XXII INQUA India 2027

QUATERNARY SCIENCE AS SOCIETAL SERVICES



# XXII INQUA INDIA 2027

## FIELD GUIDE

### INMID - 09

## QUATERNARY GEOLOGY, FLUVIAL GEOMORPHOLOGY AND LANDSCAPE EVOLUTION OF THE MIDDLE GANGA PLAIN: A FIELD-BASED STUDY FROM NAWABGANJ WETLAND BIRD SANCTUARY

Abhijit Mazumder and S. Suresh Kumar Pillai







बीरबल साहनी पुराविज्ञान संस्थान
Birbal Sahni Institute of Palaeosciences
विज्ञान एवं प्रौद्योगिकी विभाग के अंतर्गत स्वायत्त संस्थान, भारत सरकार
An autonomous institute under the Department of Science and Technology, Government of India

विज्ञान एवं प्रौद्योगिकी मंत्रालय
MINISTRY OF SCIENCE AND TECHNOLOGY

पृथ्वी विज्ञान मंत्रालय
Ministry of Earth Sciences

NCPOR

INQUA International Union for Quaternary Research

ASSOCIATION OF QUATERNARY RESEARCHERS

**Published in 2026 by**

XXII INQUA Congress, India
Birbal Sahni Institute of Palaeosciences (BSIP)
53, University Road
Lucknow – 226007, Uttar Pradesh
India

Website: www.inquaindia2027.in
Email: inqua.india@bsip.res.in

**© 2026 BSIP, Lucknow**

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission of the publisher.

**Published under the overall supervision of:**
Mahesh. G. Thakkar, Director, Birbal Sahni Institute of Palaeosciences, Lucknow
Binita Phartiyal, Organising Secretary, INQUA India 2027
Pradeep Srivastava, President, INQUA India 2027
Rahul Mohan, Vice-President, INQUA India 2027

**Field Trips Committee**
**Chairperson:** Malay Mukul
**Convener:** Anupam Sharma
**Members:** Vimal Singh, Y. P. Sundriyal, Navin Juyal, Pradeep Srivastava, R. J. Perumal, U. K. Shukla, Shanti Pappu, Yogesh Ray

Compilation and editing: Field Trips Committee in collaboration with the INQUA 2027 Secretariat.

**Design and Production:**
**XXII INQUA Congress 2027**
Anupam Sharma, BSIP, Lucknow
Akhilesh K Yadava, BSIP, Lucknow
Rakesh Rao, Goa
Creative Team, Expression 360, New Delhi

# INQUA INDIA 2027

## Field Guide Book

### INMID-09

## Quaternary Geology, Fluvial Geomorphology and Landscape Evolution of the Middle Ganga Plain: A Field-Based Study from Nawabganj Wetland Bird Sanctuary


Principal Investigator

Dr. Abhijit Mazumder

Scientist-E

Birbal Sahni Institute of Palaeosciences, Lucknow, India

Co-Principal Investigator

Dr. S. Suresh Kumar Pillai

Scientist-F

Birbal Sahni Institute of Palaeosciences, Lucknow, India

Email of Contact Person

ssureshk_pillai@bsip.res.in

Mobile No.

+91 9450297991

# Table of Contents


| | | |
|---|---|---|
| 1. | Team Leaders | 1 |
| 2. | Abstract | 2 |
| 3. | Preamble | 3-4 |
| 4. | Research Problem | 5-8 |
| 5. | Regional Geology and Stratigraphy | 8-13 |
| 6. | Literature Review | 13-14 |
| 7. | Field Transect | 15-16 |
| 8. | Geoheritage, UNESCO Heritage, Archaeological Sites, Cuisine, and Culture | 17 |
| 9. | Local Conveniences | 18 |
| 10. | Conclusions | 19 |
| 11. | Acknowledgements | 19 |
| 12. | Annexure | 20-21 |

# Team Leaders



**Dr. Abhijit Mazumder**

Scientist-E,
BSIP, Lucknow

Abhijit Mazumder is working in Birbal Sahni Institute of Palaeosciences, Lucknow, India since 2011 and presently is in the post of Scientist 'E'. He has expertise on the study of two major groups of microfossil, namely benthic foraminifera and diatom. His work reflects detailed study of palaeoecology and palaeoclimatology of Quaternary marine sediments from Arabian Sea, Bay of Bengal and Indian Ocean based on benthic foraminifera as well as the study of palaeolimnology and palaeoenvironment of inland lakes (including Antarctic lakes) based on diatom. He published his works in different national and international journals with high reputation.



**Dr. S. Suresh Kumar Pillai**

Scientist-F,
BSIP, Lucknow

Dr. S. Suresh Kumar Pillai is a Scientist 'E' at the Birbal Sahni Institute of Palaeosciences, Lucknow. He obtained his Ph.D. from the University of Lucknow for his work on "Study towards the Knowledge of Glossopteris Flora of India." His field of specialization is Gondwana Flora of India, with research interests in Permian megafossils, palaeobotany, biostratigraphy and palaeoenvironmental reconstruction. He has contributed to the development of fossil parks in India, including Mandro Fossil Park, Jharkhand, and the Marine Fossil Park at Manendragarh, Chhattisgarh. He is currently supervising five Ph.D. scholars.

