraich, Uttar Pradesh , hereby declare that this is an independent work of mine, carried out towards fulfillment of the requirements for the award of the Masters in Urban & Regional Planning at the Department of Architecture and Planning, BBDU, Lucknow. The work has not been submitted to any other organization / institution for the award of any Degree/Diploma.

…….

Versha Singh

ABSTRACT

The Project idea hovers around creating a conservation and management plan that shall help in preserving the bio- diversity, forest reserve, and wildlife along the sensitive eco-system of the Girwa River (a source tributary of Ghaghra or Saryu River) and the riverine precinct with adaptive tourism management along the river which comprises the primary area of the Katarniaghat Wildlife sanctuary. This area is known for its fragile Terai eco-system comprising a mosaic of Sal and teak forests, lush grasslands, numerous swamps, and wetlands forming the homeland to several endangered species including the tiger, Gangetic Dolphin, swamp deer, gharial, hispid hare, and Bengal florican.

The sanctuary houses around 10 villages within its boundary and another 64 villages outside the protected area, within 5 km of the sanctuary boundary. The wildlife sanctuary is also turning out to be a wildlife tourism destination for the nearby cities including the Lucknow Metropolitan which is 150 km distance from the wildlifesanctuary. The part of the forest reserve along the river forms a very pleasing and naturally serene landscape setting that is close to its natural existence. However, its undisturbed natural beauty and improved connectivity from the nearby cities have led to the sprouting of new rest houses and resorts which when not bound by forest-centric development regulations may lead to negative impacts on the bio-reserve. The forest reserve with its serene environment has great potential in terms of tourism ventures and new opportunities for socio-economic enhancement of the village dwellers within and outside the protected area. However, these ventures should be guided by a management plan sensitive to its fragile environment and bio-diversity minimizing the forest degradation and human-wildlife conflict.

The study shall help to establish a long-term plan for a sustainable eco-system helping the socio-economic improvement of the local community through adaptive tourism management and preservation of the riverine bio-diversity.

Contents

CHAPTER 1: INTRODUCTION

1.1 BACKGROUND

Katarniaghat Wildlife Sanctuary, located in the Terai region of Uttar Pradesh, India, is a protected area rich in biodiversity, playing a vital role in preserving the Gangetic ecosystem. The sanctuary is home to a wide variety of plants and animals, including many endangered and unique species. Notably, the Gangetic river dolphins, which are crucial to the sanctuary's aquatic life, can be found here.

To achieve the long-term goal of restoring sustainable populations of all endemic and endangered species in the Ganga River, the National Mission for Clean Ganga (NMCG) has started several projects. These projects aim to develop scientifically based plans to restore aquatic species. This report outlines a detailed management plan that includes strategies focused on ecotourism to help conserve the sanctuary's riverine biodiversity.

1.2 NEED FOR THE STUDY

We all are well aware of the fact that how vital the balance between us and nature and preserving it ensures our own betterment But nature is not greedy like us rather it nurtures every organism in a certain way therefore to maintain that balance, Kartaniaghat Wildlife Sanctuary has taken steps was taken by the govt to ensure the best suitable growth most naturally, during the field visit a lot of hidden potential surfaced such as infrastructure, roads, healthcare, education, and overall development of the nearby settlements. Lately, there has been work done for the development but the scope is expanding now, Hence the need for a tourist-centric bio-diversity plan is important as this creates a balance between human and wildlife preservation development.

1.3 AIM AND OBJECTIVES OF THE STUDY

1.3.1 AIM:

The study aims to establish a long-term strategy for a sustainable ecosystem, focusing on adaptive tourism management to enhance the socio-economic conditions of both local communities within and outside the sanctuary. By minimizing forest degradation and human-wildlife conflict, the proposed plan strives to unlock the full potential of the forest reserve, ensuring its prosperity while safeguarding its natural beauty.

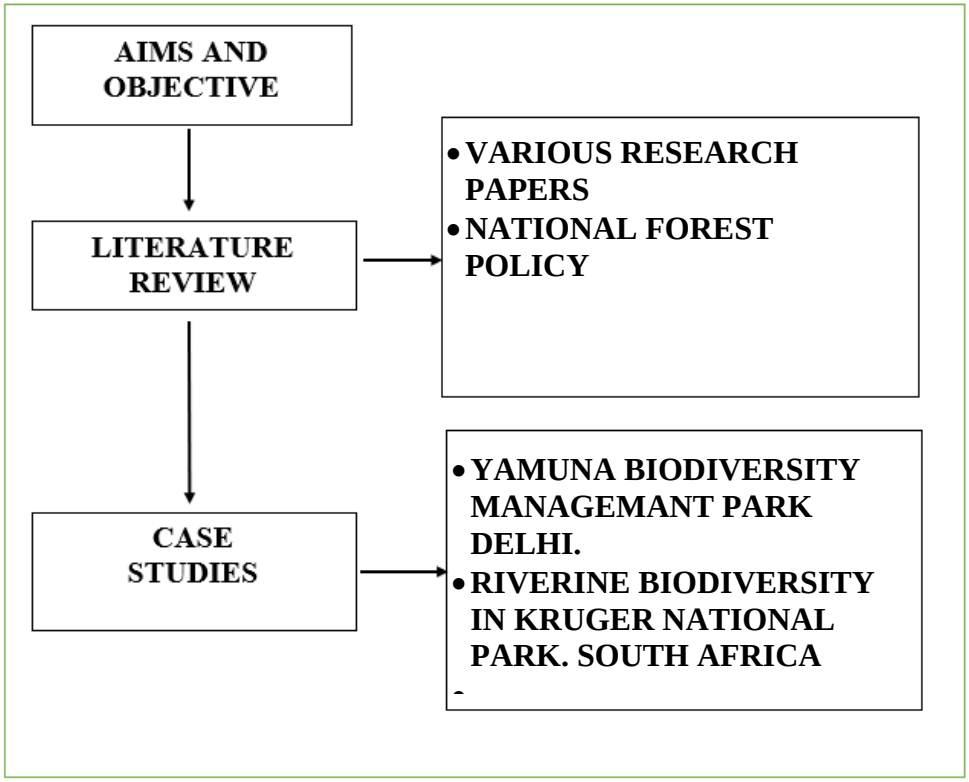
1.3.2 OBJECTIVES:

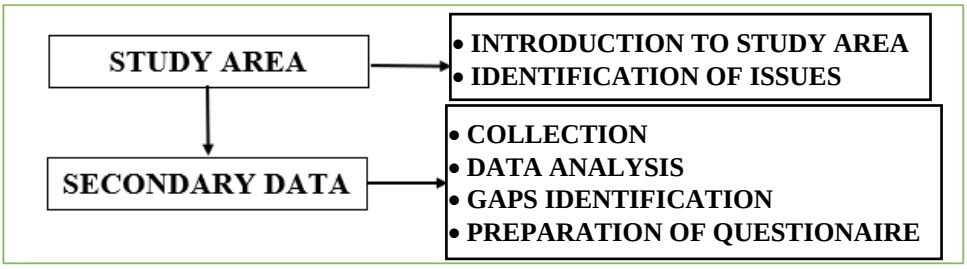
- Identifying the core area for the river species and re-orienting the tourism activities to keep the area preserved. This shall help in identifying the preserved zone area.
- Identify the tourism calendar which shall be in coherence with the annual weather cycle of the Terai Forest, including the river bio-diversity.
- Identification of sustainable methods for tourism activities and the related services to create an eco-sensitive system for tourism management.
- Identifying the reserved area for River safari and creating an SOP for the implementation of boating safari in the river zone which is conducive to the sensitive nature of the river species.
- Identification of tourism activities that shall compose the Katarniaghat Wildlife experience. It shall strictly comply with the Katarniaghat Wildlife Conservation and Management Plan and shall not negatively impact the bio-reserve and its preserved conditions.
- Mitigation Plan for the adaptive tourism activities which shall include the solid-waste management plan, river pollution, noise-pollution management, and catchment management.
- Transit plan, routing plan to phase out the existing railway line cutting through the forest. Adopting eco-transport alternatives such as CNG-fuelled boats, electric vehicles for ferrying, and safari, adopting a strict no-fossil fuel policy in the precinct.
- Providing alternative fuel options to the local community/villages so that they do not depend on the forest for resources.
- Creating an action plan for the upliftment of socio-economic status of the local community such that livelihood opportunities are created, and in turn creating a wildlife tourism oriented economy. This shall include capacity building measures and localized training measures.
- Infrastructural upliftment proposal for the local community as well as the upgraded tourism inflow in the area such that basic aspects related to watersupply, sewerage, drainage and health facility can be fulfilled.
- Preservation of the ecological status of the river and mitigate any negative impact prospectively arisen due to the influx of external visitors and enhanced tourism activities.

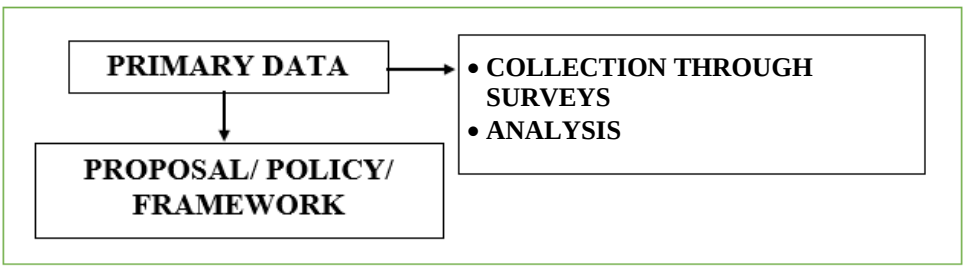
1.4 SCOPE OF WORK AND LIMITAION:

- The study is focused only on Eco Tourism development Plan for Katarnia ghat wild life sanctuary.
- The study will delve into the comprehensive management plan for riverine biodiversity in Katarniaghat Wildlife Sanctuary, exploring strategies to preserve and enhance the ecological balance.
- As per the time and study limitation, a particular area in the wild life sanctuary is selected for the study based on need and importance of development of that area.

1.5 METHODOLOGY







CHAPTER-2 LITERATURE REVIEW

2.1 RESEARCH PAPERS

2.1.1 RESEARCH PAPER-1

"Preserving the biodiversity and ecological services of rivers: New challenges and researchopportunities"

Author - Angela H Arthington,Helen Parker,Catherine R. Moncrieff,Catherine R. Moncrieff NaomiOates

YEAR - 2009

AIM & OBJECTIVE	METHODOLOGY	ANALYSIS TOOL	REMARK	OUTCOME	PARAMETERS
The aim of the research is to address the urgent need to protect rivers globally and to promote the importance of environmental flows for freshwater ecosystem health and human well-being. It presents key findings and a global action agenda that call upon various stakeholders to commit to actions for restoring and maintaining environmental flows inall rivers. The researchalso emphasizes the need for an international research effort to strengthen the research component of environmental flow assessment and implementation.	The research mentions several methodologies andanalysis tools related to environmental flow assessment and management. Some of the methodologies mentioned include: Instream Flow Incremental Methodology (IFIM): This methodology is used for stream habitat analysis and involves assessing the habitat requirements of aquatic organisms based on flowcharacteristics. Bayesian hierarchical models: These models arementioned as a tool for detecting ecological responses to flow variation and can be used to analyze and interpret monitoring data. Adaptive management: This approach is recommended for addressing uncertainties in ecological responses to flow regime changes. It involves continuously evaluating the risks and benefits of managed flow events and making adjustments based on new knowledge and data. Environmental flow scenarios: The research suggests generating a range of environmental flowscenarios to explore trade-offs between ecological values and water use for economic purposes. These scenarios represent different quantities andtiming of water flows that could be maintained within a river system.	Statistical models: The research suggests that statistical models can be used to analyze and interpret environmental flow monitoring data and update models as newknowledge and data become available. Bayesian networks: These networks are mentioned as a tool for guiding investments in flow and catchment restoration for impaired river ecosystems. They can help assess the ecological condition of rivers and guide decision-making.	The research discusses the importance of preserving the biodiversity and ecological services of rivers. It highlights the challenges and research opportunities in this field. The authors emphasize the need for environmental flow management, which involves maintaining natural flow regimes to support river ecosystems. They suggest integrating water quality management, engaging all stakeholders, and implementing and enforcing environmental flow standards. The research also mentions the Brisbane Declaration, which calls for global action to restore and maintain environmental flows in all rivers. Overall, the research emphasizes the significance of environmental flow allocations for both humans and nature and proposes an international research effort to strengthen environmental flow assessmen and implementation.	The paper discusses the challenges faced in preserving the biodiversity and ecological services of rivers. Environmental flows, or maintaining flows in rivers, are suggested as a promising strategy for integrating freshwater management in the broader scope of ecological sustainability. They are a central tool for the protection of freshwater biodiversity, resiliency, and ecological goods and services, as well as fundamental to the success of water-related Millennium Development Goals. The paper presents approaches towards setting environmental flow allocations, as well as necessary research to further contribute to the protection of river ecosystems against future losses of biodiversity, as well as ecological and cultural services. (Pages 1-16)	The paper "Preserving the Biodiversity and ecological services of Rivers" focuses on the study and research related to the preservation of river biodiversity and ecological services. The key topics covered in the paper include environmental flows, river rehabilitation and restoration, river protection, flow- ecological response relationships, modeling capacity, and hydro- ecological principles. The authors discuss the challenges and research opportunities in freshwater biology, specifically in the context of preserving the biodiversity and ecological services of rivers.

https://www.researchgate.net/publication/48380733_Preserving_the_biodiversity_and_ecological_services_of_rivers_New_challenges_and_research_opportunities

2.1.2 RESEARCH PAPER-2

"Designing protected areas to conserve riverine biodiversity: Lessons from a hypothetical redesign of the Kruger National Park

Dirk J. Roux a, Jeanne L. Nel b, Peter J. Ashton a, Andrew R. Deacon c, Ferdinand C. de Moor d, Devlyn Hardwick a, Liesl Hill a, Cornelius J. Kleynhans e, Gillian A. Maree a, Juanita Moolman e, Robert J. Scholes YEAR – 2007

AIM & OBJECTIVE	METHODOLOGY	ANALYSIS TOOL	REMARK	OUTCOME	PARAMETERS
The aim and objective of the research regarding the conservation of freshwater fishes in South Africa is to address the challenges and develop strategies for the conservation of freshwater fish species in the country. The research discusses the importance of protecting freshwater ecosystems, identifies threats to freshwater fish conservation, and explores the use of protected areas and conservation planning as tools for preserving freshwater fish populations. The goal is to ensure the long-term survival and sustainability of freshwater fish species in South Africa.	The study assessed how redesigning protected areas can help conserve riverine biodiversity using a hypothetical redesign of Kruger National Park. The authors made use of an assessment that subdivided the study area into 17 assessment units based on tertiary catchment boundaries. They collected data on freshwater fish and invertebrates and used it to identify focal families and genera to be used as fine-filter surrogates for the invertebrate species of the Lowveld. The authors also considered the implications of the riverine spatial design for conserving terrestrial biodiversity, using vegetation types as coarse-filter surrogates. Results of the study show that designing protected areas to conserve riverine biodiversity requires maintaining maximum hydrologic connectivity, resisting development pressure, fostering good governance, and being strategic in the collection, management, and use of primary data. (Pages 3-4 and 8)	The research discusses the use of several analysis tools for addressing the challenges of conserving freshwater fishes in South Africa. These tools include: Coarse filter ecosystem types: This approach offers a rapid and pragmatic approach for conservation planning in data-poor regions. It involves categorizing rivers into different types based on their ecological characteristics and using these types as surrogates for conservation planning. Focal species selection: A subset of fishspecies is selected as focal species based on their uniqueness, regional endemism, ecotone specialization, or representation of a range of other species. These focal species serve as surrogates for meeting the needs of all species in conservation planning. Invertebrate families and genera: Family-level invertebrate data are used to assess the health of river systems. Surveys are conducted to collect data on invertebrate families and genera, and these data are analyzed to understand the distribution and abundance of different invertebrate groups. These analysis tools help in setting conservation targets, identifying priority areas for conservation, and understanding the ecological processes and habitats that support freshwater fishes in South Africa.	The focal species selection is a significant analysis tool in the conservation of freshwater fishes in SouthAfrica because it allows for a more targeted and efficient approach to conservation planning. By selecting a subset of fish species that are unique, endemic, or representative of a range of other species, conservation efforts can focus on protecting these key species and their habitats. This approach helps to ensure the preservation of importantecological processes, habitats, and biodiversity in freshwater ecosystems. Additionally, using focal species as surrogates for other species can help overcome data limitations and guide conservation actions in data-poor regions. Overall, focal species selection provides a practical and strategic framework for prioritizing conservation efforts and maximizing the effectiveness of conservation actions.	The study concluded that the hypothetical redesign of Kruger National Park showed how protected areas' actual and potential contribution to conserving riverine biodiversity can be expanded while still accommodating human needs. The authors suggest that river types remain important surrogates for biodiversity and that the strategy for conserving riverine biodiversity must be embedded in a broader landscape conservation program that recognizes the importance of retaining and restoring hydrologic connectivity, taking account of catchment processes, fostering good governance, and communicating effectively with local stakeholders. Management decisions for multiple-use landscapes must prioritize conserving riverine biodiversity if riverine ecosystems in southern African parks are to remain sustainable. (Pages 3-4 and 8)	Reviewing past and present concepts related to large riverecology - Identifying uncertainties and constraints in the management of largeriver ecosystems - Discussing the use of restoration and adaptive managementto address uncertainties - Highlighting the needto integrate various scientific disciplines forthe future management of large rivers - Emphasizing the importance of public education, communication, and outreach during restoration activities - Advocating for collaborative partnerships among stakeholders to addresssocial, economic, and ecological challenges impacting large river systems

https://portals.iucn.org/library/sites/library/files/researchs/2016-064.pdf

2.1.3 RESEARCH PAPER-3

"Moving Large River Ecology from Past Theories to Future Actions:

A Review“Kathryn Mccain

2013

AIM & OBJECTIVE	METHODOLOGY	ANALYSIS TOOL	REMARK	OUTCOME	PARAMETERS
The aim of the research is to presentguidelines for assessing the success of river restoration projects using social, environmental, and economic factors. The objective is to providea framework for adaptive management, project evaluation, and increasing public and stakeholder acceptance and participation in futurerestoration efforts. The research also emphasizes the importance of knowledge sharing and learning from both successful andfailed	The research discusses the use of an adaptive management approach to create new knowledge in large river ecology. Adaptive management is defined as a decision process that allowsfor flexible decision making in the face of uncertainties. The sequence of activities used in adaptive management includes assessing the problem, designing and implementing management actions, monitoring and evaluating the outcomes, and making adjustments as needed. This approach is cyclic and can be repeated as new information becomes available. The research also mentions the use of scientifically designed experiments to gather data and assess restoration success. These experiments can be used to address various restoration objectivesand are based on a suite of guidelines that include indicators related to social, environmental, and economic factors. These guidelines can be used to evaluatethe success of river restorations and inform future restoration efforts.	The research discusses the use of a suite of guidelines presented by Woolsey et al. (2007) to assess the success of river restoration projects. These guidelines are based on 49 indicators grouped into 17 categories, addressing various restoration objectives related to social, environmental, and economic factors. The indicators cover aspects such as project acceptance, stakeholder participation, recreational use, landscape, hydrogeomorphy, and vegetation. The guidelines aim to support adaptive management, project evaluation, and increasing public and stakeholder acceptance. The research also mentions the concept of adaptive management, which involves flexible decision-making and adjusting management actions based on better understanding of outcomes.	The article "Moving Large RiverEcology from Past Theories to Future Actions: A Review" by Kathryn McCain discusses the evolution of large-river ecologyresearch from 20th century lifehistory and distribution studiesto more recent, holistic concepts like the riverine productivity model. The article explores how technological advances in data collection and modeling have led to more complex models of river ecology. With the decline of river ecosystems worldwide, the article highlights the need for effective management and restoration strategies, including the use of adaptive management. The author also acknowledges the challenges ahead, particularly the need to balance the demands of human population growth withthe preservation of river ecosystems.	By reading "Moving Large River Ecology from Past Theories to Future Actions: A Review" by Kathryn McCain, readers gain insights into the various themes central to studying and managing large rivers. The article provides an understanding of the different pathways of ecosystem recovery such as link between the flow regime and organism fitness. It also underpins the measures to be taken during restoration, witha focus on monitoring and sharing data to further evaluate successes and failures. The article also presents the need to balance the demands of human population growth with the preservation of river ecosystems	The report covers a wide range of parameters related to river restorationand biodiversity in the UK and Republic of Ireland, including: - Impacts of dams - Ecological effects of dam removal - Stakeholder participation - Hydromorphological features of rivers - Freshwater quality - River restoration techniques and sites - Socio-economic constraints and opportunities - Project risks, costs, and benefits These parameters provide a comprehensive understanding of the multifaceted aspects involved in restoring rivers and conserving biodiversity in the region, offering valuable insights for policymakers, researchers, and practitioners involved in environmental management and conservation efforts.