# Abstract

The Middle Ganga Plain constitutes one of the most important Quaternary landscapes of the Indian subcontinent, preserving an exceptional record of geological evolution, climatic variability, ecological transformation, and human adaptation. The examination Nawabganj Wetland Bird Sanctuary provides a multidisciplinary perspective on the long-term interactions between fluvial processes, environmental change and biodiversity, within this dynamic alluvial system.

The Nawabganj Wetland Bird Sanctuary (Shahid Chandra Shekhar Azad Bird Sanctuary) exemplifies the ecological significance of floodplain wetlands within the Ganga Basin. The sanctuary sustains diverse aquatic ecosystems and serves as an important habitat for resident and migratory avifauna. In addition to its ecological value, the wetland preserves sedimentary archives that contribute to understanding Holocene floodplain evolution, biodiversity dynamics, and monsoon-driven environmental changes.

This site illustrates Quaternary geological processes, landscape evolution, and ecosystem development It highlights the importance of integrating geology, geomorphology, palaeoecology, and conservation science to reconstruct past environmental changes and evaluate present-day challenges. The region serves as a natural laboratory for sustainable management of wetlands, and natural resources in the face of rapid urbanization and climate change.

# Preamble

The Middle Ganga Plain represents one of the most significant geomorphic, geological, ecological, and cultural landscapes of the Indian subcontinent. Occupying a vast stretch of the central Indo-Gangetic foreland basin, this region has evolved through complex interactions among Himalayan tectonics, Quaternary climatic fluctuations, fluvial dynamics, sedimentation processes, and human activities. The plain serves as a natural archive preserving evidence of environmental changes that have occurred over hundreds of thousands of years, while simultaneously supporting some of the earliest agricultural societies and urban settlements in South Asia. The study of the Middle Ganga Plain therefore provides a unique opportunity to understand the interconnected evolution of landscapes, ecosystems, and human civilizations.

Within this dynamic geological setting, rivers have acted as the principal agents of landscape evolution. The Ganga and its tributaries have continuously reshaped the terrain through erosion, transportation, deposition, channel migration, avulsion, and floodplain aggradation. The resulting geomorphic features include active and abandoned channels, meander scars, oxbow lakes, natural levees, flood basins, backswamps, wetlands, and alluvial terraces. These landforms collectively record the history of river dynamics and climatic variability that have governed environmental conditions throughout the Quaternary. Understanding these geomorphic processes is crucial for reconstructing past environments, assessing contemporary environmental challenges, and developing sustainable strategies for land and water resource management.

The state of Uttar Pradesh occupies a central position within the Middle Ganga Plain and contains numerous sites that illustrate the intricate relationships between geology, geomorphology, ecology, and human history. Among these, Nawabganj Wetland Bird Sanctuary provide particularly valuable insights into the evolution of the regional landscape. The Nawabganj Wetland Bird Sanctuary, officially known as Shahid Chandra Shekhar Azad Bird Sanctuary, represents an ecological expression of the same fluvial processes that shaped the broader alluvial landscape. Located within the floodplain environment of the Middle Ganga Plain, this wetland serves as an important habitat for resident and migratory birds, aquatic organisms, and diverse wetland vegetation. The sanctuary exemplifies the role of wetlands as integral components of alluvial river systems and highlights the ecological significance of geomorphic depressions, flood basins, and abandoned channel segments that originate through fluvial activity.

Wetlands such as Nawabganj are products of long-term interactions among hydrology, sedimentation, climate, and biological processes. Their formation is closely linked to river migration, floodplain aggradation, and the creation of low-lying areas capable of retaining water seasonally or permanently. These environments function as natural reservoirs, groundwater recharge zones, sediment traps, nutrient cycling centers, and biodiversity hotspots. Moreover, wetlands preserve valuable palaeoenvironmental records in their sediment sequences, including pollen, diatoms, phytoliths, geochemical signatures, and organic matter assemblages. Such proxies enable the reconstruction of past climatic conditions, vegetation changes, hydrological fluctuations, and anthropogenic influences, thereby contributing to a deeper understanding of Quaternary environmental history.

Nawabganj Wetland Bird Sanctuary illustrates the ecological and geomorphological consequences of fluvial processes. In the context of contemporary environmental challenges, including rapid urbanization, wetland degradation, groundwater depletion, river pollution, and climate change, understanding the Quaternary evolution of the Middle Ganga Plain assumes increasing importance. Historical and geological records provide critical insights into the long-term behavior of river systems and landscape responses to environmental stress. Such knowledge is essential for informed conservation planning, heritage management, disaster mitigation, and sustainable development initiatives. This field-based exploration of the Nawabganj Wetland Bird Sanctuary, therefore seeks to integrate perspectives from Quaternary geology, fluvial geomorphology, palaeoenvironmental reconstruction, and wetland ecology. Participants will gain a comprehensive understanding of the processes that have shaped the landscape over geological timescales and continue to influence ecological systems today. The region thus stands as a living laboratory where the stories of rivers, climate, and ecosystems dynamics of the Middle Ganga Plain.

# Research Problem

Understanding the interactions among climate change, river dynamics, landscape evolution, ecosystem development, and human societies represents one of the foremost challenges in Earth system science and environmental archaeology today. Across the world, major river basins such as the Nile, Mississippi, Amazon, Yangtze, Danube, Yellow River, Ganga, Yamuna, Ghaghara, Brahmaputra, and Indus preserve valuable archives of environmental change within their floodplains, wetlands, and archaeological sites. Researchers increasingly recognize that riverine landscapes are not merely passive settings for human occupation but dynamic systems that respond to climatic fluctuations, tectonic activity, hydrological variability, and anthropogenic interventions. Therefore, a central global research problem is determining how environmental changes are recorded in fluvial landscapes and how these changes influence ecological processes and human settlement patterns over long timescales.

During the last few decades, advances in Quaternary geology, geomorphology, palaeoecology, geoarchaeology, and geochronology have greatly improved our understanding of river basin evolution. Nevertheless, significant uncertainties remain regarding the relative influence of climate, tectonics, and human activities on landscape transformation. In many regions of the world, the relationships between river migration, floodplain sedimentation, wetland formation, biodiversity evolution, and cultural development remain incompletely understood. This challenge is particularly important because modern societies continue to depend heavily on river basins for agriculture, water resources, transportation, and ecosystem services. Predicting future environmental responses to climate change requires a robust understanding of how river systems behaved under past climatic conditions.

An important global issue involves the origin, evolution, and conservation of wetlands. Wetlands are among the most productive ecosystems on Earth and play critical roles in biodiversity conservation, flood regulation, groundwater recharge, carbon sequestration, and climate regulation. Yet many wetlands are disappearing due to urban expansion, agricultural intensification, river regulation, and climate change. Understanding the geological and geomorphological processes responsible for wetland formation and persistence is therefore essential for effective conservation and restoration planning. This requires long-term environmental records capable of documenting past hydrological and ecological variability.

The Indo-Gangetic Plain, and particularly the Middle Ganga Plain, provides an exceptional natural laboratory for addressing these global research challenges. Despite its immense cultural, ecological, and economic significance, the Middle Ganga Plain remains comparatively understudied when compared with river systems such as the Nile, Mississippi, or Yellow River. Several outstanding questions continue to exist regarding the timing and causes of river migration, the influence of monsoon variability on sedimentation, the role of neotectonic activity in landscape development, the evolution of wetlands, and the environmental context of early human settlements.

The field transect encompassing the Nawabganj Wetland Bird Sanctuary is uniquely positioned to address these issues because it captures multiple dimensions of landscape evolution within a relatively compact geographical area.

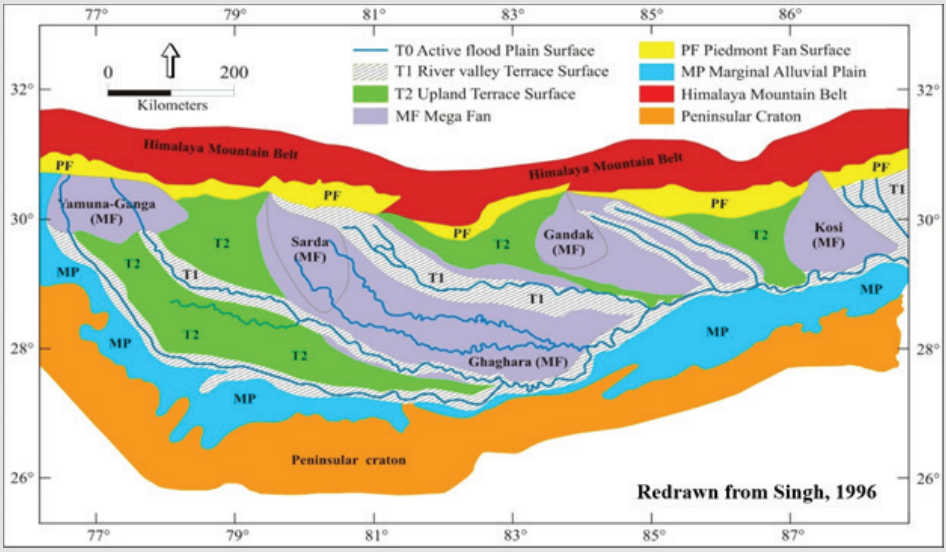
The Shahid Chandra Shekhar Azad Bird Sanctuary (formerly Nawabganj Bird Sanctuary) represents the ecological dimension of landscape evolution. The wetland serves as a modern analogue of floodplain processes and preserves evidence of hydrological, sedimentological, and biological interactions that continue to shape the landscape. Wetland sediments contain valuable palaeoenvironmental archives, including pollen, diatoms, phytoliths, geochemical indicators, and organic matter that can be used to reconstruct past climate and ecological conditions. Thus, the sanctuary provides a bridge between contemporary ecological processes and long-term environmental history.

The uniqueness of this field transects lies in its ability to integrate three major research themes that are often investigated separately: (i) Quaternary landscape evolution, and (ii) wetland ecosystem development,. The transect offers a rare opportunity to trace the continuum from geological processes operating over tens of thousands of years, through geomorphic modifications of the floodplain, to ecological responses and eventual human utilization of the landscape.

Additionally, the Middle Ganga Plain occupies a climatically sensitive position within the Indian Summer Monsoon domain. Variations in monsoon intensity have profoundly influenced river discharge, sediment transport, flood frequency, vegetation dynamics, and wetland hydrology throughout the Quaternary. Consequently, environmental records from Nawabganj have the potential to contribute not only to regional studies but also to broader discussions concerning monsoon variability, climate-human interactions, and river basin responses to global climate change.