2.1.4 RESEARCH PAPER-4

"River Restoration and Biodiversity“ Stephen Addy, Susan Cooksley, Nikki Dodd, Kerry Waylen, Jenni Stockan, Anja Byg and Kirsty Holstead2010

AIM & OBJECTIVE	METHODOLOGY	ANALYSIS TOOL	REMARK	OUTCOME	PARAMETERS
The monitoring should encompass a large geographical range and use robust scientific approaches to evaluate projects.9 Monitoring should be undertaken before restoration and afterwards for a sufficient timescale to detect both rapid and longer-term changes.9 Promote and implement simple and cost-effective monitoring methods that can be applied across all sites.9 Consistency in these monitoring methods is vital to ensure comparability between projects.9 Use citizen science to provide useful information and connect people with their river environments.9 Use monitoring evidence to evaluate projects objectively and help inform the future design and implementation of actions elsewhere.9 Understand how different projects are carried out so that opportunities and barriers can be identified to help refine future practice.9	The research describes the methodology used to develop the guidelines, which included a comprehensive literature review and consultations with river restoration practitioners, policy-makers, and other stakeholders. The research also draws on case studies and expert knowledge to provide practical and evidence-based recommendations for river restoration. The methodology emphasizes the importance of stakeholder engagement, monitoring and evaluation, and a focus on process-based approaches to restoration. (Page 6)	The research does not provide a specific analysistool or methodology. However, it does emphasize the importance of monitoringand evaluation to assess the efficacy of restoration projects, and provides guidance on selecting appropriate indicators for assessing biodiversity, geomorphology, and ecosystem services. The research also provides examples of successful restoration projects and discusses the importance of adaptive management in river restoration. Overall, the research advocates for a process-based approach to river restoration that emphasizes local knowledge, stakeholder engagement, and ongoing monitoring and evaluation to ensure the effectiveness and sustainability of restoration efforts. (Page 62)	Overall, "River Restoration and Biodiversity" provides a comprehensive and evidence-based guide to nature-based solutions for restoring rivers in the UK and Republic of Ireland. The research emphasizes the importance of restoring rivers for conservation and sustainable development, and provides practical guidance and recommendations for achieving these goals. The research draws on case studies, expert knowledge, and stakeholder engagement to offer a process-based approach to river restoration that emphasizes monitoring and evaluation, adaptive management, and a focus on local knowledgeand expertise. This research is a valuable resource for river restoration practitioners,policy makers, and other stakeholders interested in restoring rivers for biodiversity and ecosystem services.	The outcome of "River Restoration and Biodiversity" isa set of evidence-based guidelines and recommendations for natural river restoration in the UK and Republic of Ireland. The research emphasizes the importance of nature-based solutions for restoring rivers and the importance of engaging local stakeholders in the restoration process. The research provides practical advice and guidance on restoration techniques, including channel restoration, habitat restoration, and managing invasive species. Additionally, the research emphasizes the importance of monitoring and evaluation to assess the effectiveness of river restoration efforts and highlights the importance of adaptive management and stakeholder engagement in ensuring the success and sustainability of restoration projects. Overall, the research provides a comprehensive blueprint for restoring rivers in a manner that promotes biodiversity conservation and sustainable development.	The papers in this special issue focus on the following parameters in the study and research of restoring riverine landscapes: - Identifying priorities for riverine landscape restoration - Defining reference states for riverine ecosystems - Techniques and approaches for riverine landscape restoration - Implications of restoration efforts on ecosystem health and resilience These parameters are explored by experts in the field, including Christer Nilsson, RolandJansson, Björn Malmqvist, and Robert J. Naiman, providing valuable insights into the complex challenges and opportunities associated with restoring riverine ecosystems.

https://portals.iucn.org/library/sites/library/files/researchs/2016-064.pdf

2.1.5 RESEARCH PAPER-5

Restoring Riverine Landscapes: The Challenge of Identifying Priorities, Reference States, and Techniques Helen Parker,Eva Ludi

2007

AIM & OBJECTIVE	METHODOLOGY	ANALYSIS TOOL	REMARK	OUTCOME	PARAMETERS
The aim of the research "Restoring Riverine Landscapes: The Challenge of Identifying Priorities, Reference States, and Techniques" is to draw together nine presentations from the Second International Symposium on Riverine Landscapes, convened in August 2004 in Storforsen, Sweden. They summarize three themes related to river restoration: (1) setting priorities, (2) identifying relevant reference conditions, and (3) choosing appropriate techniques, and discuss ways of developing river restoration and provide examples of future needs in sustaining functioning river ecosystems that can support human societies (Pages 1 and 2).	The research "Restoring Riverine Landscapes: The Challenge of Identifying Priorities, Reference States, and Techniques" summarizes the methodology related to river restoration. The authors emphasize the importance of three themes: setting priorities, identifying relevant reference conditions, and choosing appropriate techniques. The paper also discusses the need for interdisciplinary efforts and interactive collaborations among scientists representing various fields involved in river restoration, as well as with planners, engineers, and politicians. They suggest using a flexible and adaptive management approach to accommodate some levels of both variability and unpredictability, i.e., inherent conditions of natural systems. The research provides some examples of river restoration techniques, such as re-operation of dams, which demonstrates improvements in the ecological integrity of rivers. The authors also emphasize the significance of integrating social learning in the restoration process, which can help restore multifunctionality of rivers and floodplains, and sustain functioning river ecosystems that can support human societies (Pages 4-7).	The research does not specifically mention any analysis tool for river restoration. However, it emphasizes the importance of interdisciplinary efforts and interactive collaborations among scientists representing various fields involved in river restoration, as well as with planners, engineers, and politicians. This suggests that utilizing various analysis tools, such as geographical information systems (GIS), simulation models, and monitoring techniques, in addition to expertise from different fields, can aid in the development of a more sustainable restoration approach. The research promotes a flexible and adaptive management approach to accommodate variability and unpredictability in natural systems and recommends using social learning in the restoration process to restore multifunctionality of rivers and floodplains (Pages 4-7).	The research "Restoring Riverine Landscapes: The Challenge of Identifying Priorities, Reference States, and Techniques" provides an insightful overview of river restoration methodologies, focusing on the identification of priorities, reference states, and appropriate techniques to sustain functioning river ecosystems that can support human societies. One of the key takeaways from the paper is theneed for interdisciplinary effortsand interactive collaborations among scientists representing various fields involved in river restoration. The paper also highlights the importance of integrating social learning in the restoration process to restore multifunctionality of rivers and floodplains. Overall, this research provides a valuable resource for anyone involved in river restoration and interested in developing more sustainable restoration approaches (Pages 1-8).	The research "Restoring Riverine Landscapes: The Challenge of Identifying Priorities, Reference States, and Techniques" aims to summarize three themes related to river restoration: (1) setting priorities, (2) identifying relevant reference conditions, and (3) choosing appropriate techniques. Through case studies and expert opinions, the paper emphasizes the importance of developing a flexible and adaptive management approach to accommodate variability and unpredictability in natural systems while restoring multifunctionality of rivers and floodplains. The outcome of this paper is a better understanding of river restoration methodologies and the need for interdisciplinary efforts in creating a more sustainable approach to river management (Pages 1-8).	This paper focuses on the limitations of conventional approaches to river management and the emergence of the practice of river restoration. The authors argue that restoration efforts have been disappointing because they over-rely on physical analyses and approaches, neglecting the influence of biology on river forms and processes. The paper proposes a new approach called biomic river restoration, which involves reconnecting streams within balanced and healthy biomes to leverage the power of biology in influencing river processes. The authors discuss the importance of considering small animals and vegetation in river restoration efforts and highlight the need for a paradigm shift in river management towards working with natural processes.

https://www.researchgate.net/publication/230718797_Restoring_Riverine_Landscapes_The_Challenge_of_Identifying_Priorities_Reference_States_and_Techniques

2.1.6 RESEARCH PAPER-6

"Biomic river restoration: A new focus for river management“

Matthew F. Johnson, Colin R. Thorne, Janine M. Castro, G. Mathias Kondolf, Celeste Searles Mazzacano, Stewart B. Rood, Cherie Westbrook

2019

AIM & OBJECTIVE	METHODOLOGY	ANALYSIS TOOL	REMARK	OUTCOME	PARAMETERS
The aim and objective of the article "Biomic river restoration: A new focus for river management" is to propose a new approach to river restoration, one that recognizes the influence of biology on river forms and processes and re-envisions what it means to restore a river. This new approach entails shifting the focus of river restoration from designing and constructing stable channels that mimic natural forms to reconnecting flowing waters with floodplains and wetlands, actively enhancing biodiversity, and allowing dynamic and unpredictable processes to shape the riverine landscape. Furthermore, the authors argue that this new approach must be founded on community values, supported by stakeholder engagement, defined by nature, informed by scientists, and delivered by engineers—all working in partnership with nature's riverrestorers (Pages 1-2).	The article "Biomic river restoration: A new focus for river management" proposes a new approach to river restoration based on biology and ecosystem principles. The authors draw on existing research and examples of successful projects to argue for a shift away from the traditional focus on stable channel design. Instead, they propose a more dynamic and holistic approach that recognizes the complex interplay between physical and biological factors in shaping river forms and processes. The authors emphasize the need for collaboration between engineers and scientists, as well as stakeholder involvement and community values, to achieve successfulriver restoration outcomes. They also highlight the importance of monitoring and adaptive management to ensure sustained benefits for both human and ecological communities. The article provides a conceptual framework and guiding principles for biomic river restoration, rather than a specific methodology, reflecting the diverse andsite-specific nature of river ecosystems and restoration projects (Pages 1-2 and 9-10).	The article "Biomic river restoration: A new focus for river management" primarily uses a narrative and conceptual approach, drawing on existing research and examples of successful river restoration projects to make a case for a new approach based on biology and ecosystem principles. The authors provide a conceptual framework and guiding principles for biomic river restoration, rather than a specific analysis tool. However, the article highlights the importance of monitoring and adaptive management, which may involve the use of various analytical and modeling tools, to ensure successful outcomes. These tools could include hydrological, ecological, and social impact models, as well as indicators of ecosystem health and resilience. The specific tools used will depend on the site-specific context and goals of each restoration project (Pages 1-2 and 9-10).	The article "Biomic river restoration: A new focus for river management" provides a compelling argument for a new approach to river restoration that recognizes the importance of biology and ecosystem principles. The authors highlight the limitations of traditional physics-based approaches and the need for a more dynamic and holistic approach that accommodatesthe diverse and complex interplay between physical and biological factors that shape riverine ecosystems. The article provides a useful conceptual framework and guiding principles for biomic river restoration practice and highlights the importance of community values, stakeholder engagement, and adaptive management for achieving successful outcomes. Overall, the article provides valuable insights for restoration practitioners, scientists, and decision-makers seeking to address the challenges of river management in an era of increasing environmental change. (Pages 1-2 and 9-10).	The article "Biomic river restoration: A new focus for river management" proposes a new approach to river restoration that emphasizes the importance of biology and ecosystem principles and provides a useful framework for restoration practitioners and decision-makers seeking to address the complex challenges of river management. The proposed approach shifts the focus awayfrom traditional stable channeldesign towards a more dynamic and holistic restoration strategy that recognizes the complex interplay between physical and biological factors that shape riverine ecosystems. The article highlights the importance of community values, stakeholder engagement, and adaptive management for achieving successful outcomes. The authors make a compelling case for the potential of biomic river restoration to support the recovery and resilience of riverine ecosystems and the communities that depend on them. (Pages 1-2 and 9-10).	This paper focuses on various parameters related to river ecology in India. Some of the key areas of research and study include riparian vegetation, floodplain ecology, energy dynamics, longitudinal and transverse flow of organic matter, and the impact of river regulation on the functional state of rivers. The paper also discusses the use of biomonitoring to assess the ecological impacts of human activities on river ecosystems, and recommends sampling designs and methods for studying the impacts of developmental projects on rivers. Additionally, the paper highlights the need for conservation strategies and sustainable management practices to ensure the long-termhealth of India's river ecosystems

https://onlinelibrary.wiley.com/doi/10.1002/rra.3529

2.1.7 RESEARCH PAPER-7

"River Ecology in India: Present Status and Future Research Strategy For Management and Conservation" VK. Srivastava 2007

AIM & OBJECTIVE	METHODOLOGY	ANALYSIS TOOL	REMARK	OUTCOME	PARAMETERS
The aim and objective of the paper "River Ecology in India:Present Status and Future Research Strategy For Management and Conservation" by VK Srivastava is to review the present ecological and biological conditions of rivers in India, and to provide a management and conservation approach.	The methodology used in the paper "River Ecology in India: Present Status and Future Research Strategy For Management and Conservation" involves the review of various studies, reports, and literature on the ecological and biological conditions of the rivers in India. The author surveyed and analyzed works on different rivers across the country to identify the constraints and problems related to management and conservation. For effective management, it is emphasized to assess precisely the ecological impacts caused by anthropogenic activities through biomonitoring. Suitable sampling design and method (BACI, beyond BACI, Nested sampling, Rapid bioassessment, etc.) are recommended to segregate the natural variations from the actual impacts caused. The author has also advocated for the study of functional attributes along with the structural parameters and recommended studies related to riparian vegetation, floodplain ecology, longitudinal and transverse flow of organic matter, and energy dynamics, Long-term research before and after the commission of any river valley project is also suggested to evaluate the ecological impacts close to accuracy that is essential to formulate an effective management plan. (Pages 1, 4, 9-11)	In the paper "River Ecology in India: Present Status and Future Research Strategy For Management and Conservation," the author recommends using appropriate analysis tools to conduct ecological impact assessments (EcoIA) in the management of river ecosystems. The tools recommended include BACI (Before-After-Control-Impact), Nested Sampling, Rapid Bioassessment, and Beyond BACI to segregate the natural variations from the impacts caused by anthropogenically induced developmental projects and policies. The author emphasizes the importance of using suitable statistical tools to analyze the obtained data and the practices and policies, which can lead to sustainable river ecology management in India.Strategic Environmental Assessment (SEA) procedures are also recommended for higher-level policy-making. (Pages 8, 9)	From the research "River Ecology in India: Present Statusand Future Research Strategy For Management and Conservation," it is evident that to manage the river ecosystems effectively and sustainably in India, it is essential to conduct long-term research and adopt suitable management practices. The author emphasizes the need to evaluate the ecological impacts of anthropogenic activities more accurately through biomonitoring and suitable analysis tools. Further, the author highlights the importance of integrating EcoIA findings into project planning and execution to manage the lotic ecosystem sustainably and advocates for the study of functional attributes such as energy flow in addition to structural parameters. Overall, the paper provides useful insights into the ecological management of Indian rivers and offers an effective research strategy to promote their conservation. (Pages 1, 4, 11, 15)	The paper "River Ecology in India: Present Status and Future Research Strategy For Management and Conservation" by VK Srivastavaprovides a comprehensive analysis of the current ecological and biological conditions of rivers in India and offers a strategic roadmap for managing and conserving their ecosystems sustainably. The author emphasizes the need for long-term research and suitable statistical tools to correctly evaluate the ecological impacts of anthropogenic activities and recommends policy-level monitoring through Strategic Environmental Assessment (SEA) procedures. By adopting the practices and policies suggested by the paper, India can improve the sustainable management of its river ecosystems, ensuring their preservation for current and future generations. (Pages 1, 4, 8, 15	- Plastic debris accumulation and fragmentation - River ecosystem management and "Infield" experiments - Sanitation and water challenges - Changing nature of river restoration - Biodiversity concept, threats, and conservation - Stakeholder participation for environmental management - Inter-state river water disputes in India - River restoration objectives linked with long-term research - Management of rivers crossing boundaries - Relocation practices for species in changing climates - Protection gaps for the world's rivers - River ecology research strategy in India - River water requirements

https://www.researchgate.net/publication/286226478_River_Ecology_in_India_Present_Status_and_Future_Research_Strategy_ For_Management_and_Conservation

2.1.8 RESEARCH PAPER-9

"Riverine biodiversity and importance: Potential threat and conservational challenges“

Anuradha Kumari, Sarika

2022

AIM & OBJECTIVE	METHODOLOGY	ANALYSIS TOOL	REMARK	OUTCOME	PARAMETERS
the aim and objectives of the chapter are to highlight the current threats to river biodiversity, potential improvement measures, and the challenges encountered during implementation. The chapter also includes the extent of alterations justified for the need of river restoration alongside measures that restrict further damage and the compelling argument of bringing back the natural functioning of rivers. (Page 1)	The research doesn't provide a detailed methodology. However, the research analyzes various threats to river biodiversity, potential improvement measures, and challenges encountered during implementation. The authors gathered and reviewed relevant literature and scientific studies on the topic to provide a comprehensive view of the subject matter. The authors use case studies and examples from different parts of the world to illustrate their points and provide evidence to support their arguments. The chapter utilizes an approach that seeks to identify anthropogenic factors that accelerate change on river systems and provide strategies and solutions that raise awareness and promote conservation action from all stakeholders. By reviewing the relevant studies, they provide a holistic view of river ecosystems and their importance as resourcesthat support human survival and the functioning of 7% of global biodiversity. (Pages 1-2, 4-5)	The research doesn't specify a particular analysis tool, but the authors utilize a review of relevant literature and scientific studies as their primary analysis method. They employ a qualitative approach to identify the significant factors that contribute to the current state of river biodiversity. Besides, the chapter draws examples and case studies that illustrate the impact of human activities on freshwater ecosystems. The authors provide a comprehensive review of the current threats and potential measures to address the decline in river biodiversity. The study also adopts a holistic approach that recognizes the crucial role of all stakeholders in supporting conservation action. The authors suggest a management framework that incorporates ecosystem services and recognizes the importance of aquatic systems in supporting human livelihoods, water supply, and biodiversity conservation objectives. (Pages 1-2,4-5)	The research provides insights into the threats that face river ecosystems worldwide and their impact on global biodiversity. The authors provide a comprehensive review of the current threats to river biodiversity and the potential measures to address the decline. The authors utilize various case studies and examples from different regions to illustrate their points and provide evidence to support their arguments. The research recognizes the complexity of river ecosystems 'habitat mosaic,' which responds to environmental pressures differently depending on spatial and temporal factors. The study also recognizes the critical role of stakeholders in promoting conservation action, promoting environmental awareness, and supporting restoration efforts. (Pages 1-2, 4-5)	The outcome of the study is a comprehensive understanding of the current threats to river biodiversity, potential improvement measures, and challenges encountered during implementation. The study emphasizes the importance of conserving river ecosystems in supporting global biodiversity, promoting human well-being, and ensuring sustainable development. The study recognizes the importance of involving all stakeholders in promoting conservation action, including policymakers, ecosystem managers, resource users, NGOs, citizens, and governments. The research proposes a management framework that incorporates ecosystem services and recognizes the critical role of aquatic systems in supporting human livelihoods, water supply, and the conservation of biodiversity.	The research in the paper encompasses a wide array of critical aspects related to river biodiversity and conservation. It delves into plastic debris accumulation, river ecosystem management, sanitation and water challenges, river restoration dynamics, biodiversity threats and conservation, Madagascar's freshwater biodiversity, restoration project development, filter feeders distribution, dynamic management, emerging threats, dam construction effects, urban expansion impacts, eutrophication, extinction rates, sediment impact, freshwater biodiversity conservation, stakeholder participation, inter-state river water disputes, river restoration objectives, river management, species relocation, protection gaps, river ecology research, and water requirements. These parameters collectively form acomprehensive framework for understanding and addressing the challenges and opportunities in riverbiodiversity and conservation.

https://doi.org/10.1016/B978-0-323-85045-2.00009-1

2.1.9 RESEARCH PAPER-9

"Protecting and restoring river ecosystems to support biodiversity"Susan Cooksley,Nikki Dodd 2021

AIM & OBJECTIVE	METHODOLOGY	ANALYSIS TOOL	REMARK	OUTCOME	PARAMETERS
The aim of the scoping paper on EU restoration targets for free-flowing rivers and freshwater ecosystems is to provide specific recommendations for legally binding restoration targets that address the hydromorphological elements of aquatic ecosystems to reverse the decline of freshwater biodiversity, with a focus on river continuity and the restoration of floodplains and wetlands. The objective is to drive large-scale action to protect and restore aquatic ecosystems, which are crucial for achieving both climate and biodiversity ambitions. The paper also recommends funding mechanisms, incentives for positive impacts on biodiversity, and effective management post-restoration to ensure restored river systems maintain environmental processes to achieve project goals (Pages 1, 2, 4, 5, and 12).	The methodology outlined in the scoping paper on EU restoration targets for free-flowing rivers and freshwater ecosystems involves the analysis of existing knowledge on barriers to restoration and the identification of key recommendations for restoration targets, funding mechanisms, and effective management. The paper relies on literature review, expert consultation, and case studies to support their argumentation and recommendations. The paper also utilizes tools such as GIS-based decision support systems and prioritization tools that take into account hydrological, ecological, and social criteria to aid in the identification of effective nature-based solutions for river restoration. Additionally, the papernotes the importance of monitoring programs for key freshwater biodiversity variables and other indices of holistic functioning riverine systems. The methodology is multidisciplinary, focusing on the integration of hydrology, ecology, and socio-economic factors to ensure the efficient and effective restoration of aquatic ecosystems. Overall, the methodology is geared towards identifying feasible and cost-effective solutions for the safeguarding of freshwater biodiversity and the promotion of sustainable water management practices (Pages 5, 6, 7, 10, and 11).	One of the analysis tools used in the scoping paper on EU restoration targets for free-flowing rivers and freshwater ecosystems is the GIS-based decision support system known as TNC. TNC is a tool that uses a large set of data to aid in the decision-making process by allowing users to query for various outcomes including cost effectiveness, biodiversity impact, and interventions for the targeted species. While TNC has previously been used in the USA, it is currently being field-tested in two watersheds in Slovenia to illustrate how the tool can be applied in Europe. The aim of this tool is to provide decision-makers with the necessary information to achieve successful restoration of aquatic ecosystems by prioritizing actions that result in the highest ecological and socio-economic benefits (Page 6).	The scoping paper on EU restoration targets for free-flowing rivers and freshwater ecosystems highlights the alarming situation of aquatic ecosystems in Europe and the urgent need for action to protect and restore them. The paper emphasizes the importanceof inter-sectoral collaboration and the integration of hydrology, ecology, and socio-economic factors in designing effective conservation and restoration measures. The paper also provides a set of key recommendations for improving the implementation and enforcement of existing legislation, including the Water Framework Directive and the Habitats Directive. Overall, the paper provides a valuable starting point for developing a comprehensive framework for prioritizing and implementing restoration projects that can help alleviate the plight of freshwater ecosystems and support the goals of the EU Biodiversity Strategy (Pages1, 2, and 11).	The scoping paper on EU restoration targets for free-flowing rivers and freshwater ecosystems aims to emphasize the need for improved conservation and restoration measures for aquatic ecosystems in Europe. It provides information on the current state of freshwater ecosystems, highlights the causes of threats to these ecosystems, and presentskey recommendations for improving their ecological status. The paper primarily targets policymakers and decision-makers by identifying ways to address the current situation and prioritizing areas where conservation and restoration efforts are most necessary. The paper aims to protect and replenish aquatic ecosystems and biodiversity and position freshwater conservation as a key component of achieving the goals of the EU Biodiversity Strategy (Pages 1, 2, and 11).	The paper focuses on the coherent management of rivers, emphasizing the interplay between ecosystem services, water security, and societal benefits. It explores the trends in freshwater biodiversity and the driving forces behind these trends, aiming to develop a stronger theoretical framework for linking interventions to river condition and societal benefits. The authors also delve into the implications of their findings for researchers, policy-makers, and practitioners working on water security and freshwater conservation. Additionally, the study is informed by a conceptual framework for river management research, policy, and planning, integrating perspectives from various disciplines and emphasizing political economy analysis.

https://wwfeu.awsassets.panda.org/downloads/scoping_paper_free_flowing_river_and_fw_targets_by_lre.pdf

2.1.10 RESEARCH PAPER-10

Managing Rivers for Multiple Benefits–A Coherent Approach to Research, Policy and Planning Catherine R. Moncrieff,David Tickner 2017

AIM & OBJECTIVE	METHODOLOGY	ANALYSIS TOOL	REMARK	OUTCOME	PARAMETERS
The aim of the research "Managing Rivers for Multiple Benefits – A Coherent Approach to Research, Policy and Planning" is to present a conceptual framework for a coherent approachto river management research, policy and planning in order to encourage informed, equitable and sustainable river management. The objective is to facilitate more integrated planning which takes account of the existing political, economic, infrastructure and institutional context, to achieve more balanced and equitable outcomes from river management than have hitherto been achieved. (Pages 4-5)	The methodology of the research involved a review of existing literature and research on river management, with a focus on ecosystem services, water security, and water resource management. The authors drew on multiple disciplines and schools of thought, including those traditionally associated with river management, such as ecologists and environmentaleconomists, as well as disciplines such as social science and political economy. Using a conceptual framework, the authors developed a comprehensive approach to river management that takes into accountthe varying needs and interests of different groups of stakeholders. Theframework is intended to encourage more informed, coordinated, and equitable decision-making about river management, and it includes a series of questions that can be used to guide the development of river management plans and policies. The authors also emphasize the importance of considering the powerdynamics and politics that shape river-society relationships when designing and implementing river management interventions. (Pages 4-6)	The research presents a range of tools and frameworks that can be used to facilitate integrated and equitable river management decision-making.These include a conceptual framework that integrates concepts from ecosystem science, water resource management, social science, and political economy. The framework highlights the connections between river condition, ecosystem services, and the provision of multiple benefits to different groups in society. Additionally, this research includes several sets of questions that can be used to guide more coherent and integrated research, policy, and planning on river management. By drawing on different disciplines, tools, andframeworks, the authors hopeto support more evidence- informed and equitable river management that takes account of the diverse needs and interests of all stakeholders. (Pages 5-6)	Overall, "Managing Riversfor Multiple Benefits - A Coherent Approach to Research, Policy and Planning" provides a comprehensive and integrated framework forriver management that takes into account the varied needs and interests of stakeholders. The research is well- written, well-organized, and draws on a broad base of scientific literature and research. The authors provide clear recommendations for how to integrate different approaches to river management, and offer a series of tools and frameworks that can be used by decision-makers in practice. This research will be useful for a wide range of stakeholders interested in integrated and equitable river management, including researchers, policymakers, and practitioners in government, NGOs, and the private sector. (Pages 1-9)	The outcome of "Managing Rivers for Multiple Benefits - A Coherent Approach to Research, Policy and Planning" is to provide a more coherent, equitable, and sustainable approach to river management decision-making. By drawing on a range of tools, frameworks, and interdisciplinary approaches, the authors aim to support more informed and evidence-based decision-making that takes into account the diverse needs and interests of stakeholders. Ultimately, the research provides a conceptual and practical roadmap for how to manage rivers in a way that maximizes benefits for all stakeholders, and ensures that ecological, social, and economic considerations are balanced in decision-making. The authors hope that their recommendations will lead to more effective and equitable management of river systems in the future. (Pages 1-9)	This paper provides a conceptual framework for a coherent approach to river management research, policy, and planning. It combines perspectives and information from different disciplines and schools of thought, including ecosystem services approaches, water security and water resource management approaches, and political economy analysis. The paper focuses on the overall health of a river ecosystem, including catchment processes, water quality, river flows, connectivity, biodiversity, and habitat characteristics. It also considers the societal benefits that arise from a river's ecosystem services and the trade-offs between different management options. The paper aims to facilitate the design and delivery of more coherent management interventions through explicit consideration of multiple benefits and trade-offs.

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2.2 NATIONAL FOREST POLICY -2018

2.2.1 GOAL AND OBJECTIVES

- Improvement in livelihoods for people based on sustainable use of ecosystem services.
- Checking denudation and soil erosion in the catchments of rivers and the wetlands through integrated watershed management techniques and practices.
- Manage protected areas and other wildlife rich areas with the primary objective of biodiversity conservation and for enriching other ecosystem services.
- Increase substantially the tree cover outside forests by incentivizing agro-forestry and farm forestry, facilitating assured returns, with enabling regulations and by promoting use of wood products.
- Managing and expanding green spaces in urban and peri-urban areas to enhance citizens' well-being.

2.2.3 ESSENTIAL PRINCIPLES OF FOREST MANAGEMENT

- Management of the natural biodiversity rich forests for maximizing the ecosystem services for ecological security of the nation.
- For conservation of flora, fauna and total biodiversity, the network of national parks, sanctuaries, conservation reserves, community reserves, biosphere reserves and important wildlife corridors and biodiversity heritage sites will be strengthened and extended adequately.
- Afforestation with suitable species will be intensified so as to cater to the needs of the rural population for fuel wood and small timber. Further alternative sources of energy like LPG etc. will be promoted in rural areas to reduce dependency on forests.
- Non-Timber Forest Produce (NTFP) such as medicinal and aromatic plants, oil seeds, resins, wild edibles, fiber, bamboo and grass etc. will be sustainably managed for improving the income of the tribals & other forest dependent populations.

2.2.4 STRATEGY INTRODUCTION SUSTAINABLE MANAGEMENT OF FORESTS

2.2.4.1 Reducing Threats to Forests

The various threats to Forests due to encroachments, illegal tree fallings, forests fires, invasive weeds, grazing, etc. will be addressed within the framework of the approved Working Plan/ Management Plan and also by ensuring community participation in forest management.

2.2.4.2 Enhance Quality and Productivity of natural forests

Many of our forest ecosystems have been significantly altered and degraded due to land conversion, pollution, over exploitation, deforestation and degradation etc. with adverse impacts on biological diversity and livelihoods of the local population. Protection and enrichment of dense forests will be a top priority. Degraded forests will be rehabilitated by promoting natural regeneration, by taking strict protection measures and also by planting locally suitable indigenous species for assisting the existing regeneration.

2.2.4.3 Protecting & enriching the Catchments

Schemes and projects which interfere with forests that cover steep slopes, catchments of rivers, lakes, and reservoirs, geologically unstable terrain and such other ecologically sensitive areas shall be restricted. The ecologically sensitive catchment areas shall be stabilized with suitable soil & water conservation measures and also by planting with suitable trees and grasses like bamboo etc.

2.2.4.4 Biodiversity Conservation

Biodiversity of the forest areas of the country will be surveyed and documented systematically, and sites having exceptional taxonomic and ecological value will be conserved.

2.2.4.5 Forest management for water recycling

Water is critical for all life forms and is one of the most valuable outputs from the forests. Healthy forest ecosystems helps recharge of aquifers by increasing percolation and reducing surface runoff, thereby nourishing springs, streams, rivers and other aquatic systems. Forests and other ecosystems that function as key catchments need to be identified and conserved. Scientific catchment area treatment plans will be prepared and executed as part of the forest working/ management plans

2.2.5 RESEARCH AND EDUCATION

Scientific research in forestry and wildlife is the backbone of forest management and contributes to understanding of the forest dynamics leading to pragmatic conservation planning. Forestry/ wildlife education has also been adopted by many institutions and the students graduating are finding several career opportunities within and outside government.

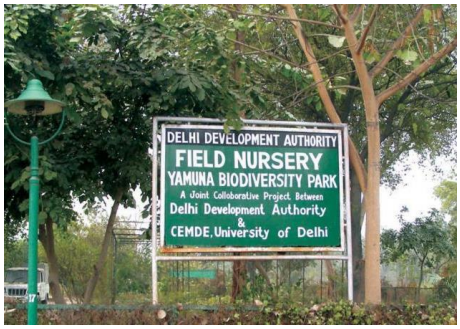
In this context, to facilitate contemporary research and education following measures will be taken:-

- Focus of forestry research will be on integrated and multidisciplinary research on forests and forest products for increasing livelihood support and economic growth.
- Research on Forest inventory including growth yield assessment of forest products, ecosystem services etc will be taken up on priority.
- Intensive and need-based research for biodiversity conservation, reclamation of degraded and mined areas for ecological security, integrated pest management, invasive alien species management, forest fires, forest hydrology and carrying capacity of ecosystems etc will be taken up on priority.
- Research on enhancing the capacity of the forest ecosystems for carbon sequestration will be taken up on priority.
- Increasing forest productivity through forest genetic resource management and tree improvement will be emphasized.
- Policy research on various forests related issues will be undertaken in changing national scenario.
- Promotion of forestry education and adoption of forestry curriculum addressing the contemporary priorities will be stressed.

CHAPTER-3 CASE STUDIES

3.1 CASE STUDY-1 YAMUNA BIODIVERSITY PARK. DELHI

3.1.1 INTRODUCTION

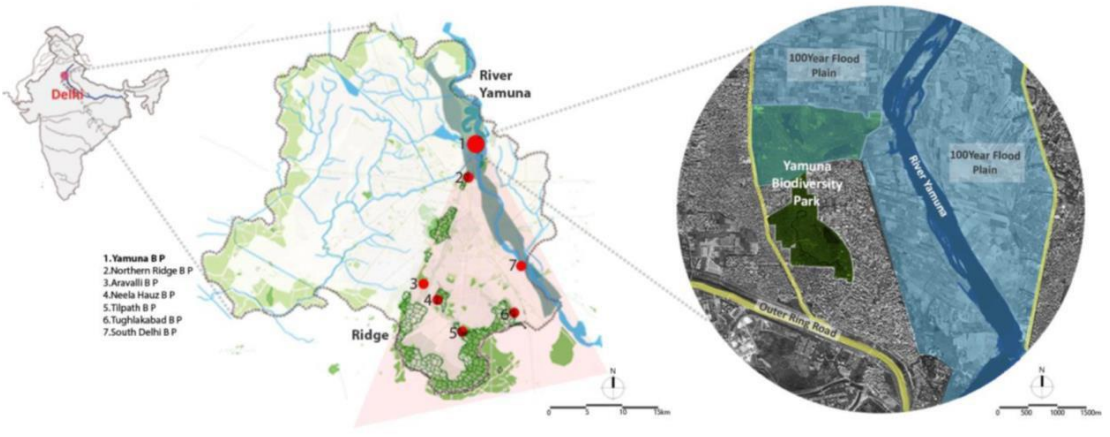


- The biosphere comprises of a complex collections of innumerable organisms, known as the Biodiversity, which constitute the vital life support for survival of human race.
- Biological diversity, abbreviated as biodiversity, represent the sum total of various life form is such as unicellular fungi, protozoa, bacteria, and multi cellular organisms such as plants. fishes, and animals at various biological levels including gens, habitats, and ecosystem .

3.1.2 ABOUT YAMUNA BIODIVERSITY PARK

Emerging as the capital's most visited public place and prominent center for learning and understanding the environment, the Yamuna Biodiversity Park has become a home for a diversity of forest communities, biologically rich wetlands, grassland communities, a wide variety of fruit yielding species and an abundance of medicinal herbs. The Park also comprises native flora and fauna which used to exist many decades before and then became extinct locally. It further, acts as a natural conservation site for specific group of endangered plants. The Yamuna Biodiversity Park is presently spread over an area of approximately 457 acres near Wazirabad village on the westernbank of the river Yamuna.

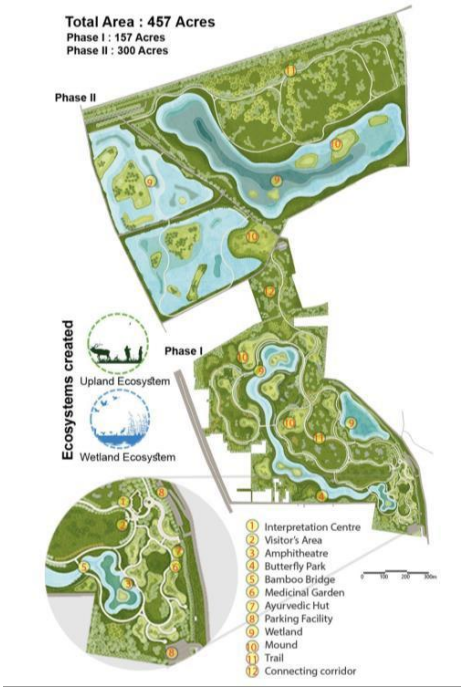
3.1.3 LOCATION

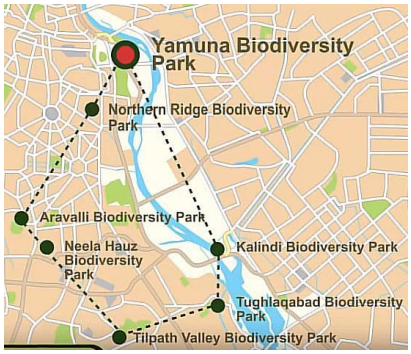


Location Map

3.1.4 MASTER PLAN

The park is divided into two phases: Phase I spreading across an area of of 157 ACRES and Phase II spreading across an area of 300 ACRES, located on the active floodplain of river Yamuna and consists of mosaic of wetlands together with the grasslands and floodplain forest communities



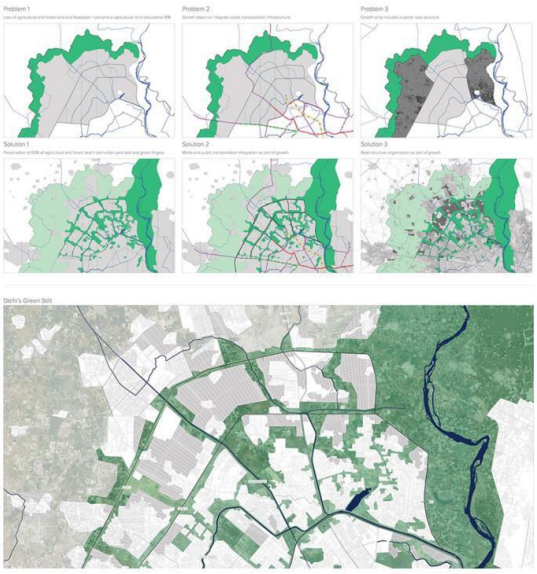


3.1.5 FEATURES

- Ten mounds which illustrate different forest ecosystems found in the Yamuna basin Structure and composition is done in such a way to give it a natural view and environment
- The soil for mounds were brought from a digging wasteland and reservoirs.
- Different species of grass and shrubs were planted for soil better holding and for increasing biomass
- Different ecosystems such as deciduous forest, evergreen forest, sub-tropical evergreen, moist tropical deciduous forest etc.
- Broad divisions are bambuselum, Nature Interpretation centre, conservatory of fruit yielding species, wetland for migratory birds and the nature reserve area

3.1.6 NEED OF BIODIVERSITY PARK

3.1.6.1 URBAN SPRAWL



The Yamuna Biodiversity Park is crucial for mitigating the impact of urban sprawl in Delhi. As rapid urbanization expands, the park serves as a green buffer, preventing encroachment onto vital natural habitats. Its strategic location along the Yamuna floodplains aids in regulating urban expansion, acting as a natural barrier against unchecked development. Preserving this biodiversity-rich area helps maintain ecological balance amidst urban sprawl, fostering sustainable coexistence between nature and urban life. The park's recreational spaces also offer residents a respite from the concrete jungle, contributing to the overall well-being of the community and addressing the challenges associated with urban sprawl.

3.1.6.2 CLIMATE CHANGE

The Yamuna Biodiversity Park plays a significant role in climate change mitigation for Delhi. Acting as a carbon sink, the park's diverse flora absorbs carbon dioxide, helping reduce greenhouse gas levels in the atmosphere. Preserving and restoring native ecosystems within the park contribute to overall environmental resilience, aiding the city in adapting to changing climate patterns. Furthermore, the park enhances local biodiversity, fostering resilient ecosystems capable of withstanding climate-related stressors. Its location along the Yamuna River also contributes to water management strategies, addressing climate-induced challenges such as extreme weather events.

3.1.6.3 INDUSTRIAL WASTE

The Yamuna Biodiversity Park in Delhi plays a crucial role in mitigating the impact of industrial waste. Located along the Yamuna River, the park serves as a natural buffer, helping filter pollutants and contaminants from industrial discharges. The park's vegetation and wetland areas act as biofilters, purifying water before it enters

the river. This contributes to water quality improvement and helps prevent the adverse effects of industrial pollution on the river ecosystem. Additionally, the park's role in floodplain management assists in regulating the dispersion of pollutants, reducing the potential harm caused by industrial waste during periods of high water levels

3.1.6.4 POPULATION PRESSURE

The Yamuna Biodiversity Park in Delhi is vital in addressing the challenges posed by population pressure. As urbanization and population growth increase, the park serves as a green lung, offering a recreational space for residents. This helps alleviate the stress on urban infrastructure by providing an alternative area for leisure and relaxation. Moreover, the park contributes to the overall well-being of the population, offering a sanctuary amid the pressures of city life. By acting as a buffer against encroachment and promoting sustainable land use, the park aids in maintaining a balance between the burgeoning population and the need for green spaces in urban areas.

3.1.6.5 WATER POLLUTION

The Yamuna Biodiversity Park plays a crucial role in mitigating water pollution in Delhi, particularly along the Yamuna River. The park's strategic location allows it to act as a natural filtration system, trapping pollutants and contaminants from urban runoff and industrial discharges. The wetland areas and vegetation within the park serve as biofilters, helping to purify water before it reaches the river. This contributes to the improvement of water quality and helps prevent the downstream effects of water pollution. The park's existence aids in maintaining a healthier aquatic ecosystem, benefiting both the local environment and the communities dependent on the Yamuna River for various purposes

3.1.6.6 AIR POLLUTION

The Yamuna Biodiversity Park serves as a vital ally in combating air pollution in Delhi. With its lush vegetation, the park acts as a natural filter, trapping and mitigating pollutants,including particulate matter. The diverse plant life contributes to increased oxygen production and carbon sequestration, addressing the imbalance caused by urbanization. By serving as a green lung within the city, the park not only improves air quality but also raises awareness about the importance of preserving green spaces in urban environments. Its role as a natural oasis offers a breath of fresh air, countering the impacts of industrialization and vehicular emissions

3.1.6.7 ECOLOGICAL FACTORS

The Yamuna Biodiversity Park holds significant importance in addressing issues relatedto land degradation, deforestation, and habitat loss in Delhi:

Land Degradation Mitigation: The park contributes to the restoration of degraded land, particularly along the Yamuna floodplains. Its vegetation helps prevent soil erosion, improves soil structure, and promotes overall soil health. This is crucial in mitigating theadverse effects of land degradation caused by urbanization and improper land use.

Deforestation Prevention: By preserving and showcasing diverse native plant species, the park acts as a green lung, countering the impact of deforestation in urban areas. It provides a model for sustainable urban forestry practices and helps maintain green cover, crucial for ecological balance and environmental health.

Habitat Restoration: The park serves as a habitat restoration site, reintroducing native flora and fauna to an area that may have faced habitat loss due to urban expansion. This isessential for the conservation of biodiversity and the re-establishment of natural ecosystems that may have been disrupted by human activities.