The field transect therefore addresses a globally relevant scientific problem: understanding how climate, rivers, wetlands, and human societies co-evolve within large alluvial landscapes. The palaeoecological and geomorphological observations from Nawabganj Wetland, provides a multidisciplinary framework for investigating long-term environmental change in the Middle Ganga Plain. Such an approach contributes directly to international efforts aimed at understanding landscape resilience, wetland sustainability, cultural adaptation, and environmental management in densely populated river basins worldwide.

One of the most significant findings emerging from recent environmental studies is that many of the water bodies around which ancient settlements developed have undergone considerable shrinkage, fragmentation, or disappearance. Watersheds have been repeatedly modified through natural processes as well as anthropogenic activities. Rapid urbanization, agricultural expansion, road construction, drainage modification, groundwater extraction, and other infrastructure developments have altered hydrological networks and transformed the landscape. Consequently, several lakes, ponds, wetlands, and abandoned channels that once played a crucial role in sustaining settlements have either diminished in size or vanished entirely. Understanding these transformations is essential for reconstructing the environmental history of the region and for developing sustainable management strategies for existing water resources.




*Geomorphology of Ganga Basin*

**Nawabganj Bird Sanctuary Wetland**

Situated in the extensive Quaternary alluvial tract of the Ganga Basin, these localities preserve a valuable record of fluvial evolution, wetland dynamics, climatic fluctuations, and human occupation spanning the Late Pleistocene and Holocene epochs. Their geological framework is characterized by thick accumulations of unconsolidated alluvial sediments, lacustrine deposits, and organic-rich horizons that provide insights into the long-term interaction between natural processes and human societies.

The Central Ganga Plain is a tectonically active foreland basin formed by sediment influx from the Himalayan hinterland. Throughout the Quaternary Period, repeated episodes of monsoon variability, river migration, floodplain aggradation, and neotectonic adjustments influenced sediment deposition across the region. Consequently, the landscape surrounding d Nawabganj is dominated by alternating layers of sand, silt, clay, and organic matter deposited under varying hydrological regimes. These deposits record shifts between high-energy fluvial environments and low-energy lacustrine or wetland conditions, thereby preserving a detailed archive of environmental change.

The Nawabganj Bird Sanctuary wetland represents a modern wetland ecosystem developed within the alluvial framework of the Ganga Plain. The wetland preserves contemporary analogues of floodplain processes while also containing sedimentary archives of past ecological conditions. Its stratified lacustrine deposits record changes in water level, nutrient status, vegetation succession, and sediment influx, providing valuable evidence for reconstructing regional palaeoclimate and environmental history.

### Structural and Geomorphological Setting

The archaeological remains occur on a slightly elevated mound rising above the surrounding floodplain. This elevation is the result of both natural and anthropogenic processes. Initially, the mound developed on a relatively stable fluvial surface created by alluvial deposition. Subsequently, centuries of human habitation, construction activities, refuse accumulation, and rebuilding generated an anthropogenic mound or settlement tell. Although no major tectonic structures are exposed at the site, the geomorphic setting reflects the influence of fluvial processes that shaped the surrounding landscape. Detailed micro-stratigraphic studies reveal multiple habitation levels separated by occupation surfaces, abandonment horizons, and sedimentary layers, indicating repeated phases of settlement expansion and modification.

### Nawabganj Bird Sanctuary wetland

The Nawabganj Bird Sanctuary Wetland, is one of the most important freshwater wetland ecosystems of the Central Ganga Plain in northern India. Located in the Unnao District of Uttar Pradesh, approximately midway between Lucknow and Kanpur, the sanctuary occupies a low-lying floodplain depression within the vast alluvial tract of the Ganga Basin. Covering an area of about 2 $km^2$, the wetland serves as a significant habitat for resident and migratory birds and constitutes an important geomorphological and palaeoenvironmental archive. From a geological perspective, the sanctuary provides valuable insights into Holocene floodplain evolution, wetland development, monsoon variability, sedimentary processes, and biodiversity dynamics within the Middle Ganga Plain.

# Regional Geology and Stratigraphy

The sanctuary lies within the Central Ganga Alluvial Plain, a major geomorphic subdivision of the Indo-Gangetic Foreland Basin. This basin developed as a consequence of the ongoing collision between the Indian and Eurasian tectonic plates, resulting in the uplift of the Himalayas and the formation of a foredeep south of the mountain front. Over millions of years, enormous quantities of sediments derived from Himalayan erosion were transported by river systems and deposited across the basin, producing thick sequences of alluvial deposits.

The regional stratigraphy is dominated by Quaternary sediments, which are generally classified into two major geomorphic units: the Bangar and Khadar plains. The Bangar represents older Pleistocene alluvium deposited during earlier phases of floodplain development and typically occupies slightly elevated surfaces. These deposits are often characterized by oxidized silts, clays, and fine sands with occasional calcareous nodules (kankar). In contrast, the Khadar consists of younger Holocene alluvium deposited by recent fluvial activity and seasonal flooding. The Nawabganj wetland is situated primarily within the Khadar zone, where unconsolidated silts, clays, and organic-rich sediments accumulate under low-energy depositional conditions.