Biodiversity Conservation: As a designated biodiversity park, it actively contributes to the conservation of various plant and animal species that might be threatened by habitatloss. The park's diverse ecosystems provide a sanctuary for indigenous and endemic species, fostering biodiversity within an urban setting.

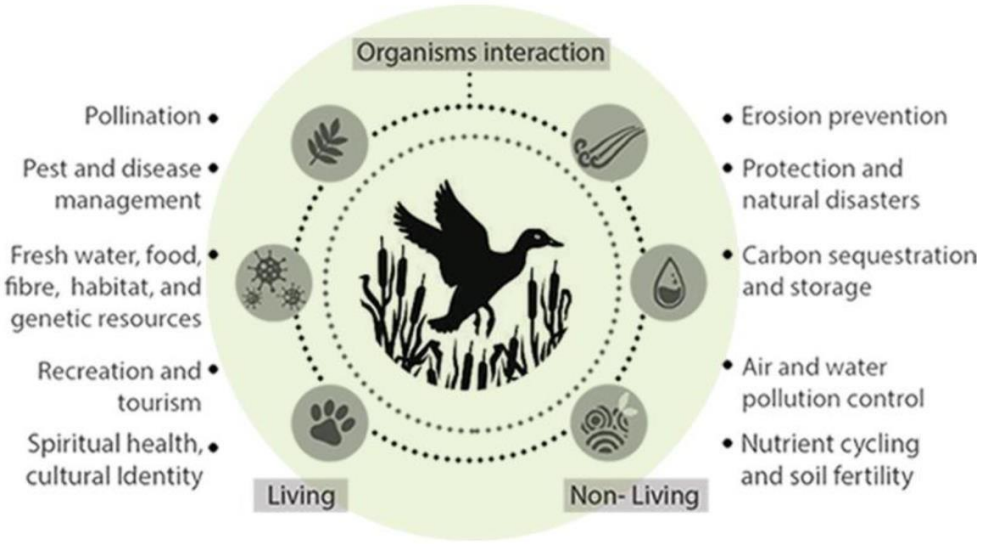
Educational Awareness: The park serves as an educational hub, raising awareness aboutthe consequences of deforestation, habitat loss, and land degradation. It educates visitors, residents, and students about the importance of preserving natural habitats and adopting sustainable practices to combat these environmental challenges.

3.1.7 VISION

The project envisions evoking environmental security through ecosystem building. In the process the projects aims at groundwater recharge and improvement of microclimate of the region. As a process of connecting to the people of Delhi, the project targets at being an abode for environmental education, research and eco-tourism.

3.1.8 CONCEPT

The concept of Yamuna Biodiversity Park developed from the idea of replicating various ecosystems thriving along the river right from the inception till its merging with river Ganga. All along its path the river supports diverse forest systems and rich naturalheritage that have helped human development in the region. Some of these forest systems are being reestablished along with pristine wetlands in Yamuna Biodiversity Park. It has been designed in a way to replicate a number of ecosystems right from the lowest storey to the highest storey of plantations.



Parameters for ecosystem building

3.1.8.1.1.1 FAUNA

Different forest communities of YBP offer multiple micro-niches and habitats allowing many animal species to come, survive and breed. Today, the Yamuna Biodiversity harbour 2000 species of plants and animals living in some 20-25 biotic communities having 3 trophic levels and diverse food web including 60 species of butterflies, 50 species of dragon and damselflies, 200 species of birds and mammalian herbivores and carnivores. The Park has attracted a specialist herbivore – Barking deer and a top carnivore – the Leopard suggesting that ecosystem is functional.The mosaic of wetlands is home for hundreds of resident and migratory birds. The green cover together with large water reservoir buffers the ambient

temperature and also influences the local weather patterns. The wetlands which are already functional harbour luxuriant aquatic vegetation, phyto- and zooplanktons and fishes. These floral and faunal features of the wetland offer food base for the resident and migratory ducks. Wetlands of YBP attract more than 5000 migratory ducks from Siberia, central Asia and Europe, each year in winters. In a span of just 14years, this highly degraded area has been turned into a lush green forest and wetland ecosystems and the diversity of birds, insects and mammals have increased many folds.

3.1.8.1.1.2 FLAURA

The flora of Yamuna Biodiversity Park in Delhi showcases a rich diversity of native plant species, contributing to the conservation of the region's natural heritage. The park features a mix of trees, shrubs, herbs, and wetland vegetation, representing various ecological zones. Some notable flora includes:

Native Trees: Species like Neem (Azadirachta indica), Peepal (Ficus religiosa), Banyan (Ficus benghalensis), and Jamun (Syzygium cumini) contribute to the park's tree canopy, providing shade and habitat for diverse fauna.

Grasses and Herbs: Various grass species and herbs, such as Indian Aloe (Aloe vera) and Lemongrass (Cymbopogon citratus), add to the ground cover, supporting biodiversity and preventing soil erosion.

Wetland Plants: The park includes wetland areas with species like Typha angustifolia (bulrush) and Sagittaria sagittifolia, contributing to water purification and enhancing the overall aquatic ecosystem.

Medicinal Plants: The park may incorporate medicinal plants like Tulsi (Ocimum tenuiflorum) and Aloe vera, promoting the conservation of traditional medicinal flora and educating visitors about their benefits.

Endemic and Rare Species: Efforts may be made to reintroduce or preserve endemic and rare plant species specific to the Yamuna floodplains, contributing to the conservation of regional biodiversity.

3.1.9 CONCLUSION

Yamuna Biodiversity Park was the first of its kind which not only helped revive lost ecosystems restore the ecological system but also has recharged ground water improved microclimate of the area and made public aware of planting trees and benefits of small microbes to vast grasslands. It’s an open lab for students to come and study life cycles of small species like butterflies and other such organisms. Yamuna Biodiversity Park is a pilot project for the development of Biodiversity parks across City. We aspire to extent this ideology across the nation and the world. YBP is a project that dreams at giving back to the Mother Earthby joining hands with the people of the region

3.2 RIVERINE BIODIVERSITY IN KRUGER NATIONAL PARK. SOUTH AFRICA

3.2.1 INTRODUCTION:

Riverine Biodiversity , Kruger National ParkExploring the Richness of Riverine Ecosystems.

3.2.1.1 Riverine Biodiversity:

Riverine biodiversity refers to the variety of plant and animal life found in and around rivers, creating complex and dynamic ecosystems.

3.2.1.2 Ecosystem Dynamics:

Riverine ecosystems are vital for maintaining ecological balance, supporting a diverse range of species, and providing essential ecological Services.

3.2.2 KRUGER NATIONAL PARK OVERVIEW:

Location, Size, Importance ForBiodiversity

Geographic Location:

Kruger National Park is located in northeastern South Africa, bordering Mozambique, andcovers an area of approximately 19,485 square kilometres

Biodiversity Hotspot:

The park is renowned for its rich biodiversity, encompassing a diverse range of ecosystems, including riverine habitats that play a critical role in supporting this ecological abundance

3.2.3 *RIVERINE ECOSYSTEMS IN KRUGER NATIONAL PARK*:

Rivers, Streams, Floodplains, Riparian Vegetation

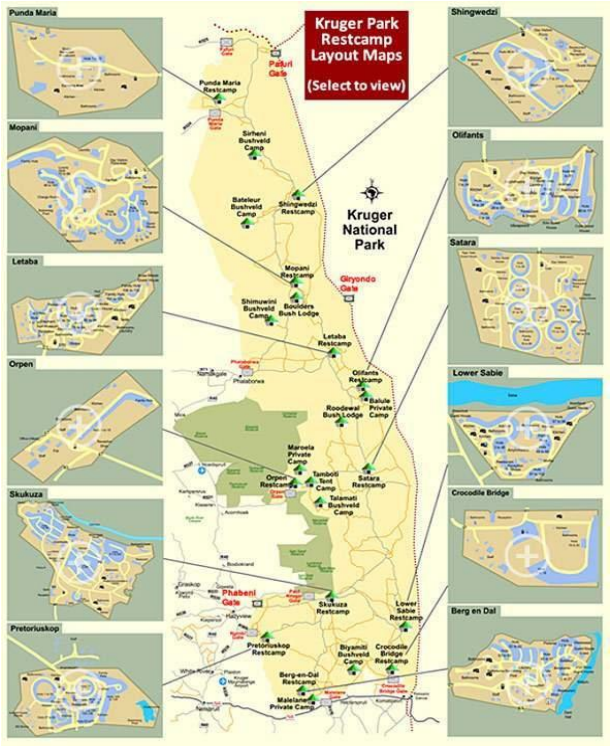
Unraveling the Diversity ofRiverine Landscapes

3.2.3.1 Diverse Waterways:

Kruger National Park is adorned with a network of rivers, streams, and floodplains, each with its own unique characteristics and ecological significance.

3.2.3.2 Riparian Vegetation:

The vegetation along riverbanks, known as riparian vegetation, supports a specialized and diverse array of plant species, shaping the ecological dynamics of the riverine ecosystems.



3.2.4 BIODIVERSITY IN RIVERINE ECOSYSTEMS:

Plant Species, Animal Species, Aquatic Life Exploring the Richness of Riverine Fauna and Flora

Flourishing Flora:

Riverine ecosystems harbor a diverse range of plant species, from water-loving aquatic plants to lush vegetation along the riverbanks

Abundant Fauna*:*

An array of animal species, including mammals, birds, reptiles, and insects, find their home within the intricate habitats of riverineecosystems

Aquatic Diversity:
The rivers and waterways support a wealth of aquatic life, including fish, amphibians, and myriad of invertebrates, each playing a crucial role in the ecological balance of the riverine ecosystems

3.2.5 THREATS TO RIVERINE BIODIVERSITY:

HABITAT DEGRADATION, POLLUTION, INVASIVE SPECIES: Addressing Challenges to Riverine Ecosystems

3.2.5.1 Habitat Degradation:

Human activities, such as dam construction and land-use changes pose significant threats to the integrity of riverine habitats

3.2.5.2 Pollution Issues:

Chemical pollution from agricultural runoff and urban areas, as well as plastics and litter, detrimentallyimpact the health of riverine ecosystems

3.2.5.3 Invasive Species:

The introduction of non-native plants and animals disrupts the ecological balance of riverine ecosystems, outcompeting native species and altering the dynamics of the habitats

3.2.6 CONSERVATION REPORTS IN KRUGER NATIONAL PARK:

PROTECTED AREAS, RESTORATION PROJECTS, MONITORING

Safeguarding the Integrity of Riverine Habitats

3.2.6.1 Protected Areas:

Designated conservation areas within Kruger National Park safeguards critical riverine habitats and their associated biodiversity

3.2.6.2 Restoration Initiatives:

Ongoing restoration projects aim to rehabilitate degraded riverine ecosystems,restoring their ecological functions and supporting native species

3.2.6.3 Monitoring and Management:

Continuous monitoring and management practices ensure the health of riverine habitats, allowing for adaptive conservation strategies to safeguard their integrity

3.2.7 RESEARCH STUDIES ON RIVERINE BIODIVERSITY:

SCIENTIFIC SURVEYS, DATA COLLECTION, SPECIESASSESSMENTS

Unveiling the Depths of Scientific Exploration

3.2.7.1 Scientific Surveys:

In-depth surveys and ecological studies provide valuable insights into thebiodiversity and ecological dynamics of riverine ecosystems.

3.2.7.2 Data Collection:

Systematic collection of ecological data aids in understanding the intricateecological processes and species interactions within riverine habitats

3.2.7.3 Species Assessments:

Assessments of plant and animal species abundance and distribution help in gauging the health and vitality of riverine ecosystems, informing conservation and management strategies.

3.2.8 BIODIVERSITY OF SABIE RIVER:

SPECIES COMPOSITION, THREATS, CONSERVATION ACTIONS

Uncovering the Story of Sabie River's Ecological Tapestry

3.2.8.1 Species Composition:

The Sabie River hosts a rich diversity of plant and animal species, shaping itsunique ecological tapestry and significance within Kruger National Park.

3.2.8.2 Threats and Conservation:

Challenges such as habitat degradation, pollution, and invasive species pose threats to the Sabie River's biodiversity, inspiring targeted conservation actions and restoration efforts.

3.2.9 MONITORING RIVERINE VEGETATION:

VEGETATION DYNAMICS, IMPACT OF HERBIVORES, MANAGEMENT STRATEGIES: Understanding the Vitality of Riverine Vegetation Dynamics

3.2.9.1 Vegetation Dynamics:

The fluctuating dynamics of riverine vegetation, influenced by water levels, seasonal changes, and herbivore browsing, shape the ecological balance of riverine habitats

3.2.9.2 Impact of Herbivores:

The grazing and browsing behavior of herbivores can have significant ecological implications for riverine vegetation dynamics, influencing the overall health of these vital habitats

3.2.9.3 Management Strategies:

Implementing effective management strategies, such ascontrolled burns and habitat restoration, is essential for maintaining the ecological The integrity of riverine vegetation

3.2.10 FISH DIVERSITY IN KRUGER'S RIVERS:

FISH SPECIES, FISHING PRESSURES, CONSERVATION MEASURES: Untangling the Intricacies of Riverine Fish Diversity

3.2.10.1 Fish Species Diversity:

Kruger's rivers support a diverse range of fish species,

each playing a unique ecological role in the freshwater ecosystems of the park Fishing Pressures: The impact of fishing activities and anthropogenic pressures shape the dynamics of fish populations in the rivers, influencing their biodiversity and ecological functions

3.2.10.2 Conservation Measures:

By implementing sustainable fishing practices, habitat restoration, and monitoring, conservation measures aim to protect and sustain the diverse fish diversity found in Kruger's rivers

3.2.11 CONCLUSION:

KEY FINDINGS, IMPORTANCE OF RIVERINE BIODIVERSITY CONSERVATION

The conclusion of Designing Protected Areas to conserve riverine biodiversity: Lessons from a Hypothetical Redesign of the Kruger National Park" emphasizes the need for a shift in the way protected areas are designated and managed to contribute meaningfully to the conservation of riverine biodiversity. The study compares the current spatial design of the Kruger National Park with an idealized configuration optimized for conserving riverine biodiversity. It presents recommendations for increasing the effectiveness of protected areas for conserving riverine biodiversity, either through expanding existing protected areas or improving the design of new protected areas.

The study demonstrates that appropriate planning can significantly improve the efficiency of species representation within the same area of catchment conserved. It also highlights the importance of striving for maximum hydrologic connectivity and fostering good relationships across park fences to ensure the long-term persistence of riverine biodiversity within protected.

CHAPTER 4 : INTRODUCTION TO SITE

4.1 REGIONAL SETTING AND OVERVIEW

Katarnia Ghat Wildlife Sanctuary's regional setting in the Terai region along the Indo-Nepal border provides a unique ecological and socio-cultural context. Its rich biodiversity, part of the larger Terai Arc Landscape, is supported by diverse habitats and a complex interplay of natural and human factors. Effective conservation strategies involve addressing human-wildlife conflict, promoting sustainable livelihoods, and enhancing connectivity and accessibility while preserving the sanctuary's ecological integrity.

- Latitude: Approximately 28°18'N
- Longitude: Approximately 81°10'E
- Area: 551 square kilometers
- Elevation: Varies from 150 to 200 meters above sea level

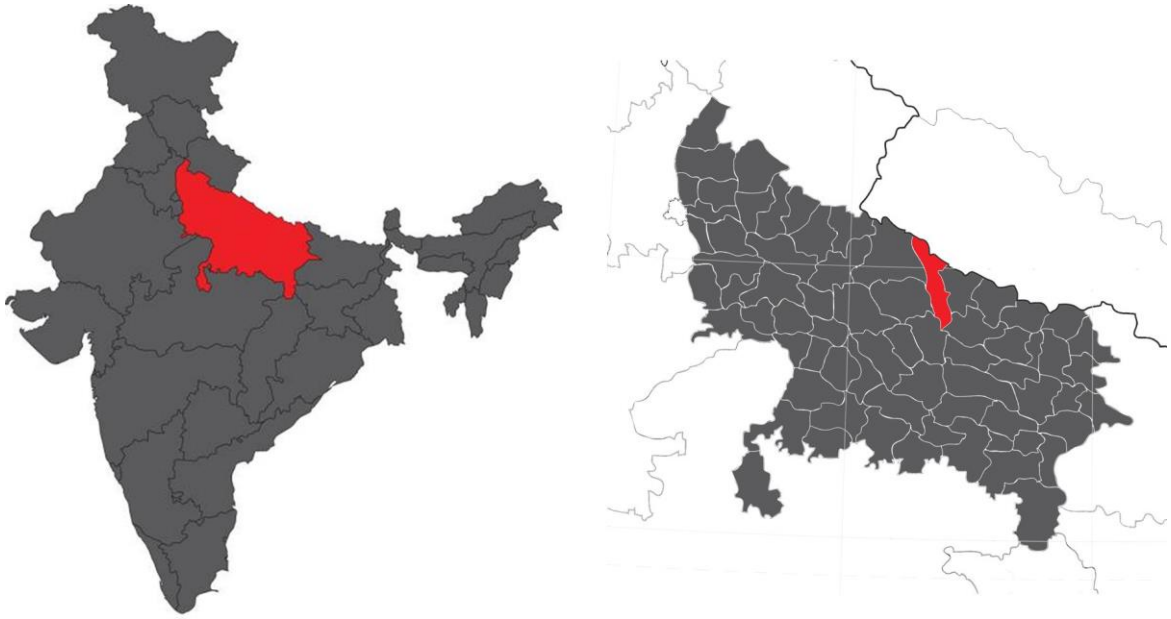
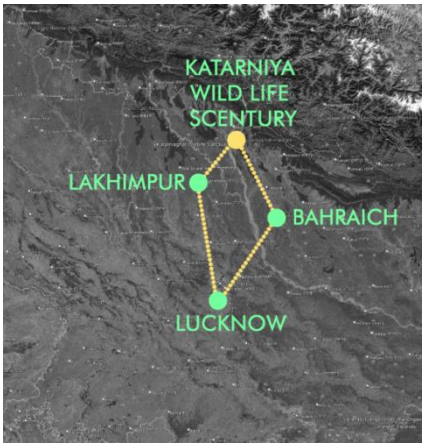


Figure 1Map showing geographical location of Bahraich District

4.2 LINKAGES AND CONNECTIVITY

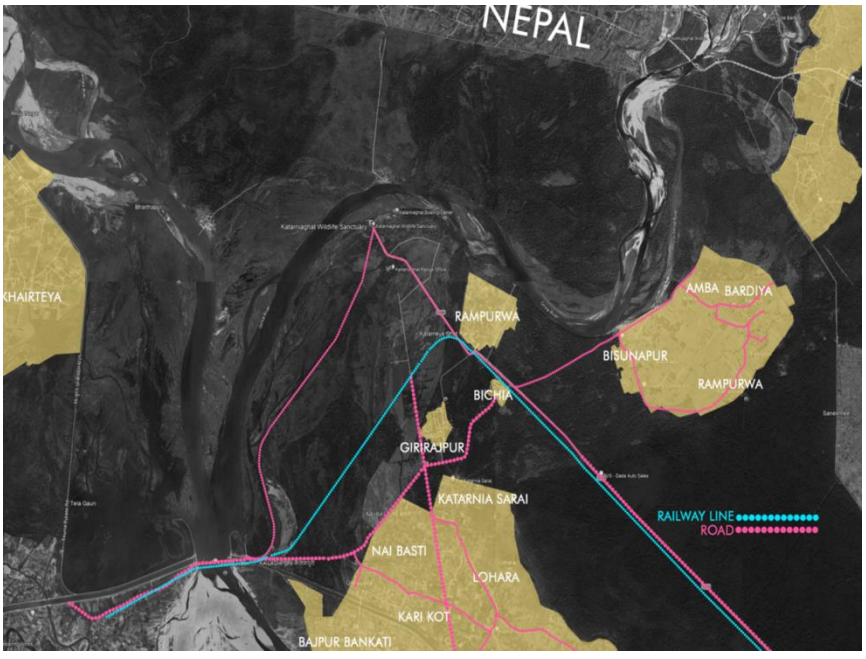
Katarnia Ghat Wildlife Sanctuary, is well-connected to several important cities and Metropolitan cities such as Lucknow, Delhi and Baherich . Also having a good conection with the Tourist Circuits such as Varansi , Ayodhya . Understanding its linkages and connectivity is crucial for both ecological conservation and tourism development and the linkages could be understand in various ways as follows.



4.2.12 Infrastructure and Accessibility

4.2.12.1 Road Connectivity:

- The sanctuary is accessible by road, with the nearest major town being Bahraich. The Wildlife is located at the NH 730 H and state highways National Highways crossing through the sanctuary Area
- Bahraich is well-connected to other cities in Uttar Pradesh and beyond via national and state highways.
- Bus Stop Bichhiya is the only bus stop and provide the connection to Haridwar and Delhi .



4.2.12.2 Rail Connectivity:

- The railway station in the sanctuary are at Kakraha , Murtiha, Nishangarah and Bichhia, They are located on the Gonda-Bahraich Branch railway line (meter gauge) of NER. Katerniaghat can be approached from Gonda also, which is situated on the main railway line from Lucknow to Gorakhpur.

4.2.12.3 Air Connectivity:

- The nearest airport is Chaudhary Charan Singh International Airport in Lucknow, approximately 160 kilometers from the sanctuary.

4.2.12.4 Local Transport Options

Private Vehicles: Many visitors prefer to use their private vehicles to navigate the sanctuary. This offers flexibility and convenience, allowing you to explore at your own pace.

Taxis: Taxis can be hired from nearby towns such as Bahraich or Lakhimpur Kheri. They are a convenient option for those who do not have their own vehicle.

Jeep Safaris: The sanctuary offers jeep safaris, which are one of the best ways to explore the dense forests and spot wildlife. These safaris are usually organized by the forest department or local tour operators. They typically have experienced guides who can help in spotting animals and birds. There is a bust stop in Bichia from there 2 bus run every day one for Delhi and another for Haridwar.

Local Population and Tribal community living there mainly use the Bicycles and Motorcycles there are no option for any other mode of transport for the local Residents.

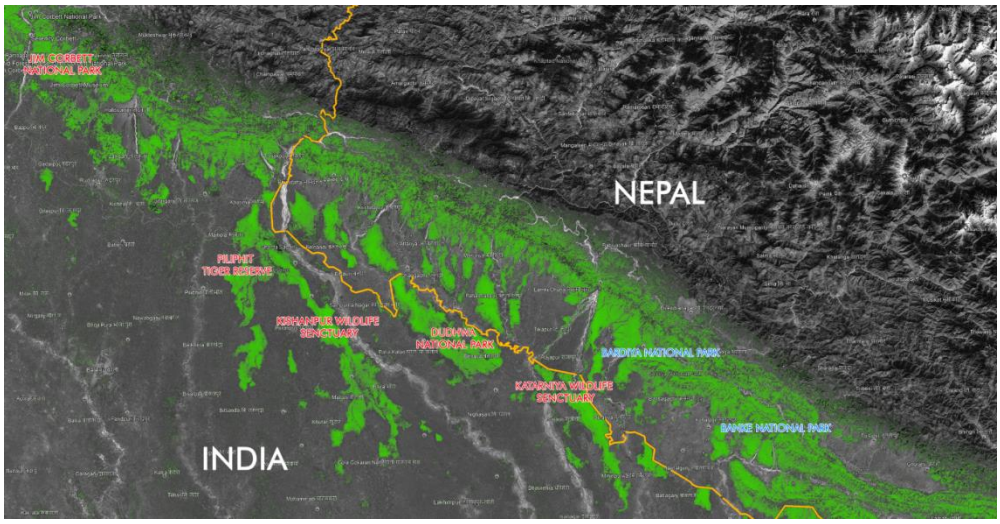
4.2.13 Ecological Linkages and Connectivity

4.2.13.1 Dudhwa Tiger Reserve:

- Katarnia Ghat is part of the larger Dudhwa Tiger Reserve, which also includes the Dudhwa National Park and Kishanpur Wildlife Sanctuary.
- These areas collectively form a significant tiger habitat in the Terai region, allowing for the movement and genetic exchange of wildlife, particularly tigers and elephants.

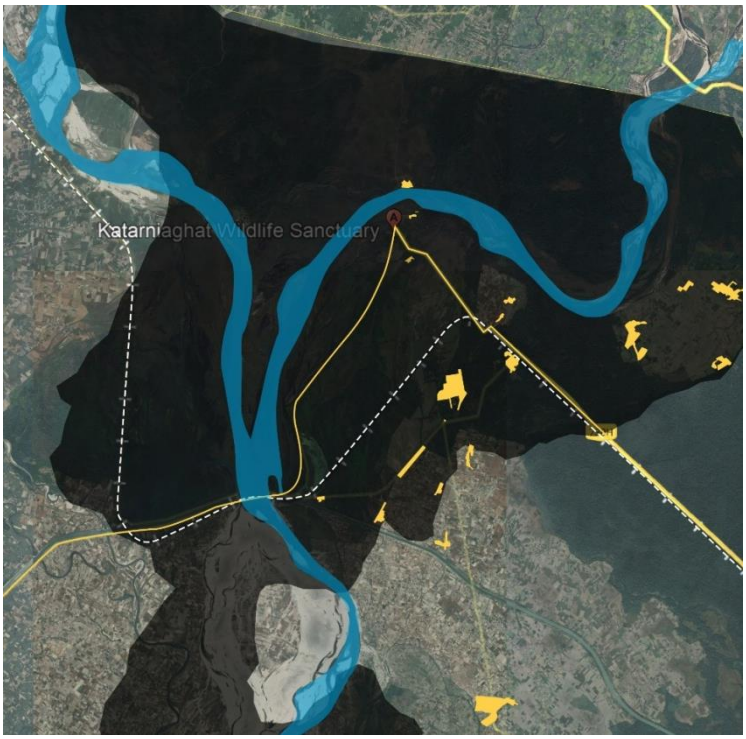
4.2.13.2 Terai Arc Landscape:

- The sanctuary is part of the Terai Arc Landscape (TAL), which spans across India and Nepal.
- TAL is a critical corridor for wildlife, providing connectivity between various protected areas, including Chitwan National Park in Nepal and several other Indian sanctuaries and national parks.
- This landscape supports species migration, breeding, and genetic diversity.



4.2.13.3 Ghaghra River:

- The Ghaghra River, a major tributary of the Ganges, flows through the sanctuary.
- The river also acts as a natural corridor for wildlife movement.
- .The River Kandala and the river Girwa make further the river Ghaghra.



4.2.14 Community and Administrative Linkages, Stake Holders

4.2.14.1 Local Committees:

- The sanctuary is surrounded by numerous villages whose residents depend on the forest for their livelihoods.
- Committee's involvement in Tourism is facilitated through various initiatives by the forest department and NGOs.
- Eco-development committees and village forest councils play a role in managing resources and reducing human-wildlife conflict.

4.2.14.2 Forest Department:

- The Uttar Pradesh Forest Department is responsible for the management and administration of the sanctuary.
- Anti-poaching units, wildlife monitoring teams, and forest guards are active in maintaining the sanctuary's ecological integrity.

4.2.14.3 Conservation NGOs:

- Several non-governmental organizations (NGOs) work in and around the sanctuary to promote conservation, conduct research, and engage with local communities.
- These organizations collaborate with the forest department on various projects, including wildlife monitoring, habitat restoration, and community education.

4.2.15 Tourism Linkages

4.2.15.1 Eco-Tourism:

- Katarnia Ghat Wildlife Sanctuary offers eco-tourism opportunities such as wildlife safaris, bird watching, and nature trails.
- The development of eco-tourism infrastructure, including visitor centers, guided tours, and accommodation facilities, is aimed at promoting sustainable tourism.

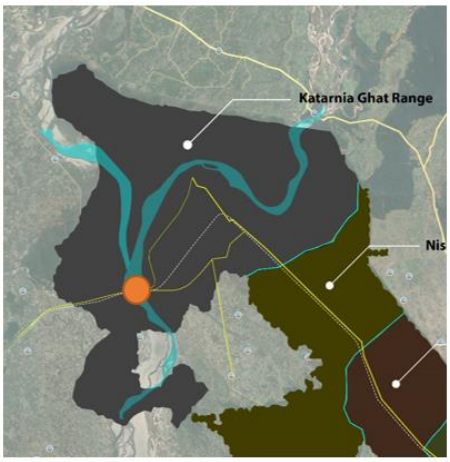
4.2.15.2 Regional Tourism Circuit:

- The sanctuary is part of a larger regional tourism circuit that includes other attractions in the Terai region and nearby cultural and historical sites.
- Tour operators offer packages that combine visits to multiple destinations, enhancing the overall tourist experience.

Katarnia Ghat Wildlife Sanctuary's linkages and connectivity are multifaceted, involving ecological corridors, infrastructure networks, community interactions, and tourism integration. These connections are vital for the sanctuary's conservation efforts, economic development of local communities, and the promotion of sustainable tourism. Effective management and strategic planning are essential to balance these aspects and ensure the long-term preservation of this critical wildlife habitat.

4.3 HISTORY AND EVOLUTION

Girijapuri Barrage and other project on the river was initiated in 1962. During the construction work many of the worker and professional team was established nearby katarnia ghat. Many of decedents and other group of people of nearby districts still inhabits the area.



- **1856:** Government of Oudh acquired proprietary rights over Katarniaghat Wildlife forests.
- **1861:** Forests declared to be state forests, previously administered under Waste Land Rules. Initiated "scientific management" which led to heavy destruction of wildlife.
- **1962:** Girijapuri Barrage and other project on the river was initiated in
- **1975:** Establishment of Katarniaghat Wildlife Sanctuary.
- **1987:** Inclusion in Project Tiger.Dudhwa Tiger Reserve: Comprises Katarniaghat Wildlife Sanctuary, Kishanpur Wildlife Sanctuary, and Dudhwa National Park.
- **2014:** The wild life Sanctuary access to the Public is opened.
- 2**021** : Ministry of Environment, Forest and Climate Change, Identifies the site for Eco Tourism Development.
- **2022 :** Inclusion in 'One District, One Destination' (ODOD) scheme .

4.4 GEOPHYSICAL CONDITIONS (River Basin Conditions and Annual River Cycle)

Katarniaghat Wildlife Sanctuary's geophysical conditions, driven by the Girwa and Ghaghara River's annual cycle, sustain its biodiversity and ecosystems, emphasizing the interplay of water resources, vegetation dynamics, and wildlife habitats crucial for conservation efforts.

River Basin (Girwa River):

- Perennial river originating from the Himalayas, flowing through Indo-Gangetic plains.
- Water levels fluctuate due to snowmelt and monsoon rains.

Annual River Cycle:

Pre-Monsoon (March to June)

Water Levels: During the pre-monsoon season, water levels in the Girwa River are typically low due to reduced rainfall and increased evaporation.

River Flow: The flow of the river decreases, leading to narrower and shallower water channels.

Wildlife Impact: Reduced water levels can affect the availability of water for wildlife. Animals might concentrate around remaining water sources.

Monsoon (July to September)

Water Levels: The monsoon season brings heavy rainfall, significantly increasing the water levels in the Girwa River.

River Flow: The flow of the river becomes much stronger, and the river can overflow its banks, leading to flooding in certain areas.

Wetlands Formation: Flooding helps in the formation and replenishment of wetlands, which are crucial for the sanctuary's biodiversity.

Aquatic Life: The increased water flow supports the breeding of fish and other aquatic organisms.

Post-Monsoon (October to November)

Water Levels: Post-monsoon, the water levels begin to recede as the rainfall decreases.

River Flow: The flow remains strong initially but gradually reduces.

Vegetation: The receding waters leave behind nutrient-rich silt, benefiting the surrounding vegetation.

Wildlife: Animals benefit from the abundance of water and food sources during this period.

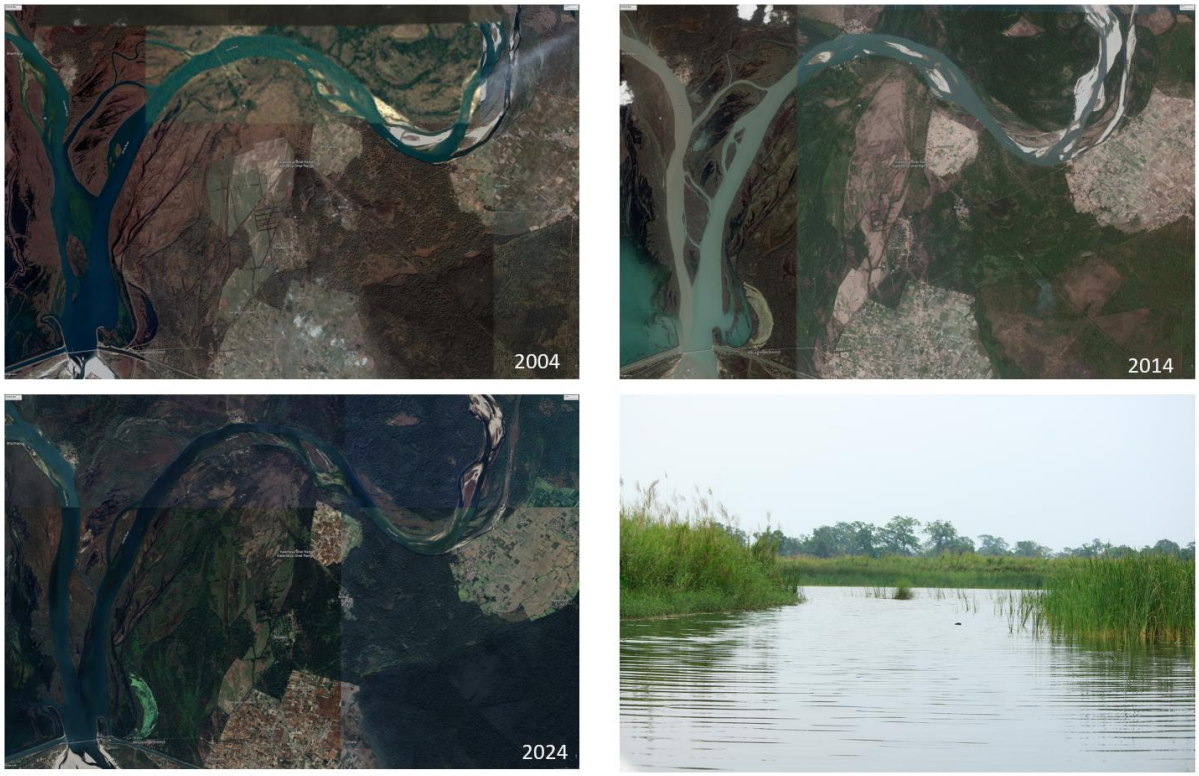
Winter (December to February)

Water Levels: During winter, water levels in the Girwa River are relatively stable but lower than during the monsoon season.

River Flow: The flow of the river becomes steady and moderate.

Temperature: Cooler temperatures reduce evaporation rates, helping maintain water levels.

Wildlife Activity: This period is crucial for many species as they rely on the stable water levels for drinking and hunting**.**Reduced water flow, temporary drying of smaller water bodies

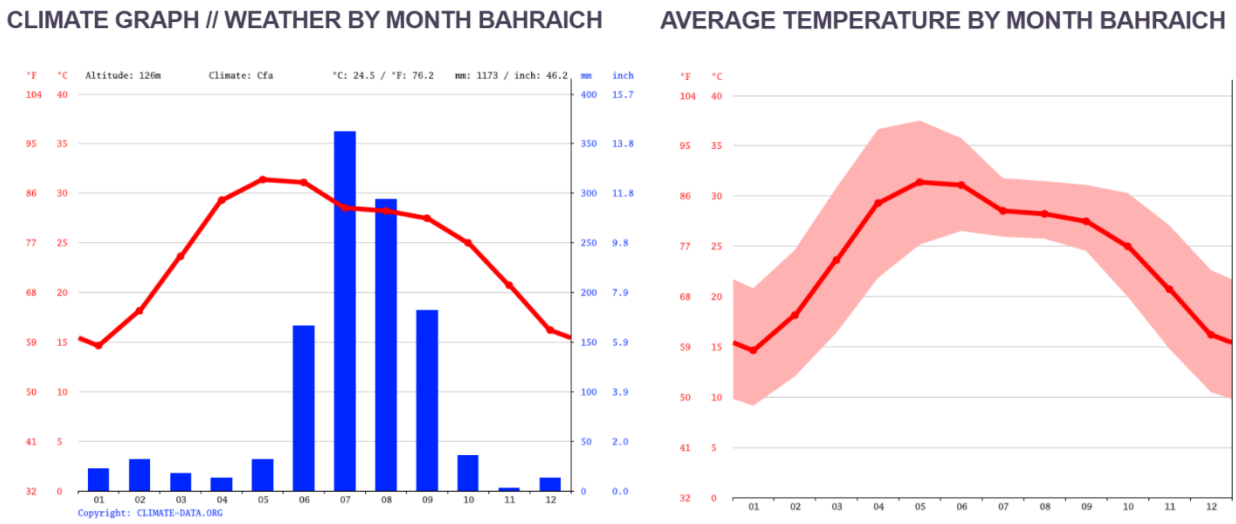


4.5 CLIMATIC CONDITIONS OF THE TOWN (Rainfall and Temperature)

Katarniaghat experiences a subtropical climate typical of the Indo-Gangetic plains. The climatic conditions of Katarniaghat Wildlife Sanctuary play a crucial role in shaping its ecosystem and supporting its rich biodiversity. Some key climatic conditions of the sanctuary:

1. **Temperature**:
    - Summers: Generally hot and dry, with temperatures often exceeding 40°C (104°F) during the hottest months of May and June.
    - Winters: Cool and pleasant, with temperatures dropping to around 5-10°C (41-50°F) in December and January.
2. **Rainfall**:
    - Monsoon season (July-September): The sanctuary receives most of its annual rainfall during this period, with heavy showers and occasional thunderstorms. Annual rainfall typically ranges from 1000 to 1500 mm.
3. **Humidity**:
    - High humidity levels are common during the monsoon season, contributing to the lush vegetation and biodiversity of the sanctuary.
4. **Vegetation**:
    - The climatic conditions support a variety of vegetation types, including tropical moist deciduous forests, riverine forests, and grasslands.
5. **Impact on Wildlife**:
    - The seasonal variations in climate influence the behavior and distribution of wildlife species within the sanctuary. Many animals are more active during the

cooler months, while the monsoon season supports breeding and lush foraging opportunities.



4.6 CHARACTERISTICS OF THE STUDY AREA

The Katarniaghat Wildlife Sanctuary is a protected area in the Upper Gangetic plain, near Bahraich city in Bahraich district of Uttar Pradesh, India and covers an area of 400.6 km2 (154.7 sq mi) in the Terai of the Bahraich district. In 1987, it was brought under the purview of the Project Tiger, and together with the Kishanpur Wildlife Sanctuary and the Dudhwa National Park it forms the Dudhwa Tiger Reserve. It was established in 1975. It is home to many endangered species. Its northern boundary lies along the Indo- Nepal border and covers a total area of 551 sq. km. Katarniaghat Wildlife Sanctuary stands out for its diverse wildlife, unique ecosystem influenced by the Ghaghara River, and efforts to balance conservation with sustainable human activities.

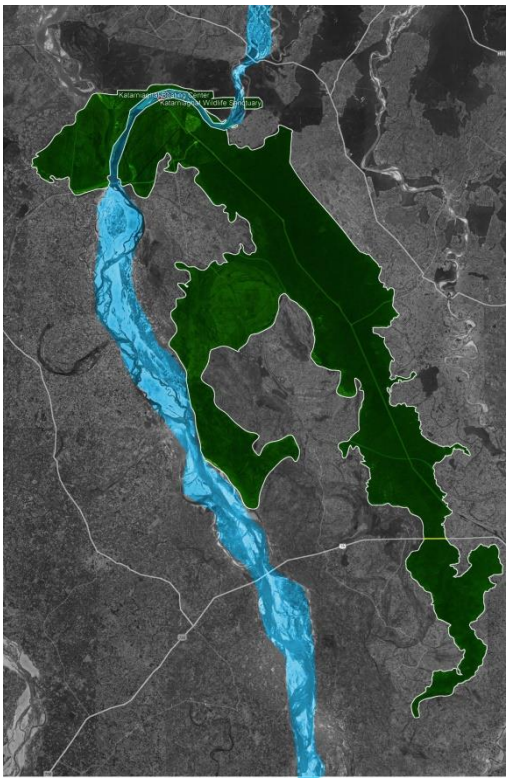


Figure 2 Illustration showing the extent of Katarnia Wildlife Sanctury

4.6.1 Location and Landscape:

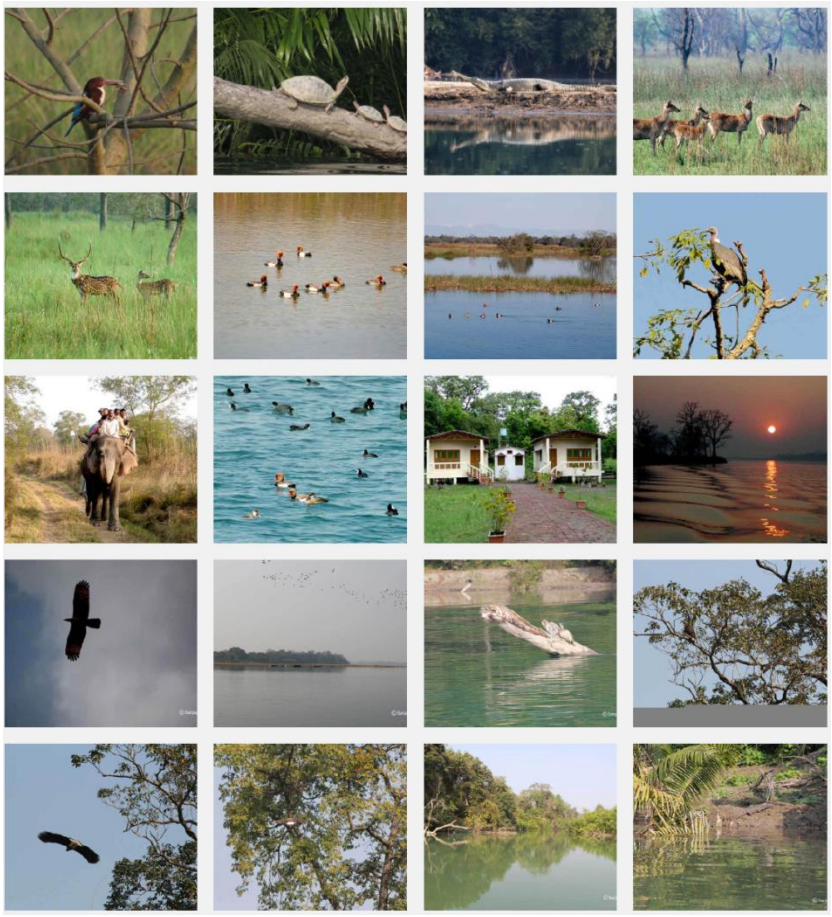
4.6.2 Avian Diversity:

- Important bird area with over 350 bird species recorded, including resident and migratory birds.