Sedimentological studies indicate that the wetland basin contains alternating layers of clay, silt, fine sand, and organic matter. These deposits record repeated fluctuations in hydrological conditions, including periods of enhanced flooding, water stagnation, organic productivity, and sediment influx. Such stratified sediment sequences serve as natural archives preserving evidence of environmental changes that occurred throughout the Holocene.

**Geomorphological Structure and Wetland Formation**

The geomorphology of the Nawabganj Bird Sanctuary reflects the dynamic fluvial environment of the Central Ganga Plain. The sanctuary occupies a shallow depression formed through floodplain processes associated with river migration, meander abandonment, and seasonal inundation. Although no major active river channel is directly connected to the wetland today, its origin is closely linked to the long-term evolution of nearby fluvial systems.

Wetlands in the Ganga Plain commonly originate through channel cut-offs, oxbow lake formation, flood-basin development, or local topographic depressions created by differential sedimentation. The Nawabganj wetland likely evolved from one such floodplain depression that gradually became isolated from active river channels while continuing to receive seasonal water inputs. Monsoonal rainfall, surface runoff, local drainage, and groundwater seepage contribute to maintaining the wetland hydrology.

The basin is characterized by extremely low relief and poor drainage, conditions that favour prolonged water retention. Fine-grained clay and silt sediments reduce permeability and facilitate the accumulation of standing water. Organic-rich muds develop through the decomposition of aquatic vegetation and biological productivity within the wetland ecosystem. Consequently, the sanctuary functions as a natural sediment trap, recording both local ecological processes and broader environmental changes occurring within the basin.

**Palaeontology and Palaeoecological Significance**

Although the Nawabganj wetland is not known for classical vertebrate or invertebrate fossil assemblages, it possesses substantial palaeoecological significance. Wetland sediments preserve numerous biological remains and geochemical indicators that can be used to reconstruct past environmental conditions. These include pollen grains, phytoliths, diatoms, ostracods, charcoal particles, plant macrofossils, organic matter, and isotopic signatures.

The sanctuary is particularly important from the perspective of avian palaeoecology. Every year, the wetland hosts a large number of resident and migratory bird species arriving from Central Asia, Siberia, Europe, and other regions. Organic-rich sediments accumulate feathers, eggshell fragments, skeletal remains, and biological debris that contribute to the palaeoecological record. Variations in bird populations and species composition can provide indirect evidence of climatic fluctuations, habitat changes, and hydrological conditions through time.

Pollen and phytolith assemblages preserved within wetland sediments enable reconstruction of past vegetation communities surrounding the sanctuary. Such records

help identify changes in forest cover, grassland expansion, agricultural development, and wetland vegetation dynamics. Similarly, diatom assemblages serve as sensitive indicators of water chemistry, nutrient availability, salinity, and hydrological variability. Together, these biological proxies facilitate detailed reconstructions of Holocene environmental history.

**Quaternary Geological Significance**

From a Quaternary geological perspective, the Nawabganj Bird Sanctuary represents a classic example of Holocene floodplain evolution within the Ganga Basin. The development of the wetland is closely linked to river dynamics, monsoonal climate variability, and sedimentation processes operating throughout the Holocene epoch. Following the Last Glacial Maximum, strengthening monsoon conditions during the Early Holocene increased river discharge and floodplain sedimentation across northern India. These hydrological changes promoted channel migration, avulsion, flood-basin formation, and wetland development throughout the alluvial plain.

The sedimentary record preserved within the sanctuary provides evidence of repeated environmental fluctuations associated with variations in monsoon intensity. Periods of stronger monsoons likely resulted in increased flooding, higher water levels, enhanced sediment supply, and greater aquatic productivity. Conversely, weaker monsoon phases may have caused reduced water availability, increased terrestrial influence, and changes in wetland ecology. Consequently, the sanctuary serves as an important natural archive for understanding regional climatic variability during the Holocene.

Moreover, the wetland provides insights into the interaction between natural environmental processes and human activities. Agricultural expansion, groundwater extraction, land-use modification, and urbanization have increasingly influenced hydrological regimes throughout the Ganga Plain. These anthropogenic impacts are often recorded in sedimentary sequences through changes in erosion rates, nutrient influx, pollen assemblages, and organic matter composition. Thus, the sanctuary offers opportunities to investigate both natural and human-induced environmental changes.

**Biodiversity and Environmental Importance**

The ecological significance of Nawabganj Bird Sanctuary extends beyond its geological value. The wetland supports a rich diversity of aquatic plants, fish, amphibians, reptiles, insects, and birds.










*View of Nawabganj Bird Sanctuary*






*Avian community and wetland front view of Nawabganj Bird Sanctuary*





*Glimpse of Nawabganj Bird sanctuary Wetland with vegetation and algal community*

It functions as an important stopover and wintering ground for migratory waterfowl traveling along the Central Asian Flyway. Species such as pintails, gadwalls, shovelers, pochards, teals, and various waders utilize the wetland during seasonal migrations.





*Glimpse of the biota within the Nawabganj Bird sanctuary wetland*

The relationship between biodiversity and Quaternary environmental processes is particularly important. Wetland ecosystems are highly sensitive to hydrological fluctuations controlled by monsoon variability. Consequently, changes in species composition often reflect broader climatic and environmental trends. The sanctuary therefore serves as a living analogue for interpreting palaeoecological records preserved within wetland sediments.