- Prominent species include the Sarus crane, painted stork, and several species of eagles and vultures.

4.6.3 Flora:

- Vegetation includes tropical moist deciduous forests and riverine vegetation.
- Supports a variety of plant species, contributing to the sanctuary's ecological balance and food sources for wildlife.

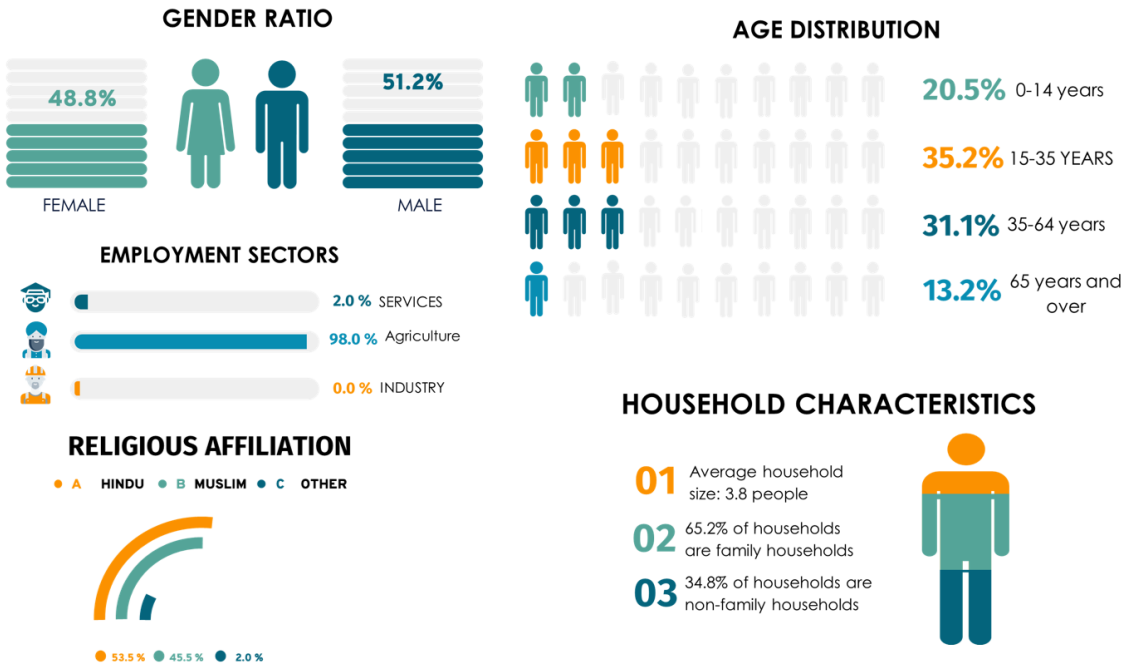


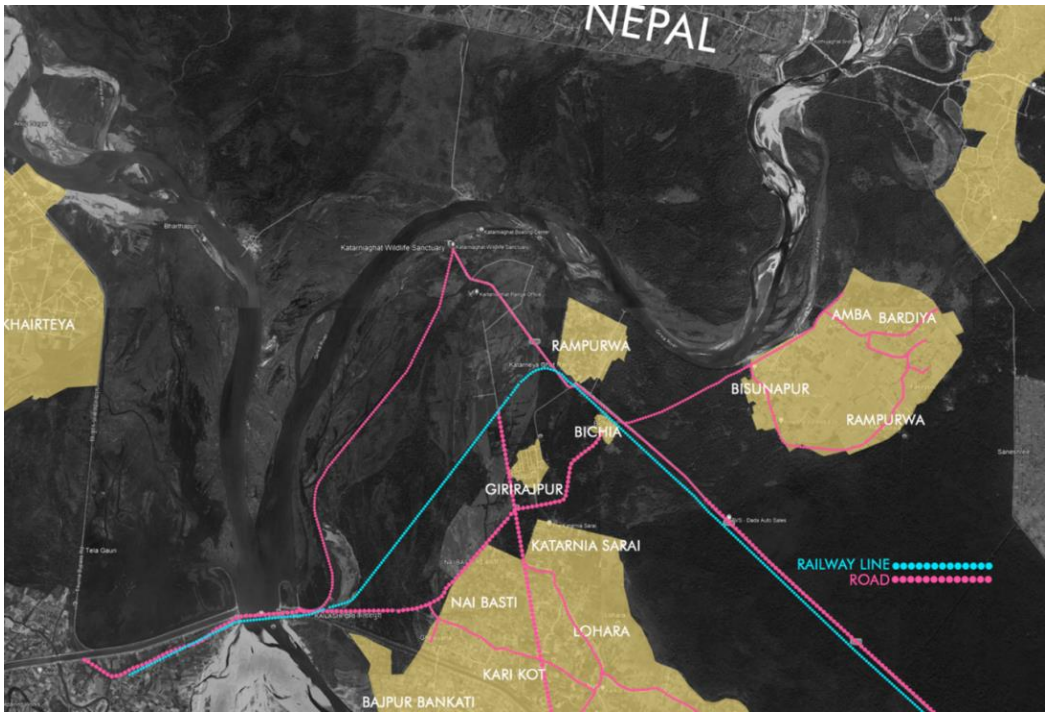
4.7 DEMOGRAPHIC PROFILE

Influences the demographic profile of the surrounding areas rather than having a direct resident population within its boundaries. The demographic profile of the region around Katarnia Ghat Wildlife Sanctuary includes information about the nearby human settlements, population characteristics, socio-economic conditions, and cultural aspects.

Total population: 42,806 (as of 2011 census)

Currently its around **56,000** as told by the Gram Pradhan of Fakirpuri and Girjapuri.





4.7.1 Surrounding Area Demographics

4.7.1.1 Population:

The sanctuary is surrounded by numerous villages and small towns. The population density in these areas varies, with some villages being more densely populated than others.

4.7.1.2 Tribal Community

The tribal community of Katarniya Ghat consists of the Tharu people. The Tharu are an indigenous ethnic group primarily residing in the Terai region of southern Nepal and northern India, including Uttar Pradesh. They are known for their distinct culture, traditions, and way of life.

Over the period of time the tribal people of the ghat range have adopted a lifestyle similar to normal locals and have been rehabilitated by the government under various tribal settlement schemes Ekikrit Adivasi Vikas Pariyojna.

Majority of the Tharu community resides in villages of **FAKIRPURI**, **RAMPURWA** and **BISUNAPUR**, while some people of the community reside in the village **BARDIYA**

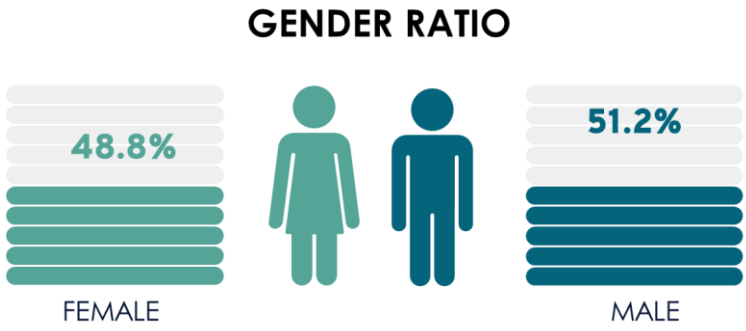
4.7.1.3 POPULATION GROWTH RATE

Katarnia Ghat Wildlife Sanctuary itself does not have a resident human population, as it is a protected area designated for wildlife conservation. However, the population growth rate in the surrounding areas, particularly in Bahraich district of Uttar Pradesh where the sanctuary is located, can provide insight into demographic trends that may impact the sanctuary. According to the 2011 Census of India, Bahraich district had a population of approximately 3.48 million. The population growth rate from 2001 to 2011 was around 25.22%, which is relatively high compared to the national average. Although the 2021 Census data is yet to be

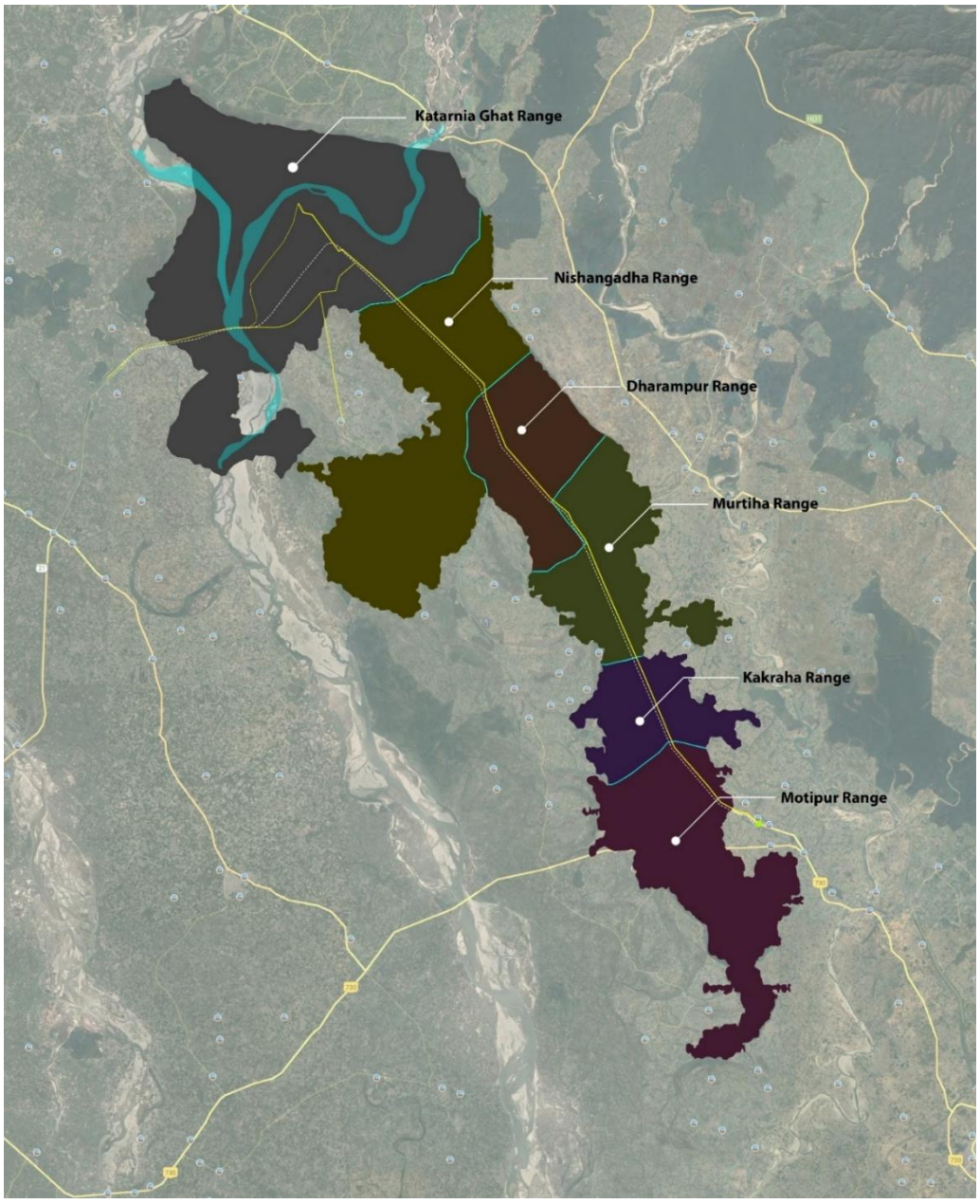
released, estimates suggest that the population growth rate in the district has continued to be significant due to high birth rates and declining mortality rates. Total population: 42,806 (as of 2011 census) Currently its around 56,000 as told by the Gram Pradhan of Fakirpuri and Girjapuri.

SEX RATIO AND LITERACY RATE

Katarnia Ghat Wildlife Sanctuary does not have its own sex ratio and literacy rate, understanding these demographic indicators in the surrounding Bahraich district is crucial. The region faces challenges related to low literacy rates and a skewed sex ratio, which have implications for community development and conservation efforts. Addressing these issues through targeted educational and empowerment programs is vital for the sustainable management of the sanctuary and the well-being of its neighboring communities.

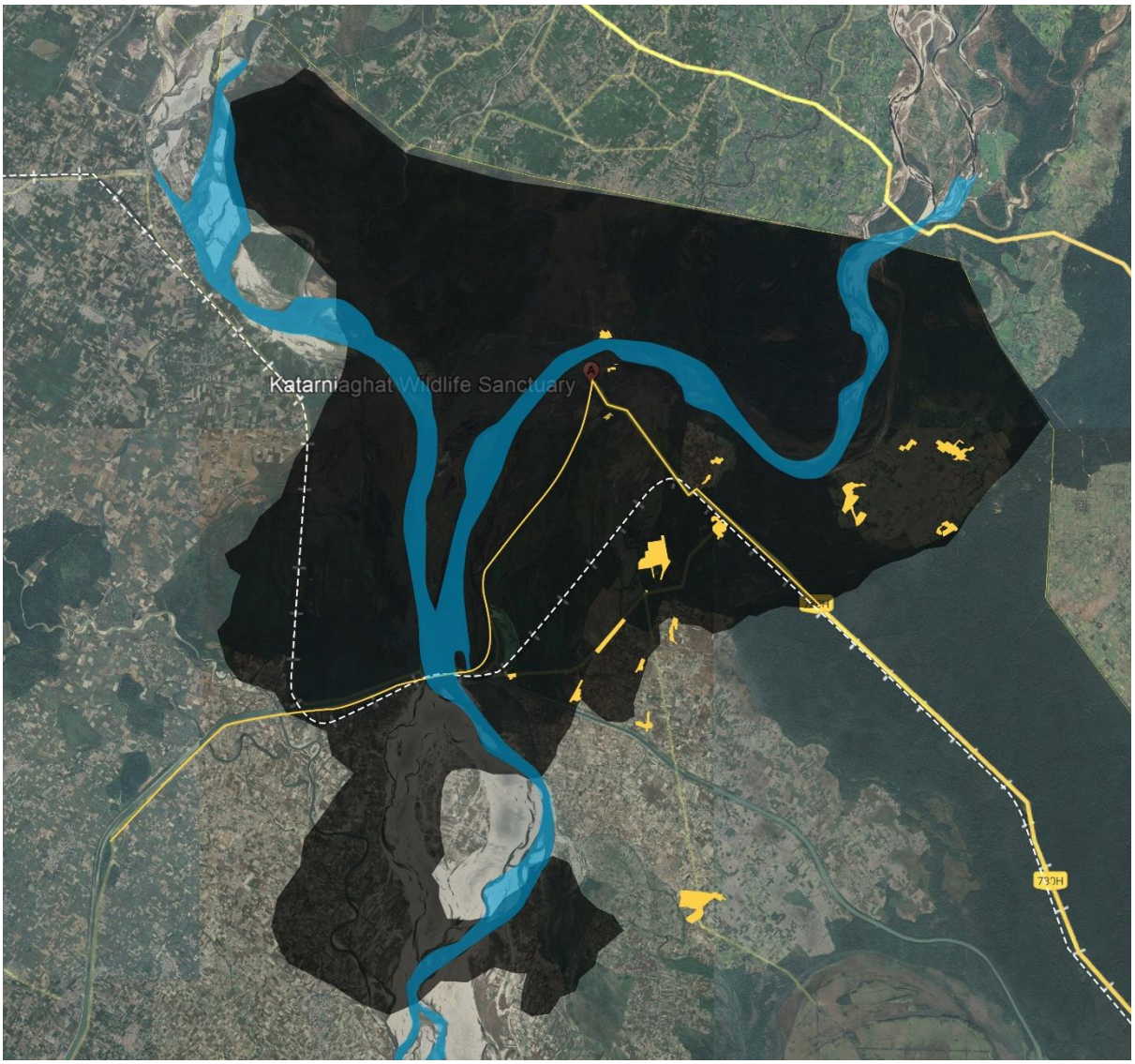


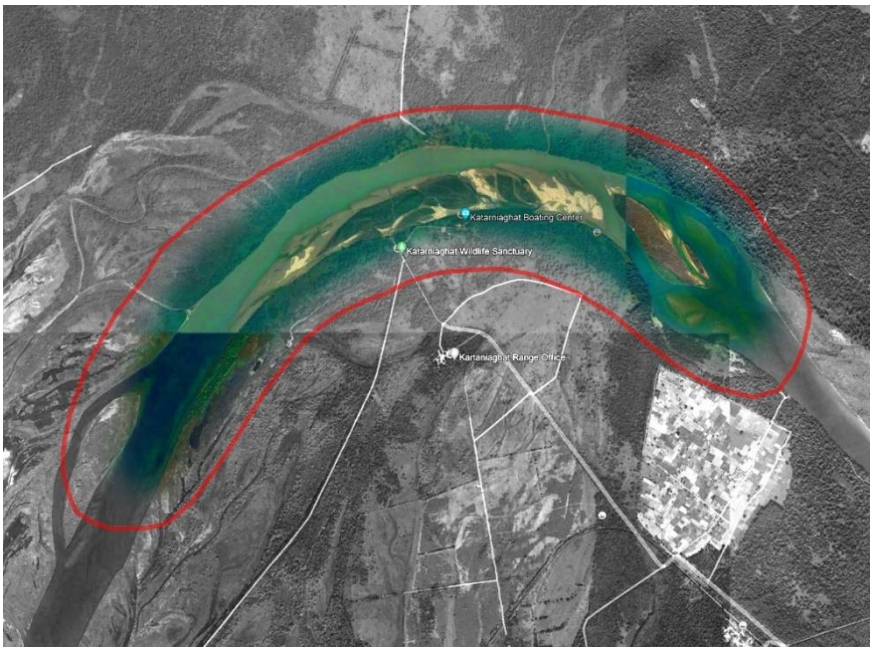
1. LOCATION MAP OF STUDY AREA

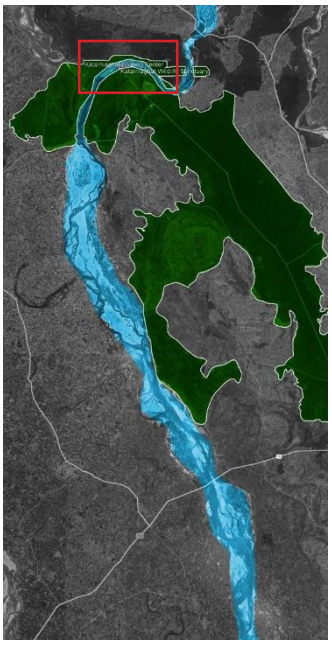


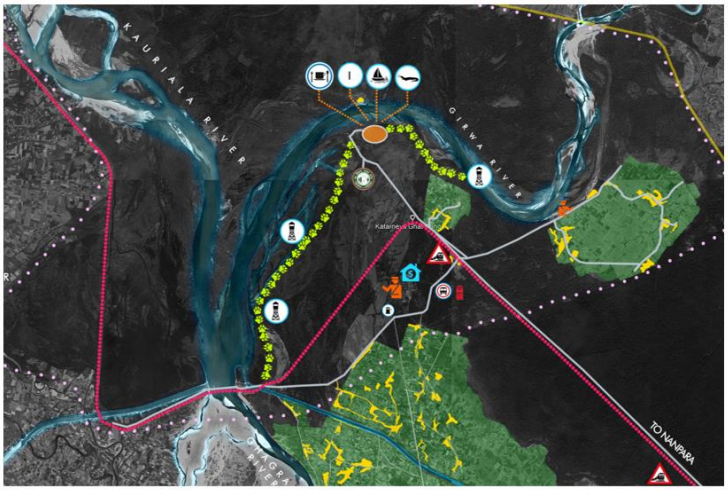
The Katarniaghat Wildlife Sanctuary is comprising of six Forest Ranges.

- **Katarnia ghat range**
- **Nishangadha range**
- **Dharampura range**
- **Murthia range**
- **Kakarha range**
- **Motipur range (buffer area)**


Katarniaghat Wildlife Sanctuary
730H


Katarniaghat Boating Center
Katarniaghat Wildlife Sanctuary
Katarniaghat Range Office

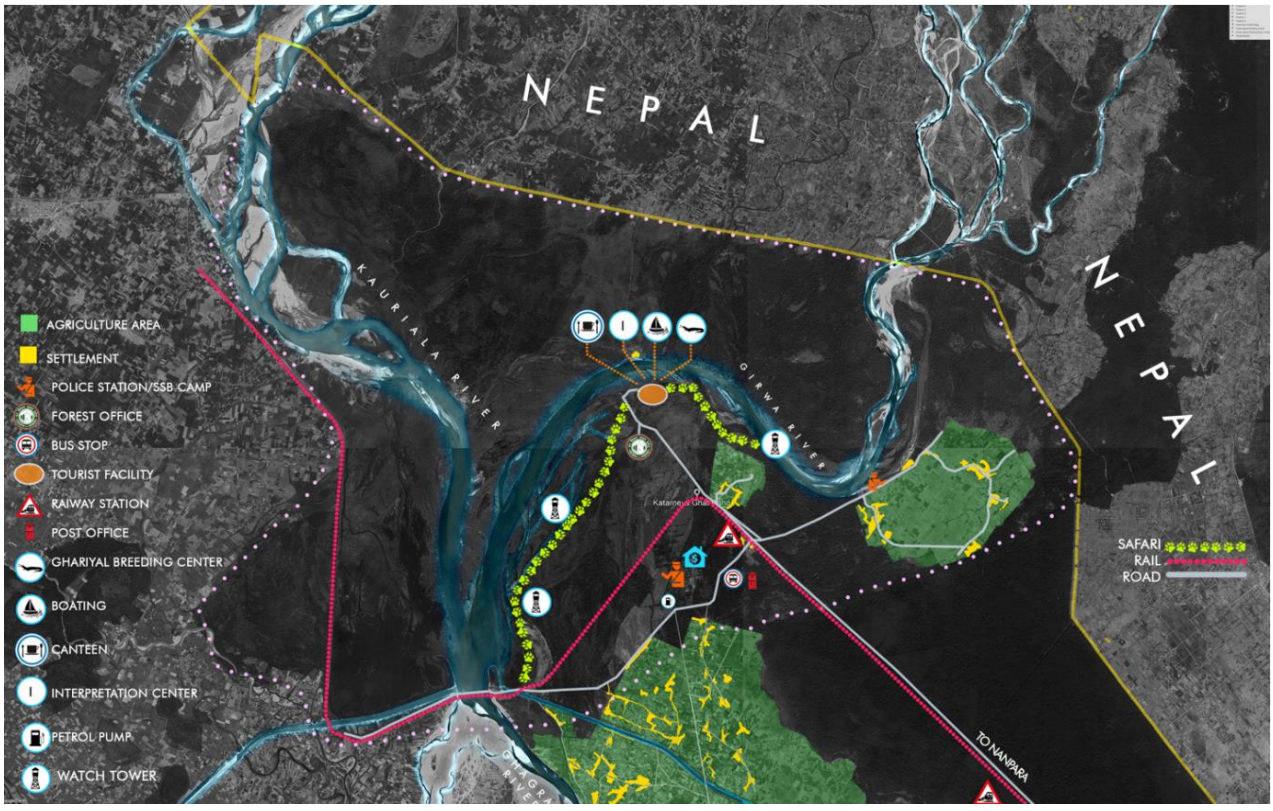



KAURIALA RIVER
GIRWA RIVER
TO NANPARA


बिछिया
BICHIA
01705Y


उ. प्र. परिवहन
फेयर प्राइस स्टोर
बिछिया


IndianOil


NEPAL
NEPAL
KAURIALA RIVER
GIRWA RIVER
TO NANPARA
AGRICULTURE AREA
SETTLEMENT
POLICE STATION/SSB CAMP
FOREST OFFICE
BUS STOP
TOURIST FACILITY
RAIWAY STATION
POST OFFICE
GHARIYAL BREEDING CENTER
BOATING
CANTEEN
INTERPRETATION CENTER
PETROL PUMP
WATCH TOWER
SAFARI
RAIL
ROAD

CHAPTER 5 DATA COLLECTION & ANALYSIS OF SECONDARY & PRIMARY DATA

Secondary data is the data which is collected by other than user. Such data more quickly available when primary data is not available. The common sources for secondary data are censuses, information from government department, organizational records and other research projects. Secondary data analysis can save the time as compared to primary data.

5.1 METHODOLOGY ADOPTED FOR DATA COLLECTION

1. Secondary Data: Secondary data for Katarnia ghat wild life sanctuary is collected from various source which mainly includes demographical profile of city, data related to wildlife sanctuary like Flora, Fauna, Area , stake holders, Revenue, existing Facilities etc. This data is analysed and further used to formulation questionnaire to conduct primary survey.

2. Survey design: After secondary data collection and analysis, information gap is identified. And as per the information need survey format was designed. Survey design is mainly on the basis of information needed to analyze current Tourism scenario and Facilities for the local residents of the area and initiatives for eco-tourism development..

3. Primary Data: Primary data is collected by face to face citizen opinion survey.

4. Mapping: Mapping has been done to understand existing facilities and management. It includes existing land use mapping, transportation network mapping , mapping of public green spaces etc.

The analysis of the data collected from primary and secondary sources has broadly been divided into four categories namely – connectivity, comfort, conviviality and convenience These categories or parameters were selected on the basis of the observations from literature study and case studies.

Table 1 PARAMETERS AND INDICATORS SELECTED

PARAMETER	INDICATORS
ENVIRONMENTAL FLOWS	STROM WATER MANAGEMENT
	CATCHMENT ZONES
	WATER SUPPLY
	SEWAGE MANAGEMENT
RIVER RESTORATION	RIVER BASIN MANAGEMENT
	BIODIVERSITY
	GREEN COVER
URBANEXPANSION IMPACTS	URBAN SPRAWL
	INFRASTRUCTURE EXPENSION
ECO TOURISM DEVELOPMENT	SUSTAINABLE DEVELOPMENT
	NATURAL SITES
	PRESERVATION OF HERITAGE
	TOURIST FACILITIES

5.2 PRIMARY AND SECCONDARY DATA ANALYSIS

After the collection of Primary and Secondary the Data has been Analysed and further the issues , opportunities has been discussed

5.3 IDENTIFIED ISSUES AND OPPORTUNITIES FOR THE DEVELOPMENT

5.3.1 Socio-Economic Issues

It has been established from the primary and secondary data collected from the subject area that there are limited resources in the villages surrounding the sanctuary and most of the economy is identified by the agricultural, farming and cattle related practices which is uncertain and also creates conflicts between the community and the wildlife. Identifying the

socio economic issues is important because it will help in creating linkages and guide the tourism related proposals for a sustainable economy. Following are certain issues identified in this regard;

- The farming and agriculture practices are uncertain and does not offer reliable livelihood to the community. These agricultural products are either fulfilling their own requirement as direct use or to some extent to the forest office staff. and many times its destroyed by the Animals.

खेतों में घुसे हाथी, 10 बीघा फसल चौपट

नुकसान

कतर्नियां से हटाए गए रेंजर अनूप लखनऊ भेजे गए

बहराइच, संवाददाता। कतर्नियाघाट से लगे किसानों के खेतों में लगी फसलें हाथियों का झुंड चट कर रहा है। शुक्रवार की रात तार फेंसिंग को तोड़कर खेतों में घुसे हाथियों ने चार किसानों के 10 बीघे गेहूं की फसल को चौपट कर दिया। पीपा पीटने व गोला दागने पर हाथियों का झुंड जंगल की ओर चला गया। पीड़ित किसानों ने मुआवजे की मांग की है। कतर्नियाघाट वन्यजीव प्रभाग के निशानगाड़ा रेंज से लगे ग्राम पंचायत रमपुरवा के हरिहर पुर लालपुर व सेंटी फार्म गांव में शुक्रवार की रात को चेनलिंक फेंसिंग तोड़कर जंगली हाथियों का झुंड खेत में घुस गया। हाथियों ने गांव निवासी किसान हरदेव कौर का तीन बीघा, जोगा सिंह का दो, सुखविंदर कौर का दो व मलकीत सिंह के तीन बीघा गेहूं की फसल को खाकर व रौंदकर चौपट कर डाला। किसानों ने हांका व गोला दागर किसी तरह हाथियों को जंगल की ओर भगाया। किसान मलकीत सिंह पीपा ने बताया कि हाथियों ने वन विभाग की ओर से लगाए गए फेंसिंग को कई जगह तोड़ दिया है।

- The cattle related practices often causes conflicts between the community and the wildlife which is harming the wildlife of the forest. The forest office tries and operationalize awareness programs to minimize these conflicts and adopt practices which will minimize the impact but the impact is slow and limited.

जंगल से काटकर ईंट-भट्ठों में झोंक रहे लकड़ियां

संवाद न्यूज एजेंसी

हर बार कार्रवाई की बात कह माफिया को शह दे रहा विभाग

श्रावस्ती। वन संपदा से समृद्ध जिले में जंगलों का अंधाधुंध दोहन जारी है। इसकी शिकायत के बाद भी जिम्मेदार अधिकारी हर बार कार्रवाई की बात कह जांच ठंडे बस्ते में डाल देते हैं। माफिया बेखौफ जंगल से लकड़ियां काटकर ईंट-भट्ठों में झोंक देते हैं।

जंगल से जलौनी के नाम काट कर लाए गए पेड़। -संवाद

ककरदरी जंगल में अवैध कटान का सिलसिला रुकने का नाम नहीं ले रहा है। स्थानीय माफिया खुलेआम मुख्य मार्गों के किनारे लगे पेड़ों को काट रहे हैं। ऐसा ही कुछ जमुनहा व मल्हीपुर क्षेत्र में देखा जा सकता है। ककरदरी जंगल से प्रतिबंधित प्रजाति के पेड़ों को काटकर आसपास के ईंट भट्ठों में झोंका जा रहा है।

इस काम में लकड़ी माफिया के साथ ही जंगलों में अपने मवेशियों को चराने वाले लकड़हारे भी शामिल हैं। लकड़हारे जंगल की कीमती लकड़ियों को काटकर जलौनी के नाम पर बेचे रहे हैं। इसकी न सिर्फ क्षेत्रवासियों द्वारा शिकायत की जा रही है बल्कि समय-समय पर पुलिस व एसएसबी द्वारा खुलासा भी किया जाता है। हर बार विभागीय अधिकारी जांच कराने की बात कह मामले में लीपापोती कर देते हैं।

इससे जिले में जंगल का दायरा दिन-प्रतिदिन घटता जा रहा है। इस संबंध में रेंजर ककरदरी सुबोध कुमार शुक्ला बताते हैं कि अवैध कटान रोकने के लिए लगातार अभियान चलाया जा रहा है। जो मामले प्रकाश में आते हैं, उनमें कार्रवाई भी की जा रही है। फिर भी कहीं कोई कमी है तो उसकी जांच कराकर कार्रवाई की जाएगी।

तेंदुए के हमले में बालिका की मौत

घर से बालिका को खींच ले गया तेंदुआ, 200 मीटर की दूरी पर मिला क्षत विक्षत शव

सिद्दीपुरवा, बहराइच

अमृत विचार। जनपद के धर्मापुर गांव निवासी एक आठ वर्षीय बालिका को तेंदुआ घर से खींच ले गया। उसका शव परिवार के लोगों ने बुधवार सुबह क्षत -विक्षत हालत में बरामद किया।

कतर्नियाघाट वन्य जीव प्रभाग के धर्मापुर रेंज अंतर्गत धर्मापुर गांव निवासी श्यामा (8) पुत्री चुन्नू मंगलवार शाम को घर के सामने अन्य बच्चों के साथ मौजूद थी। बालिका कुछ देर में बच्चों से अलग हुई। इसी दौरान एक तेंदुआ जंगल से निकल कर आया और बालिका को उठा ले गया। बालिका के न दिखने पर परिवार के लोगों ने खोजबीन शुरू की। लेकिन उसका कुछ पता नहीं चला। जिस पर परिवार के लोगों ने पुलिस को सूचना दी। बुधवार सुबह सभी बालिका की खोजबीन कर रहे थे। तभी घर से 200 मीटर की दूरी पर बालिका का क्षत-विक्षत शव मिला।। सूचना पाकर वन क्षेत्राधिकारी टीम के साथ मौके पर पहुंचे।

डीएफओ वी शिव कुमार ने बताया कि बालिका को शाम को तेंदुआ खींच ले गया था। अलग-अलग टुकड़ों में शव बरामद हुआ है। शव को पोस्टमार्टम के लिए भेजा जा रहा है। घटनास्थल का निरीक्षण किया गया है। तात्कालिक आर्थिक सहायता राशि 10हजार रुपये पीड़ित परिवार को दिया गया है।

तेंदुए के हमले में बालिका की मौत के बाद जांच करते अधिकारी। अमृत विचार

- There are barely any adequate number of health facilities in the villages which makes the local population vulnerable. There is one PHC in the village which offers health services to the people. Any serious health concern or procedures related to admission for medical purposes are dealt in Bahraich district.

- The education sector of the village is also lacking to a great extent. There is one primary school in the village and children requiring secondary education have to another town which is 30 kms from the village.
- The transportation options are also limited as roadways is the only medium apart from the privately owned vehicles which offers access to the wildlife sanctuary or the villages in the surrounding area. There are just four bus trips the village bus stand which connects the area with the district Bahraich. The sanctuary is close to the international border which is why there is no through route passing through the village. However, Katarniaghat Wildlife Sanctuary is connected by a network of roads primarily comprising state highways and rural roads. The condition of these roads varies, with some stretches being well-maintained while others are prone to deterioration, especially during the monsoon season.
- The nearest major railway station is in Bahraich, which connects to larger cities such as Lucknow and Gorakhpur, facilitating movement of people and goods. There used to be a railway connection to the sanctuary in the pre-independence era as was told by the forest and locals but due lack of any commercial viability it remained defunct and not in use. An alleged old station structure could be seen at the time of documentation visit.
- There are limited infrastructural services available in the village in terms of sanitation. Sanitation facilities have improved with government initiatives like the Swachh Bharat Abhiyan, but many households still lack proper toilets. Open defecation, although reduced, remains a concern in some areas.
- Illegal Activities such as fishing and Poching is also there in some area need to be take in notice and to rectified.

5.3.2 Development opportunities with linkages to Wildlife Tourism

The potential for the proposed development are defined by the opportunities which are present in the presented scenario and create a potential for sustained development if initiated in a planned manner.

However, it is important to identify the issues in the subject area which need to be addressed such that they do not become a hindrance or bottlenecks in reaping the benefits of tourism growth.

1. **Environmental Assessment**
    a. Ecotourism Potential: Assess the natural attractions and biodiversity that could attract tourists, such as wildlife reserves, scenic landscapes, or unique ecosystems.
    b. Carrying Capacity: Evaluate the area’s capacity to support tourism without degrading natural resources or disrupting wildlife habitats.
    c. Impact Assessment: Identify potential impacts of increased tourism on local flora, fauna, and ecosystems.
2. **Social and Economic Factors**
    a. Community Benefits: Evaluate how tourism could benefit local communities through job creation, income generation, and infrastructure improvements.
    b. Cultural Heritage: Identify opportunities to showcase local culture, traditions, and heritage sites to tourists, fostering community pride and economic opportunities.
    c. Local tribe and villagers can be engaged in capacity building and community strengthening initiatives which shall prepare them for tourism oriented services like tour guides, forest guides, boat operators, safari vehicle operators etc.
    d. Local tribes can also be trained to use the local materials in creating handicrafts. The forest and the surroundings has wide variety of trees and plants. Residual from the vegetation like bamboo roots, chutes from plants, tree bark, seeds etc. shall create a wide array of by-products which can be used to create handicraft and souvenirs and thereby create a small cottage industry established and operated by the local people making them self-reliant and providing sustainable livelihood.
    e. A boost in the wildlife tourism industry may also be capable of expanding and transforming entirely the commercia transportation sector which shall be oriented to towards the inflow and outflow of visitors and the wildlife maintenance related activities. Strengthening the transportation and mobility to and from the national sanctuary shall be integral to take economic benefits from this sector.
3. **Tourism Planning**
    a. Infrastructure Needs: Determine infrastructure requirements such as accommodations, transportation, visitor centers, and waste management facilities.
    b. Visitor Management: Develop strategies for managing visitor flows, minimizing congestion, and preserving the visitor experience and natural environment.
4. **Issues Identification**

a. Ecological Impact: Assess potential threats to wildlife and habitats from increased human activity, such as habitat disturbance, pollution, or introduction of invasive species.
b. Cultural Impact: Consider the impact of tourism on local traditions, customs, and community cohesion.

5. **Opportunities for Mitigation and Enhancement**
   a. **Sustainable Tourism Practices**: Promote eco-friendly tourism practices such as low-impact accommodations, wildlife viewing guidelines, and responsible waste disposal.
   b. **Community Involvement**: Engage local communities in tourism planning and development to ensure their needs and concerns are addressed.
6. **Regulatory and Legal Considerations**
   a. Permitting and Zoning: Obtain necessary permits and adhere to zoning regulations for tourism infrastructure development.
   b. Environmental Compliance: Ensure compliance with environmental laws and regulations to minimize negative impacts on natural resources.
7. **Monitoring and Adaptation**
   a. Visitor Monitoring: Implement monitoring programs to track visitor numbers, behaviour, and impacts on wildlife and ecosystems.
   b. Adaptive Management: Adjust tourism strategies based on monitoring data and stakeholder feedback to mitigate negative impacts and enhance visitor experiences.
8. **Long-Term Sustainability**
   a. Education and Awareness: Educate tourists about the importance of conservation and responsible tourism practices.
   b. Benefits Sharing: Ensure that economic benefits from tourism are equitably shared with local communities and contribute to sustainable development.

By systematically addressing these aspects, both challenges and opportunities for sustainable tourism growth in a natural wildlife semi-urban setting can be identified. This approach helps to balance economic development with environmental and cultural conservation, ensuring that tourism enhances rather than degrades the natural and cultural heritage of the area.

Further the opportunities for a sustainable tourism growth for Katarniaghat Wildlife sanctuary has been discussed.

a) Rich Biodiversity and wildlife safari
   - **Opportunity**: The sanctuary's diverse flora and fauna, including endangered species like tigers and gharials, present a unique attraction for ecotourists.
   - **Action**: Develop guided tours and wildlife safaris that promote responsible wildlife viewing practices to minimize disturbance to wildlife habitats.

b) Cultural and Community Engagement**:**
   - **Opportunity**: Involvement of local communities in tourism activities can provide economic opportunities and promote cultural exchanges.
   - **Action:** Develop community-based tourism initiatives that showcase local traditions, handicrafts, and cuisine, ensuring benefits directly contribute to local livelihoods.

c) Infrastructure Development
   - **Opportunity**: Properly planned infrastructure such as eco-lodges, visitor centers, and nature trails can enhance visitor experience while minimizing environmental impact.
   - **Action**: Implement eco-friendly infrastructure using sustainable building practices and renewable energy sources, ensuring minimal disruption to the sanctuary's ecosystem.

5.3.3 Infrastructural Gaps and Demand Assessment

There are small settlements on the fringes of the wildlife sanctuary which may be considered in the category of rural settlements. There are three to four different settlement patches on the south-western fringes of the wildlife sanctuary. Two of these settlements also have predominantly

Water requirements based on CPHEEO guidelines based on the need of the population and typical usage patterns.

- **Basic Requirement**: 40 liters per capita per day (lpcd). This is considered the minimum amount of water needed for drinking, cooking, and basic hygiene.
- **Enhanced Requirement**: Depending on the local conditions and community needs, this can be increased to 55-70 lpcd, especially in areas with higher standards of living or where additional facilities are provided (e.g., bathing, washing, livestock)

However the factors affecting water requirements in the rural areas are defined by following stated points;

- Higher population density may require more water.
- **Climate and Weather Conditions**: Arid or semi-arid regions may need additional water.
- **Economic and Social Conditions**: Areas with higher economic development may have higher water consumption.
- Local Practices such as Usage patterns, such as for livestock or irrigation, may influence the total water requirement.

The population of communities and indigenous tribes can be varies based on the specific villages and communities included within the vicinity of the sanctuary. The Katarniaghat Wildlife Sanctuary, located in the Bahraich district of Uttar Pradesh, India, encompasses several villages and tribal settlements within and around its boundaries. The sanctuary is home to various tribal communities, including the Tharu tribe, which is indigenous to the Terai region. There are multiple villages located around the sanctuary, each with its own population count. It will difficult to ascertain the number of people living in the communities however taking into account all the villages and the Tharu tribe, which is indigenous to the Terai region including areas around Katarniaghat the total population of these areas has been accounted to 52,000.

Population growth

The rural population growth rate in India has been decreasing over the past few decades but for a conservative estimate, we can use an average annual growth rate of 1.5%. This rate can vary, but it's a reasonable figure for rural areas considering the demographics and population progressions in similar such areas having rural populations.

As the services like water requirements and water treatments are calculated for 30 years the projected population for 2054 will be considered for the proposed infrastructural requirements.

- **Current Population (P_{present})**: 52,000
- **Annual Growth Rate (r)**: 1.5% or 0.015
- **Number of Years (t)**: 2054 - 2024 = 30

P_{2054}=52,000 X (1+ 0.015)^{30}

P_{2054}= 52,000 X (1.015)^{30}

the value of (1.015)^{30} ≈1.558

So,

P_{2054}=52,000×1.558

P_{2054} ≈ 81,016

Therefore , the total population for which the services are to be designed shall be approximately **81,016** people, assuming a consistent annual growth rate.

Water Requirement

The water requirement considering the ideal requirement in a rural setting with additional requirements as per improved living conditions has been considered 70lpcd.

The total water requirement for the villages shall be:

81,016 X 70 = 56,71,120 lpcd

i.e. 5.6 ML per days

In the current scenario there is no organized water supply infrastructure and the sources are well, handpumps etc. apart from the directly from the river. Therefore the total demand should be considered as the requirement for the water supply infrastructure to be designed for this area.