The Nawabganj Bird Sanctuary Wetland represents an outstanding example of a Holocene floodplain wetland within the Central Ganga Plain. Its geological framework consists of Holocene Khadar alluvium overlying older Pleistocene Bangar deposits, while its geomorphology reflects the long-term influence of fluvial processes, floodplain sedimentation, and monsoonal hydrology. Although classical fossil records are limited, the sanctuary preserves an exceptional palaeoecological archive in the form of organic-rich sediments, pollen, phytoliths, diatoms, and avian remains. These records provide valuable evidence of climatic variability, vegetation history, hydrological fluctuations, and biodiversity evolution during the Quaternary. Consequently, the sanctuary serves as a vital natural laboratory for studying wetland evolution, palaeoecology, monsoon dynamics, and human–environment interactions in the Middle Ganga Plain.

# Literature Review

The Middle Ganga Plain (MGP) has attracted considerable scientific attention owing to its significance in Quaternary geology, fluvial geomorphology, archaeology, palaeoecology, and human settlement studies. Research conducted over the last few decades has demonstrated that the region preserves a rich archive of environmental and cultural evolution spanning the Late Pleistocene and Holocene. Studies by Singh (1996, 2009), Tewari (2004), Gibling et al. (2005), Sinha et al. (2005), Srivastava et al. (2017), Rajoriya et al. (2026) and numerous palaeoenvironmental investigations have highlighted the role of monsoon variability, river migration, sedimentation, and human adaptation in shaping the landscape of the Ganga Basin.

Geomorphological and sedimentological studies have focused primarily on the evolution of the Ganga and its tributaries, emphasizing the influence of climatic fluctuations and neotectonic activity on channel migration, floodplain development, and sediment accumulation. Research has revealed that the Middle Ganga Plain experienced repeated phases of aggradation and incision during the Quaternary, controlled largely by monsoon-driven hydrological changes. These studies have established the importance of abandoned channels, oxbow lakes, wetlands, and floodplain depressions as archives of environmental change.

Research on Nawabganj Bird Sanctuary (Shahid Chandra Shekhar Azad Bird Sanctuary) has largely focused on wetland ecology, avifaunal diversity, migratory bird populations, conservation biology, and hydrological management. Ecological studies have documented the sanctuary's importance as a habitat for resident and migratory birds along the Central

Asian Flyway. However, geological and palaeoenvironmental investigations remain comparatively limited despite the wetland's potential as a sedimentary archive of Holocene environmental change. Farooqui et al. (2023) presented a comprehensive multi-proxy palaeoenvironmental reconstruction of an oxbow lake from the Central Ganga Plain (CGP), northern India, spanning approximately the last 4,600 years. Published in The Holocene, the study is significant because floodplain lakes and wetlands of the Ganga basin preserve valuable sedimentary archives that record past changes in climate, hydrology, vegetation, and human activities. Although the Ganga Plain is one of the most important regions for understanding the evolution of the Indian Summer Monsoon (ISM), high-resolution palaeoenvironmental records from its wetlands remain relatively scarce. This study therefore contributes substantially to our understanding of Late Holocene environmental changes in the region by integrating palynological, sedimentological, and environmental datasets to reconstruct hydroecological variability through time.

Despite its strengths, the study also highlights avenues for future research. Higher-resolution chronological control could improve the identification of centennial-scale climatic events, while additional proxies such as stable isotopes and biomarkers could refine interpretations of hydrological and ecological changes. Integration with archaeological evidence would further enhance understanding of human-environment interactions within the floodplain. Nevertheless, Farooqui et al. (2023) provide one of the most detailed and comprehensive palaeoenvironmental reconstructions available from an oxbow lake in the Central Ganga Plain. Their work demonstrates that the evolution of the lake over the past 4,600 years was controlled by a complex interplay of monsoon variability, hydrological change, vegetation dynamics, and increasing human activity, thereby offering valuable insights into the long-term environmental history of the Middle Ganga Plain.

Despite substantial progress, several important issues remain unresolved. First, there is a lack of integrated studies combining geomorphology, sedimentology, and palaeoecology in around the Nawabganj bird sanctuary. Most investigations have been conducted independently, limiting our understanding of coupled human–environment interactions. Second, high-resolution chronological frameworks based on radiocarbon dating and other geochronological techniques are still insufficient for many sedimentary and archaeological sequences. Third, the influence of neotectonic activity on floodplain evolution and settlement distribution remains poorly constrained. Fourth, the long-term impacts of human activities on wetland hydrology, biodiversity, and sedimentation require further investigation.

Finally, rapid urbanization around Lucknow, agricultural intensification, groundwater extraction, and wetland degradation pose serious threats to these archives. Future research should adopt a multidisciplinary approach integrating geospatial analysis, sedimentology, palynology, geoarchaeology, isotopic studies, and ecological monitoring. Such studies would significantly improve our understanding of Quaternary environmental change, monsoon dynamics, wetland evolution, and cultural adaptation within the Middle Ganga Plain and contribute to sustainable heritage and ecosystem management.

# Field Transect

**Nawabganj Wetland Bird Sanctuary: Location, Geomorphology, Sedimentology, Chronology, and Geochemistry**

Nawabganj Wetland Bird Sanctuary, recently renamed Shaheed Chandra Shekhar Azad Bird Sanctuary, is situated in Unnao District between Lucknow and Kanpur and comprises a shallow floodplain wetland formed within an abandoned meander or oxbow depression.