Transportation and Mobility

There is a limited network of roads and streets available in the area. The mobility should be assessed in three different categories owing to the complexity of the subject;

i. **Access main Road-** This road is a 7-8mt wide road providing main connectivity to the Katarniaghat Wildlife Sanctuary and the overall area. It's a bituminous road with some abrasion and rutting instances at several places. At several places the road edges are broken and disintegrated which due to the effects of heavy rainfall. Periodical maintenance is required to improve the condition of the road.

The mobility network can also be improved as there can be an alternative road from a different direction meeting on the main Bahraich road as an alternative route to the main sub-arterial road.

ii. **The** internal village roads are in poor condition as most of them are not bitumen road, and are kutcha roads or brick soled roads. There are also severe issues regarding waterlogging on the roads for short period of time. As the area falls close to the basin area of the riverine, it runs off towards the northern direction.

iii. **Wildlife sanctuary (Safari routes):** These roads are a prime concern for the study and the present condition of the routes is not good as there are lot of patches and undulations on the road which creates inconvenience to the visitors. Additional routes within the forest area is also required to offer access to interesting parts and increase the safari activities and route. But due to the bad condition of the roads and kutcha bajari roads in these parts this is not achieved yet.

Sewerage treatment requirement

There are no Sewerage treatment facilities available in either the village area nor the forest department area. Soat pits however are used in the forest department area and some houses of the villages. Rest of the sewage might probably find its way running towards the river plain.

5.3.4 Tourism Scenario and Issues identified in its management

a) Ecological impact

Issue: Increased tourist footfall and infrastructure development can lead to habitat degradation and disturbance to wildlife.

Mitigation: Conduct thorough environmental impact assessments (EIAs) before any development, and implement strict guidelines for waste management, noise control, and visitor behavior.

Community Integration and benefit sharing

- **Issue**: Unequal distribution of tourism benefits may lead to social tensions and inequitable development.
- **Mitigation**: Foster partnerships with local communities through capacity building, training programs, and revenue-sharing mechanisms from tourism activities.

Regulatory and Compliance challenges

- **Issue**: Ensuring compliance with environmental regulations and managing visitor flows can be challenging in remote and sensitive ecosystems.
- **Mitigation**: Strengthen enforcement of existing regulations, establish visitor carrying capacity limits, and monitor tourist activities through visitor management systems.

Infrastructure and Access Management

- **Issue**: Balancing the need for tourism infrastructure with conservation priorities can pose logistical and financial challenges.
- **Mitigation**: Develop a sustainable tourism master plan that prioritizes low-impact infrastructure, integrates nature-based solutions, and utilizes innovative funding mechanisms such as public-private partnerships (PPPs).

Long term Sustainability Strategies

- **Stakeholder Collaboration**: Foster partnerships between government agencies, NGOs, local communities, and private sector stakeholders to ensure holistic and inclusive tourism development.
- **Monitoring and Evaluation**: Implement robust monitoring programs to track environmental indicators, visitor satisfaction, and socio-economic impacts, adjusting strategies based on findings.
- **Capacity Building**: Invest in training programs for local guides, hospitality staff, and community members to enhance tourism management skills and promote sustainable practices.

5.3.5 Need for Eco-Tourism and sustainable development

Ecotourism is increasingly recognized as a sustainable development option that balances conservation with community benefits. In India, wildlife sanctuaries, including those in Uttar Pradesh like Katarniaghat Wildlife Sanctuary, offer unique opportunities to promote ecotourism. This approach not only aids in wildlife conservation but also supports local economies and fosters environmental awareness.

Benefits of Eco-tourism

- Conservation of Biodiversity- Ecotourism generates revenue that can be reinvested into conservation efforts. Entrance fees, guided tours, and eco-lodges contribute financially to the maintenance and protection of wildlife habitats. Increased human presence and the involvement of local communities in tourism can deter poaching and other illegal activities. For instance, the presence of

tourists and local guides in sanctuaries provides secure environment and helps in monitoring wildlife.

The sanctuary is home to diverse species, including tigers, leopards, gharials, and numerous bird species. Conservation efforts here focus on protecting these species and their habitats. Ecotourism revenue supports various conservation projects such as anti-poaching patrols, habitat restoration, and wildlife monitoring programs.

- Economic Development - Ecotourism creates jobs for local communities. Positions such as guides, lodge staff, and conservation officers provide direct employment opportunities. Beyond direct employment, ecotourism stimulates the local economy by supporting ancillary services like handicrafts, local markets, and transportation. For example, local artisans can sell crafts to tourists, providing a supplementary income source.

- Community Empowerment- Successful ecotourism models often involve local communities in planning and decision-making processes, ensuring that their needs and knowledge are integrated. This fosters a sense of ownership and responsibility towards conservation efforts.
- Capacity Building and Self Reliant economy- Training programs in hospitality, guiding, and environmental education empower local residents with new skills and knowledge, enhancing their ability to participate effectively in the tourism sector. Local communities can be employed as guides, staff at eco-lodges, and in conservation activities. This provides a steady income and reduces dependency on unsustainable practices like logging or poaching. There are already live cases existing in the villages where the locals are engaged in safari guide activities. The effort should be on formalizing and making it more effective and organized.
- Environmental education and Awareness- Ecotourism provides a platform for educating tourists and local communities about the importance of biodiversity and conservation. Interpretation centers, guided tours, and informational materials help raise awareness about wildlife and environmental issues. Exposure to natural habitats and conservation challenges can inspire tourists to adopt more sustainable lifestyles and advocate for environmental protection in their own communities.

Ecotourism facilitates cultural exchange between visitors and local communities, promoting mutual respect and understanding. This can lead to greater appreciation and support for traditional knowledge and practices.

Ecotourism, when implemented thoughtfully, offers a sustainable development pathway that harmonizes conservation goals with socio-economic benefits. In the context of Indian wildlife sanctuaries, including those in Uttar Pradesh like Katarniaghat, ecotourism not only aids in the preservation of biodiversity but also supports local communities, fosters environmental education, and encourages sustainable practices. By addressing challenges and leveraging the unique strengths of these regions, ecotourism can be a powerful tool for sustainable development.

CHAPTER 6: Development Masterplan and Proposal

6.1 Ecotourism Vision

The vision for the development is guided by the identification of the issues and opportunities lying after carefully gauging the scenario present, evaluating the strengths and it can be directed to generate a sustainable approach for the development of which will benefit the flora and fauna, help in their preservation as well as create socio-economic opportunities for the local community.

The vision for the Eco Tourism plan in terms of Bio-conservation and preservation of the Forest areas has been highlighted by following stated points.

i. To provide informed and rich wilderness experience to visitors by enabling them to view a cross-section of Protected Area values
ii. To build up an interpretive programme to spread awareness about the importance of biodiversity conservation
iii. Facilitating wildlife eco-tourism involving local communities
iv. Obtaining contributions from private commercial tour operators and lodge owners for local community development
v. Obtaining contributions from tour operators for maintaining tourist facilities, staff welfare.
vi. Recycling of tourist gate receipts for community welfare through Tiger Conservation Foundation.

Description of Proposals

The proposals laid out for the Katarniaghat Wildlife sanctuary for Biodiversity and Tourism management are categorized below:

1. **Establishment of revamped Wildlife Tourism**

   A refurbished Wildlife tourism plan shall be established which shall bear the following objectives;

   Attract the visitors from the entire state. – Currently tourists who wish to take wildlife tourism experience plan their trip to Corbett National Park which also has its entry point at Ramnagar, Uttar Pradesh. People in the central or eastern part of the state who don't wish to travel far towards corbett, they go towards Dhudhwa National park.

However, considering the distance to be covered to reach and the features offered by the national park, there are very less options for the tourists to experience wildlife sanctuaries.

The rejuvenated tourism plan shall offer attraction points to the visitor and give them both the options to either arrive the sanctuary, complete their safari and return the same day; or another option shall be to offer unique services and attraction features which make the tourist stay back at the place and enjoy a whole some experience of the forest, natural environment and unique views & experience of the river.

The presence of the riverine bio-biodiversity is an advantage of the Katarniaghat Wildlife sanctuary which no other nearer national park offers.

The refurbished tourism plan shall therefore include and strengthen accommodation and eating facilities for the visitors such that the visitors may get hygienic and safe places to stay back within the sanctuary and get a holistic experience of wildlife sanctuary. The accommodation facilities shall be compulsorily developed in wildlife thematic style which shall be able to offer inclusive and experiential value to the visitors. These have been detailed in the respective sections below.

The wildlife safari experience also shall be completely transformed which shall be inclusive, integrate environmentally cohesive features and shall be sustainable boosting the local socio economic conditions.

Detailed below are the proposed features planned as part of the Eco Tourism development & Management plan for Katerniaghat sanctuary.

a) Natural History Museum, Katarniaghat

Natural History Museum shall be the highlight of the new tourism infrastructure wherein a museum with exhibit space of at least 1000 sqm shall be created which shall comprise of thematic galleries including the importance of wildlife, the species found in the Katerniaghat sanctuary both from flora and fauna diversity of the bio-reserve stating their features. These may include taxidermized mounts put inside displays or replicas and dioramas depicting the wildlife of the sanctuary. At least 5 different galleries on two floors can be proposed with adequate orientation gallery, main display galleries, storage spaces, repository spaces, a preservation laboratory, a multimedia room, office space apart from additional service spaces.

A roof top restaurant/canteen can also be proposed on the same premises with jungle safari theme having observation deck spaces overlooking the majestic river on the northern direction. All these spaces are to be well-designed and thematic representations so that it creates a interest and awareness towards wildlife and the visitor experience can be enhanced.

There is already a display area at the local range office which offers to inform the visitor about the local wildlife. The newly proposed premises shall do it in a more profound and experiential manner.

b) Riverfront Trek

This component shall include nature walk park overlooking the Girwa river with wooden observatory decks and which can be connected with the boating jetties.

The main feature of this component is the adaptive Riverfront development which will be done to improve the access, outreach, experience and aesthetics to the natural environment. This component shall incorporate some riverfront development along a short stretch of around 1 km aligned to the left bank of the Girwa river. The riverfront development shall include small retaining structure, preferably in gabion wall structure construction style with some stabilization methods so that the development proposed is resilient to the periodic flooding and climatic changes.

There should be strict **no concrete policy** for this proposed development encouraging the use of local materials as far as possible, using natural cut stone, rubble masonry for retaining-wall/toe wall structures in developing the promenades for the walk, as indicated in the conceptual images below.

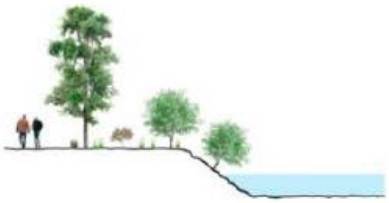
The trek shall be always accompanied by a trained guards and shall be a part of renewed wildlife packages available for the Bio-reserve.

This shall include halt points on the trek having resting spaces designed in cohesive manner. Shelter points shall be there probably in the form of **projected observation decks** to get unique views of the river and the associated riverine biodiversity.

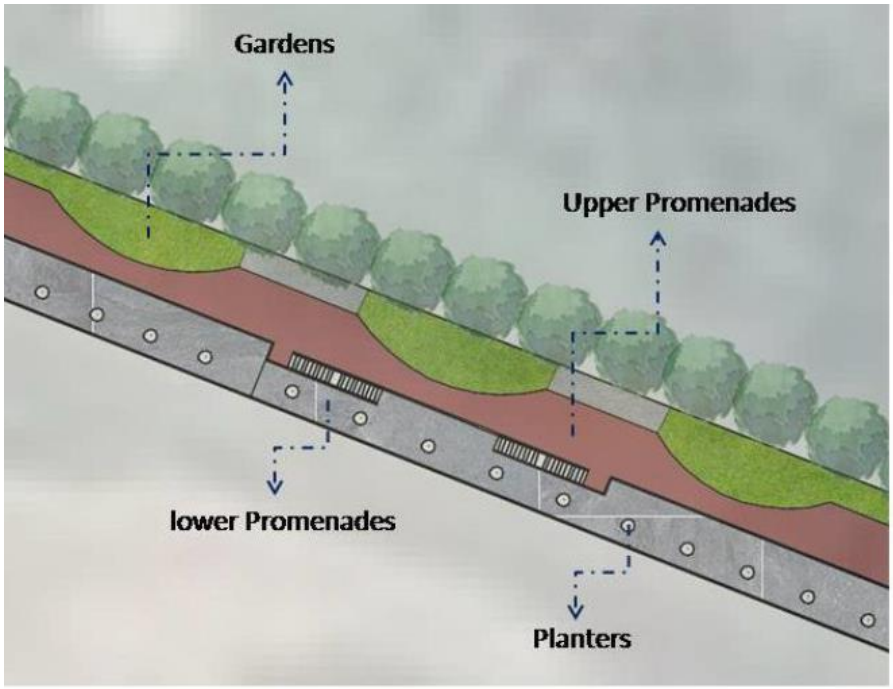
Some part of the renewed wildlife safari on electric vehicle shall overlap with the new proposed riverfront corridor such that those taking the vehicles for the jungle safari may also get opportunity to have experience of the riverfront and riverine overlooked by the dense sal trees on the other side of the river.

A) Walk at the edge of the water

B) Walk in a setback position



C) A multilevel open space



c) River Safari

River safari is currently done on the Girwa river which as per proposal has to go through a transformation which includes a fleet of electric powered boats or CNG powered boats so as to eradicate the use of diesel run engines on the river surface which degrades and affects the waterbody. These new boats shall bear no noise from the engines only minimum noise from the propellers.

Another feature will be a cruise boat which may be a solar powered version or electric/CNG run motor. The cruise boat shall offer a capacity of upto 10 people and cover greater distance. It shall have a greater deck space with circulation and sitting spaces giving a richer experience to the visitors.

This river safari shall be one of the first of its kind having river safari as part of the jungle expedition and shall offer unique experiential values to the visitors. The wildlife which the visitors will be able to spot on the river safari shall be Gharial, Gangetic dolphins and some unique fish species. The riparian eco-system is unique to Katerniaghat where Gangetic Dolphins, Gharial, Muggar and colonies of vulture is commonly sighted. The common sight of these rare species is a unique feature of Katerniaghat as stated in the schematic masterplan prepared by the forest department here.

d) Jungle Retreat Home

These shall be the accommodation facilities offered by the forest department which shall basically comprise of canvas tents offering staying options to the visitors which is more in a cohesive manner to integrate jungle safari concept. These staying options shall also impart experiential value to the visitor and shall include at least 10 twin tents with supporting facilities.

e) Repackaging of the Wildlife Tourism activities and establish Jungle Safari Infrastructure for the tourists this shall include creating different Wildlife safari packages to the visitor based on the duration of the visit and the services offered, the highest one being that comprises of all the facilities including transportation, fooding etc.

f) Promotion and Packaging- Creation of an online portal stating the different Wildlife Safari packages with booking options available. Convenience of booking various plans as per the choice of visitors, shall be the highlight of this system. This shall be popularized by printing it on all kinds of brochures, leaflets, books and other interpretative materials. The souvenirs like hats, caps, safari jackets, T-shirts and various handicraft items will carrythematic transformation of Katerenaighat Wildlife sanctuary.

6.2 Engagement of Stakeholders for management of tourism activities

Online portal management

Transportation management

Major stakeholders shall be the local community which shall be trained with adequate capacity building measures so that they can be directly engaged in the rejuvenated wildlife safari and tourism activities. Various services where they can be accommodated are;

i. Wildlife Guides
ii. Transportation operators
iii. Accommodation management
iv. Boat operators
v. Fooding services

Jungle safari - Agency for procurement and operation of Electric variants of jeeps within the sanctuary. The agency shall be responsible for the maintenance and upkeep of the vehicles and the operation shall be dealt by the Forest department themselves.

6.3 Opportunities for Socio-Economic Development of the Villages and Community

The new management shall allow for sustainable harvesting of resources, such as non-timber forest products, medicinal plants, and fisheries, which support local livelihoods which can be used in establishing medium cottage industries in precincts itself and shall have the potential to attract the visitors thronging to the national park.

Several capacity building measures shall also be a part of this plan which will help to strengthen the management plan and give it a sustainable approach.

It also aims at income generation out the ecotourism activities for the local community. The ecotourism services may generate income only when the community offers ecotourism services to the visitors on professional lines. The policy addresses this issue by providing capacity building for ecotourism services among the community members. The training and capacity building shall include Capacity building of the community by Exposure Visits, Training for catering, housekeeping, service and nature guides.

6.4 Integrated Smart Solutions for Security and Surveillance

This shall include a control room where the feed of all the security cameras as well as wildlife tracking shall be done. Apart from managing security and protocol in the river precincts and the forest it will also be used for wildlife tracking, survey and mapping and strengthening the protection of the wildlife in the riverine ecosystem. GPS enabled wildlife safari vehicles and

boats can be tracked from here and any activity related to violation or tourism related grievance can be tracked from here. This control station shall provide robustness to the tourism as well as wildlife management in the precincts.

6.5 Infrastructural Proposals

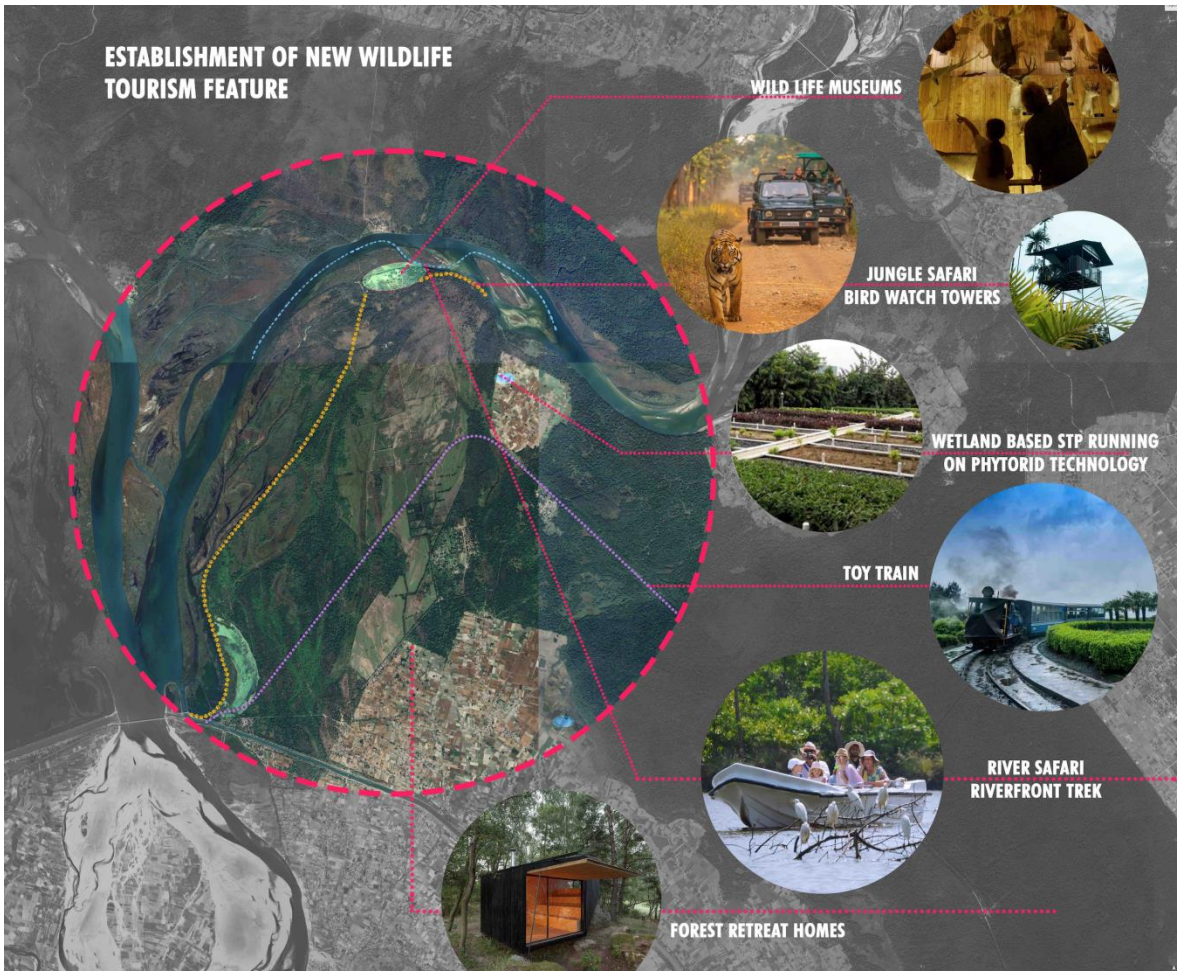
i. A 200KLD Constructive wetland based STP running on phytorid technology which has less maintenance cost and integrates well with the natural environment.

ii. 1MLD SBR technology based STP close to the settlement areas/villages to treat the waste generated by the local community area.

iii. Rain Water Harvesting with recharge pits at strategical location in the settlement areas.

iv. Well-designed drainage network in the settlement areas ensuring no sewerage is spilled in the storm water drainage channels.

v. DTW (deep tube well) for Water supply in settlement areas as well as tourist area ensuring water adequacy as per the CPHEEO norms (100lpcd)



6.6 Mitigating the negative impacts of Human settlements as well

Spillage of the drains and sewerage in the river shall be avoided by creating catchment through well planned drainage infrastructure.

Agriculture and farming practices which involves use of noise generating engines such as tractors and other processing equipment shall be warded off in phase manner as part of the action plan. Eradicating the use of any major equipment running on diesel generators etc shall be adopted.