Geomorphologically, the sites occur within the active alluvial tract of the Middle Ganga Plain, characterized by meander belts, oxbow lakes, flood basins, natural levees, and backswamp environments. The landscape has evolved under the influence of monsoon-controlled river discharge, avulsion, and periodic flooding. The wetland basin at Nawabganj represents a low-energy depositional environment that receives sediment inputs from local runoff and seasonal inundation.

Sedimentologically, the deposits are dominated by alternating layers of clay, silty clay, silt, and fine sand, reflecting fluctuations in hydrological energy and depositional conditions. Wetland sediments contain abundant organic matter, aquatic microfossils, pollen, and palynological remains, indicating varying lacustrine and marshy conditions. A

Chronological studies based on radiocarbon dating and archaeological evidence suggest that sediment accumulation in the region spans the Late Pleistocene to the Holocene, with many wetland archives preserving records of environmental changes during the last several millennia. Geochemically, the sediments are characterized by variations in total organic carbon (TOC), nitrogen, sulfur, stable isotopes ($\delta^{13}C$ and $\delta^{15}N$), and elemental composition, reflecting changes in vegetation, productivity, redox conditions, monsoon intensity, and anthropogenic influence. Together, these archives provide a robust framework for reconstructing Holocene palaeoenvironmental evolution, hydroecological dynamics, and human–environment interactions in the Middle Ganga Plain.




*Google image of Nawabganj Bird Sanctuary*




*Location map of Nawabganj Bird Sanctuary*

# Geoheritage, UNESCO Heritage, Archaeological Sites, Cuisine, and Culture

The Shaheed Chandra Shekhar Azad Bird Sanctuary (formerly Nawabganj Wetland Bird Sanctuary) are located within the geologically significant Middle Ganga Plain of Uttar Pradesh. This region preserves a remarkable combination of biodiversity, and ecology that reflect thousands of years of interaction between humans and the dynamic floodplain environment.

The Nawabganj wetland itself represents an excellent example of an oxbow-lake-derived wetland ecosystem developed within the floodplain. Its sediments preserve valuable archives of past climatic changes, monsoon variability, vegetation history, and human-induced environmental modifications. Such wetlands are important natural laboratories for understanding Holocene environmental evolution in northern India.

Although no UNESCO World Heritage Site is located near Nawabganj, several internationally significant heritage sites occur within the broader region. The nearest UNESCO World Heritage property is Agra Fort and Taj Mahal, while the sacred city of Varanasi has long been considered for UNESCO recognition because of its exceptional cultural and religious importance.. The nearby Lucknow city is recognized as the UNESCO Creative City of Gastronomy.

Famous local dishes include:

- Galouti Kebab
- Kakori Kebab
- Tunday Kebab
- Shami Kebab
- Awadhi Biryani
- Nihari-Kulcha
- Sheermal
- Roomali Roti
- Kulfi Falooda
- Malai Gilori

Street-food culture around the park is equally vibrant, offering chai, bun makkhan, pav bhaji, chaat, momos, ramen, and fusion snacks popular among students and families. Vegetarian foods such as poori-sabzi, kachori, seasonal vegetables, and traditional sweets including peda, jalebi, and revri are also widely consumed. Local agricultural products, especially wheat, rice, pulses, and sugarcane, continue to support the rural economy and shape regional food habits.

The Nawabganj exemplify the close relationship between geological processes, wetland ecosystems, archaeological heritage, and cultural development in the Middle Ganga Plain. Their significance extends beyond local importance, offering valuable insights into environmental change, human adaptation, biodiversity conservation, and the enduring cultural traditions of northern India.

# Local Conveniences

**1. Medical Facilities and Emergency Care Around Nawabganj Wetland Bird Sanctuary (Unnao)**

- Nawabganj Sewa Hospital – The nearest hospital to the sanctuary, suitable for first aid and routine emergencies.
- Larger medical facilities are available in Unnao town and Lucknow city, approximately 35–45 km away.

**2. Assistance in Case of a Lost or Stolen Passport**

For international visitors:

- Immediately report the loss at the nearest police station and obtain a First Information Report (FIR).
- Contact your embassy or consulate in New Delhi or the nearest diplomatic mission.
- Visit the nearest Passport Seva Kendra (PSK) in Lucknow for documentation support.
- Keep digital copies of your passport, visa, travel insurance, and identity documents before the excursion.

Important emergency numbers in India:

- Police: 112
- Ambulance: 108
- Tourist Helpline: 1363 or 1800-11-1363

**3. Markets and Shopping Areas**

Near Nawabganj Wetland Bird Sanctuary

- Kundan Market – Local shopping area in Unnao for general supplies and daily-use items.
- Habiba Market – Local market serving nearby communities with food items and basic necessities.
- Raees Vagetable and the surrounding Unnao markets provide fresh produce and essential commodities.

**Useful Facilities**

- ATMs, pharmacies, fuel stations, and restaurants are readily available along the Lucknow–Kanpur Highway near Nawabganj.
- Mobile network coverage (Jio, Airtel, BSNL, and Vi) is generally good across all three excursion locations.

# Conclusion

The Middle Ganga Plain represents one of the most significant Quaternary landscapes of the Indian subcontinent, where interactions among climate, fluvial dynamics, ecology, and human societies have shaped the environment over thousands of years. The study of t Nawabganj Wetland Bird Sanctuary provides a comprehensive understanding of the region's geological evolution, palaeoenvironmental history, biodiversity, and wetland conservation.

Nawabganj Wetland Bird Sanctuary, , highlights the ecological significance of floodplain wetlands within the Middle Ganga Plain. The sanctuary supports diverse aquatic flora and fauna, including numerous resident and migratory bird species, and exemplifies the role of wetlands in maintaining biodiversity, groundwater recharge, nutrient cycling, and ecosystem resilience.

The site demonstrates the continuum linking geological processes, environmental evolution, and landscape evolution. Integrated multidisciplinary research involving Quaternary geology, geomorphology, palaeoecology, and conservation science is essential for understanding past environmental changes and for promoting sustainable management of this culturally and environmentally important landscape.

# Acknowledgements

We express our sincere gratitude to Prof. Mahesh G. Thakkar, Director, Birbal Sahni Institute of Palaeosciences (BSIP), Lucknow, for his constant encouragement and for providing the necessary infrastructural facilities, logistical support, and institutional resources that were instrumental in the successful organization and execution of the Mid-INQUA Field Workshop. We also gratefully acknowledge the valuable guidance, cooperation, and support extended by the office bearers of the INQUA throughout the planning and implementation of the workshop. Their contributions in coordinating scientific activities and fostering collaboration among participants significantly enhanced the overall success of the event. We further extend our appreciation to all faculty members, research scholars, technical staff, and supporting personnel whose dedicated efforts contributed to the smooth conduct of the field workshop and enriched the scientific discussions and field investigations undertaken during the programme. Their collective assistance played a vital role in making the workshop a productive and rewarding academic experience for all participants.

# Annexure

## Field Excursion Guidelines: Do's and Don'ts

To ensure the safety of all participants and to promote responsible scientific field practices, all participants are requested to adhere to the following guidelines throughout the field excursions.

Keep a valid passport (for international participants) or a government-issued photo ID (for Indian participants) with you at all times during the field excursion.

| Do's | Don'ts |
|---|---|
| 1. Follow the instructions of the excursion leaders, coordinators, and local authorities at all times. | 1. Do not collect rocks, fossils, archaeological artefacts, biological specimens, or any other materials without prior authorization. |
| 2. Remain with the group and inform the excursion leader before leaving the designated route. | 2. Do not damage, deface, or remove material from geological outcrops, caves, monuments, heritage structures, or other natural features. |
| 3. Wear appropriate field attire, including sturdy closed-toe footwear, full-length trousers, a hat or cap, and weather-appropriate clothing. | 3. Do not wander alone or separate from the excursion group without informing the field leaders. |
| 4. Carry sufficient drinking water, personal medications, sunscreen, insect repellent, and other essential field supplies. | 4. Do not climb unstable slopes, cliffs, rock formations, or enter hazardous areas unless specifically instructed or supervised. |
| 5. Keep a valid photo identification and your excursion registration details with you during travel. | 5. Do not swim or enter rivers, lakes, lagoons, or coastal waters unless expressly authorized by the excursion leaders. |
| 6. Respect local customs, religious sites, cultural heritage, and private property. | 6. Do not consume alcohol, recreational drugs, or engage in unsafe or irresponsible behaviour during the excursion. |
| 7. Follow the Leave No Trace principles by carrying back all waste and helping to keep field sites clean. | 7. Do not operate drones or other restricted equipment without obtaining the necessary permissions. |
| 8. Use designated trails and approved observation areas to minimise environmental disturbance. | 8. Do not photograph restricted installations, sensitive locations, or local residents without prior permission. |
| 9. Observe geological, ecological, archaeological, and cultural features carefully without causing any damage. | |

10. Record field observations systematically and collect samples only with prior permission from the excursion leaders and the relevant authorities.

11. Exercise caution near cliffs, riverbanks, caves, unstable slopes, road cuts, and other potentially hazardous terrain.

12. Respect wildlife by maintaining a safe distance from animals, birds, reptiles, insects, and their habitats.

13. Immediately report any illness, injury, emergency, or hazardous situation to the excursion organizers.

14. Be prepared for changing weather conditions and comply with all safety advisories issued by the excursion leaders.

9. Do not create excessive noise or disturb local communities, religious activities, wildlife, or natural habitats.

10. Do not leave valuables unattended or rely solely on mobile phone connectivity in remote areas.

11. Do not undertake any activity that may compromise your safety, the safety of fellow participants, or the conservation of the area's geological, ecological, archaeological, or cultural heritage.

## Disclaimer

Participation in the field excursions is entirely at the participant's own risk. While the Organising Committee and excursion leaders will make every reasonable effort to ensure participant safety and provide appropriate guidance, they shall not be held responsible for any personal injury, illness, loss of personal belongings, property damage, delays, or unforeseen incidents arising during travel or field activities. Participants are expected to act responsibly, follow all instructions issued by the excursion leaders, and comply with applicable local laws and regulations throughout the excursion.













Scan for
Field Guide Book


**Contact Details:**

INQUA Secretariat
Birbal Sahni Institute of Palaeosciences (BSIP),
53, University Road, Lucknow-226 007 U.P, India

**Email:** inqua.india@gmail.com | inqua.india@bsip.res.in

**Phone:** +916386696896 | +916392507990